

# Girijananda Chowdhury University, Assam

## Course Structure of

### Four Year Under Graduate Programme (FYUGP) in Physics

| SUMMARISED COURSE STRUCTURE |                    |                |     |     |     |     |                                                                       |            |                                                                   |
|-----------------------------|--------------------|----------------|-----|-----|-----|-----|-----------------------------------------------------------------------|------------|-------------------------------------------------------------------|
| SEM                         | DSC<br><br>(Major) | DSC<br>(Minor) | MDC | AEC | SEC | VAC | Internship/<br>Dissertation/<br>project                               | Credit     | Exit<br>option                                                    |
| I                           | 4                  | 4+4            | 3   | 2   | 3   | 2   |                                                                       | 22         | Certification                                                     |
| II                          | 4                  | 4+4            | 3   | 2   | 3   | 2   |                                                                       | 22         |                                                                   |
| III                         | 4                  | 4+4            | 3   | 2   | 3   | -   |                                                                       | 20         | Diploma                                                           |
| IV                          | 16                 | -              | -   | 2   |     | 2   |                                                                       | 20         |                                                                   |
| V                           | 16                 | -              | -   |     | -   |     | 4                                                                     | 20         | Bachelor<br>Degree                                                |
| VI                          | 20                 | -              | -   | -   | -   | -   |                                                                       | 20         |                                                                   |
| <b>Total</b>                |                    |                |     |     |     |     |                                                                       | <b>124</b> |                                                                   |
| <b>Credit</b>               |                    |                |     |     |     |     |                                                                       |            |                                                                   |
| VII                         | 8                  | 4+4            | -   | -   | -   | -   | -                                                                     | 20         | Bachelor<br>Degree<br>(Honours)/<br>Honours<br>(with<br>Research) |
| VIII                        | 12                 | -              | -   | -   | -   | -   | Project/Dissertation<br>(2+2)/(12)<br>Core(4+4+4+4)/Core(4)<br>Lab(4) | 20         |                                                                   |
| <b>Total</b>                |                    |                |     |     |     |     |                                                                       | <b>164</b> |                                                                   |
| <b>Credit</b>               |                    |                |     |     |     |     |                                                                       |            |                                                                   |

DSC: Disciplinary Core Course MDC: Multidisciplinary Course SEC: Skill Enhancement Course AEC: Ability enhancement Course VAC: Value Added Course

| YEAR – 1       |                      |                    |       |              |
|----------------|----------------------|--------------------|-------|--------------|
| First Semester |                      |                    |       |              |
| Code           | Course               | Category of Course | L-T-P | Total Credit |
| BPY23101T      | Introductory Physics | Core               | 4-0-0 | 4            |
| BPY23101T      | *MINOR-1             | Minor              | 4-0-0 | 4            |
| BPY23102T      | *MINOR-2             | Minor              | 4-0-0 | 4            |
| BPY23141T      | **MDC-I              | MDC                | 3-0-0 | 3            |
|                | AEC-I                | AEC                | 2-0-0 | 2            |
|                | SEC-I                | SEC                | 3-0-0 | 3            |
|                | VAC-I                | VAC                | 2-0-0 | 2            |
| TOTAL          |                      |                    |       | 22           |

| Second Semester |                          |                    |       |              |
|-----------------|--------------------------|--------------------|-------|--------------|
| Code            | Course                   | Category of Course | L-T-P | Total Credit |
| BPY23103T       | Physics in Everyday Life | Core               | 4-0-0 | 4            |
| BPY23103T       | *MINOR-3                 | Minor              | 4-0-0 | 4            |
| BPY23104T       | *MINOR-4                 | Minor              | 4-0-0 | 4            |
| BPY23142T       | **MDC-II                 | MDC                | 3-0-0 | 3            |
|                 | AEC-II                   | AEC                | 2-0-0 | 2            |
|                 | SEC - II                 | SEC                | 3-0-0 | 3            |
|                 | VAC -II                  | VAC                | 2-0-0 | 2            |
| TOTAL           |                          |                    |       | 22           |

**EXIT OPTION WITH CERTIFICATION**. However, such students who desire to exit after 1 year of study need to undertake a vocational course (4 credits).

\*Refer AnnexureI, \*\*Refer AnnexureII

| YEAR – 2       |                        |                    |       |              |
|----------------|------------------------|--------------------|-------|--------------|
| Third Semester |                        |                    |       |              |
| Code           | Course                 | Category of Course | L-T-P | Total Credit |
| BPY23201T      | Mathematical Physics-I | Core               | 3-0-2 | 4            |
| BPY23201T      | *MINOR-5               | Minor              | 3-0-0 | 4            |
| BPY23202T      | *MINOR-6               | Minor              | 0-0-2 | 4            |
| BPY23143T      | **MDC-III              | MDC                | 3-0-0 | 3            |
|                | AEC – III              | AEC                | 2-0-0 | 2            |
|                | SEC - III              | SEC                | 3-0-0 | 3            |
| TOTAL          |                        |                    |       | 20           |

| Fourth Semester |                                    |                    |                |              |
|-----------------|------------------------------------|--------------------|----------------|--------------|
| Code            | Course                             | Category of Course | L-T-P          | Total Credit |
| BPY23203T       | Mechanics and Properties of Matter | Major              | 4-0-0          | 4            |
| BPY23204T       | Electricity and Magnetism          | Major              | 4-0-0          | 4            |
| BPY23203P       | Mechanics-Lab                      | Major              | 0-0-4          | 2            |
| BPY23204P       | Electricity and Magnetism-Lab      | Major              | 0-0-4          | 2            |
|                 | ***Elective-1                      | Major              | In AnnexureIII | 4            |
|                 | AEC-IV                             | AEC                | 2-0-0          | 2            |
|                 | VAC-III                            | SEC                | 2-0-0          | 2            |
| TOTAL           |                                    |                    |                | 20           |

\* Refer Annexure-I, \*\* Refer Annexure-II, \*\*\*Refer Annexure-III

N.B: Course Codes of the courses offered from department is provided.

**EXIT OPTION WITH DIPLOMA.** However, such students who desire to exit after 2 years of study need to undertake a vocational course (4 credits)

**YEAR – 3**

| <b>Fifth Semester</b> |                        |                           |              |                     |
|-----------------------|------------------------|---------------------------|--------------|---------------------|
| <b>Code</b>           | <b>Course</b>          | <b>Category of Course</b> | <b>L-T-P</b> | <b>Total Credit</b> |
| BPY23301T             | Analog Electronics     | Major                     | 4-0-0        | 4                   |
| BPY23302T             | Waves and Optics       | Major                     | 4-0-0        | 4                   |
| BPY23301P             | Analog Electronics-Lab | Major                     | 0-0-4        | 2                   |
| BPY23302P             | Waves and Optics-Lab   | Major                     | 0-0-4        | 2                   |
|                       | ***Elective-2          | Major                     | 4-0-0        | 4                   |
| BPY23303R             | Internship             | Major                     | 0-0-8        | 4                   |
| <b>TOTAL</b>          |                        |                           |              | <b>20</b>           |

\*\*\*Refer Annexure III

| <b>Sixth Semester</b> |                         |                           |              |                     |
|-----------------------|-------------------------|---------------------------|--------------|---------------------|
| <b>Code</b>           | <b>Course</b>           | <b>Category of Course</b> | <b>L-T-P</b> | <b>Total Credit</b> |
| BPY23304T             | Thermal Physics         | Major                     | 4-0-0        | 4                   |
| BPY23305T             | Digital Electronics     | Major                     | 4-0-0        | 4                   |
| BPY23306T             | Quantum Mechanics       | Major                     | 4-0-0        | 4                   |
| BPY23304P             | Thermal Physics- Lab    | Major                     | 0-0-4        | 2                   |
| BPY23305P             | Digital Electronics-Lab | Major                     | 0-0-4        | 2                   |
|                       | ***Elective-3           | Major                     | 4-0-0        | 4                   |
| <b>TOTAL</b>          |                         |                           |              | <b>20</b>           |

**EXIT OPTION WITH THREE YEARS BACHELOR'S DEGREE****(A)FOUR YEARS BACHELOR'S DEGREE (HONOURS)**

| <b>Seventh Semester</b> |                            |                           |              |                     |
|-------------------------|----------------------------|---------------------------|--------------|---------------------|
| <b>Course Code</b>      | <b>Course</b>              | <b>Category of Course</b> | <b>L-T-P</b> | <b>Total Credit</b> |
| BPY26401T               | Mathematical Physics II    | Major                     | 3-1-0        | 4                   |
| BPY26402T               | Advanced Quantum Mechanics | Major                     | 3-1-0        | 4                   |
| BPY26403T               | Classical Mechanics        | Major/Minor 7             | 3-1-0        | 4                   |
| BPY26404T               | Modern Physics             | Major/Minor 8             | 3-1-0        | 4                   |
| BPY26405P               | General Laboratory I       | Major                     | 0-0-8        | 4                   |
| <b>TOTAL</b>            |                            |                           |              | <b>20</b>           |

| Eighth Semester |                              |                    |       |              |
|-----------------|------------------------------|--------------------|-------|--------------|
| Course Code     | Course Name                  | Category of Course | L-T-P | Total Credit |
| BPY26406T       | Atomic and Molecular Physics | Major              | 3-1-0 | 4            |
| BPY26407T       | Semiconductor Physics        | Major              | 3-1-0 | 4            |
| BPY26408T       | Statistical Mechanics        | Major              | 3-1-0 | 4            |
| BPY26409T       | Research Methodology         | Major              | 3-1-0 | 4            |
| BPY26410P       | General Laboratory II        | Major              | 0-0-4 | 2            |
| BPY26411R       | Minor Project                | Major              | 0-0-4 | 2            |
| TOTAL           |                              |                    |       | 20           |

#### EXIT OPTION WITH FOUR YEARS BACHELOR DEGREE (HONOURS)

#### (B)FOUR YEARS BACHELOR'S DEGREE (HONOURS WITH RESEARCH)

| Seventh Semester |                            |                    |       |              |
|------------------|----------------------------|--------------------|-------|--------------|
| Course Code      | Course Name                | Category of Course | L-T-P | Total Credit |
| BPY26401T        | Mathematical Physics II    | Major              | 3-1-0 | 4            |
| BPY26402T        | Classical Mechanics        | Major/Minor7       | 3-1-0 | 4            |
| BPY26403T        | Advanced Quantum Mechanics | Major              | 3-1-0 | 4            |
| BPY26404T        | Modern Physics             | Major/Minor 8      | 3-1-0 | 4            |
| BPY26405P        | General Laboratory I       | Major              | 0-0-8 | 4            |
| TOTAL            |                            |                    |       | 20           |

| Eighth Semester |                                                             |                    |        |              |
|-----------------|-------------------------------------------------------------|--------------------|--------|--------------|
| Code            | Course                                                      | Category of Course | L-T-P  | Total Credit |
| BPY26409T       | Research Methodology(UG Level)                              | Major              | 4-0-0  | 4            |
| BPY26412R       | Research Project (UG Dissertation)                          | Major              | 0-0-24 | 12           |
| BPY26413P       | Advanced Research Laboratory/use of MATLAB, Mathematica etc | Major              | 0-0-8  | 4            |
| TOTAL           |                                                             |                    |        | 20           |

#### EXIT OPTION WITH DEGREE (HONOURS WITH RESEARCH)

**LIST OF COURSES:**

| <b>ANNEXURE-I: (MINOR COURSES)</b> |                 |                            |              |                     |
|------------------------------------|-----------------|----------------------------|--------------|---------------------|
| <b>Course</b>                      | <b>Semester</b> | <b>Name of the Course</b>  | <b>L-T-P</b> | <b>Total Credit</b> |
| MINOR-1                            | I               | Introductory Physics       | 4-0-0        | 4                   |
| MINOR-2                            | I               | Renewable Energy Resources | 4-0-0        | 4                   |
| MINOR-3                            | II              | Physics in Everyday Life   | 4-0-0        | 4                   |
| MINOR-4                            | II              | Atmospheric Physics        | 4-0-0        | 4                   |
| MINOR-5                            | III             | Mathematical Physics-I     | 3-0-2        | 4                   |
| MINOR-6                            | III             | Sports Science             | 4-0-0        | 4                   |
| MINOR-7                            | VII             | Classical Mechanics        | 3-1-0        | 4                   |
| MINOR-8                            | VII             | Modern Physics             | 3-1-0        | 4                   |

| <b>ANNEXURE-II: (MDC COURSES)</b> |                 |                                |              |                     |
|-----------------------------------|-----------------|--------------------------------|--------------|---------------------|
| <b>Course</b>                     | <b>Semester</b> | <b>Name of the Course</b>      | <b>L-T-P</b> | <b>Total Credit</b> |
| MDC-1                             | I               | Physics For All                | 3-0-0        | 3                   |
| MDC-2                             | II              | Physics of Earth               | 3-0-0        | 3                   |
| MDC-3                             | III             | Indian Contribution to Science | 3-0-0        | 3                   |

| <b>ANNEXURE-III: (ELECTIVE COURSES)</b> |                 |                               |                    |              |                     |
|-----------------------------------------|-----------------|-------------------------------|--------------------|--------------|---------------------|
| <b>Course</b>                           | <b>Semester</b> | <b>Name of the Course</b>     | <b>Course Code</b> | <b>L-T-P</b> | <b>Total Credit</b> |
| Elective-1                              | IV              | (a)Laser and Nonlinear Optics | BPY23221T          | 4-0-0        | 4                   |
|                                         |                 | (b1)Computational Physics     | BPY23222P          | 3-0-2        |                     |
|                                         |                 | (c)Introductionto Nanoscience | BPY23223T          | 4-0-0        |                     |
| Elective-2                              | V               | (a)Sustainability Science     | BPY23321T          | 4-0-0        | 4                   |
|                                         |                 | (b)Crystal Analysis           | BPY23322T          | 4-0-0        |                     |
| Elective -3                             | VII             | (a)Plasma Physics             | BPY23323T          | 4-0-0        | 4                   |
|                                         |                 | (b)Spectroscopy               | BPY23324T          | 4-0-0        |                     |

## Detailed Syllabi

### SEMESTER-I

| DSC (Major+ Minor)                                                                                                                                                                                                                               | Introductory Physics                                                                            | L | T | P | C               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                  |                                                                                                 | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Basic Science                                                                                                                                                                                                              |                                                                                                 |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                        |                                                                                                 |   |   |   |                 |
| 1. To provide the fundamental knowledge of measurements and dimensions                                                                                                                                                                           |                                                                                                 |   |   |   |                 |
| 2. To enable students to develop an understanding of different types of matter and their properties.                                                                                                                                             |                                                                                                 |   |   |   |                 |
| 3. To make students familiar with motion, force and work from the point of view of Physics                                                                                                                                                       |                                                                                                 |   |   |   |                 |
| 4. To introduce the basic ideas about sound propagation through various media.                                                                                                                                                                   |                                                                                                 |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                           |                                                                                                 |   |   |   |                 |
| After successful completion of the course, the students will be able to                                                                                                                                                                          |                                                                                                 |   |   |   |                 |
| CO1: Remember the units of fundamental quantities, the basic constituents and nature of matter, motion , force, work and sound.                                                                                                                  |                                                                                                 |   |   |   |                 |
| CO 2: Understand the fundamental properties of matter, gravitational forces, work done and sound.                                                                                                                                                |                                                                                                 |   |   |   |                 |
| CO 3: Apply the knowledge gained to measure fundamental physical quantities.                                                                                                                                                                     |                                                                                                 |   |   |   |                 |
| CO 4: Analyze the action of forces on bodies and energy and work done.                                                                                                                                                                           |                                                                                                 |   |   |   |                 |
| <b>Module 1: PHYSICAL WORLD AND ITS MEASUREMENTS</b>                                                                                                                                                                                             |                                                                                                 |   |   |   | <b>8 hours</b>  |
| Physics and its scope, Units and Measurements, Errors in Measurements, Dimensional Analysis                                                                                                                                                      |                                                                                                 |   |   |   |                 |
| <b>Activity :</b>                                                                                                                                                                                                                                |                                                                                                 |   |   |   |                 |
| 1) To measure fundamental quantities – length (using slide calipers), diameter (using screw gauge), time (using stop clock), weight (using physical balance)                                                                                     |                                                                                                 |   |   |   |                 |
| <b>Module 2: MATTER – NATURE AND BEHAVIOUR</b>                                                                                                                                                                                                   |                                                                                                 |   |   |   | <b>20 hours</b> |
| Definition of matter, solid, liquid and gas, characteristics – shape, volume and density, change of state – melting (absorption of heat, freezing, evaporation, condensation, sublimation                                                        |                                                                                                 |   |   |   |                 |
| Elements, compounds and mixtures – heterogeneous and homogeneous mixtures                                                                                                                                                                        |                                                                                                 |   |   |   |                 |
| Atoms and molecules, Chemical formula for common compounds, atomic and molecular masses                                                                                                                                                          |                                                                                                 |   |   |   |                 |
| Electrons, protons and neutrons, valency, atomic number and mass number, isotopes and isobars.                                                                                                                                                   |                                                                                                 |   |   |   |                 |
| <b>Activity :</b>                                                                                                                                                                                                                                |                                                                                                 |   |   |   |                 |
| 1) Determination of melting point of ice and boiling point of water.                                                                                                                                                                             |                                                                                                 |   |   |   |                 |
| 2) Preparation of mixture and compound                                                                                                                                                                                                           |                                                                                                 |   |   |   |                 |
| <b>Module 3: MOTION, FORCE AND WORK</b>                                                                                                                                                                                                          |                                                                                                 |   |   |   | <b>22 hours</b> |
| Distance and displacement, velocity, uniform and non-uniform motion along a straight line, acceleration, distance-time and velocity-time graphs for uniform motion and uniformly accelerated motion, elementary idea of uniform circular motion. |                                                                                                 |   |   |   |                 |
| Gravitation, Universal Law of Gravitation, force of gravitation of the earth (gravity), acceleration due to gravity, mass and weight, free fall                                                                                                  |                                                                                                 |   |   |   |                 |
| Work done by a force, energy, power, kinetic and potential energy, Law of conservation of energy (excluding commercial unit of energy)                                                                                                           |                                                                                                 |   |   |   |                 |
| <b>Module 4: SOUND</b>                                                                                                                                                                                                                           |                                                                                                 |   |   |   | <b>10 hours</b> |
| Nature of sound and its propagation through various media, speed of sound, range of hearing in humans, ultrasound, reflection of sound, echo                                                                                                     |                                                                                                 |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                       |                                                                                                 |   |   |   | <b>60 hours</b> |
| <b>Activity :</b>                                                                                                                                                                                                                                |                                                                                                 |   |   |   |                 |
| 1) Determination of melting point of ice and boiling point of water.                                                                                                                                                                             |                                                                                                 |   |   |   |                 |
| 2) Preparation of mixture and compound.                                                                                                                                                                                                          |                                                                                                 |   |   |   |                 |
| <b>Text Book(s)</b>                                                                                                                                                                                                                              |                                                                                                 |   |   |   |                 |
| 1.                                                                                                                                                                                                                                               | Science Textbook for classes IX and X, NCERT Publication                                        |   |   |   |                 |
| 2.                                                                                                                                                                                                                                               | Physics, Part I for class XI, NCERT Publication                                                 |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                           |                                                                                                 |   |   |   |                 |
| 1.                                                                                                                                                                                                                                               | Fundamentals of Physics, David Halliday, Robert Resnick, Jearl Walker, (John Wiley & Sons Inc.) |   |   |   |                 |

| DSC<br>(Minor)                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Renewable Energy Resources                                                                 | L | T | P | C               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                            | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Basic Science                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                            |   |   |   |                 |
| 1. To provide knowledge about the depleting non-renewable energy sources and alternative energy sources<br>2. To enable students to develop an understanding of the different applications of renewable energy<br>3. To make students aware of wind energy and its harvesting and solar energy<br>4. To develop fundamental idea regarding ocean energy and its potential as an energy resource.<br>5. To provide fundamental knowledge regarding geothermal energy and hydro energy. |                                                                                            |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                            |   |   |   |                 |
| After successful completion of the course, the students will be able to<br>CO1: remember the fundamentals of fossil fuels, solar energy, wind energy, ocean energy and geothermal and hydro energy.<br>CO 2: understand and appreciate the need to shift to renewable energy resources.<br>CO 3: apply the knowledge of renewable energy resources gained to practical situations.<br>CO 4: analyze the harvesting of non-conventional sources of energy.                             |                                                                                            |   |   |   |                 |
| <b>Module 1: FOSSIL FUELS AND ALTERNATE SOURCES OF ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            |   |   |   | <b>9 hours</b>  |
| Fossil fuels and nuclear energy and their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in offshore wind energy, tidal energy, wind energy systems, solar energy, biomass, biochemical conversion, biogas generation, hydroelectricity                                                                                                                                                                                           |                                                                                            |   |   |   |                 |
| <b>Module 2: SOLAR ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            |   |   |   | <b>18 hours</b> |
| Solar energy, its importance, storage of solar energy, solar pond, solar water heater, solar cooker, solar green houses, solar cell, absorption air conditioning, need and characteristics of photovoltaic(PV) systems, PV models and equivalent circuits, sun tracking systems.<br><b>Activity :</b><br>1) To build a solar greenhouse<br>2) To build a solar box cooker                                                                                                             |                                                                                            |   |   |   |                 |
| <b>Module 3: WIND ENERGY HARVESTING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                            |   |   |   | <b>18 hours</b> |
| Fundamentals of wind energy, wind turbines and different electrical machines in wind turbines, power electronic interfaces and grid interconnection topologies, wind energy conversion, wind mill, basic components of wind mill conversion system, types of wind mills, conversion and efficiency.<br><b>Activity :</b><br>3) To construct a vertical wind turbine.                                                                                                                  |                                                                                            |   |   |   |                 |
| <b>Module 4: OCEAN ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            |   |   |   | <b>8 hours</b>  |
| Ocean energy potential against wind and solar, wave characteristics and statistics, wave energy devices. Tide characteristics and statistics, tide energy technologies, ocean thermal energy, osmotic power, ocean bio-mass                                                                                                                                                                                                                                                           |                                                                                            |   |   |   |                 |
| <b>Module 5: GEOTHERMAL ENERGY AND HYDRO ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |   |   |   | <b>7 hours</b>  |
| Geothermal resources, geothermal technologies<br>Hydropower resources, hydropower technologies, environmental impact of hydro power sources.                                                                                                                                                                                                                                                                                                                                          |                                                                                            |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                            |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Non-conventional Energy Sources – G. D Rai, Khanna Publications, 2001                      |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Non-conventional Energy Resources – B. H. Khan, McGrae Hill, 3 <sup>rd</sup> edition, 2017 |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                            |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Solar Energy – Suhas P. Sukhative, Tata McGraw Hill Publishing Company Limited.            |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Wind Energy System – Gary L. Johnson, Printice Hall Inc., New Jersey, 1985.                |   |   |   |                 |



| MDC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PHYSICS FOR ALL                                                                                                                                 | L | T | P | C               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                 | 3 | 0 | 0 | 3               |
| <b>Pre-requisite:</b> Preliminary concept of Science and Mathematics.                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                 |   |   |   |                 |
| <b>Course Objective</b><br>(1)To enhance the fundamental knowledge of systems of units to be used in daily life.<br>(2) To have a broader concept of laws to understand planetary motion, satellites and Global Positioning System.<br>(3)To enhance the knowledge of basics heat and thermodynamics and understanding basics of home appliances.<br>(4) To enhance the knowledge of sound and its propagation.<br>(5) To develop the concept of different phenomena associated with light. |                                                                                                                                                 |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO1: to remember different units and laws connected with motion, heat, sound, light.<br>CO 2: to understand the basics of kinematics, sound, heat and light.<br>CO 3: to apply the concepts of physics in understanding the mechanism of various instruments.<br>CO 4: to analyze the concepts of basic physics to learn the various facts about nature.                                  |                                                                                                                                                 |   |   |   |                 |
| <b>Module 1: Units and Measurements</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                 |   |   |   | <b>10 hours</b> |
| CGS, FPS, MKS, SI system of units, their inter conversion relations, Dimensional formula of physical quantities. Dimension analysis and its applications to simple problems, Problems on conversion among system of units, . Measured value and absolute value; Accuracy and Precision, Error in measurement and its Types, Error estimation formulae.                                                                                                                                      |                                                                                                                                                 |   |   |   |                 |
| <b>Module 2: Mechanics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                 |   |   |   | <b>10 hours</b> |
| Scalar and Vector quantities, distance, displacement, speed, velocity, acceleration, Circular motion, rotational motion , preliminary idea of angular displacement, velocity, Planetary motion, Gravitational force, acceleration due to gravity in different places, concept of inertia, Newton’s laws, natural and artificial satellites, examples, introduction to global positioning system                                                                                             |                                                                                                                                                 |   |   |   |                 |
| <b>Module 3: Heat</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                 |   |   |   | <b>9 hours</b>  |
| Concepts of Heat and Tempearture, Units of temperature: Centigrade, Fahrenheit and Kelvin scale, their inter-conversion formulae, Heat transfer processes: conduction, convection and radiation, explanation of change of states of matter, working principles of Refrigerator, Air Conditioner, Microwave Oven.                                                                                                                                                                            |                                                                                                                                                 |   |   |   |                 |
| <b>Module 4: Sound</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                 |   |   |   | <b>8 hours</b>  |
| Longitudinal nature of sound, Frequency, and its unit and Pitch, Loudness and Intensity, Production and detection of sound , Audible frequency range, infrasonic and ultrasonic sounds, Noise and Music, Principle of Loudspeaker and Microphone, vibration and production of sound in Musical Instruments                                                                                                                                                                                  |                                                                                                                                                 |   |   |   |                 |
| <b>Module 5: Light</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                 |   |   |   | <b>8 hours</b>  |
| Reflection, Refraction and Dispersion of light, Application of formation of images by plane mirror, convex and concave mirror, formation of rainbow, scattering of colours during sunrise and sunset, blue colour of sky, light production in bulb, different types of light bulbs, Laser, LED, Solar spectrum                                                                                                                                                                              |                                                                                                                                                 |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                 |   |   |   | <b>45 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                 |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Conceptual Physics, Paul G. Hewitt, Pearson Education, 2017.                                                                                    |   |   |   |                 |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Physics Made Simple: A complete Introduction to the basic principles of this fundamental science, Christopher G. De Pree, Crown Publisher, 2005 |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Concept of Physics, H.C Verma, Bharat Bhawan Publisher, 2021                                                                                    |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                 |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | The Basics of Physics, Rusty L. Myers, Greenwood Press, 2005                                                                                    |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | AK Basics of Physics, Anil Kumar Kakodiya, 2023.                                                                                                |   |   |   |                 |

## SEMESTER-II

| DSC<br>(major+ minor<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | PHYSICS IN EVERYDAY LIFE | L | T | P | C        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|---|---|---|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                          | 4 | 0 | 0 | 4        |
| Pre-requisite: Preliminary concept of Science and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |   |   |   |          |
| Course Objectives:<br>(1) To enhance the fundamental knowledge of laws of motion which is helpful to understand the excitement in related activities of life?<br>(2) To have an overview of heat and temperature in understanding the theory behind thermometers, woodstoves etc.<br>(3) To develop a concept on sound waves to relate with different instruments.<br>(4) To create more awareness about electricity and magnetism to relate the theory to practical life.<br>(5) To enhance the theory of light propagation, formation of images, lasers etc.                                                                                                                                                                                                                                                                                                                                                                     |                          |   |   |   |          |
| Course Outcome:<br>After successful completion of the course, the students will be able<br>CO1: to remember the basic concepts of Physics to learn the dynamics of objects, heat and thermodynamics, sound, electricity and magnetism and light.<br>CO 2: to understand the fundamentals of Physics to various instruments we use in our daily life.<br>CO 3: to apply different theories in various instruments.<br>CO 4: to analyze the laws of physics behind various natural phenomena and activities.                                                                                                                                                                                                                                                                                                                                                                                                                         |                          |   |   |   |          |
| Module 1: The laws of motion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |   |   |   | 15 hours |
| Skating: Inertia, vector quantities, position, velocity, force, acceleration, mass, net force, Newton’s first and second laws, inertial frames of reference, unit<br>Falling Bodies: gravity, weight, uniform acceleration, projectile motion, vector components, support forces, Newton’s third law, energy, work, conservation of energy, kinetic and potential energies, gravitational potential energy, ramp & its mechanical advantage<br>Seesaws: rotational inertia; angular velocity; torque; angular acceleration; rotational mass, net torque; Newton’s first, second, and third laws of motion; centres of mass and gravity; levers; balance<br>Rockets and Space Travel: reaction forces, law of universal gravitation, elliptical orbits, escape velocity, Kepler’s laws, speed of light, concepts of general and special relativity, equivalence principle.<br>(Explanation is to be done with related experiments ) |                          |   |   |   |          |
| Module 2: Heat and Temperature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                          |   |   |   | 10 hours |
| Scales: Thermal energy, Heat and Temperature, different scales of measuring temperature & their relations.<br>Woodstoves: thermal equilibrium, chemical bonds and reactions, conduction, thermal conductivity, convection, radiation, heat capacity<br>Water, Steam and Ice: phases of matter, phase transitions, melting, freezing, condensation, evaporation, relative humidity, latent heats of melting and evaporation, sublimation, deposition, boiling, Airconditioners.<br>(Explanation is to be done with related experiments)                                                                                                                                                                                                                                                                                                                                                                                             |                          |   |   |   |          |
| Module 3: Sound                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                          |   |   |   | 10 hours |
| Waves: wave motion, transverse and longitudinal waves.<br>Clocks : time and space, natural resonance, harmonic oscillators, simple harmonic motion and its frequency, period, amplitude<br>Musical Instruments: sound; music; vibrations in strings, air, and surfaces; fundamental and higher-order modes; harmonic and non harmonic overtones; sympathetic vibration; standing and travelling waves; transverse and longitudinal waves; velocity and wavelength of mechanical waves; superposition, different types of musical instruments<br>(Explanation is to be done with related experiments)                                                                                                                                                                                                                                                                                                                               |                          |   |   |   |          |
| Module 4: Electricity and magnetism                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                          |   |   |   | 15 hours |
| Static Electricity: electric charge, electrostatic forces, Coulomb’s law, electrostatic potential energy, voltage, charging by contact, electric polarization, electrical conductors and insulators<br>Current: electric current; electric circuits; direction of current flow; electrical resistance; voltage drops;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |   |   |   |          |

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| voltage rise; relationship among current, voltage, and power; Ohm's law; resistors and their series and parallel combinations.<br>Household Magnets: earth as a magnet, magnetic pole, magnetostatic forces, Coulomb's law for magnetism, ferromagnetism, magnetic polarization, magnetic domains, magnetic materials, magnetic fields, magnetic flux, relationship between electric and magnetic fields<br>Electric power distribution: direct and alternating currents, superconductivity, transformers, induction, magnetic field energy, relationship between changing magnetic fields and electric fields, Lenz's law, inductors, induced emf, electrical safety, generators, motors<br>(Explanation is to be done with related experiments)             |                 |
| <b>Module 5: Light</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>10 hours</b> |
| Reflection and refraction, index of refraction, dispersion, and interference in electromagnetic waves<br>Cameras: eye and camera, refracting optics, converging lenses, real images, focus, focal lengths, f-numbers, the lens equation, diverging lenses, virtual images, light sensors, vision and vision correction, different types of defects in human eye.<br>LEDs and Lasers, optical fibres, metals, insulators, and semiconductors; photoconductors; p-n junction diodes; light-emitting diodes; incoherent and coherent light; spontaneous and stimulated emission; population inversion; laser amplification and oscillation; laser safety, optical fibre: structure and light propagation<br>(Explanation is to be done with related experiments) |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |
| <ol style="list-style-type: none"> <li>1. Physics in our daily lives, Umme Ammara, gurucool publishing</li> <li>2. The Physics of Everyday Things, James KaKalios, RH US(2017)</li> <li>3. Physics in Everyday Life, Shaswant Goswami, Vedang Sati, (2016)</li> <li>4. How Things Work The Physics of Everyday Life, Louis A. Bloomfield, Wiley publishing(WileyPLUS)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                              |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |
| <ol style="list-style-type: none"> <li>1. Feynmann Lectures on Physics, Matthew Sands, Richard Feynmann and Robert B. Leighton Vol I, Vol II, Vol III.</li> <li>2. Storm in a Teacup: The Physics of Everyday Life, Helen Czerski, Publisher Black Swan</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |

| <b>DSC (Minor)</b>                                                                                                                                                                                                                                                                                                                                                                           | <b>Atmospheric Physics</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------|----------|----------|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                              |                            | <b>4</b> | <b>0</b> | <b>0</b> | <b>4</b>        |
| <b>Pre-requisite:</b> Basic Physics                                                                                                                                                                                                                                                                                                                                                          |                            |          |          |          |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                    |                            |          |          |          |                 |
| <ol style="list-style-type: none"> <li>1. To provide fundamental knowledge regarding the earth's atmosphere</li> <li>2. To give an in-depth introduction of atmospheric thermodynamics</li> <li>3. To introduce atmospheric aerosols and analyse its impact on the global climate</li> <li>4. To introduce students to different methods of atmospheric observation</li> </ol>               |                            |          |          |          |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                       |                            |          |          |          |                 |
| After successful completion of the course, the students will be able to<br>CO1: remember the laws involving thermodynamics, scattering and dissipation mechanism.<br>CO 2: understand the fundamentals of the earth's atmosphere and its thermodynamics, aerosols and cloud<br>CO 3: apply the knowledge gained to make atmospheric observations.<br>CO 4: analyze atmospheric observations. |                            |          |          |          |                 |
| <b>Module 1: INTRODUCTION TO EARTH'S ATMOSPHERE</b>                                                                                                                                                                                                                                                                                                                                          |                            |          |          |          | <b>14 hours</b> |
| State of the earth's atmosphere: main constituents of dry air, CO <sub>2</sub> , ozone, water vapour, aerosols; vertical thermal structure of the atmosphere : troposphere, stratosphere, mesosphere, thermosphere and exosphere; environmental lapse rate, hydrostatic equilibrium, hydrostatic equation                                                                                    |                            |          |          |          |                 |
| <b>Module 2: ATMOSPHERIC THERMODYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                  |                            |          |          |          | <b>18 hours</b> |
| Gas Laws, Ideal Gas Law, Dalton's Law, First Law of Thermodynamics, equivalence between heat and                                                                                                                                                                                                                                                                                             |                            |          |          |          |                 |

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| work, thermal capabilities, isothermal, isochoric, isobaric transformation, adiabatic transformation, Poisson relation, thermodynamic properties of water, latent heat, Clausius-Clapeyron's relation, Approximation and consequences of Clausius-Clapeyron relation, moist air, mean molecular weight of dry and moist air.                                                                                                                            |                                                                                                                    |
| <b>Module 3: AEROSOL AND CLOUD</b>                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>14 hours</b>                                                                                                    |
| Classification of atmospheric aerosol, production and removal mechanisms, concentration and size distribution, adsorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Beer-Bouguer-Lambert Law<br>Macro and microphysical characteristics of cloud: droplet growth and cloud dissipation mechanism, radiative transfer in cloudy atmosphere, role of aerosol and cloud in climate.                                       |                                                                                                                    |
| <b>Module 4: ATMOSPHERIC OBSERVATIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                               | <b>14 hours</b>                                                                                                    |
| General principles of meteorological measurements and observational procedures, conventional and self recording measurements of atmospheric variables, upper air measurements: pilot balloons, radiosonde, ozonesonde, GPS sonde.<br>Surface based remote sensing: working principle and applications of LIDAR, SONAR, Water RADAR, radiological satellites, multiscanner radio-meters and their applications in the observation of weather parameters. |                                                                                                                    |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>60 hours</b>                                                                                                    |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                    |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Physics of the Atmosphere and Climate – Murray L. Salby, Cambridge University Press                                |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Introduction to Atmospheric Physics – D.G. Andrews, Cambridge University Press                                     |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                    |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | An Introduction to Dynamic Meteorology- Vol. 1., James R. Holton.                                                  |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Remote Sensing of Aerosols, Clouds and Precipitation – T. Islam, Y. Hu, A. A. Kokhanovsky, J. Wang (Eds.) Elsevier |

| MDC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Physics of the Earth | L | T | P | C               |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                      | 3 | 0 | 0 | 3               |
| <b>Pre-requisite:</b> Basic Physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                      |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                      |   |   |   |                 |
| 1. To provide fundamental knowledge regarding the earth and the universe<br>2. To give an in-depth introduction structure of the earth and its components<br>3. To introduce dynamical processes related to solid earth, hydrosphere, atmosphere and biosphere<br>4. To make students aware of different factors disturbing the earth's ecosystem                                                                                                                                                                  |                      |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |   |   |   |                 |
| After successful completion of the course, the students will be able to<br>CO1: remember various aspects of the structure of the earth and the universe.<br>CO 2: understand the fundamentals of planet earth, its structure, the dynamical processes involved and the factors disturbing its stability.<br>CO 3: analyze the origin of the universe and planet earth, its magnetic field, ocean circulations.<br>CO 4: evaluate the dynamical processes and factors disturbing the stability of the earth.        |                      |   |   |   |                 |
| <b>Module 1: THE EARTH AND THE UNIVERSE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |   |   |   | <b>12 hours</b> |
| Origin of universe, creation of elements and earth. A holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography.<br>General characteristics and origin of the universe, the Big Bang Theory. Age of the universe and Hubble constant, formation of galaxies, earth's orbit and spin, Asteroids: origin, types and examples, meteorites and asteroids, earth in the solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. |                      |   |   |   |                 |
| <b>Module 2: STRUCTURE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                      |   |   |   | <b>11 hours</b> |
| The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy<br>The Hydrosphere: The oceans, their extent, depth, volume, chemical composition, river systems                                                                                                                                                                                                                                                                                                    |                      |   |   |   |                 |

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| The Atmosphere: Layers, variation of temperature with altitude, variation of density and pressure with altitude, cloud formation                                                                                                                                                                                                                                       |                                                                                                                            |
| The Cryosphere: Polar caps and ice sheets, mountain glaciers, permafrost.                                                                                                                                                                                                                                                                                              |                                                                                                                            |
| <b>Module 3: DYNAMICAL PROCESSES</b>                                                                                                                                                                                                                                                                                                                                   | <b>15 hours</b>                                                                                                            |
| <b>The Solid Earth:</b> Origin of the magnetic field, source of geothermal energy, convection of the earth's core and production of its magnetic field, mechanical layering of the earth, introduction of geophysical methods of earth investigation, concept of plate tectonics; types of earth movements, Earthquake and earthquake belts, Richter scale, geophones. |                                                                                                                            |
| <b>Hydrosphere:</b> Ocean circulations, oceanic current system and effect of Coriolis's force, tides, tsunamis                                                                                                                                                                                                                                                         |                                                                                                                            |
| <b>The Atmosphere:</b> Atmospheric circulation, weather and climate changes, earth's temperature and greenhouse effect <b>Biosphere:</b> water cycle, carbon cycle                                                                                                                                                                                                     |                                                                                                                            |
| <b>Module 4: DISTURBING THE EARTH</b>                                                                                                                                                                                                                                                                                                                                  | <b>7 hours</b>                                                                                                             |
| Contemporary dilemmas – (a) human population dynamics (b) Atmosphere: greenhouse gas emissions, climate change, air pollution (c) Hydrosphere: fresh water depletion, water pollution (d) Geosphere: chemical effluents, nuclear waste (e) Biosphere: biodiversity loss, deforestation. Robustness and fragility of ecosystems.                                        |                                                                                                                            |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                             | <b>45 hours</b>                                                                                                            |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                            |
| 1.                                                                                                                                                                                                                                                                                                                                                                     | Physics of the Earth, Frank D. Stacey, Paul M. Davis, 2008, Cambridge University Press                                     |
| 2.                                                                                                                                                                                                                                                                                                                                                                     | Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press. |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                            |
| 1.                                                                                                                                                                                                                                                                                                                                                                     | The Blue Planet : An Introduction to Earth System Science, Brian J. Skimnner, Stephen C. Portere, 1994, John Wiley & Sons  |
| 2                                                                                                                                                                                                                                                                                                                                                                      | The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press                   |

### SEMESTER-III

| DSC<br>(Major+Minor)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Mathematical Physics I                                                                                             | L | T | P | C        |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    | 3 | 0 | 2 | 4        |
| Pre-requisite: Basic Physics and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                    |   |   |   |          |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |   |   |   |          |
| 1. To provide the fundamental knowledge of calculus and differential equations.<br>2. To enable students to learn different properties vectors and their differentiation and integration.<br>3. To make students familiar with orthogonal curvilinear coordinates.<br>4. To introduce the dirac delta function and its properties.                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |   |   |   |          |
| Course Outcome:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    |   |   |   |          |
| After successful completion of the course, the students will be able to<br>CO1: Remember expressions of gradient, divergence and curl in orthogonal curvilinear coordinates.<br>CO 2: Understand the fundamentals of calculus, vector differentiation and vector integration.<br>CO 3: Apply the knowledge of Calculus to solve simple problems.<br>CO 4: Analyze the properties of Dirac Delta function.                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |   |   |   |          |
| Module 1: CALCULUS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |   |   |   | 15 hours |
| Recapitulation: Differentiation, plotting of functions, intuitive ideas of continuous, differentiable etc. functions and plotting of curves. Approximation: Taylor and Binomial series (statements only)<br>First Order and Second Order differential equations: First Order differential equations and Integrating factor. Homogeneous equations with constant coefficients, Wronskian and general solution.<br>Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor , with simple examples.                                                                                                                                                                           |                                                                                                                    |   |   |   |          |
| Module 2: VECTOR CALCULUS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |   |   |   | 18 hours |
| Properties of vectors, Scalar product and vector product, scalar triple product and their interpretation in terms of area and volume, respectively. Scalar and vector fields.<br>Vector differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators, vector identities.<br>Vector Integration: Ordinary integrals of vectors. Multiple integrals, Jacobian, notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields, flux of a vector field. Gauss’ Divergence Theorem, Green’s and Stokes Theorems and their applications (no rigorous proofs) |                                                                                                                    |   |   |   |          |
| Module 3: ORTHOGONAL CURVILINEAR COORDINATES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                    |   |   |   | 7 hours  |
| Orthogonal curvilinear coordinates. Derivation of gradient, divergence, curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                    |   |   |   |          |
| Module 4: DIRAC DELTA FUNCTION AND ITS PROPERTIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                    |   |   |   | 5 hours  |
| Definition of Dirac delta function. Representation as a limit of a Gaussian function and rectangular function. Properties of Dirac delta function.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |   |   |   |          |
| Total Lecture hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                    |   |   |   | 45 hours |
| Text Book(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                    |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Mathematical Methods for Physicists, G.B. Arkfen, H.J. Weber, F.E, Harris, 2013, 7 <sup>th</sup> edition, Elsevier |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | An Introduction to Ordinary Differential Equations, E.A. Coddington, 2009, PHIIO Learning.                         |   |   |   |          |
| Reference Books                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Mathematical Tools for Physics, Lames Nearing, 2010, Dover Publications                                            |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Mathematical Methods for Scientists and Engineers, S.S. McQuarrie, 2003, Viva Book                                 |   |   |   |          |

| <b>Laboratory in Mathematical Physics-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |
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| <b>Prerequisite : Basic Computer Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |
| <b>Course Objective :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |
| <b>Course Objective :</b><br>1) Makes students gain a broad perspective about the uses of computers in engineering industry. .<br>2) Develops basic understanding of computers, the concept of algorithm and algorithmic thinking.<br>3) An ability to incorporate exception handling in object-oriented programs.<br>4) Develops the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |
| <b>CO1:</b> Get the basic knowledge in fundamentals of programming, algorithms and programming technologies and fundamentals of Computer Science.<br><b>CO2:</b> The course will help to give a basic idea how to Control the sequence of the program and give logical outputs<br><b>CO3:</b> Construct programs involving decision structures and loops<br><b>CO4:</b> Get concept of Strings for writing programs related to character array.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |
| <b>List of Experiments:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |
| 1) <b>Development of programs using multiple arithmetic and logical operators. Programs for addition, subtraction, multiplication etc.</b><br>2) <b>Programs using simple control statements such as if else, while, do while etc. Making a program for a calculator for example. Extracting the digits of an integer, reversing digits, finding sum of digits etc.</b><br>3) <b>Programs using For loop, switch statement etc. eg. Finding average of numbers, multiplication of numbers etc. Checking for primes, generation of Armstrong numbers. .</b><br>4) <b>Generation of the Fibonacci sequence, finding the square root of a number, calculation of factorials, printing various patterns using for loop.</b><br>5) <b>Programs using Arrays: declaring and initializing arrays. Program to do simple operations with arrays. Strings – inputting and outputting strings. Using string functions such as strcat, strlen etc. Writing simple programs for strings without using string functions.</b> |                 |
| <b>Total Lab Hours :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>30 Hours</b> |
| <b>Text Books :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |
| 1) PROGRAMMING IN ANSI C BY E. BALGURUSWAMY, TATA MC-GRAW HILL<br>2) PROGRAMMING WITH C, SCHAUM SERIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |

| DSC<br>(minor)                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Sports Science                                                                                                                 | L | T | P | C               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Preliminary concept of Science and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                |   |   |   |                 |
| <b>Course Objectives:</b><br>(1)To enhance the fundamental knowledge of dynamics which is helpful to understand the field of sports like shooting, discuss throw etc.<br>(2) To develop the basic idea on gravitation to understand climbing, scating, swimming etc.<br>(3)To have an outlook on food and nutrition of our body.<br>(4)To enhance the basics of kinesiology, biomechanics and sports.<br>(5)To be aware of mental and physical health for a positive lifestyle. |                                                                                                                                |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO1: to remember the laws of dynamics required for understanding physics behind sports.<br>CO 2: to understand the theories related with practical field of sports.<br>CO 3: to apply the importance of food and nutrition for good health.<br>CO 4: to analyze kinesiology, biomechanics and sports for physical fitness and positive lifestyle.                             |                                                                                                                                |   |   |   |                 |
| <b>Module 1: Dynamics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                |   |   |   | <b>15 hours</b> |
| <b>Measurement:</b> Physical quantities, Standards and Units, International system of Units, Standards of time, length and mass, Precision and significant figures<br><b>Newton's laws of motion:</b> Newton's first law. Force, mass. Newton's second law. Newton's third law, Mass and weight. Applications of Newton's laws.<br><b>Projectile motion:</b> Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw.                                |                                                                                                                                |   |   |   |                 |
| <b>Module 2: Gravitation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                |   |   |   | <b>10 hours</b> |
| <b>Conservation laws:</b> Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carom, Billiards, Racing)<br><b>Centre of mass:</b> Physics behind Cycling, Rock climbing, Skating<br><b>Gravitation:</b> Origin, Newton's law of gravitation, Archimedes’s principle, Buoyancy & Physics behind swimming                                                                                                                      |                                                                                                                                |   |   |   |                 |
| <b>Module 3: Health</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                |   |   |   | <b>10 hours</b> |
| <b>Food and Nutrition:</b> Proteins, Vitamins, Fat, Blood pressure. Problems due to the deficiency of vitamins.<br><b>Energy:</b> Different forms of Energy, Conservation of mass-energy<br><b>Physical exercises:</b> Walking, Jogging and Running, Weight management                                                                                                                                                                                                          |                                                                                                                                |   |   |   |                 |
| <b>Module 4: Kinesiology, Biomechanics &amp; Sports</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                |   |   |   | <b>15 hours</b> |
| Meaning & Importance of Kinesiology & Biomechanics in Physical Education & Sports ,<br>Newton’s Law of Motion & its application in sports, example of Friction and its effects in Sports, examples,<br>Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc)                                                                                                                                       |                                                                                                                                |   |   |   |                 |
| <b>Module 5: Physical Fitness, Wellness &amp; Lifestyle</b>                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                |   |   |   | <b>10 hours</b> |
| Components of Physical fitness, Components of Health related fitness , Components of wellness<br>Preventing Health Threats through Lifestyle Change , Concept of Positive Lifestyle, Introduction to Yoga, mental and physical benefits of yoga.                                                                                                                                                                                                                                |                                                                                                                                |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Yakov Perelman. Physics for Entertainment. Createspace Independent Pub, 2010.                                                  |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Yakov Perelman. Physics Everywhere. Prodinnova Publishers, 2014.                                                               |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Vassilios McInnes Spathopoulos. An Introduction to the Physics of Sports. Createspace Independent Publishing Platform, 2013.   |   |   |   |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Swaminathan M. Handbook of Food and Nutrition. Bangalore Press. 2012.                                                          |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Walter Lewin.                                                                                                                  |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | For the Love of Physics. Taxmann Publications Pvt. Ltd., 2012.<br>Srilakshmi B. Food Science. New Age International Pub. 2015. |   |   |   |                 |



| MDC                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Indian Contribution to Science                                                                                                                                   | L | T | P | C               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                  | 3 | 0 | 0 | 3               |
| <b>Pre-requisite:</b> Preliminary concept of Science and Mathematics.                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                  |   |   |   |                 |
| <b>Course Objectives:</b><br>1. To enhance the knowledge of Indian science from ancient to modern..<br>2. To develop interest on ancient discoveries.<br>3. To identify ancient rituals and relations with modern methods.<br>4. To gather knowledge about the Nobel Lauretes of Indian origin.<br>5. To enhance the knowledge of the lives of Indian scientists.                                                                                                        |                                                                                                                                                                  |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO1: to remember the development of science from ancient to modern India.<br>CO 2: to understand different fields of science originated in ancient India<br>CO 3: to apply the traditional Indian customs and rituals, its relation to science, its effect.<br>CO 4: to analyze the different scientific discoveries provided by the Nobel Laureates of Indian origin. |                                                                                                                                                                  |   |   |   |                 |
| <b>Module 1: India’s Contribution to Science and Technology (from Ancient to Modern)</b>                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                  |   |   |   | <b>10 hours</b> |
| Proindependence: Water management, Iron and Steel, Farming Techniques and Fertilisers, Physics, Medicine and Surgery, Post Independence: Atomic Energy, Space, Electronics and Information Technology, Oceanography, Biotechnology, Council of Scientific and Industrial Research, The beginning of Indian Astronomy, Chemistry in Early Literature, Medicinal Tradition in Ancient India                                                                                |                                                                                                                                                                  |   |   |   |                 |
| <b>Module 2: Science in Ancient India</b>                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                  |   |   |   | <b>8 hours</b>  |
| Different studies on plants and animals, Biodiversity and folk traditions, Mathematics in India by early Indian astronomers, early historical period, classical period, Metallurgy in India                                                                                                                                                                                                                                                                              |                                                                                                                                                                  |   |   |   |                 |
| <b>Module 3: Indian Traditional Knowledge</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                  |   |   |   | <b>7 hours</b>  |
| About nature, flora and fauna, Sacred groves, wildlife, Bishnois and conservation, Ayurveda, elements of nature, ways of treatment, medical instruments in ancient India, yoga, traditional knowledge in relation to science, customs and beliefs in different parts of India, positive and negative side,                                                                                                                                                               |                                                                                                                                                                  |   |   |   |                 |
| <b>Module 4: Nobel Laureates of Indian Origin</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                  |   |   |   | <b>8 hours</b>  |
| Sir Ronald Ross, Sir C.V Raman, Subrahmanyam Chandrasekhar, Har Govind Khorana, Venkataraman Ramakrisnan, their contributions.                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                  |   |   |   |                 |
| <b>Module 5: Lives of few Scientists and their contributions</b>                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                  |   |   |   | <b>12 hours</b> |
| Sushruta, Bhaskara II, Aryabhatta, Jagadish Chandra Bose, Acharya Prafulla Chandra Roy, Birbal Sahni, P.C Mahalanobis, Meghnad Saha, Satyendra Nath Bose, Srinivas Ramanujam, Salim Ali,,Panchanan Maheshwari, B.P Pal, Homi Jehangir Bhaba, Kalpana Chawla, Sunita Williams, Smt Anna Mani, E.K Janaki Ammal                                                                                                                                                            |                                                                                                                                                                  |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                  |   |   |   | <b>45 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                  |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A Short History of Science and Technology In India, Dr Sanjay Sen, Mahabeer Publications, 2019                                                                   |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Doctors, Scientists, & Engineers of Ancient India, S, Narain, Kalpaz Publications, 2017                                                                          |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | From the Beginning of Time: Modern Science and the Puranic Universe, Ganesh Swaminathan, 2020                                                                    |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                  |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | India’s Glorius Scientific Tradition, Suresh Soni, Prabhat Prakashan, 2020                                                                                       |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | The Unknown, Chiranit Majumdar, Notion Press Media Pvt Ltd, 2022                                                                                                 |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Lilavati’s Daughters: The Women Scientists of India, Edited by Rohini Godbole and Ram Ramaswamy, Published by Indian Academy of Sciences, ISBN 978-81-8465-005-1 |   |   |   |                 |

## SEMESTER IV

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MECHANICS AND PROPERTIES OF MATTER                                                    | L | T | P | C               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                       | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> 12 <sup>th</sup> standard Physics course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                       |   |   |   |                 |
| <b>Course Objective</b><br>(1) aims to understand the concepts of fundamentals of dynamics.<br>(2) to be familiar with rotational motion and different parameters related to it to understand the concepts behind it.<br>(3) enhance the knowledge on gravitation and its related areas by understanding laws and theory behind pendulum.<br>(4) to have a broader perspective about the flow of liquids in viscous medium and capillary tubes.<br>(5) to enhance the knowledge of elasticity by understanding relations of elastic constants and bending of beams.                                                                                                                                                                                                                                                                                                                               |                                                                                       |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO1: to remember different laws which govern the dynamics of a system: a particle, system of particles, planetary motion and fluids.<br>CO 2: to understand the concepts of fundamentals of dynamics, flow of liquids and elasticity.<br>CO 3: to apply the concepts of mechanics in different systems.<br>CO 4: to analyze the values of different parameters of various physical systems.                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                       |   |   |   |                 |
| <b>Module 1: Fundamentals of Dynamics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                       |   |   |   | <b>24 hours</b> |
| Reference frames, Reviews of Newton’s laws, Inertial and non inertial frames, Rotating frame, Coriolis force, centripetal and centrifugal force, Other effects and applications of centrifugal force, Projectile motion, horizontal range, maximum height attained by a projectile, Dynamics of a system of particles, centre of mass<br>Galilean transformation equations, Galilean invariance, Lorentz transformation equations, length contraction, time dilation, transformation of velocity.<br>Uniform circular motion, angular velocity, angular acceleration, couple, work done by a couple, angular momentum, principle of conservation of angular momentum, rotation about a fixed axis, moment of inertia, kinetic energy of rotation, general theorems on moment of inertia, calculation of moment of inertia for rectangular, spherical and cylindrical bodies about different axes. |                                                                                       |   |   |   |                 |
| <b>Module 2: Gravitation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                       |   |   |   | <b>12 hours</b> |
| Newton’s laws on gravitation, motion of a particle in central force field(motion in a plane, angular momentum is conserved, areal velocity is constant), Kepler’s laws(only statement)<br>The simple pendulum, compound pendulum, interchangeability of the centres of suspension and oscillation, Kater’s reversible pendulum.<br>Satellite in circular orbit and applications, Geosynchronous orbits, basic idea of global positioning system (GPS), weightlessness, physiological effects on astronauts.                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |   |   |   |                 |
| <b>Module 3: Liquids</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                       |   |   |   | <b>12 hours</b> |
| Rate of flow of liquid, Bernoulli’s equation, Applications of Bernoulli’s equation, Viscosity, Poiseulle’s equation, critical velocity, motion of a body in viscous medium, Stoke’s law.<br>Molecular force, molecular range, sphere of influence, surface tension, surface film and surface energy, excess pressure inside a liquid drop, rise of liquid in capillary tubes, angle of contact.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                       |   |   |   |                 |
| <b>Module 4: Elasticity</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |   |   |   | <b>12 hours</b> |
| Elasticity, Stress and strain, equivalence of a shear to a compression and an extension at right angles to each other, Hooke’s law, Different elastic constants, Strain energy per unit volume for different strains, Poisson’s ratio, its limit, relation between different elastic constants, twisting couple on a cylinder<br>Bending of beams, bending moment, cantilever, -loaded at free end, loaded at the middle for different shapes.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                       |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                       |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                       |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mechanics, D.S Mathur, S.Chand and Company Limited, 2000.                             |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Physics, Resnick, Halliday and Walker 8/e.2008, Wiley.                                |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, TataMcGraw-Hill. |   |   |   |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.            |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                       |   |   |   |                 |

|    |                                                                                                          |
|----|----------------------------------------------------------------------------------------------------------|
| 1. | Analytical Mechanics, G.R. Fowles and G.L. Classiday.2005, Cengage Learning.                             |
| 2. | Theoretical Mechanics, M. R. Spiegel, 2006,Tata McGraw Hill.                                             |
| 3. | Physics for Scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning. |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ELECTRICITY AND MAGNETISM | L | T | P | C               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                           | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> 12 <sup>th</sup> standard Physics course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                           |   |   |   |                 |
| <b>Course Objective</b><br>(1) Aims to enhance the concepts of electrostatics in finding out the electric intensity and electric potential in different charge distributions.<br>(2) to be familiar with the dielectric properties of matter by understanding the concepts of different parameters.<br>(3) enhance the knowledge the electromagnetic field to familiar with the concepts of different instruments.<br>(4) to have a broader perspective about magnetic materials by understanding the theory of different theories.<br>(5) to enhance the knowledge of circuits, both DC and AC.                                                                                                                                                                                                                                           |                           |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO1: to remember different laws associated with electrostatics, magnetostatics, electromagnetic induction and dielectrics.<br>CO2: to understand the theories related to charge distributions, magnetic and electromagnetic behavior of various substances.<br>CO3: to apply the concepts of electrostatics, dielectrics and electromagnetic to different systems: charged conductors, motors, molecules, transformers etc.<br>CO4: to analyze various parameters associated with charge distributions, magnetic substances, dielectrics and others viz, various instruments.                                                                                                                                                            |                           |   |   |   |                 |
| <b>Module 1: Electric Field and Electric Potential</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                           |   |   |   | <b>12 hours</b> |
| Electric field and its conservative nature, electric intensity and electric potential, Poisson's and Laplace equations, Gauss's law, applications to charge distributions with spherical, cylindrical and planar symmetry, Mechanical force experienced by unit area of a charged surface, electric intensity and potential due to an electric dipole, capacitance of a system of charged conductors, parallel plate capacitor, cylindrical capacitor, method of images and application to: (1) plane infinite sheet and (2) sphere.                                                                                                                                                                                                                                                                                                       |                           |   |   |   |                 |
| <b>Module 2: Dielectric Properties of Matter</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |   |   |   | <b>12 hours</b> |
| Dielectric polarization, dielectric constant and displacement vector, external field of a dielectric medium, the electric field in a material medium, Gauss's theorem in dielectric, electric susceptibility and dielectric constant, dielectric loss, applications of dielectric material, point charge in a dielectric fluid, The Claussius-Mossotti relation, Polar molecules: The Langevin Debye Formula                                                                                                                                                                                                                                                                                                                                                                                                                               |                           |   |   |   |                 |
| <b>Module 3: Electromagnetic Induction and Electrical Circuits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                           |   |   |   | <b>24 hours</b> |
| Faraday's laws on electromagnetic induction, Lenz's law, Self induction, mutual induction, unit of inductance, energy stored in an inductor, motional emf, eddy current, AC generator, DC generator, DC motor, Induction motor, Transformer, energy loss, Determination of self and mutual inductance Helmholtz equation of growth and decay of current in L-R circuit, charging of a condenser, discharging of a condenser through an inductor, charging of a capacitor through L & R, discharge of a capacitor through L & R, AC circuits, operator J, AC circuit containing inductance, AC circuit containing Resistance and Inductance, AC circuit containing Resistance and capacitance, AC circuit containing Resistance, Inductance and Capacitance(series resonance circuit and parallel resonant circuit), Power in an AC circuit |                           |   |   |   |                 |
| <b>Module 4: Magnetostatics and Electromagnetic Theory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |   |   |   | <b>12 hours</b> |
| Biot-Savart's law and its applications, Magnetic materials, definitions of different parameters, diamagnetic, paramagnetic and ferromagnetic substances, ferromagnetic domains, hysteresis curve, hysteresis loss, calculation from area of hysteresis loop, soft and hard magnetic substances, Langevin theory of diamagnetism, Langevin theory of paramagnetism, Weiss's theory of ferromagnetism, Ampere's law, equation of continuity, Inconsistency of Ampere's law, Maxwell's modifications of Ampere's law, Displacement current, Maxwell's equations, Physical significance.                                                                                                                                                                                                                                                       |                           |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |   |   |   | <b>60 hours</b> |

| <b>Text Book(s)</b>    |                                                                                               |
|------------------------|-----------------------------------------------------------------------------------------------|
| 1.                     | Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw. |
| 2.                     | Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.                     |
| 3.                     | Introduction to Electrodynamics, D.J.Griffiths, 3 <sup>rd</sup> Edn.,1998, Benjamin Cummings. |
| 4.                     | Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.                   |
| <b>Reference Books</b> |                                                                                               |
| 1.                     | Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press         |
| 2.                     | Feynman Lectures Vol. 2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.      |
| 3.                     | Electricity and Magnetism, D C Tayal, 1988, Himalayan Publishing House.                       |

| DSC                                                                                                                         | MECHANICS AND PROPERTIES OF MATTER - LAB | L | T | P | C        |
|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---|---|---|----------|
|                                                                                                                             |                                          | 0 | 0 | 4 | 2        |
| Prerequisite : Basics of 12 standard Physics lab                                                                            |                                          |   |   |   |          |
| Course Objective :                                                                                                          |                                          |   |   |   |          |
| 1) The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. |                                          |   |   |   |          |
| 2) To develop the Experimental and Analytical Skills.                                                                       |                                          |   |   |   |          |
| 3) Understanding of basic physics concepts through direct observation of empirical evidence and hands on learning           |                                          |   |   |   |          |
| 4) The laboratory will help students understand the role of direct observation in physics                                   |                                          |   |   |   |          |
| Course Outcome:                                                                                                             |                                          |   |   |   |          |
| CO1: Learning basic concept of measuring apparatus and gravity of earth by using Kater’s pendulum and Bar pendulum          |                                          |   |   |   |          |
| CO2: Get the knowledge of moment of inertia of a body.                                                                      |                                          |   |   |   |          |
| CO3: To enhance the knowledge of elasticity and viscosity of materials and liquids.                                         |                                          |   |   |   |          |
| CO4: The course will help to understand the stress and strain of a materials                                                |                                          |   |   |   |          |
| List of Experiments :                                                                                                       |                                          |   |   |   |          |
| 1) To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.                                                      |                                          |   |   |   |          |
| 2) To determine the value of g using Bar Pendulum.                                                                          |                                          |   |   |   |          |
| 3) To find the value of g by using Kater’s pendulum                                                                         |                                          |   |   |   |          |
| 4) To find the moment of inertia of an unknown body by using moment of inertia table.                                       |                                          |   |   |   |          |
| 5) To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c)Modulus of rigidity.                       |                                          |   |   |   |          |
| 6) To determine the Moment of Inertia of a Flywheel.                                                                        |                                          |   |   |   |          |
| 7) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).                           |                                          |   |   |   |          |
| 8) To determine the elastic Constants of a wire by Searle’s method                                                          |                                          |   |   |   |          |
| 9) To determine the Young’s Modulus of a Wire by Optical Lever Method.                                                      |                                          |   |   |   |          |
| 10) Determination of the rigidity modulus of the material of a wire by Statical Method.                                     |                                          |   |   |   |          |
| Total Hours:                                                                                                                |                                          |   |   |   | 60 hours |
| Textbooks:                                                                                                                  |                                          |   |   |   |          |
| 1) A TEXT BOOK ON PRACTICAL PHYSICS: K. G. MAZUMDAR & B.GHOSH                                                               |                                          |   |   |   |          |
| 2) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH                                                                  |                                          |   |   |   |          |

| DSC                                                                                                                                                 | ELECTRICITY AND MAGNETISM LAB | L | T | P | C        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|---|---|---|----------|
|                                                                                                                                                     |                               | 0 | 0 | 4 | 2        |
| Prerequisite : Basics of 12 standard Physics lab                                                                                                    |                               |   |   |   |          |
| Course Objective :                                                                                                                                  |                               |   |   |   |          |
| 1) The students will have a good foundation in the fundamentals related to the experiments included in this course and their advanced applications. |                               |   |   |   |          |
| 2) The students will get motivated to develop small experiments related to these techniques and develop their physical understanding.               |                               |   |   |   |          |
| 3) Understanding of basic physics concepts through direct observation of empirical evidence and hands-on learning                                   |                               |   |   |   |          |
| Course Outcome:                                                                                                                                     |                               |   |   |   |          |
| CO1: Learning basic concept of measuring meter bridge, potentiometer and resonance circuit.                                                         |                               |   |   |   |          |
| CO2: Get the knowledge of earth's magnetic field and meter bridge.                                                                                  |                               |   |   |   |          |
| CO3: To enhance the knowledge of post office box and tangent galvanometer.                                                                          |                               |   |   |   |          |
| CO4: The course will help to understand the potential difference concept by using potentiometer.                                                    |                               |   |   |   |          |
| List of Experiments :                                                                                                                               |                               |   |   |   |          |
| 1) To find the value of horizontal components of earth's magnetic field by using magnetometer.                                                      |                               |   |   |   |          |
| 2) Compare the value of two low resistance by using drop of potential method using a meter bridge                                                   |                               |   |   |   |          |
| 3) Determination of ratio of two low resistance using Potentiometer.                                                                                |                               |   |   |   |          |
| 4) Determination of Resistance of a Galvanometer using Post Office Box.                                                                             |                               |   |   |   |          |
| 5) To determine the horizontal component ( $B_H$ ) of the earth's field by using Tangent Galvanometer.                                              |                               |   |   |   |          |
| 6) Determination of specific resistance of the material of a wire by meter bridge                                                                   |                               |   |   |   |          |
| 7) Measure the average resistance per unit length of a meter bridge wire by Carey-Foster method                                                     |                               |   |   |   |          |
| 8) Measured the EMF of a cell by using potentiometer.                                                                                               |                               |   |   |   |          |
| 9) Measured the current flowing in a circuit by using potentiometer                                                                                 |                               |   |   |   |          |
| 10) To draw the resonance curve of a series LCR circuit and hence determine th Q-factor.                                                            |                               |   |   |   |          |
| Total Hours:                                                                                                                                        |                               |   |   |   | 60 hours |
| Textbooks:                                                                                                                                          |                               |   |   |   |          |
| 3) A TEXT BOOK ON PRACTICAL PHYSICS: K. G. MAZUMDAR & B.GHOSH                                                                                       |                               |   |   |   |          |
| 4) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH                                                                                          |                               |   |   |   |          |

| DSE I                                                                                                                                                                                                        | Lasers and Nonlinear Optics | L | T | P | C               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                              |                             | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Quantum Mechanics and Electricity and Magnetism.                                                                                                                                       |                             |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                    |                             |   |   |   |                 |
| 1. To impart a comprehensive course on the operating principles – stimulated emission and population inversion, spectral properties and types of lasers.                                                     |                             |   |   |   |                 |
| 2. To disseminate lectures on the applications of lasers in industrial, biomedical and research and development sectors.                                                                                     |                             |   |   |   |                 |
| 3. To give the students an overview of nonlinear optics and the important properties of nonlinear optical materials.                                                                                         |                             |   |   |   |                 |
| 4. To evaluate the connection between the properties of nonlinear optical materials and the numerous phenomena that could be attributed to such properties.                                                  |                             |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                       |                             |   |   |   |                 |
| After successful completion of the course, the students will be able                                                                                                                                         |                             |   |   |   |                 |
| CO 1: to remember the basics of the operating principles and types of lasers.                                                                                                                                |                             |   |   |   |                 |
| CO 2: to understand the important properties and phenomena associated with nonlinear optical materials.                                                                                                      |                             |   |   |   |                 |
| CO 3: to apply the factors leading to nonlinear optical properties in materials.                                                                                                                             |                             |   |   |   |                 |
| CO 4: to analyze the spectral properties of lasers and to understand the applications of lasers in industrial, biomedical and research applications.                                                         |                             |   |   |   |                 |
| <b>Module 1: Basics, Operating Principles and Types of Lasers</b>                                                                                                                                            |                             |   |   |   | <b>20 Hours</b> |
| Introduction to lasers, Stimulated and Spontaneous Emission, Optical Cavities, Einstein Coefficients, Population Inversion, Threshold Condition, Laser Rate Equations, Three and Four level lasers, types of |                             |   |   |   |                 |

|                                                                                                                                                                                                                                                 |                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| lasers - CW and Pulsed Lasers, Examples of Lasers – Ruby, Helium-Neon and CO <sub>2</sub> Lasers.                                                                                                                                               |                                                                                                        |
| <b>Module 2: Spectral Properties and Uses of Lasers</b>                                                                                                                                                                                         | <b>10 hours</b>                                                                                        |
| Line Broadening Mechanisms – Natural, Collision and Doppler Broadening, Quality Factor, Industrial Applications – Laser Printing, Research Applications – Laser Induced Fusion and Laser Cooling, Biomedical Applications – Ophthalmic Surgery. |                                                                                                        |
| <b>Module 3: Nonlinear Optics</b>                                                                                                                                                                                                               | <b>15 hours</b>                                                                                        |
| Overview of Nonlinear Optics, Nonlinear Polarization, 2 <sup>nd</sup> Harmonic Generation, Phase Matching, Sum and Difference Frequency Generation, Optical Parametric Amplification.                                                           |                                                                                                        |
| <b>Module 4: Nonlinear Optical Phenomena</b>                                                                                                                                                                                                    | <b>15 hours</b>                                                                                        |
| Group Velocity Dispersion, Self-focusing, Kerr effect, Cross-Phase Modulation, Self-Phase Modulation, Four-Wave Mixing and Phase Conjugation.                                                                                                   |                                                                                                        |
| <b>Textbook (s)</b>                                                                                                                                                                                                                             |                                                                                                        |
| 1.                                                                                                                                                                                                                                              | <b>Optical Electronics, A. Ghatak and K. Thyagrajan, Cambridge India (2017).</b>                       |
| 2.                                                                                                                                                                                                                                              | <b>Nonlinear Optics, Robert Boyd, Academic Press Inc; 3rd edition (2008).</b>                          |
| 3.                                                                                                                                                                                                                                              | <b>Lasers and Nonlinear Optics, B. B. Laud, New Age International (2023).</b>                          |
| <b>Reference Books</b>                                                                                                                                                                                                                          |                                                                                                        |
| 1.                                                                                                                                                                                                                                              | <b>Lasers – Fundamentals and Applications, K. Thyagrajan and A. Ghatak, Laxmi Publications (2019).</b> |
| 2.                                                                                                                                                                                                                                              | <b>Introduction to Nonlinear Optics, Geoffrey New, Cambridge University Press (2011).</b>              |

| DSE I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Computational Physics | L | T | P       | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---|---|---------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       | 2 | 0 | 4       | 4 |
| Pre-requisite: Basic Physics and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                       |   |   |         |   |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |   |   |         |   |
| 1. To provide knowledge about the role of computers in solving physical problems.<br>2. To make students learn how to make flowcharts and algorithms to solve physical problems.<br>3. To teach programming languages Fortran and Python.<br>4. To provide hands-on training on computer programs for solving physical problems (applications).<br>5. To teach data visualization using basic commands of GNU plot, Matplotlib and Plotly.                                                                                                                                                                      |                       |   |   |         |   |
| Course Outcome:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |   |   |         |   |
| After successful completion of the course, the students will be able to<br>CO1: Remember the basic commands of GNU plot, Matplotlib and Plotly.<br>CO 2: Understand how to write computer programs using Fortran and Python to solve simple problems.<br>CO 3: Apply computers for solving problems in Physics.<br>CO 4: Analyse the role of computers in solving physical problems.                                                                                                                                                                                                                            |                       |   |   |         |   |
| Module 1: INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |   | 3 hours |   |
| Importance of computers in Physics, paradigm for solving physics problems for solution. Introduction to various OS, Linux OS such as RedHat, Ubuntu, Scientific Linux, Usage of Basic linux commands. Text editors such as vi and Emacs.                                                                                                                                                                                                                                                                                                                                                                        |                       |   |   |         |   |
| Module 2: BASICS OF SCIENTIFIC PROGRAMMING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |   |   | 4 hours |   |
| Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.                                                                                                                                                                 |                       |   |   |         |   |
| Module 3: SCIENTIFIC PROGRAMMING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |   |   | 9 hours |   |
| Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. |                       |   |   |         |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Programming with Python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                         |
| <b>Module 4: CONTROL STATEMENTS, FUNCTIONS AND SUBROUTINES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>9 hours</b>                                                                                                                                                                                          |
| Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. [SEP]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                         |
| <b>Module 5: VISUALIZATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>5 hours</b>                                                                                                                                                                                          |
| Introduction to graphical analysis and its limitations. Introduction to Gnuplot. Importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, curve fitting – straight line, polynomials, user defined function. Physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.<br><br>Visualization using Matplotlib, Plotly                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                         |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>30 hours</b>                                                                                                                                                                                         |
| <b>HANDS ON EXERCISES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>30hours</b>                                                                                                                                                                                          |
| <ol style="list-style-type: none"> <li>1) Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor.</li> <li>2) To print out all natural even/ odd numbers between given limits.</li> <li>3) To find maximum, minimum and range of a given set of numbers.</li> <li>4) Calculating Euler number using <math>\exp(x)</math> series evaluated at <math>x=1</math></li> <li>5) To compile a frequency distribution and evaluate mean, standard deviation etc.</li> <li>6) To evaluate sum of finite series and the area under a curve.</li> <li>7) To find the product of two matrices</li> <li>8) To find a set of prime numbers and Fibonacci series.</li> <li>9) To write program to open a file and generate data for plotting using Gnuplot.</li> <li>10) Plotting trajectory of a projectile projected horizontally.</li> <li>11) Plotting trajectory of a projectile projected making an angle with the horizontally.</li> <li>12) Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an [SEP]eps file and as a pdf file.</li> <li>13) To find the roots of a quadratic equation.</li> <li>14) Motion of a projectile using simulation and plot the output for visualization.</li> <li>15) Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.</li> <li>16) Motion of particle in a central force field and plot the output for visualization.</li> </ol> |                                                                                                                                                                                                         |
| <b>Total hours (Lecture + Hands on) = 60 hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                         |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                         |
| <ol style="list-style-type: none"> <li>1. Introduction to Numerical Analysis, S.S. Sastry, 5<sup>th</sup> Edn., 2012, PHI Learning Pvt. Ltd.</li> <li>2. Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).</li> <li>3. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                         |
| <ol style="list-style-type: none"> <li>1.</li> <li>2.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010) Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)</p> |

| DSE I                                                                                                                                                                                                                                                                                                                                                                                                                                            | INTRODUCTION TO NANOSCIENCE                                                                            | L | T | P | C        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        | 4 | 0 | 0 | 4        |
| Pre-requisite: Basic Physics                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |   |          |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                        |   |   |   |          |
| 1. To provide fundamental knowledge about nonmaterial's                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        |   |   |   |          |
| 2. To enable students to learn different methods of synthesis and characterization of nano structured materials.                                                                                                                                                                                                                                                                                                                                 |                                                                                                        |   |   |   |          |
| 3. To make students familiar with optical properties of nonmaterial's.                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   |   |          |
| 4. To learn about the remarkable electron transport properties of nonmaterial's.                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                        |   |   |   |          |
| 5. To provide knowledge about application of nonmaterial's.                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                        |   |   |   |          |
| Course Outcome:                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |   |   |   |          |
| After successful completion of the course, the students will be able to                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        |   |   |   |          |
| CO 1: Remember the laws related to physics at the nanoscale.                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |   |          |
| CO 2: Understand different features associated with optical and transport properties at the nanoscale.                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   |   |          |
| CO 3: Apply properties of materials at the nanoscale in emerging areas.                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        |   |   |   |          |
| CO 4: Analyse different methods of synthesis and characterization of nanomaterials.                                                                                                                                                                                                                                                                                                                                                              |                                                                                                        |   |   |   |          |
| Module 1: NANOSCALE SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                        |   |   |   | 10 hours |
| Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement : Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.                         |                                                                                                        |   |   |   |          |
| Module 2: SYNTHESIS OF NANOSTRUCTURE MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        |   |   |   | 8 hours  |
| Top down and Bottom-up approach, Photolithography, Ball milling, Gas phase condensation, Vacuum deposition, Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapor deposition (CVD), Sol-Gel, Electro deposition, Spray pyrolysis. Hydrothermal synthesis, Preparation through colloidal methods, Molecular Beam Epitaxy growth of quantum dots.                                      |                                                                                                        |   |   |   |          |
| Module 3: CHARACTERIZATION                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                        |   |   |   | 8 hours  |
| X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy                                                                                                                                                                                                                                                                                    |                                                                                                        |   |   |   |          |
| Module 4: OPTICAL PROPERTIES                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |   | 14 hours |
| Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons, Excitons in direct and indirect band gap semiconductor nanocrystals, Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures |                                                                                                        |   |   |   |          |
| Module 5: ELECTRON TRANSPORT                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |   | 6 hours  |
| Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects.                                                                                                                                                                                                                                                                   |                                                                                                        |   |   |   |          |
| Module 5: APPLICATIONS                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   |   | 14 hours |
| Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots- magnetic data storage. Micro Electromechanical Systems (MEMS), Nano electromechanical Systems (NEMS).       |                                                                                                        |   |   |   |          |
| Total Lecture hours                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                        |   |   |   | 60 hours |
| Text Book(s)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                               | C. P. Poole Jr. & F. J. Owens, <i>Introduction to Nanotechnology</i> , (Wiley-Interscience,2003)       |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                               | S.K. Kulkarni, <i>Nanotechnology: Principles &amp; Practices</i> (Capital Publishing Company)          |   |   |   |          |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                               | K.K. Chattopadhyay and A. N. Banerjee, <i>Introduction to Nanoscience and Technology</i>               |   |   |   |          |
| Reference Books                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                               | Richard Booker, Earl Boysen, <i>Nanotechnology</i> (John Wiley and Sons).                              |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                               | M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, <i>Nanoparticle Technology Handbook</i> (Elsevier, 2007). |   |   |   |          |



## Semester V

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Analog Electronics                                                                                | L | T | P | C               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Preliminary concept of 12 <sup>th</sup> standard Physics course.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                   |   |   |   |                 |
| <b>Course Objectives:</b><br>(1)To enhance the knowledge in band theory of solids and semiconductors.<br>(2)To have a thorough knowledge on optical excitation and devices.<br>(3)To have a broader concept on junctions to understand semiconductor devices.<br>(4) To enhance the knowledge of transistors and their applications.<br>(5) To develop the concept of oscillators.                                                                                                                                                                                                                                                           |                                                                                                   |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO 1: to remember different parameters related to the electronic devices.<br>CO 2: to understand the basics of junction diodes, transistors, amplifiers, oscillators and CRO.<br>CO 2: to apply the theories of basic electronic circuits to study their characteristics curves.<br>CO 3: to analyze the results of different parameters related to the electronics circuits.                                                                                                                                                              |                                                                                                   |   |   |   |                 |
| <b>Module 1: Junctions Diodes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                   |   |   |   | <b>12 hours</b> |
| Fabrication and Types of Junctions, Unbiased pn junction, energy level diagram and built in potential, diffusion and drift of carriers: Einstein relation, biased pn junction, volt-amp characteristic of pn junction, effect of temperature on I-V characteristics, DC and AC resistance of pn junction, junction capacitance, Zener diode, tunnel diode, light emitting diode, point contact diode, liquid crystal display.                                                                                                                                                                                                                |                                                                                                   |   |   |   |                 |
| <b>Module 2: Transistors</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                   |   |   |   | <b>12 hours</b> |
| Introduction, Bipolar Junction Transistor, Transistor currents, Transistor fabrication, Transistor Configuration and Characteristics, Common base and common emitter static characteristics, Transistor $\alpha$ and $\beta$ , current and voltage notation, load line, transistor biasing:fixed bias or base bias, collector-feedback bias, emitter- feedback bias..                                                                                                                                                                                                                                                                        |                                                                                                   |   |   |   |                 |
| <b>Module 3: Amplifiers</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                   |   |   |   | <b>20 hours</b> |
| Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as a 2-port Network. H-parameter. Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model.Input and Output Impedance. Current, Voltage, and Power Gains. Classification of Class A, B & C Amplifiers. Differential amplifiers.<br>Characteristics of an Ideal and Practical Op-Amp (IC 741). Open-loop and Closed-loop Gain.<br>Frequency Response. CMRR. Slew Rate and Concept of Virtual Ground.<br>Field effect transistors: JFET, MOSFET, FET amplified model and parameters, FET versus BJTs, Feedback principle. |                                                                                                   |   |   |   |                 |
| <b>Module 4: Oscillators</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                   |   |   |   | <b>8 hours</b>  |
| Types of oscillators, basic principle of oscillator, requirements of feedback oscillators, tuned-collector oscillator, Hartley Oscillator, Colpitts Oscillator, phase shift oscillator                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                   |   |   |   |                 |
| <b>Module 5: Introduction to Cathode Ray Oscilloscope (CRO)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   |   |   |   | <b>8 hours</b>  |
| Block Diagram of CRO. Electron Gun, Deflection System, and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                   |   |   |   | <b>60 hours</b> |
| <b>Textbook(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                   |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006).             |   |   |   |                 |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Jasprit Singh, Semiconductor Devices: Basic Principles by John Wiley & Sons ptd Ltd Singapore     |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Donald Neamen , Dhruves Biswas “Semiconductor Physics and Devices” McGraw-Hill Education          |   |   |   |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | C.T. Sah, Fundamentals of solid-state electronics, World Scientific Publishing Co Inc, 1991.      |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                   |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Y. Tsividis and M. Colin, Operation and Modeling of the MOS Transistor. Oxford Univ. Press, 2011  |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021. |   |   |   |                 |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                   | Waves and Optics | L | T | P | C               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                       |                  | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Basic Physics and Mathematics                                                                                                                                                                                                                                                                                                                                                                   |                  |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                             |                  |   |   |   |                 |
| 1. To provide the fundamental knowledge of collinear and perpendicular harmonic oscillations.                                                                                                                                                                                                                                                                                                                         |                  |   |   |   |                 |
| 2. To enable students to learn different properties wave motion, velocity of waves and their superposition.                                                                                                                                                                                                                                                                                                           |                  |   |   |   |                 |
| 3. To make students familiar with electromagnetic nature of light and its properties.                                                                                                                                                                                                                                                                                                                                 |                  |   |   |   |                 |
| 4. To make students familiar with wave phenomena like interference and diffraction and interferometers.                                                                                                                                                                                                                                                                                                               |                  |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                |                  |   |   |   |                 |
| After successful completion of the course, the students will be able to                                                                                                                                                                                                                                                                                                                                               |                  |   |   |   |                 |
| CO 1: Remember the fundamentals of interference and diffraction and other phenomena of wave optics.                                                                                                                                                                                                                                                                                                                   |                  |   |   |   |                 |
| CO 2: Understand the electromagnetic nature of light.                                                                                                                                                                                                                                                                                                                                                                 |                  |   |   |   |                 |
| CO 3: Apply the knowledge of collinear and perpendicular harmonic oscillations to related fields.                                                                                                                                                                                                                                                                                                                     |                  |   |   |   |                 |
| CO 4: Analyze the properties of superposition of waves and their applications.                                                                                                                                                                                                                                                                                                                                        |                  |   |   |   |                 |
| <b>Module 1: SUPERPOSITION OF COLLINEAR HARMONIC OSCILLATIONS</b>                                                                                                                                                                                                                                                                                                                                                     |                  |   |   |   | <b>8 hours</b>  |
| Simple harmonic motion (SHM), linearity and superposition principle, superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (beats). Superposition of N collinear harmonic oscillations with (1) equal phase differences and (2) equal frequency differences.                                                                                                         |                  |   |   |   |                 |
| <b>Module 2: SUPERPOSITION OF PERPENDICULAR HARMONIC OSCILLATIONS</b>                                                                                                                                                                                                                                                                                                                                                 |                  |   |   |   | <b>3 hours</b>  |
| Graphical and analytical methods. Lissajous figures with equal and unequal frequencies and their uses.                                                                                                                                                                                                                                                                                                                |                  |   |   |   |                 |
| <b>Module 3: WAVE MOTION</b>                                                                                                                                                                                                                                                                                                                                                                                          |                  |   |   |   | <b>9 hours</b>  |
| Plane and spherical waves. Longitudinal and Transverse waves. Plane progressive (Travelling) waves. Wave equation. Particle and wave velocities. Pressure of a longitudinal wave. Energy transport. Intensity of Wave.                                                                                                                                                                                                |                  |   |   |   |                 |
| <b>Module 4: VELOCITY OF WAVES</b>                                                                                                                                                                                                                                                                                                                                                                                    |                  |   |   |   | <b>8 hours</b>  |
| Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.                                                                                                                                                                                                                                            |                  |   |   |   |                 |
| <b>Module V: SUPERPOSITION OF TWO HARMONIC WAVES</b>                                                                                                                                                                                                                                                                                                                                                                  |                  |   |   |   | <b>5 hours</b>  |
| Stationary (Stationary) waves in a string: fixed and free ends. Analytical treatment. Phase and group velocities. Changes with respect to position and time.                                                                                                                                                                                                                                                          |                  |   |   |   |                 |
| <b>Module VI: WAVE OPTICS</b>                                                                                                                                                                                                                                                                                                                                                                                         |                  |   |   |   | <b>3 hours</b>  |
| Electromagnetic nature of light. Definition and properties of wavefront. Huygen's Principle. Temporal and Spatial coherence.                                                                                                                                                                                                                                                                                          |                  |   |   |   |                 |
| <b>Module VII: Interference</b>                                                                                                                                                                                                                                                                                                                                                                                       |                  |   |   |   | <b>9 hours</b>  |
| Division of amplitude and wavefront. Young's double slit experiment. Lloyd's mirror and Fresnel's biprism, phase change on reflection: Stoke's treatment. Interference in thin films, parallel and wedge-shaped films, fringes of equal inclination (Haidinger fringes), fringes of equal thickness (Fizeau fringes). Newton's rings: Measurement of wavelength and refractive index. Interferometers (basic concept) |                  |   |   |   |                 |
| <b>Module VIII: Polarization</b>                                                                                                                                                                                                                                                                                                                                                                                      |                  |   |   |   | <b>5 hours</b>  |
| Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering, Polarization by double refraction and Huygen's theory, Nicol prism, production and analysis of circularly and elliptically polarized light.                                                                                                                                              |                  |   |   |   |                 |
| <b>Module IX: Diffraction</b>                                                                                                                                                                                                                                                                                                                                                                                         |                  |   |   |   | <b>10 hours</b> |
| Fraunhofer diffraction: Single slit, rectangular and circular aperture, resolving power of a telescope, double slit, multiple slits, diffraction grating, resolving power of a grating.                                                                                                                                                                                                                               |                  |   |   |   |                 |
| Fresnel diffraction: Fresnel's Assumptions. Fresnel's half period zones for plane wave, explanation of rectilinear propagation of light. Theory of Zone Plate: Multiple foci of a zone plate, Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.                                                                                                                                  |                  |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                            |                  |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                   |                  |   |   |   |                 |

|                        |                                                                                  |
|------------------------|----------------------------------------------------------------------------------|
| 1.                     | Waves: Berkeley Physics Course, Vol. 3, Francis Crawford, 2007, Tat McGraw-Hill. |
| 2.                     | Optics, Ajoy Ghatak, Tata McGraw-Hill.                                           |
| <b>Reference Books</b> |                                                                                  |
| 1.                     | Fundamentals of Optics, F.A. Jenkins and H.E.White, 1981, Mc-Graw Hill.          |
| 2.                     | Vibrations and Waves, A.P. French, 1 <sup>st</sup> Edn, 2003, CRC Press.         |

| DSC                                                                                                                                                                                          | ANALOG ELECTRONICS LAB                                                                                               | L | T | P | C        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                              |                                                                                                                      | 0 | 0 | 4 | 2        |
| Prerequisite : Basics of 12 standard Physics lab                                                                                                                                             |                                                                                                                      |   |   |   |          |
| Course Objective :                                                                                                                                                                           |                                                                                                                      |   |   |   |          |
| 1) The Objective of this course is to provide an experimental foundation for the theoretical concepts introduced in the lectures.                                                            |                                                                                                                      |   |   |   |          |
| 2) To help students understand the role of direct observation in physics and to distinguish between inferences based on theory and the outcomes of experiments.                              |                                                                                                                      |   |   |   |          |
| 3) The students will acquire motivation to develop small experiments related to these techniques and develop their physical understanding.                                                   |                                                                                                                      |   |   |   |          |
| 4) Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.                            |                                                                                                                      |   |   |   |          |
| Course Outcome:                                                                                                                                                                              |                                                                                                                      |   |   |   |          |
| CO1: Learning basic concept of diode and Zener diode and its working principle                                                                                                               |                                                                                                                      |   |   |   |          |
| CO2: Get the knowledge of transistor and its working principle.                                                                                                                              |                                                                                                                      |   |   |   |          |
| CO3: To enhance the knowledge of hall effect and band theory of semiconductors and                                                                                                           |                                                                                                                      |   |   |   |          |
| CO4: The course will help to understand the concept of dielectric and ferroelectric material.                                                                                                |                                                                                                                      |   |   |   |          |
| List of Experiments :                                                                                                                                                                        |                                                                                                                      |   |   |   |          |
| 1) To draw the static characteristics curves of a semiconductor diode and hence to determine its DC and AC resistance for a given current.                                                   |                                                                                                                      |   |   |   |          |
| 2) To draw the characteristics of a Zener diode.                                                                                                                                             |                                                                                                                      |   |   |   |          |
| 3) To draw characteristics curves of a Transistor in CE configuration for different base currents and to determine the AC current gain from the active region of the characteristics curves. |                                                                                                                      |   |   |   |          |
| 4) To determine the Planck’s constant using LEDs of at least 4 different colours.                                                                                                            |                                                                                                                      |   |   |   |          |
| 5) Determine the Band gap of a semiconductor by four probe method                                                                                                                            |                                                                                                                      |   |   |   |          |
| 6) Measure the Hall Effect in Semiconductor.                                                                                                                                                 |                                                                                                                      |   |   |   |          |
| 7) Measurement of magnetic susceptibility by Quincke’s tube method                                                                                                                           |                                                                                                                      |   |   |   |          |
| 8) To determine the dielectric constant of material                                                                                                                                          |                                                                                                                      |   |   |   |          |
| 9) To study the half wave and full wave rectifier of a diode                                                                                                                                 |                                                                                                                      |   |   |   |          |
| 10) To draw static characteristics of a junction field effect transistor(FET) and hence to determine its parameters                                                                          |                                                                                                                      |   |   |   |          |
| Total Lab Hours :                                                                                                                                                                            |                                                                                                                      |   |   |   | 60 Hours |
| Text Books :                                                                                                                                                                                 |                                                                                                                      |   |   |   |          |
| 1.                                                                                                                                                                                           | ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B. L. FLINT AND H.T. WORSNOP,                                               |   |   |   |          |
| 2.                                                                                                                                                                                           | 1971, ASIA PUBLISHING HOUSE<br>A TEXT BOOK OF PRACTICAL PHYSICS, I.PRAKASH & RAMAKRISHNA, 11THED., 2011, KITAB MAHAL |   |   |   |          |
| 3.                                                                                                                                                                                           | A TEXT BOOK ON PRACTICAL PHYSICS: K.G. MAZUMDAR & B.GHOSH.                                                           |   |   |   |          |
| 4.                                                                                                                                                                                           | A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH.                                                             |   |   |   |          |

| DSC                                                                                                                                                                                  | Waves and Optics Lab                                                      | L | T | P | C        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                      |                                                                           | 0 | 0 | 4 | 2        |
| Prerequisite : Basics of 12 standard Physics lab                                                                                                                                     |                                                                           |   |   |   |          |
| Course Objective                                                                                                                                                                     |                                                                           |   |   |   |          |
| 1) The students will be able to interpret data (both theoretical and experimental) and subsequently learn how the important parameters can be derived from a given set of results. . |                                                                           |   |   |   |          |
| 2) The students will be able to understand the operational principle of these components while using them for experimental investigations.                                           |                                                                           |   |   |   |          |
| 3) The students will learn the physics of different optical instrumentations and the ways to improve the knowledge of nature of light.                                               |                                                                           |   |   |   |          |
| Course Outcome:                                                                                                                                                                      |                                                                           |   |   |   |          |
| CO1: Students get the basic idea of the knowledge of nature of light.                                                                                                                |                                                                           |   |   |   |          |
| CO2: Get the knowledge of focal length and other properties of light.                                                                                                                |                                                                           |   |   |   |          |
| CO3: To enhance the knowledge of refractive index and diffraction of light.                                                                                                          |                                                                           |   |   |   |          |
| CO4: The course will help to understand the nature of ultrasonic wave and different modes of wave.                                                                                   |                                                                           |   |   |   |          |
| List of Experiments :                                                                                                                                                                |                                                                           |   |   |   |          |
| 1) Determine the power of a) convex lens b) concave lens.                                                                                                                            |                                                                           |   |   |   |          |
| 2) Determine the focal length of a concave mirror with the help of a convex lens                                                                                                     |                                                                           |   |   |   |          |
| 3) Determine the refractive index of water by using convex lens and a mirror                                                                                                         |                                                                           |   |   |   |          |
| 4) To determine the radius of curvature of a Plano-Convex lens by using Newton's ring apparatus.                                                                                     |                                                                           |   |   |   |          |
| 5) To determine the refractive index of the material of a prism by using Spectrometer.                                                                                               |                                                                           |   |   |   |          |
| 6) To determine the wavelength of laser source using diffraction of single slit.                                                                                                     |                                                                           |   |   |   |          |
| 7) To determine the wavelength of laser source using diffraction of single slit.                                                                                                     |                                                                           |   |   |   |          |
| 8) To determine the wavelength of laser source by using diffraction grating.                                                                                                         |                                                                           |   |   |   |          |
| 9) To determine the frequency of an electrically maintained tuning fork by,                                                                                                          |                                                                           |   |   |   |          |
| a) Transverse mode of vibration b) Longitudinal mode of vibration.                                                                                                                   |                                                                           |   |   |   |          |
| Total Hours:                                                                                                                                                                         |                                                                           |   |   |   | 60 hours |
| Textbooks:                                                                                                                                                                           |                                                                           |   |   |   |          |
| 1)                                                                                                                                                                                   | A Text Book On Practical Physics: K.G. Mazumdar & B.Ghosh                 |   |   |   |          |
| 2)                                                                                                                                                                                   | A Text Book On Practical Physics: Dr. Samir Kumar Ghosh                   |   |   |   |          |
| 3)                                                                                                                                                                                   | Advanced Practical Physics For Students, B. L. Flint And H.T. Worsnop     |   |   |   |          |
| 4)                                                                                                                                                                                   | A Text Book Of Practical Physics, I.Prakash & Ramakrishna, 11th ed., 2011 |   |   |   |          |

| DSE II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SUSTAINABILITY SCIENCE                                                                                                       | L | T | P | C        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                              | 4 | 0 | 0 | 4        |
| Pre-requisite: 12 <sup>th</sup> standard Physics course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              |   |   |   |          |
| Course Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                              |   |   |   |          |
| (1) aims to enhance the knowledge on sustainability development by means of various theories.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                              |   |   |   |          |
| (2) to have a broader perspective of sustainability goals and green technology.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                              |   |   |   |          |
| (3) to have a wider concept on different approaches of sustainability development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |   |   |   |          |
| Course Outcome:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                              |   |   |   |          |
| After successful completion of the course, the students will be able                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                              |   |   |   |          |
| CO 1: to remember different laws related to sustainable development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                              |   |   |   |          |
| CO 2: to understand green technologies and different approaches to sustainability development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                              |   |   |   |          |
| CO 3: to apply various technological approaches towards sustainability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              |   |   |   |          |
| CO 4: to analyze the best technique for a sustainable future.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                              |   |   |   |          |
| Module 1: Sustainability and sustainable development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                              |   |   |   | 20 hours |
| Introduction, Objectives, Population and food, Resources and limits to growth, understanding sustainability development-pillars of sustainable development, ecological foundations of basic human needs-human needs and approaches: Abraham Maslow’s Hierarchy of needs and related approaches, human scale development approach, sustainability hierarchy, equity, basic needs and ecology, principles of sustainability development, Brundtland report, post Brundtland report-evolving concept, the post Brundtland: critics, intra and Inter-generational equity in resources availability, dimensions of sustainability, Sustainable Development Goals (SDGs) and strategies to achieve the 17 SDGs                                                                                                                                                                                                                              |                                                                                                                              |   |   |   |          |
| Module 2: Sustainability science and Green technology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |   |   |   | 20 hours |
| Objectives, defining sustainability science, central elements of sustainability science, goal and structure of sustainability science, sustainability science as discipline, global challenges, human population and growth rate, inequities and social disruption, gender dimension in environmental issues, climate change, rising materialism and vanishing ethical issues, Technology and society, essential components of technology-hardware and software, peopleware, management ware, systems of technology-nonmineral based versus mineral based technologies, automation versus labour intense technologies, centralized versus decentralized technologies, individual versus collective technologies, single purpose versus multi-purpose technologies,n technological development and environment, evolutionary capacity of technology, concept of sustainable technology, constraints in adopting sustainable technology |                                                                                                                              |   |   |   |          |
| Module 3: Approaches towards sustainability development                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              |   |   |   | 20 hours |
| Natural resource management: objectives, natural resources-classification and components, problems and issues, natural resource management-causes and depletion of natural resources, approaches applied on natural resource management-integrated approach, adaptive approach, precautionary approach, community based natural resource management, gender and natural resource management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                              |   |   |   |          |
| Watershed Management: Objectives, the watershed, characteristics, concept and definition of watershed management-watershed management and local livelihood, watershed management in India, Approaches-sectoral approach for watershed management, integrated watershed management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |   |   |   |          |
| Participation in policy and planning: objectives, concepts, coordination, collaboration and cooperation, participatory development communication, tools and methodology for effective utilization of communication, Physical exposure to organizations working on sustainable practices and relevant activities, e.g., WWF-India, Climate Partner, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              |   |   |   |          |
| Total Lecture hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                              |   |   |   | 60 hours |
| Text Book(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                              |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Jeremy L. Caradonna, <i>Sustainability: A History</i> , (2014), Oxford University Press.                                     |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | David Auge, <i>Man’s Search for Sustainability</i> , (2023), AMZ Book Publishing Services.                                   |   |   |   |          |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bell, Michael and Michael, S. Carolan, <i>An Invitation to Environmental Sociology</i> , (2004), Pine Forge Press, New York. |   |   |   |          |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ellent, R, <i>Environment, Subsistence and System</i> , (1983), Cambridge University Press.                                  |   |   |   |          |
| Reference Books                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                              |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Sustainability Science: Managing Risk and Resilience for Sustainable Developpment, (2023).                                   |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Maslow, A.H, <i>Motivation and Human Personality</i> (1970), Harper, New York.                                               |   |   |   |          |

| DSE II                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CRYSTAL ANALYSIS                                                                                                            | L | T | P | C               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                             | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> 12 <sup>th</sup> standard Physics course                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                             |   |   |   |                 |
| <b>Course Objective</b><br>(1) aims to enhance the concepts of crystal structure by study of different parameters and structure of different crystals<br>(2) to be familiar with the properties, applications of X-rays and X-ray diffraction methods.<br>(3) enhance the knowledge of all experimental techniques which explains crystal structure.<br>(4) to have a broader perspective on the analysis of crystal composition, size, and morphology via different techniques. |                                                                                                                             |   |   |   |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br>CO1: to remember various laws in crystals and their characteristics.<br>CO2: to understand X-ray diffraction studies related to crystals, experimental techniques and analysis.<br>CO3: to apply the theories of crystals in the structural study.<br>CO4: to analyze the crystal structure through different theoretical and experimental techniques.                         |                                                                                                                             |   |   |   |                 |
| <b>Module 1: Crystal Structure</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                             |   |   |   | <b>10 hours</b> |
| Solids: Amorphous and crystalline, space lattice, basis vectors, unit cell, lattice parameters, crystal systems, Bravais lattices, crystal plane and Miller Indices, interplanar spacing, indices of a direction, symmetry and symmetry elements.                                                                                                                                                                                                                                |                                                                                                                             |   |   |   |                 |
| <b>Module 2: X-Ray Diffraction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                             |   |   |   | <b>20 hours</b> |
| X Rays- production, continuous and characteristic X rays, X-ray diffraction, Laue experiment, Bragg’s law, Laue equations, X –ray powder diffraction, Debye- Scherrer Technique.<br>Reciprocal lattice, Geometrical Construction of the reciprocal lattice, reciprocal lattice for simple cubic and f.c.c lattices, diffraction of X-rays on reciprocal lattice, Bragg’s condition in terms of reciprocal lattice, vector form of Bragg’s equation, Brillouin Zone.              |                                                                                                                             |   |   |   |                 |
| <b>Module 3: Experimental Techniques</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                             |   |   |   | <b>15 hours</b> |
| Basics of TEM, TEM instrumentation: electron sources; electromagnetic lenses; geometric and wave optics applied to TEM; lens aberrations and resolution<br>Interaction between fast electron and thin crystal, SEM, EDS, SAED (experimental details).                                                                                                                                                                                                                            |                                                                                                                             |   |   |   |                 |
| <b>Module 4: Analysis</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                             |   |   |   | <b>15 hours</b> |
| Analysis of a sample: X-ray fluorescence, X-ray diffraction, SEM, TEM, HR-TEM, EDS, SAED (students are to visit to Instrumentation centres having these facilities)                                                                                                                                                                                                                                                                                                              |                                                                                                                             |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                             |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                             |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | William D. Callister, Jr., Materials Science and Engineering: An Introduction, 7th Edition, John Wiley & Sons, (2006).      |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Maureen M. Julian, Foundations of Crystallography, Taylor & Francis Group (2008).                                           |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Martin T. Dove, Structure and Dynamics-An atomic view of materials, Oxford University Press, (2003).                        |   |   |   |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | B.D. Cullity and S.R. Stock, Elements of X-ray Diffraction, 3rd edition, Addison-Wesley Publishing Company (2001).          |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                             |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J. W. Edington, Practical Electron Microscopy in Materials Science, MacMillan, Philips Technical Library, Eindhoven (1974). |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | M. de Graef, Introduction to Conventional Transmission Electron Microscopy, Cambridge University Press, New York (2003).    |   |   |   |                 |

## Semester VI

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Thermal Physics                                                                                                                                       | L | T | P | C               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                       | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Mathematical Physics and Basic Physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                       |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                       |   |   |   |                 |
| 1. To deliver a comprehensive course on the basics of thermodynamics, the laws of radiation and statistical physics at the undergraduate level.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                       |   |   |   |                 |
| 2. To disseminate lecture on the physics behind the three laws of thermodynamics and the concepts of Entropy and Unattainability of Absolute Zero.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                       |   |   |   |                 |
| 3. To give the students a view of why the statistical description of the photon - quanta of radiation is important in the theory of thermal radiation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                       |   |   |   |                 |
| 4. To analyze how the statistical concept of microstates and macrostates could explain the thermodynamic properties of materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                       |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                       |   |   |   |                 |
| After successful completion of the course, the students will be able                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                       |   |   |   |                 |
| CO 1: to remember the Zeroth and First Law of Thermodynamics in the work done in thermodynamics processes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                       |   |   |   |                 |
| CO 2: to understand the concept of Entropy in thermodynamic transformations and the physics of phase transitions on the basics of the Maxwell's Relations and the Clausius-Clayperon's Equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                       |   |   |   |                 |
| CO 3: to apply the basics of thermodynamic properties such viscosity, conductivity and diffusivity in the Kinetic Theory of Gases.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                       |   |   |   |                 |
| CO 4: to analyze how the ultraviolet catastrophe was resolved by adopting the principles of quantum mechanics in the statistical description of radiation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                       |   |   |   |                 |
| <b>Module 1: Fundamental Concepts and the First Law of Thermodynamics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                       |   |   |   | <b>15 Hours</b> |
| Basic Idea of the Thermodynamic Description of a System, Zeroth Law of Thermodynamics, Thermal Equilibrium, Concept of Temperature. Exact Differentials, First Law of Thermodynamics – Internal Energy, Work Done in Thermodynamic Processes – Isothermal, Adiabatic, Isobaric and Isochoric, Path Dependence of Work Done, Degrees of Freedom, $C_p$ - $C_v$ and $C_p/C_v$ Relation.                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                       |   |   |   |                 |
| <b>Module 2: 2<sup>nd</sup> Law of Thermodynamics, Entropy and Thermodynamic Potentials</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                       |   |   |   | <b>15 hours</b> |
| Carnot Cycle, Second Law of Thermodynamics – Clausius and Kelvin-Planck Statement, Entropy, Temperature-Entropy Diagrams, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of Thermodynamics – Unattainability of Absolute Zero (Qualitative Idea). TdS Equations, Physics of the Thermodynamic Potentials - Internal Energy, Enthalpy, Helmholtz free energy, and Gibbs free energy, Maxwell's Relations, Joule-Thompson Expansion, Phase Transition – 1 <sup>st</sup> and 2 <sup>nd</sup> order and the Clausius-Clayperon Equation, Surface Films and Variation of Surface Tension with Temperature, Magnetic World and Cooling due to Adiabatic Demagnetization. |                                                                                                                                                       |   |   |   |                 |
| <b>Module 3: Kinetic Theory of Gases</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                       |   |   |   | <b>10 hours</b> |
| Basic Assumptions, Molecular Flux, Principle of Equipartition of Energy, Classical Theory of Specific Heat Capacity. Real Gas and the Van der Waals' Equation of State, Collision Cross Section, Mean Free Path, Coefficient of Viscosity, Thermal Conductivity and Diffusion.                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                       |   |   |   |                 |
| <b>Module 4: Thermal Radiation and Statistical Physics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                       |   |   |   | <b>20 hours</b> |
| Blackbody Radiation, Spectral Distribution, Rayleigh-Jean's Law, Ultraviolet Catastrophe, Planck's Postulate, Birth of Quantum Mechanics, Stefan-Boltzmann Law, Wien's Displacement Law.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                       |   |   |   |                 |
| Energy States and Energy Levels, Necessity of Statistics in Thermodynamics, Macrostate and Microstate, Boltzmann and Shannon Entropy, Thermodynamic, Probability, Classical Statistics - Maxwell-Boltzmann Distribution, Quantum Statistics – Fermi-Dirac and Bose-Einstein Distribution.                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                       |   |   |   |                 |
| <b>Textbook (s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                       |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics</b> , S. C. Garg, R. M. Bansal and C. K. Ghosh, McGraw Hill (2017). |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Thermodynamics, Kinetic Theory and Statistical Thermodynamics</b> , F. W. Sears and G. L. Sallinger, Narosa Publishing House (1975).               |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Heat and Thermodynamics</b> , R. H. Dittman and M. W. Zemansky, McGraw Hill (2017).                                                                |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                       |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>An Introduction to Thermal Physics</b> , D. V. Schroeder, Oxford University Press (2021).                                                          |   |   |   |                 |

| DSC                                                                                                                                                                                                                                                           | Digital Electronics                                                                              | L | T | P | C        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                                                                                               |                                                                                                  | 4 | 0 | 0 | 4        |
| Pre-requisite: Basic Physics and Mathematics                                                                                                                                                                                                                  |                                                                                                  |   |   |   |          |
| Course Objectives:                                                                                                                                                                                                                                            |                                                                                                  |   |   |   |          |
| 1. To teach students the basics of digital circuits and Boolean algebra.                                                                                                                                                                                      |                                                                                                  |   |   |   |          |
| 2. To learn different concepts associated with arithmetic circuits and sequential circuits.                                                                                                                                                                   |                                                                                                  |   |   |   |          |
| 3. To make students familiar with microprocessor architecture.                                                                                                                                                                                                |                                                                                                  |   |   |   |          |
| Course Outcome:                                                                                                                                                                                                                                               |                                                                                                  |   |   |   |          |
| After successful completion of the course, the students will be able to                                                                                                                                                                                       |                                                                                                  |   |   |   |          |
| CO 1: Remember the laws of Boolean algebra.                                                                                                                                                                                                                   |                                                                                                  |   |   |   |          |
| CO 2: Understand the working principle of CRO, data processing circuits, arithmetic circuits and sequential circuits.                                                                                                                                         |                                                                                                  |   |   |   |          |
| CO 3: Apply digital logic to solve real life problems.                                                                                                                                                                                                        |                                                                                                  |   |   |   |          |
| CO 4: Analyze the integrated circuits in the architecture of a microprocessor.                                                                                                                                                                                |                                                                                                  |   |   |   |          |
| Module 1: INTRUDUCTION TO CRO                                                                                                                                                                                                                                 |                                                                                                  |   |   |   | 4 hours  |
| Block Diagram of CRO, Electron Gun, Deflection System and Time Base, Deflection Sensitivity, Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.                                                |                                                                                                  |   |   |   |          |
| Module 2: DIGITAL CIRCUITS                                                                                                                                                                                                                                    |                                                                                                  |   |   |   | 12 hours |
| Difference between analog and digital circuits, binary numbers, decimal to binary and binary to decimal conversion, BCD, octal and hexadecimal numbers. AND, OR and NOT gates, NAND and NOR gates as universal gates, XOR and XNOR gates.                     |                                                                                                  |   |   |   |          |
| Module 3: BOOLEAN ALGEBRA                                                                                                                                                                                                                                     |                                                                                                  |   |   |   | 10 hours |
| De Morgan's Theorems, Boolean laws, simplification of logic circuit using Boolean Algebra, fundamental products, idea of minterms and maxterms, conversion of a Truth table into equivalent logic circuit by (1) Sum of Products Method and (2) Karnaugh Map. |                                                                                                  |   |   |   |          |
| Module 4: ARITHMETIC CIRCUITS                                                                                                                                                                                                                                 |                                                                                                  |   |   |   | 6 hours  |
| Binary addition, binary subtraction using 2's complement, Half and Full adders, Half & Full subtractors, 4-bit binary adder/subtractor.                                                                                                                       |                                                                                                  |   |   |   |          |
| Module 5: SEQUENTIAL CIRCUITS                                                                                                                                                                                                                                 |                                                                                                  |   |   |   | 8 hours  |
| SR, D, and JK Flip-Flops, clocked (Level and Edge Triggered) Flip-Flops, Preset and Clear operations, race-around conditions in JK Flip-Flop, M/S JK Flip-Flop.                                                                                               |                                                                                                  |   |   |   |          |
| Module 5: TIMERS                                                                                                                                                                                                                                              |                                                                                                  |   |   |   | 4 hours  |
| IC555: Block diagram and applications: Astable multivibrator and Monostable multivibrator.                                                                                                                                                                    |                                                                                                  |   |   |   |          |
| Module 7: SHIFT REGISTERS                                                                                                                                                                                                                                     |                                                                                                  |   |   |   | 6 hours  |
| Serial-in-Serial-out. Serial-in-Parallel-out.Parallel-in-Serial-out and Parallel-in- Parallel-out Shift Registers (only up to 4 bits).                                                                                                                        |                                                                                                  |   |   |   |          |
| Module 8: INTRODUCTION TO MICROPROCESSORS                                                                                                                                                                                                                     |                                                                                                  |   |   |   | 10 hours |
| 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components, Pin-out diagram. Buses, Registers, ALU, Memory, Stack memory and Timing . <sup>[1]</sup> Introduction to Assembly Language: 1-byte, 2-byte and 3-byte instructions.       |                                                                                                  |   |   |   |          |
| Total Lecture hours                                                                                                                                                                                                                                           |                                                                                                  |   |   |   | 60 hours |
| Text Book(s)                                                                                                                                                                                                                                                  |                                                                                                  |   |   |   |          |
| 1.                                                                                                                                                                                                                                                            | Digital Principles and Applications, A.P.Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw |   |   |   |          |
| 2.                                                                                                                                                                                                                                                            | Modern digital Electronics, R. P. Jain, McGraw Hill Education, 4 <sup>th</sup> Edition.          |   |   |   |          |
| 3.                                                                                                                                                                                                                                                            | Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.                                 |   |   |   |          |
| Reference Books                                                                                                                                                                                                                                               |                                                                                                  |   |   |   |          |
| 1.                                                                                                                                                                                                                                                            | Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill.                                |   |   |   |          |
| 2.                                                                                                                                                                                                                                                            | Microprocessor Architecture Programming & applications with 8085, R.S. Goankar, Prentice Hall.   |   |   |   |          |



| Dsc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Quantum Mechanics | L | T | P | C               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Basic Physics and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |   |   |   |                 |
| <div><div></div><div>1. To land on an area of new formalism of physics i.e., quantum mechanics needed to understand few critical events observed between 1900 and 1925</div><div>2. To provide knowledge of time dependent and time independent Schrodinger Equation.</div><div>3. To enable students to learn different aspects of Bound States.</div><div>4. To make students familiar with quantum theory of hydrogen-like atoms.</div><div>5. To learn different concepts associated with atoms in electric and magnetic fields.</div><div>6. To provide knowledge about Quantum Mechanical aspects of many-electron atoms.</div></div>                                                                                                                                                                                       |                   |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |   |   |   |                 |
| After successful completion of the course, the students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |   |   |   |                 |
| CO 1: Remember the basics of Bound States and their applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |   |   |   |                 |
| CO 2: Understand different Quantum Mechanical aspects of hydrogen-like atoms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |   |   |   |                 |
| CO 3: Apply time dependent and time independent Schrodinger Equation to solve simple problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |   |   |   |                 |
| CO 4: Analyze the different properties of atoms in electric and magnetic fields.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |   |   |   |                 |
| <b>Module 1: EMERGENCE OF QUANTUM MECHANICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |   |   |   | <b>5 hours</b>  |
| Introduction to some critical events in physics observed between 1900 to 1925 that led to some radical theoretical proposals (called quantum theory) beyond accepted classical physics. Blackbody radiation, photoelectric effect, the Compton effect, wave properties and electron diffraction, the Bohr atom, the correspondence principle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |   |   |   |                 |
| <b>Module 2: WAVE MECHANICS: THE SCHRODINGER EQUATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |   |   |   | <b>15 hours</b> |
| Wave-Particle duality and concept of wave function, plane waves and wave packets, Probability Interpretation of Wave Function, the Schrodinger equation, the Heisenberg uncertainty relation: more on the probability interpretation of wave function: importance of phases, probability current densities, conditions for physical acceptability of wave functions, normalization, linearity and superposition principles; expectation values and the momentum in wave mechanics, momentum operator, wave function in momentum space, Wave Function of a Free Particle.                                                                                                                                                                                                                                                          |                   |   |   |   |                 |
| <b>Module 3: TIME INDEPENDENT SCHRODINGER EQUATION (IN ONE DIMENSION)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |   |   |   | <b>20 hours</b> |
| Time independent Schrodinger equation, eigenvalue equations and problem for a particle in a box, the expansion postulate and its physical interpretation, momentum eigenfunction and the free particle, normalization of free particle wave function, degeneracy and parity; some more applications to one dimensional potentials- (i) potential step, (ii) potential well with $E>0$ and $E<0$ for bound states, (iii) potential barrier and tunneling effect and (iv) harmonic oscillator.<br>General structure of wave mechanics: eigenfunctions and eigenvalues, Hamiltonian operator, some properties eigenvalues and eigenfunctions, Position, momentum and Energy operators; commutator of position and momentum operators, energy eigenfunctions, arbitrary wavefunction as a linear combination of energy eigenfunctions |                   |   |   |   |                 |
| <b>Module 4: THE SCHRÖDINGER EQUATION IN 3 DIMENSIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |   |   |   | <b>5 hours</b>  |
| Schrodinger equation in spherical polar coordinates; separation of variables of wavefunctions in central potential (radial and angular parts); application to hydrogen atom, its energy spectrum, degeneracy of the spectrum and origin of quantum numbers n, l and m [qualitatively introduce angular solution $Y_{lm}(\theta,\varphi)$ ], plots of radial and angular probability distribution in convenient forms upto second excited states.                                                                                                                                                                                                                                                                                                                                                                                  |                   |   |   |   |                 |
| <b>Module 5: ATOMS IN ELECTRIC AND MAGNETIC FIELDS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |   |   |   | <b>8 hours</b>  |
| Electron angular momentum. Angular momentum quantization. Electron Spin and Spin Angular Momentum. Larmor’s Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Normal and Anomalous Zeeman Effect, Paschen Back Effect, Electron Magnetic Moment and Magnetic Energy, gyromagnetic ratio, Bohr magneton                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |   |   |   |                 |
| <b>Module 6: MANY ELECTRON ATOMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |   |   |   | <b>7 hours</b>  |
| Pauli’s Exclusion Principle. Symmetric and Anti-symmetric Wave Functions. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Atom Model, Spin-orbit coupling in atoms-L-S and J-J couplings, Hund’s rule, Term symbol, spectra of hydrogen and alkali atom.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |   |   |   | <b>60 hours</b> |

| <b>Text Book(s)</b>    |                                                                                                                                                      |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                     | A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill                                                           |
| 2.                     | Quantum Mechanics: Theory and Applications, (2019), (Extensively revised 6th Edition), Ajoy Ghatak and S. Lokanathan, Laxmi Publications, New Delhi. |
| 3.                     | Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.                                                                               |
| 4.                     | Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.                                                                         |
| 5.                     | Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.                                                                            |
| <b>Reference Books</b> |                                                                                                                                                      |
| 1.                     | Introduction to Quantum Mechanics, D.J. Griffith, 2 <sup>nd</sup> Edition, Pearson Education, 2005                                                   |
| 2.                     | Quantum Mechanics, G. Aruldas, 2nd Edn. 2002, PHI Learning of India.                                                                                 |
| 3.                     | Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer                                                                   |
| 4.                     | Quantum Mechanics for Scientists & Engineers, D. A. B. Miller, 2008.                                                                                 |

| DSC                                                                                                                                                                                 | Thermal Physics Lab | L | T | P | C        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---|---|---|----------|
|                                                                                                                                                                                     |                     | 0 | 0 | 4 | 2        |
| Prerequisite : Basics of 12 standard Physics lab                                                                                                                                    |                     |   |   |   |          |
| Course Objective :                                                                                                                                                                  |                     |   |   |   |          |
| 1) This course aims to provide a good platform to mechanical engineering students to understand, model and appreciate concept of dynamics involved in thermal energy transformation |                     |   |   |   |          |
| 2) Students will apply the analytical techniques and graphical analysis to the experimental data.                                                                                   |                     |   |   |   |          |
| 3) To develop intellectual communication skills and discuss the basic understanding of various experimental principles involved.                                                    |                     |   |   |   |          |
| Course Outcome:                                                                                                                                                                     |                     |   |   |   |          |
| CO1: To apply the knowledge of mathematics, physics to understand the mechanical equivalent of heat and thermal conductivity phenomenon                                             |                     |   |   |   |          |
| CO2: Ability to understand the basic concepts of thermodynamic such as temperature, pressure, system, properties, process, state, cycles and equilibrium.                           |                     |   |   |   |          |
| CO3: To get the knowledge of Thermocouple, Calorimeter and Platinum resistance thermometer.                                                                                         |                     |   |   |   |          |
| CO4: This lab will help the students to understand specific heat and convection of heat in various environments.                                                                    |                     |   |   |   |          |
| List of Experiments :                                                                                                                                                               |                     |   |   |   |          |
| 1) To determine Mechanical Equivalent of Heat, J, by Joule’s Calorimeter method                                                                                                     |                     |   |   |   |          |
| 2) To determine the Coefficient of Thermal Conductivity of Cu by Searle’s Apparatus.                                                                                                |                     |   |   |   |          |
| 3) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton’s disc method                                                                        |                     |   |   |   |          |
| 4) To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).                                                                                 |                     |   |   |   |          |
| 5) To study the variation of Thermo-EMF of a Chromium – Aluminum Thermocouple with Difference of Temperature of its Two Junctions.                                                  |                     |   |   |   |          |
| 6) To find the specific heat of a liquid by using Calorimeter                                                                                                                       |                     |   |   |   |          |
| 7) To measure the emissivity of test plate.                                                                                                                                         |                     |   |   |   |          |
| 8) To find the Stefan’s constant.                                                                                                                                                   |                     |   |   |   |          |
| 9) Evaluate the Specific Heat of Air at constant pressure.                                                                                                                          |                     |   |   |   |          |
| 10) To determine average surface heat transfer coefficient for a pipe by forced convection.                                                                                         |                     |   |   |   |          |
| Total Hours:                                                                                                                                                                        |                     |   |   |   | 60 hours |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                   |
| 1) 1) A Text Book On Practical Physics: K.G. Mazumdar & B.Ghosh.<br>2) A Text Book On Practical Physics: Dr. Samir Kumar Ghosh.<br>3) Advanced Practical Physics For Students, B. L. Flint And H.T. Worsnop, 1971, Asia Publishing House<br>4) A Text Book Of Practical Physics, I.Prakash & Ramakrishna, 11thed., 2011, Kitab Maha |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Digital Electronics Lab                                                               | L | T | P | C               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                       | 0 | 0 | 4 | 2               |
| <b>Prerequisite : Basics of 12 standard Physics lab</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                       |   |   |   |                 |
| <b>Course Objective :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                       |   |   |   |                 |
| 1) To develop problem solving and critical thinking skills by observing various practical outcomes for further applications.<br>2) To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate technical equipments.<br>3) Design of circuits using new technology and latest components and to develop practical applications of physics materials and use of principle in the right way to implement the modern technology. .<br>4) The students will have a good foundation in the fundamentals related to the experiments included in this course and their advanced applications.                                                                                                                                                                                         |                                                                                       |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                       |   |   |   |                 |
| <b>CO1:</b> Learning basic concept of voltage, current and measurement of their readings in CRO.<br><b>CO2:</b> Get the knowledge of various logic gates such as OR, NOT, NAND.<br><b>CO3:</b> To enhance the knowledge of working principle of various flip-flops<br><b>CO4:</b> The course will help to understand the concept of OPAMP in inverting and non-inverting and buffer mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                       |   |   |   |                 |
| <b>List of Experiments :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                       |   |   |   |                 |
| 1) To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.<br>2) To study and verify the truth table of logic gates<br>3) To design a switch (NOT gate) using a transistor.<br>4) To verify and design AND, OR, NOT and XOR gates using NAND gates.<br>5) To design a combinational logic system for a specified Truth Table<br>6) To convert a Boolean expression into logic circuit and design it using logic gate ICs.<br>7) Half Adder, Full Adder and 4- bit binary Adder<br>8) To build Flip - Flop (RS, Clocked RS, D - type and JK) circuits using NAND gates.<br>9) To construct inverting voltage amplifier and to determine the close loop voltage gain<br>10) To construct inverting voltage amplifier and to determine the close loop voltage gain<br>11) To construct a buffer amplifier using IC 741 and to determine voltage gain. |                                                                                       |   |   |   |                 |
| <b>Total Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                       |   |   |   | <b>60 hours</b> |
| <b>Text book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                       |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A TEXT BOOK ON PRACTICAL PHYSICS: K.G. MAZUMDAR & B.GHOSH                             |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A TEXT BOOK ON PRACTICAL PHYSICS: DR. SAMIR KUMAR GHOSH                               |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B. L. FLINT AND H.T. WORSNOP, 1971           |   |   |   |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A TEXT BOOK OF PRACTICAL PHYSICS, I.PRAKASH & RAMAKRISHNA, 11THED., 2011, KITAB MAHAL |   |   |   |                 |

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| <b>DSE III</b> | <b>Plasma Physics</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|----------------|-----------------------|----------|----------|----------|----------|

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                           |                                                                                                                        | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Electromagnetic Theory                                                                                                                                                                                                                                                                              |                                                                                                                        |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                 |                                                                                                                        |   |   |   |                 |
| 1. To deliver a comprehensive course on the basics of plasma physics, the theoretical modelling, the instabilities and the applications of plasma.                                                                                                                                                                        |                                                                                                                        |   |   |   |                 |
| 2. To disseminate lectures on the physics behind the motion of charged particles in EM fields and how this forms the basis of theoretical modelling of plasma.                                                                                                                                                            |                                                                                                                        |   |   |   |                 |
| 3. To give the students a view of why the two-fluid model of plasma forms the major foundation of the numerous phenomena associated with it.                                                                                                                                                                              |                                                                                                                        |   |   |   |                 |
| 4. To analyze how the motion of charged particles in plasma leads to the emergence of plasma waves and instabilities in the plasma.                                                                                                                                                                                       |                                                                                                                        |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                        |   |   |   |                 |
| After successful completion of the course, the students will be able                                                                                                                                                                                                                                                      |                                                                                                                        |   |   |   |                 |
| CO 1: to remember the basic properties and conditions for a mixture of ions to be plasma.                                                                                                                                                                                                                                 |                                                                                                                        |   |   |   |                 |
| CO 2: to understand the motion of charged particles in uniform and non-uniform EM fields and using this, build an understanding of the fluid model of plasmas.                                                                                                                                                            |                                                                                                                        |   |   |   |                 |
| CO 3: to apply the physics behind the numerous waves that arise in plasma such as Alfven, Magneto-Acoustic and Ion-Acoustic waves and the implications of dusty plasma in space plasma and the mesosphere of the earth.                                                                                                   |                                                                                                                        |   |   |   |                 |
| CO 4: to analyze the instabilities in plasma such as Rayleigh and Kelvin-Helmholtz instabilities.                                                                                                                                                                                                                         |                                                                                                                        |   |   |   |                 |
| <b>Module 1: Basics of Plasma Physics</b>                                                                                                                                                                                                                                                                                 |                                                                                                                        |   |   |   | <b>15 Hours</b> |
| Basic Properties of Plasma, Quasi-neutrality, Debye Shielding, Plasma Frequency, Plasma Parameter, Criteria for Plasma, Plasma Production in Laboratory: Glow Discharge Plasma and Pachen Law, Magnetically Confined Open and Closed systems (linear pinch, mirror machine and Tokamak).                                  |                                                                                                                        |   |   |   |                 |
| <b>Module 2: Single Particle Motion and Fluid Description of Plasma</b>                                                                                                                                                                                                                                                   |                                                                                                                        |   |   |   | <b>20 hours</b> |
| Concept of Lorenz Force, Charged particle motion in uniform and non-uniform EM fields, Electric and Grad-B Drift, Curvature Drift and Magnetic Mirrors, Adiabatic Invariants - $\mu$ and J, Coulomb collisions, Characteristic Relaxation Times, Fluid Description of Plasma – Two Fluid Model, The Plasma Approximation. |                                                                                                                        |   |   |   |                 |
| <b>Module 3: Waves in Plasma</b>                                                                                                                                                                                                                                                                                          |                                                                                                                        |   |   |   | <b>15 hours</b> |
| Group velocity and Phase velocity, Normal Mode Analysis, Plasma Oscillations, Alfven waves, Dissipative Effect, Magneto-acoustic Waves, Hydro-magnetic Waves, Linear and Nonlinear Ion-Acoustic Waves and Electron Plasma Wave.                                                                                           |                                                                                                                        |   |   |   |                 |
| <b>Module 4: Instabilities and Applications of Plasma</b>                                                                                                                                                                                                                                                                 |                                                                                                                        |   |   |   | <b>10 hours</b> |
| Magneto-hydrodynamic instabilities- Rayleigh-Taylor and Kelvin Helmholtz instabilities, Industrial Applications - Biomedical and Material sciences, Thermonuclear Fusion and ITER.                                                                                                                                        |                                                                                                                        |   |   |   |                 |
| <b>Textbook (s)</b>                                                                                                                                                                                                                                                                                                       |                                                                                                                        |   |   |   |                 |
| 1                                                                                                                                                                                                                                                                                                                         | Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen, Springer Nature 3 <sup>rd</sup> Edition (2015). |   |   |   |                 |
| 2                                                                                                                                                                                                                                                                                                                         | Physics of Fluids and Plasmas, Arnab Rai Choudhuri, Cambridge University Press (1998).                                 |   |   |   |                 |
| 3                                                                                                                                                                                                                                                                                                                         | Fundamentals of Plasma Physics, J. A. Bittencourt, Springer-Verlag New York (2010).                                    |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                        |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                        | Introduction to Plasma Physics, R. J. Goldston, CRC Press (2020).                                                      |   |   |   |                 |

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|                                                                                                                                                                                                                                                                                                            |                                                                                                                                             | 4 | 0 | 0 | 4               |
| <b>Pre-requisite:</b> Quantum Mechanics.                                                                                                                                                                                                                                                                   |                                                                                                                                             |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                  |                                                                                                                                             |   |   |   |                 |
| 1. To impart a comprehensive course on the physics of molecular spectroscopy and its applications in unveiling the molecular structure of substances.                                                                                                                                                      |                                                                                                                                             |   |   |   |                 |
| 2. To disseminate lectures on the applications of quantum mechanics (specifically the rigid rotor and quantum harmonic oscillator model) in rotational and vibrational spectroscopy.                                                                                                                       |                                                                                                                                             |   |   |   |                 |
| 3. To evaluate the connection between the molecular properties of materials and the numerous types of spectroscopies that could be applied to study its properties.                                                                                                                                        |                                                                                                                                             |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                     |                                                                                                                                             |   |   |   |                 |
| After successful completion of the course, the students will be able                                                                                                                                                                                                                                       |                                                                                                                                             |   |   |   |                 |
| CO 1: to remember the basics of the physical principles that the spectroscopic methods are based on.                                                                                                                                                                                                       |                                                                                                                                             |   |   |   |                 |
| CO 2: to understand the important properties associated with the molecular structure materials.                                                                                                                                                                                                            |                                                                                                                                             |   |   |   |                 |
| CO 2: to apply the spectral properties of molecules in the basics of rotational and vibrational spectroscopy.                                                                                                                                                                                              |                                                                                                                                             |   |   |   |                 |
| CO 3: to analyze the physics behind Electronic Spectroscopy and the famed Raman effect.                                                                                                                                                                                                                    |                                                                                                                                             |   |   |   |                 |
| <b>Module 1: Basics of Spectroscopy</b>                                                                                                                                                                                                                                                                    |                                                                                                                                             |   |   |   | <b>5 Hours</b>  |
| Interaction of electromagnetic radiation with molecules, Various types of spectra, Born-Oppenheimer approximation, Franck-Condon principle and Free Electron Model.                                                                                                                                        |                                                                                                                                             |   |   |   |                 |
| <b>Module 2: Atomic Spectroscopy</b>                                                                                                                                                                                                                                                                       |                                                                                                                                             |   |   |   | <b>15 hours</b> |
| Pauli's Exclusion Principle, Spectral Terms, Vector Model for Three or more Valence Electrons atoms, Branching Rule, Landé Interval Rule, LS and JJ Coupling, Energy Levels and Selection Rules, Spectra of Oxygen and Nitrogen, Zeeman Effect, Paschen-Bach effect, Stark Effect and Hyperfine Structure. |                                                                                                                                             |   |   |   |                 |
| <b>Module 3: Rotational and Vibrational Spectroscopy</b>                                                                                                                                                                                                                                                   |                                                                                                                                             |   |   |   | <b>20 hours</b> |
| Rotational Spectroscopy: Selection Rules, Intensities of Spectral Lines, Determination of Bond Lengths of Diatomic and Linear Triatomic Molecules, Isotopic Substitution.                                                                                                                                  |                                                                                                                                             |   |   |   |                 |
| Vibrational Spectroscopy: Classical Equation of Vibration, Computation of Force Constant, Anharmonicity, Morse Potential, Dissociation Energies, Fundamental Frequencies, Overtones, Hot Bands, Degrees of Freedom for Polyatomic Molecules, Modes of Vibration, Concept of Group Frequencies.             |                                                                                                                                             |   |   |   |                 |
| <b>Module 4: Electronic and Raman Spectroscopy</b>                                                                                                                                                                                                                                                         |                                                                                                                                             |   |   |   | <b>20 hours</b> |
| Electronic Spectroscopy: Electronic Transitions, Singlet and Triplet States, Fluorescence and Phosphorescence, Dissociation and Predissociation, Calculation of Electronic Transitions of Polyenes using Free Electron Model.                                                                              |                                                                                                                                             |   |   |   |                 |
| Raman Spectroscopy: Qualitative Treatment of Rotational Raman Effect; Effect of Nuclear Spin, Vibrational Raman Spectra, Stokes and Anti-Stokes lines, Selection Rules.                                                                                                                                    |                                                                                                                                             |   |   |   |                 |
| <b>Textbook (s)</b>                                                                                                                                                                                                                                                                                        |                                                                                                                                             |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                         | Atomic and Molecular Spectroscopy: Basic Concepts and Applications, Rita Kakkar, Cambridge University Press (2015).                         |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                         | Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles 2 <sup>nd</sup> Edition, Robert Resnick and Robert Eisberg, Wiley (2007). |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                         | Molecular Spectra and Molecular Structure: Spectra of Diatomic Molecules Vol.1, , Gerhard Herzberg, Krieger Publishing Company (1989).      |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                     |                                                                                                                                             |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                         | Introduction to Spectroscopy, D. L. Pavia, Cengage India Pvt. Ltd. (2015).                                                                  |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                         | Molecular Structure and Spectroscopy, G. Arulhas, Prentice Hall India (2007).                                                               |   |   |   |                 |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                 | Mathematical Physics Ii                                                                                                                                         | L | T | P        | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|----------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                 | 3 | 1 | 0        | 4 |
| Pre-requisite: HS level Mathematics and Mathematical Physics I                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                 |   |   |          |   |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                 |   |   |          |   |
| 1. To provide fundamental knowledge of complex variables.                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                 |   |   |          |   |
| 2. To enable students to learn different properties of Fourier and Laplace Transforms.                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                 |   |   |          |   |
| 3. To make students familiar with elementary probability theory and the fundamentals of group theory.                                                                                                                                                                                                                                                                                               |                                                                                                                                                                 |   |   |          |   |
| 4. To provide knowledge about tensors and their applications.                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                 |   |   |          |   |
| 5. To provide knowledge about special functions used in Physics.                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                 |   |   |          |   |
| Course Outcome:                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                 |   |   |          |   |
| After successful completion of the course, the students will be able to                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                 |   |   |          |   |
| CO 1: Remember the properties of special functions.                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                 |   |   |          |   |
| CO 2: Understand the fundamentals of complex variables, Fourier and Laplace transforms, Probability theory, Group theory and special functions.                                                                                                                                                                                                                                                     |                                                                                                                                                                 |   |   |          |   |
| CO 3: Apply the knowledge of complex variables, probability theory, Fourier and Laplace transform to solve simple problems.                                                                                                                                                                                                                                                                         |                                                                                                                                                                 |   |   |          |   |
| CO 4: Analyze the properties of Tensors and their applications in different areas of Physics.                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                 |   |   |          |   |
| Module 1: COMPLEX VARIABLES                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                 |   |   | 15 Hours |   |
| Analytical Functions, Cauchy-Riemann Conditions, Cauchy’s Integral Theorem, Cauchy’s Integral formula, Taylor and Laurent’s series expansion, Cauchy’s Residue Theorem, Simple examples of contour integration                                                                                                                                                                                      |                                                                                                                                                                 |   |   |          |   |
| Module 2: FOURIER AND LAPLACE TRANSFORMS                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                 |   |   | 8 hours  |   |
| Fourier Transform, Convolution Theorem, Laplace Transforms, Laplace Transforms of derivatives, Substitution properties of Laplace Transform, Properties of gamma and beta functions, Error function and Dirac Delta functions.                                                                                                                                                                      |                                                                                                                                                                 |   |   |          |   |
| Module 3: PROBABILITY AND GROUP THEORY                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                 |   |   | 11 hours |   |
| Elementary Probability Theory, Random Variables, Binomial, Poisson and Normal Distributions, Central Limit Theorem, Central difference formula, Iterative process, Newton-Raphson formula, Introductory Group Theory                                                                                                                                                                                |                                                                                                                                                                 |   |   |          |   |
| Module 4: TENSORS                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                 |   |   | 15 hours |   |
| Contravariant and Covariant Tensor, Jacobian, Relative Tensor, Pseudo Tensors (Example: charge density, angular momentum), Riemann space (Example: Euclidean space and 4D Minkowski space), Christoffel Symbols, Transformation of Christoffel symbols, Covariant differentiation, Ricci’s theorem Divergence, Curl and Laplacian tensor form, stress and strain tensor, Hooke’s Law in tensor form |                                                                                                                                                                 |   |   |          |   |
| Module 5: SPECIAL FUNCTONS                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                 |   |   | 11 hours |   |
| Series solution of differential equations with variable coefficients, Legendre, Hermite, Laguerre, Associated Laguerre polynomials, Bessel functions and their generating functions, Recurrence relations, Orthogonal Properties and Rodrigue’s formula                                                                                                                                             |                                                                                                                                                                 |   |   |          |   |
| Total Lecture hours                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                 |   |   | 60 hours |   |
| Textbook(s)                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                 |   |   |          |   |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                  | MATHEMATICAL METHODS FOR PHYSICISTS, G.B. ARKFEN, H.J. WEBER, F.E, HARRIS, 2013, 7 <sup>TH</sup> EDITION, ELSEVIER                                              |   |   |          |   |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                  | COMPLEX VARIABLE (SCHAUM’S OUTLINES), MURRAY SPIEGEL, SEYMOUR LIPSCHUTZ, JOHN SCHILLER, DENNIS SPELLMAN, REVISED 2 <sup>ND</sup> EDITION, MCGRAW HILL EDUCATION |   |   |          |   |
| REFERENCE BOOKS                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                 |   |   |          |   |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                  | ADVANCED ENGINEERING MATHEMATICS, E. KREYSZIG (2 <sup>ND</sup> EDITION, PEARSON, 2002)                                                                          |   |   |          |   |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                  | MATHEMATICAL PHYSICS, B.D. GUPTA, VIKAS PUBLICATION HOUSE, 1986                                                                                                 |   |   |          |   |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                  | MATHEMATICAL PHYSICS, A.K. GHATAK, I.C. GOYAL, S.J.CHUA, LAXMI PUBLICATIONS PRIVATE LIMITED, 2016                                                               |   |   |          |   |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                  | MATHEMATICAL METHODS, M.C. POTTER AND J. GOLDBERG, PRENTICE-HALL (2 <sup>ND</sup> EDITION, 1987)                                                                |   |   |          |   |

| DSC | Classical Mechanics | L | T | P | C |
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|     |                     | 3 | 1 | 0 | 4 |

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| <b>Pre-requisite:</b> HS level Statistics and Dynamics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |
| <b>Course Objective</b><br>1. Aims to understand the concepts of generalized coordinates and its subsequent applications to Lagrangian and Hamiltonian dynamics.<br>2. To be familiar with Hamiltonian dynamics and its applications to solve complex problems in a simplified manner.<br>3. Enhance the knowledge regarding motion of the bodies under central force.<br>4. To have a broader perspective of rigid body kinematics in terms of mathematical analysis.<br>5. To enhance the knowledge of canonical transformation theory.                                                                                                              |                 |
| <b>Course Outcome:</b><br>After successful completion of the course, the students will be able<br><b>CO1:</b> To remember the concepts of generalized coordinates, Hamiltonian dynamics, central force, rigid body dynamics and canonical transformation theory. and its subsequent applications to Lagrangian and Hamiltonian dynamics.<br><b>CO 2:</b> To understand different theories which explains the dynamics of systems?<br><b>CO 3:</b> To apply the concepts of Lagrangian and Hamiltonian dynamics to solve complex problems.<br><b>CO 4:</b> To analyze various parameters involved in the classical dynamics theory in various problems. |                 |
| <b>Module 1: Lagrangian Dynamics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>10 hours</b> |
| Lagrangian Dynamics: Constraints, Generalized coordinates, Concept of virtual work, D'Alembert principle, Lagrange equation from D'Alembert principle, Velocity dependent potential, Expression for kinetic energy of a system in terms of Generalized coordinates and Cyclic coordinates, Symmetry properties and conservation theorems.                                                                                                                                                                                                                                                                                                              |                 |
| <b>Module 2: Hamiltonian Dynamics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>12 hours</b> |
| Hamiltonian dynamics: Hamiltonian function H and conservation of energy: Jacobi's integral and its significance, Hamilton's equation, Routhian, Hamiltonian, Variation principle, Derivation of Lagrange equation, Extension of Hamilton's Principle, to non-holonomic system, A hoop rolling without slipping on an inclined plane, Modified Hamilton's Variation principle, Derivation of Hamilton's equation from variation principle, $\Delta$ - variations, Principle of least actions in various forms, Introduction to Nonlinear Dynamical Theory and Chaos.                                                                                    |                 |
| <b>Module 3: Motion under Central Force</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>14 hours</b> |
| The Two Body Central Force Problem: Central force and motion in a plane, Reduction of a two body central force to equivalent one body problem, Equation of motion and first integral, Differential equation for an orbit, Equivalent one dimensional problem and classification of orbits for some specific potential, Integral power law potential, Virial theorem, Relation between kinetic and potential energy, Kepler's Problems: Equation of orbit and the kind of the orbit, Motion in time.                                                                                                                                                    |                 |
| <b>Module 4: Rigid body kinematics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>12 hours</b> |
| The kinematics of rigid body motion: Independent co-ordinate of a rigid body, Orthogonal transformation, Formal properties of transformation matrix, Euler angles, Euler's theorem, Finite rotation, Infinitesimal rotations (contact transformation), Angular momentum, Moment of inertia tensor, Product of inertia, Inertia tensor, Principal moment of inertia: Principal axis, Kinetic energy of motion of a rigid body about a point, Normal modes.                                                                                                                                                                                              |                 |
| <b>Module 5: Canonical transformation theory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>12 hours</b> |
| Canonical transformation and Hamilton Jacobi theory: Canonical transformation, Legendre transformation, Generating functions, Conditions for canonical transformation, Bilinear invariant Condition, Poisson's brackets, Lagrange brackets, Invariance of Poisson bracket under canonical transformation, Angular momentum Poisson bracket relation, Hamilton Jacobi equation for Hamilton's principal function, Harmonic oscillator problem by Hamilton, Jacobi method, Hamilton's characteristic function.                                                                                                                                           |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>60 hours</b> |
| <b>Textbook(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |
| 1. H. GOLDSTEIN: CLASSICAL MECHANICS, NAROSA PUBLISHING HOUSE, 2001<br>2. JONH R TAYLOR, CLASSICAL MECHANICS, UNIVERSITY SCIENCE BOOKS, U.S, 2004<br>3. DAVID MORIN, INTRODUCTION TO CLASSICAL MECHANICS, CAMBRIDGE UNIVERSITY PRESS, 2009<br>MURRAY SPIEGEL: THEORETICAL MECHANICS, MCGRAW HILL EDUCATION, 2017.<br>4. FREDERICK W. BYRON AND ROBERT W. FULLER: MATHEMATICS OF CLASSICAL AND QUANTUM                                                                                                                                                                                                                                                  |                 |

|                        |                                                                                                                                       |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 5.                     | PHYSICS, DOVER PUBLICATIONS; REVISED ED. EDITION, 1992.                                                                               |
| 6.                     | STEVEN H. STROGATZ: NONLINEAR DYNAMICS AND CHAOS: WITH APPLICATIONS IN PHYSICS, BIOLOGY, CHEMISTRY, AND ENGINEERING, CRC PRESS, 2015. |
| <b>Reference Books</b> |                                                                                                                                       |
| 1.                     | N. C. RANA AND P. S. JOAG: CLASSICAL MECHANICS, TATA MC-GRAW HILL, NEW DELHI, 1991.                                                   |
| 2.                     | S. L. GUPTA, V. KUMAR, H. V. SHARMA: CLASSICAL MECHANICS, PRAGATI PRAKASHAN, MEERUT, 2009.                                            |
| 3.                     | P. V. PANAT: CLASSICAL MECHANICS, NAROSA PUBLISHING HOUSE, 2000.                                                                      |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Advanced Quantum Mechanics                                                                | L | T | P | C               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                           | 3 | 1 | 0 | 4               |
| <b>Pre-requisite:</b> Graduation Level Physics and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                           |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                           |   |   |   |                 |
| 1. To provide knowledge of the formalism of Quantum Mechanics<br>2. To enable students to learn different aspects of Quantum Dynamics.<br>3. To make students familiar with angular momentum algebra<br>4. To provide knowledge about approximation methods in Quantum Mechanics.<br>5. To provide knowledge about Scattering and Relativistic Quantum Mechanics.                                                                                                                                                                                                                                                                                                |                                                                                           |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                           |   |   |   |                 |
| After successful completion of the course, the students will be able to<br><b>CO1:</b> Remember the basic formalism of Quantum Mechanics, Quantum Dynamics, Angular Momentum, Angular Momentum, Approximation Methods, Scattering and Relativistic Quantum Mechanics.<br><b>CO 2:</b> Understand different aspects of angular momentum algebra for applications.<br><b>CO 3:</b> Apply the knowledge of Quantum Mechanics to solve simple problems.<br><b>CO 4:</b> Analyze Quantum Mechanical problems using approximation methods.                                                                                                                             |                                                                                           |   |   |   |                 |
| <b>Module 1: GENERAL FORMALISM OF QUANTUM MECHANICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                           |   |   |   | <b>15 hours</b> |
| Mathematical properties of linear vector spaces, Dirac's Bra and Ket notation, Inner product, norm of a vector, orthonormality and linear independence, Basis and dimension, Outer product, projection operator, completeness, closure property, Hermitian operators, eigenvalues and eigenvectors, postulates of Quantum Mechanics, wave function, probability density, orthogonality criterion, Representation Theory, change of basis, Unitary operator, matrix representation of operators, position and momentum representations, Expectation values, uncertainty relation, Ehrenfest Theorem, Schrodinger time independent and time dependent formulation. |                                                                                           |   |   |   |                 |
| <b>Module 2: QUANTUM DYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                           |   |   |   | <b>12 hours</b> |
| Gaussian Wave Packet, Schrodinger picture, Heisenberg picture, solution of simple harmonic oscillator problem by the operator method, symmetry and conservation laws, symmetries in Quantum Mechanics – hydrogen atom and spherical harmonics, spatial translation, time translation, parity, time reversal, Density matrices                                                                                                                                                                                                                                                                                                                                    |                                                                                           |   |   |   |                 |
| <b>Module 3: ANGULAR MOMENTUM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                           |   |   |   | <b>10 hours</b> |
| Orbital Angular Momentum, angular momentum algebra, spin, Ladder operators and their matrix representations, spin angular momenta and Pauli matrices, symmetric and anti-symmetric wave functions, Pauli's Exclusion Principle, spin and statistics, addition of angular momenta, Clebsch-Gordan coefficients                                                                                                                                                                                                                                                                                                                                                    |                                                                                           |   |   |   |                 |
| <b>Module 4: APPROXIMATION METHODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                           |   |   |   | <b>10 hours</b> |
| Time Independent Perturbation Theory, Variational Theory, WKB Method and their applications, Time dependent Perturbation Theory, transition to a continuum of final states – Fermi's Golden Rule, applications to constant and harmonic perturbations, sudden and adiabatic approximations.                                                                                                                                                                                                                                                                                                                                                                      |                                                                                           |   |   |   |                 |
| <b>Module 5: SCATTERING AND RELATIVISTIC QUANTUM MECHANICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                           |   |   |   | <b>13 hours</b> |
| Scattering: The scattering experiments, relationship of cross-section and wave function, scattering amplitude, phase shifts, partial wave analysis, Born Approximation and applications.<br>Relativistic Quantum Mechanics: Klien-Gordon and Dirac equations, Semi-classical theory of radiation – Einstein coefficients, atom field interaction, dipole matrix elements, spontaneous and stimulated emission rates, Selection Rules.                                                                                                                                                                                                                            |                                                                                           |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                           |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                           |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | QUANTUM MECHANICS : THEORY AND APPLICATION, A. GHATAK AND S. LOKNATHAN, 4 <sup>TH</sup>   |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | EDITION, MACMILLAN, 1999<br>MODERN QUANTUM MECHANICS, J.J. SAKURAI (ADDISON-WESLEY, 1993) |   |   |   |                 |



| REFERENCE BOOKS |                                                                                                    |
|-----------------|----------------------------------------------------------------------------------------------------|
| 1.              | QUANTUM MECHANICS, L.I. SCHIFT, 3 <sup>RD</sup> EDITION, MC-GRAW HILL, 1968                        |
| 2.              | INTRODUCTION TO QUANTUM MECHANICS, D.J. GRIFFITH, 2 <sup>ND</sup> EDITION, PEARSON EDUCATION, 2005 |
| 3.              | QUANTUM PHYSICS, S. GASIOROWICZ, WILEY (3 <sup>RD</sup> EDITION, 2003)                             |

| DSC                                                                                                                                                                                                                                                                                                                                                               | Modern Physics                                                                          | L | T | P | C               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                   |                                                                                         | 3 | 1 | 0 | 4               |
| <b>Pre-requisite:</b> Preliminary concepts of Mechanics, Waves, Optics and Atomic Physics at HS Physics level.                                                                                                                                                                                                                                                    |                                                                                         |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                         |                                                                                         |   |   |   |                 |
| 1. To introduce the foundations of special relativity and Lorentz transformations.                                                                                                                                                                                                                                                                                |                                                                                         |   |   |   |                 |
| 2. To develop understanding of quantum mechanics and its applications.                                                                                                                                                                                                                                                                                            |                                                                                         |   |   |   |                 |
| 3. To impart knowledge of atomic and molecular spectra.                                                                                                                                                                                                                                                                                                           |                                                                                         |   |   |   |                 |
| 4. To impart knowledge of lasers and optical fibre communication.                                                                                                                                                                                                                                                                                                 |                                                                                         |   |   |   |                 |
| 5. To provide fundamental concepts of nuclear structure, radioactivity, and nuclear reactions.                                                                                                                                                                                                                                                                    |                                                                                         |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                            |                                                                                         |   |   |   |                 |
| After successful completion of the course, the students will be able                                                                                                                                                                                                                                                                                              |                                                                                         |   |   |   |                 |
| <b>CO 1:</b> to understand the principles of special relativity and apply Lorentz transformations.                                                                                                                                                                                                                                                                |                                                                                         |   |   |   |                 |
| <b>CO 2:</b> to apply quantum mechanical concepts to simple physical systems.                                                                                                                                                                                                                                                                                     |                                                                                         |   |   |   |                 |
| <b>CO 3:</b> to analyze atomic and molecular spectra of different systems.                                                                                                                                                                                                                                                                                        |                                                                                         |   |   |   |                 |
| <b>CO 4:</b> to apply lasers in optical fibre communication.                                                                                                                                                                                                                                                                                                      |                                                                                         |   |   |   |                 |
| <b>CO 5:</b> to explain nuclear properties, radioactive decay and nuclear reactions using modern physics concepts.                                                                                                                                                                                                                                                |                                                                                         |   |   |   |                 |
| <b>Module 1: Special Relativity</b>                                                                                                                                                                                                                                                                                                                               |                                                                                         |   |   |   | <b>10 Hours</b> |
| Breakdown of classical mechanics at high velocities, postulates of special relativity, Lorentz transformations, space-time coordinates, velocity transformation, time dilation, length contraction, relativistic momentum, relativistic energy, mass-energy equivalence, four-vectors, Minkowski space-time, relativistic Doppler effect.                         |                                                                                         |   |   |   |                 |
| <b>Module 2: Quantum Mechanics</b>                                                                                                                                                                                                                                                                                                                                |                                                                                         |   |   |   | <b>15 hours</b> |
| Wave-particle duality, de Broglie hypothesis, wave packets, Heisenberg uncertainty principle, Schrodinger wave equation (time-dependent and time independent forms), particle in a one-dimensional box, harmonic oscillator, quantum tunneling, operators and observables, eigenvalues and eigenfunctions, expectation values, orbital and spin angular momentum. |                                                                                         |   |   |   |                 |
| <b>Module 3: Atomic, Molecular physics</b>                                                                                                                                                                                                                                                                                                                        |                                                                                         |   |   |   | <b>10 hours</b> |
| Bohr theory of hydrogen atom, Sommerfield model, hydrogen atom (qualitative treatment), fine structure, spin-orbit interaction, Zeeman effect, Stark effect. Rotational, vibrational and electronic spectra, Raman effect, molecular bonding, LCAO and molecular orbital theory.                                                                                  |                                                                                         |   |   |   |                 |
| <b>Module 4:Lasers and optical fibre communication</b>                                                                                                                                                                                                                                                                                                            |                                                                                         |   |   |   | <b>10 hours</b> |
| Einstein coefficients, population inversion, He-Ne laser, Nd:YAG laser, semiconductor laser and applications. Total internal reflection, numerical aperture, optical fibres, attenuation, dispersion and optical fibre communication.                                                                                                                             |                                                                                         |   |   |   |                 |
| <b>Module 5: Nuclear Physics</b>                                                                                                                                                                                                                                                                                                                                  |                                                                                         |   |   |   | <b>15 hours</b> |
| Nuclear properties, nuclear size, mass and binding energy, liquid drop model, shell model, radioactive decay, alpha, beta and gamma decay, nuclear reactions, fission, fusion, GM counter, scintillation detector and semiconductor detector.                                                                                                                     |                                                                                         |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                                                                        |                                                                                         |   |   |   | <b>60 hours</b> |
| <b>Textbook (s)</b>                                                                                                                                                                                                                                                                                                                                               |                                                                                         |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                | ARTHUR BEISER, CONCEPTS OF MODERN PHYSICS.                                              |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                | KENNETH S. KRANE, MODERN PHYSICS.                                                       |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                | DAVID J. GRIFFITHS, INTRODUCTION TO QUANTUM MECHANICS.                                  |   |   |   |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                | EISBERG AND RESNICK, QUANTUM PHYSICS OF ATOMS, MOLECULES, SOLIDS, NUCLEI AND PARTICLES. |   |   |   |                 |

| REFERENCE BOOKS |                                                    |
|-----------------|----------------------------------------------------|
| 1.              | S.L. GUPTA AND S. KUMAR, MODERN PHYSICS.           |
| 2.              | R. MURUGESHAN, MODERN PHYSICS.                     |
| 3.              | A.K. GHATAK AND S. LOKANATHAN, QUANTUM MECHANICS.  |
| 4.              | P.M. MATHEWS AND K. VENKATESAN, QUANTUM MECHANICS. |

| DSC                                                                                                                                                                                                            | General Laboratory I | L | T | P | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---|---|---|---|
|                                                                                                                                                                                                                |                      | 0 | 0 | 8 | 4 |
| <b>Pre-requisite:</b> Basic Computer Skills.                                                                                                                                                                   |                      |   |   |   |   |
| <b>Course Objectives:</b>                                                                                                                                                                                      |                      |   |   |   |   |
| <b>Course Objective :</b>                                                                                                                                                                                      |                      |   |   |   |   |
| 1) To gain a broad perspective about the uses of computers in engineering industry. .                                                                                                                          |                      |   |   |   |   |
| 2) To develop basic understanding of computers, the concept of algorithm and algorithmic thinking.                                                                                                             |                      |   |   |   |   |
| 3) To improve the ability to incorporate exception handling in object-oriented programs.                                                                                                                       |                      |   |   |   |   |
| 4) To develop the use of the C programming language to implement various algorithms and develops the basic concepts and terminology of programming in general.                                                 |                      |   |   |   |   |
| <b>Course Outcome:</b>                                                                                                                                                                                         |                      |   |   |   |   |
| After successful completion of the course, the students will be able                                                                                                                                           |                      |   |   |   |   |
| <b>CO1:</b> To learn the basic knowledge in fundamentals of programming, algorithms and programming technologies and fundamentals of Computer Science.                                                         |                      |   |   |   |   |
| <b>CO2:</b> To understand the basic idea of how to control the sequence of a program and give logical output.                                                                                                  |                      |   |   |   |   |
| <b>CO3:</b> To Develop C programs to solve simple engineering problems using looping constructs.                                                                                                               |                      |   |   |   |   |
| <b>4:</b> To apply the concept of Strings for writing programs related to character array.                                                                                                                     |                      |   |   |   |   |
| <b>List of Experiments:</b>                                                                                                                                                                                    |                      |   |   |   |   |
| 1) <b>Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c input and c output</b>                                                  |                      |   |   |   |   |
| a) Write a program to display a string of alphabets ex: Hello World.                                                                                                                                           |                      |   |   |   |   |
| b) Write a program to take two values using standard input function and find:                                                                                                                                  |                      |   |   |   |   |
| i) Addition of two values.                                                                                                                                                                                     |                      |   |   |   |   |
| ii) Subtraction of a value from another value.                                                                                                                                                                 |                      |   |   |   |   |
| iii) Multiplication of two values.                                                                                                                                                                             |                      |   |   |   |   |
| iv) Division between two values.                                                                                                                                                                               |                      |   |   |   |   |
| v) Modulo division between two values.                                                                                                                                                                         |                      |   |   |   |   |
| c) Write a program to read a character in upper case and then print in lower case                                                                                                                              |                      |   |   |   |   |
| d) Write a program to convert degrees Fahrenheit into degrees Celsius.                                                                                                                                         |                      |   |   |   |   |
| 2) <b>Programs using simple control statements such as if-else, while, do-while, for loop etc.</b>                                                                                                             |                      |   |   |   |   |
| a) Write a program to find whether the given number is even or odd.                                                                                                                                            |                      |   |   |   |   |
| b) Write a program to find whether a given year is a leap year or not.                                                                                                                                         |                      |   |   |   |   |
| c) Write a program to calculate the root of a quadratic equation.                                                                                                                                              |                      |   |   |   |   |
| d) Write a program to display the sin(x) value where x ranges from 0 to 360 in steps of 15.                                                                                                                    |                      |   |   |   |   |
| e) Write a program to calculate the average of numbers entered by the user using while statement.                                                                                                              |                      |   |   |   |   |
| f) Write a program using do-while loop to display the square and cube of first n natural numbers.                                                                                                              |                      |   |   |   |   |
| g) Write a program to calculate $X^n$ by using for loop.                                                                                                                                                       |                      |   |   |   |   |
| h) Write a program to calculate square root of a number by using break and continue statement.                                                                                                                 |                      |   |   |   |   |
| 3) <b>Programs using Arrays: declaring and initializing arrays. Program to do simple operations with arrays Strings – inputting and outputting strings. Using string functions such as strcat, strlen etc.</b> |                      |   |   |   |   |
| a) Write a program to read and display n numbers using an array.                                                                                                                                               |                      |   |   |   |   |
| b) Write a program to arrange the elements of an array in ascending order.                                                                                                                                     |                      |   |   |   |   |

- c) Write a program to interchange the largest and the smallest number in the array.
- d) Write a program to delete number from an array that is already sorted in ascending order.
- e) Write a program to merge two unsorted arrays Write a program to implement linear search.
- f) Write a program to print the elements of a 2D array.
- g) Write a program to read and print the elements of a matrix.

4) Write a program (by using function) :

- a) Concept of Function
- b) User defined Function
- c) System Defined Function
- d) Types of parameter passing in function
- e) Sum of two numbers.
- f) Subtraction of a value from another value.

6) Solve the s-wave Schrodinger equation for the ground state and the first excited state of the Hydrogen atom:

$$\frac{d^2 u}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2} [V(r) - E], \quad \text{where } V(r) = -\frac{e^2}{r}$$

Here,  $m$  is the reduced mass of the electron. Obtain the energy Eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen

6) Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{1}{R} \frac{d}{dr} \left( r^2 \frac{dR}{dr} \right) - \frac{2mr^2}{\hbar^2} [V(r) - E] = l(l + 1)$$

where  $m$  is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential,

$$V(r) = -\frac{e^2}{r} e^{-r/a}$$

The ground state is expected to be above -12 eV in all three cases.

#### Textbook(s)

1. PROGRAMMING IN ANSI C BY E. BALGURUSWAMY, TATA MC-GRAW HILL.
2. PROGRAMMING WITH C, SCHAUM SERIES.
3. A FIRST COURSE IN PROGRAMMING WITH C, T. JEYAPOOVAN, VIKASH PUBLISHING HOUSE PVT. LTD.
4. COMPUTER FUNDAMENTALS AND PROGRAMMING IN C, REEMA TAHREJA, OXFORD HIGHER EDUCATION

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                 | Atomic And Molecular Physics                                                                                                                  | L | T | P | C               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                               | 3 | 1 | 0 | 4               |
| <b>Pre-requisite:</b> Quantum Mechanics.                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                               |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                               |   |   |   |                 |
| 1. To impart a comprehensive course on the applications of Quantum Mechanics in the Physics of Atoms and Molecules.                                                                                                                                                                                                                                                                                                                 |                                                                                                                                               |   |   |   |                 |
| 2. To disseminate lectures on the Molecular Physics of Diatomic Molecules.                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                               |   |   |   |                 |
| 3. To evaluate the connection behind spectroscopic methods such Raman Effect, Electron Spin Resonance (ESR) and Nuclear Magnetic Resonance (NMR) and Molecular Physics.                                                                                                                                                                                                                                                             |                                                                                                                                               |   |   |   |                 |
| 4. To teach students the physics behind the operation of Lasers and the properties associated with it.                                                                                                                                                                                                                                                                                                                              |                                                                                                                                               |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                               |   |   |   |                 |
| After successful completion of the course, the students will be able                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                               |   |   |   |                 |
| <b>CO 1:</b> To remember the operating principles of Laser, the properties and the numerous types of Lasers.                                                                                                                                                                                                                                                                                                                        |                                                                                                                                               |   |   |   |                 |
| <b>CO 2:</b> To understand the application of Perturbation Theory in the Fine Structure of Hydrogen and spectroscopic methods such as Zeeman and Stark Effect.                                                                                                                                                                                                                                                                      |                                                                                                                                               |   |   |   |                 |
| <b>CO 3:</b> To apply the physics behind the Rotational, Vibrational and Electronic structure of Diatomic Molecules.                                                                                                                                                                                                                                                                                                                |                                                                                                                                               |   |   |   |                 |
| <b>CO 4:</b> To analyze the physics of various spectroscopic methods such as Raman Effect, ESR and NMR based on the lectures of Molecular Physics.                                                                                                                                                                                                                                                                                  |                                                                                                                                               |   |   |   |                 |
| <b>Module 1: Atomic Physics</b>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                               |   |   |   | <b>20 Hours</b> |
| Fine Structure of One-Electron Atoms – Mass Correction, Spin-Orbit and Darwin Terms, Effect of Electric and Magnetic Fields: Zeeman, Paschen-Bach and Stark Effects, Ground State of Two-Electron Atoms – Perturbation Theory and Variational Methods, LS and JJ Coupling, Lande Interval and Selection Rules, Collision and Doppler Broadening.                                                                                    |                                                                                                                                               |   |   |   |                 |
| <b>Module 2: Molecular Physics - I</b>                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                               |   |   |   | <b>10hours</b>  |
| Born-Oppenheimer approximation for diatomic molecules, Rotational, Vibration and Electronic Structure of Diatomic Molecules, Spectroscopic terms, Electronic Structure - Molecular Symmetry and the States, Molecular Orbital and Valence Bond Methods for Hydrogen molecule and ion.                                                                                                                                               |                                                                                                                                               |   |   |   |                 |
| <b>Module 3: Molecular Physics - II</b>                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                               |   |   |   | <b>15 hours</b> |
| Rotational Spectra of Diatomic Molecules, Isotope Effect, Vibrational Spectra of Diatomic Molecules - Harmonic and Anharmonic Vibrators, Vibration-Rotation Spectra, Electronic Spectra of Diatomic Molecules - Vibrational Structure of Electronic Transitions, Rotational Structure of Electronic Bands - P, Q, R branches, Fort rat diagram, Franck-Condon principle, Electron Spin and Hund’s cases, Raman Effect, ESR and NMR. |                                                                                                                                               |   |   |   |                 |
| <b>Module 4: Lasers</b>                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                               |   |   |   | <b>15 hours</b> |
| Operating Principle of Laser –Threshold Condition for Laser Oscillation, Rabi frequency, Laser Pumping, Population Inversion and Resonator Modes, Multilevel rate equations and saturation, Laser Properties and Profile of Spectral Lines, Types of Lasers - He-Ne, CO2 and Semiconductor.                                                                                                                                         |                                                                                                                                               |   |   |   |                 |
| <b>Textbook(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                               |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                  | PHYSICS OF ATOMS AND MOLECULES (2 <sup>ND</sup> EDITION PEARSON, JANUARY 2003), B. H. BRANSDEN AND C. J. JOACHAIN.                            |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                  | MOLECULAR STRUCTURE AND SPECTROSCOPY (PRENTICE HALL INDIA, JANUARY 2007), G. ARULDHAS.                                                        |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                  | OPTICAL ELECTRONICS (CAMBRIDGE INDIA, JANUARY 2017), AJOY GHATAK AND K. THYAGARAJAN.                                                          |   |   |   |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                               |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                  | PRINCIPLES OF QUANTUM MECHANICS (CAMBRIDGE UNIVERSITY PRESS, AUGUST 2016), DAVID J. GRIFFITHS.                                                |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                  | QUANTUM PHYSICS OF ATOMS, MOLECULES, SOLIDS, NUCLEI AND PARTICLES (2 <sup>ND</sup> PAPERBACK WILEY, JANUARY 2006), R. RESNICK AND R. EISBERG. |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                  | FUNDAMENTALS OF MOLECULAR SPECTROSCOPY (TATA MCGRAW HILL, JUNE 2001), C. BANWELL AND E. MCCASH.                                               |   |   |   |                 |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Semiconductor Physics                                                                         | L | T | P | C        |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                               | 3 | 1 | 0 | 4        |
| Pre-requisite: Preliminary concept of 12 <sup>th</sup> standard Electronics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                               |   |   |   |          |
| Course Objectives:<br>1. To enhance the knowledge in band theory of solids and semiconductors.<br>2. To have a thorough knowledge on optical excitation and devices.<br>3. To have a broader concept on junctions to understand semiconductor devices.<br>4. To enhance the knowledge of transistors and their applications.<br>5. To develop the concept of oscillators.                                                                                                                                                                                                                                                                                                                            |                                                                                               |   |   |   |          |
| Course Outcome:<br>After successful completion of the course, the students will be able to<br>CO1: Remember the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.<br>CO 2: Understand the optical excitation and photoconductive devices<br>CO 3: Apply the theories to the working, design considerations and applications of various semiconducting devices.<br>CO 4: To analyze various transistor oscillator and their types.                                                                                                                                                                             |                                                                                               |   |   |   |          |
| Module 1: Band Theory of Solids and Semiconductors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                               |   |   |   | 15 hours |
| Failure of free electron theory, Sommerfield Quantum Theory, concept of Fermi level, Bloch Theorem, Kronig-Penney Model, formation of energy bands, velocity and effective mass of electron, distinction between metals, insulators and semiconductors, intrinsic semiconductors, extrinsic semiconductors, n-type and p-type, drift velocity, mobility and conductivity of intrinsic semiconductors, variation of conductivity with temperature, carrier concentration and Fermi level for intrinsic semiconductor, hole concentration in valence band, carrier concentration, Fermi level, and conductivity for extrinsic semiconductor.                                                           |                                                                                               |   |   |   |          |
| Module 2: Optical Excitation in Semiconductor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                               |   |   |   | 10 hours |
| Optical absorption, carrier generation, Carrier life time, diffusion length and photo conductivity, Direct and indirect recombination and trapping, Photoconductive devices. Diffusion of carriers, Einstein relation, Continuity equation, Carrier injection, Diffusion length. Haynes-Shockley experiment.                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                               |   |   |   |          |
| Module 3: Junctions Diodes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                               |   |   |   | 12 hours |
| Fabrication and Types of Junctions, Unbiased pn junction, energy level diagram and built in potential, diffusion and drift of carriers: Einstein relation, biased pn junction, volt-amp characteristic of pn junction, effect of temperature on I-V characteristics, DC and AC resistance of pn junction, junction capacitance, zener diode, tunnel diode, light emitting diode, point contact diode, liquid crystal display.                                                                                                                                                                                                                                                                        |                                                                                               |   |   |   |          |
| Module 4: Transistors and Amplifiers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                               |   |   |   | 16 hours |
| Introduction, Bipolar Junction Transistor, Transistor currents, Transistor fabrication, Transistor Configuration and Characteristics, Common base and common emitter static characteristics, Transistor alpha and beta, current and voltage notation, load line, transistor biasing: fixed bias or base bias, collector-feedback bias, emitter feedback bias, two port network representation of a transistor, open circuit impedance parameters or z-parameters, short-circuit admittance parameters or y-parameters, hybrid parameters or h-parameters, common emitter amplifier, Field effect transistors: JFET, MOSFET, FET amplified model and parameters, FET versus BJTs, Feedback principle. |                                                                                               |   |   |   |          |
| Module 5: Photo detector                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                               |   |   |   | 7 hours  |
| LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photo detectors: Ideal conversion efficiency, Fill factor, Equivalent circuit, Voc, Isc and Load resistance, Spectral response. Reverse saturation current in photo detector.                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                               |   |   |   |          |
| Total Lecture hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                               |   |   |   | 60 hours |
| Text Book(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                               |   |   |   |          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | STREETMAN, B. AND BANERJEE, S., SOLID STATE ELECTRONICS, PRENTICE HALL INDIA, (2006).         |   |   |   |          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | JASPRIT SINGH, SEMICONDUCTOR DEVICES: BASIC PRINCIPLES BY JOHN WILEY & SOND PTD LTD SINGAPORE |   |   |   |          |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | DONALD NEAMEN , DHRUBES BISWAS "SEMICONDUCTOR PHYSICS AND DEVICES" MCGRAW-HILL EDUCATION      |   |   |   |          |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | C.T. SAH, FUNDAMENTALS OF SOLID STATE ELECTRONICS, WORLD SCIENTIFIC PUBLISHING CO INC, 1991.  |   |   |   |          |

| Reference Books |                                                                                                   |
|-----------------|---------------------------------------------------------------------------------------------------|
| 1.              | Y. TSIVIDIS AND M. COLIN, OPERATION AND MODELING OF THE MOS TRANSISTOR. OXFORD UNIV. PRESS, 2011  |
| 2.              | A.K. MAINI, N. MAINI, ALL-IN-ONE ELECTRONICS SIMPLIFIED, KHANNA BOOK PUBLISHING, NEW DELHI, 2021. |

| DSC                                                                                                                                                                                                                                                                                                       | Statistical Mechanics                                                          | L | T | P | C               |
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|                                                                                                                                                                                                                                                                                                           |                                                                                | 3 | 1 | 0 | 4               |
| <b>Pre-requisite:</b> Preliminary knowledge of Statistics and Mathematics.                                                                                                                                                                                                                                |                                                                                |   |   |   |                 |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                 |                                                                                |   |   |   |                 |
| 1. To provide fundamental knowledge about Statistical Mechanics for describing systems containing large number of particles.                                                                                                                                                                              |                                                                                |   |   |   |                 |
| 2. To introduce the advance concepts of Classical Statistical Mechanics so that students will be equipped with sufficient knowledge of the subject.                                                                                                                                                       |                                                                                |   |   |   |                 |
| 3. To impart fundamental knowledge of Quantum Statistical Mechanics and its applications.                                                                                                                                                                                                                 |                                                                                |   |   |   |                 |
| 4. To develop the interest and ability among students to solve challenging physical problems by the application of techniques of Statistical Mechanics in future.                                                                                                                                         |                                                                                |   |   |   |                 |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                    |                                                                                |   |   |   |                 |
| After successful completion of the course, it is expected that the students will be able to                                                                                                                                                                                                               |                                                                                |   |   |   |                 |
| <b>CO1:</b> Remember the Statistical Laws for all physical phenomena.                                                                                                                                                                                                                                     |                                                                                |   |   |   |                 |
| <b>CO 2:</b> Understand and appreciate different features of Quantum Statistical Mechanics so as to gain insight into diverse physical phenomena.                                                                                                                                                         |                                                                                |   |   |   |                 |
| <b>CO 3:</b> Apply different aspects of Classical Statistical Mechanics.                                                                                                                                                                                                                                  |                                                                                |   |   |   |                 |
| <b>CO 4:</b> Analyze the universality of critical exponents characterizing phase transitions.                                                                                                                                                                                                             |                                                                                |   |   |   |                 |
| <b>Module 1:REVIEW OF THERMODYNAMICS AND TOPICS IN PROBABILITY THEORY</b>                                                                                                                                                                                                                                 |                                                                                |   |   |   | <b>10 hours</b> |
| Statistical basis of thermodynamics, probability concepts, entropy of a probability distribution, random walk, microstate and macro state, phase space, Liouville theorem                                                                                                                                 |                                                                                |   |   |   |                 |
| <b>Module 2: CLASSICAL STATISTICAL MECHANICS</b>                                                                                                                                                                                                                                                          |                                                                                |   |   |   | <b>19 hours</b> |
| Concept of ensembles, micro canonical, canonical and grand canonical ensembles, system in grand canonical ensembles, Partition functions, principle of equipartition of energy.                                                                                                                           |                                                                                |   |   |   |                 |
| Energy of Harmonic oscillator, partition function for canonical ensemble, energy fluctuations in the canonical ensemble, partition function and Thermodynamic function for grand canonical ensemble, density fluctuations in the grand canonical ensemble, theory of paramagnetism, negative temperature. |                                                                                |   |   |   |                 |
| <b>Module 3: QUANTUM STATISTICAL MECHANICS</b>                                                                                                                                                                                                                                                            |                                                                                |   |   |   | <b>15 hours</b> |
| Indistinguishable particles in quantum mechanics, Bosons and Fermions, Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. Fermi-Dirac statistics, Fermi energy, ideal Fermi gas, Density operator, Quantum Liouville equation, pure and mixed states.                         |                                                                                |   |   |   |                 |
| <b>Module 4: FLUCTUATIONS AND PHASE TRANSITIONS</b>                                                                                                                                                                                                                                                       |                                                                                |   |   |   | <b>16 hours</b> |
| Brownian motion; diffusion equation, approach to equilibrium: the Fokker –Planck equation, introduction to non-equilibrium processes                                                                                                                                                                      |                                                                                |   |   |   |                 |
| First and second order phase transition, phase diagram, Interacting spin systems, the Ising model (one dimension), paramagnetic and ferromagnetic phases, liquid helium                                                                                                                                   |                                                                                |   |   |   |                 |
| <b>Total Lecture hours</b>                                                                                                                                                                                                                                                                                |                                                                                |   |   |   | <b>60 hours</b> |
| <b>Text Book(s)</b>                                                                                                                                                                                                                                                                                       |                                                                                |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                        | Statistical Mechanics, R.K. Pathria (Butterworth-Heinemann, Second Edn, 1996). |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                        | Statistical Mechanics, K. Huang (2nd edition, Wiley-India, 2008).              |   |   |   |                 |
| 3.                                                                                                                                                                                                                                                                                                        | Statistical Physics : L. Landau And E.M. Lifshitz                              |   |   |   |                 |
| <b>REFERENCE BOOKS</b>                                                                                                                                                                                                                                                                                    |                                                                                |   |   |   |                 |
| 1.                                                                                                                                                                                                                                                                                                        | STATISTICAL MECHANICS: AN ADVANCED COURSE WITH PROBLEMS AND                    |   |   |   |                 |
| 2.                                                                                                                                                                                                                                                                                                        | SOLUTIONS, RYOGO KUBO (NORTH- HOLLAND, 1965)                                   |   |   |   |                 |
|                                                                                                                                                                                                                                                                                                           | STATISTICAL PHYSICS : F. REIF                                                  |   |   |   |                 |

| DSC                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Research Methodology                                                                                                                                                     | L | T | P | C        |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                          | 4 | 0 | 0 | 4        |
| Pre-requisite: Preliminary concept of 12 <sup>th</sup> standard Physics                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                          |   |   |   |          |
| Course Objectives:<br>1. To enhance the knowledge about the basic rules and types of research design.<br>2. To gain insights into how scientific research is conducted<br>3. To identify the influencing factor or determinants of research parameters.<br>4. To test the significance, validity and reliability of the research results                                                                                                                                       |                                                                                                                                                                          |   |   |   |          |
| Course Outcome:<br>After successful completion of the course, the students will be able<br>CO1: Understand scientific method, hypothesis formulation, and research design.<br>CO2: Develop skills in literature survey and academic writing.<br>CO3: Learn experimental planning, data acquisition, and error analysis.<br>CO4: Understand ethical practices, plagiarism, authorship norms.<br>CO5: Prepare research proposals, seminar presentations, and scientific reports. |                                                                                                                                                                          |   |   |   |          |
| Module 1: Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                          |   |   |   | 10 hours |
| Meaning, objectives, types of research; scientific method; hypothesis formulation; variables; sampling; research design; case studies in Physics.                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                          |   |   |   |          |
| Module 2: Literature survey                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                          |   |   |   | 12 hours |
| Primary vs secondary literature; Scopus, Web of Science, arXiv; reference managers (Zotero, Mendeley); reading scientific papers; annotated bibliographies.                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                          |   |   |   |          |
| Module 3: Data analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                          |   |   |   | 14 hours |
| Experimental planning; data acquisition; error analysis; curve fitting; regression; basics of Python/Origin for data analysis.                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                          |   |   |   |          |
| Module 4: Ethics                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                          |   |   |   | 10 hours |
| Plagiarism; authorship norms; data fabrication/falsification; ethical use of AI tools; copyright; open-access policies                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                          |   |   |   |          |
| Module 5: Reporting                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                          |   |   |   | 14 hours |
| Writing proposals; structure of scientific papers; poster/oral presentations; seminar report preparation; peer review process.                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                          |   |   |   |          |
| Total Lecture hours                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                          |   |   |   | 60 hours |
| Text Book(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                          |   |   |   |          |
| 1.<br>2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Research Methodology: Methods and Techniques — C.R. Kothari<br>Research Methods for the Behavioral Sciences — Gravetter & Forzano                                        |   |   |   |          |
| Reference Books                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                          |   |   |   |          |
| 1.<br>2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Research Methodology: A Step-by-Step Guide for Beginners — Ranjit Kumar • Research Design: Qualitative, Quantitative, and Mixed Methods Approaches — Creswell & Creswell |   |   |   |          |

| DCS | General Lab-II | L | T | P | C |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                      | 0 | 0 | 12 | 6 |
| <b>Prerequisite : Graduate level Laboratory knowledge</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                      |   |   |    |   |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                      |   |   |    |   |
| <p>This course aims at performing basic physics experiments by the students. The students will be able to determine:</p> <ol style="list-style-type: none"> <li>1. Some physical parameters and design circuits to understand important principles of Physics.</li> <li>2. Enable the students to analyze problems starting from first principles, evaluate and validate experimental results, and draw logical conclusions thereof.</li> <li>3. Make the students to understand that acquiring knowledge and skills appropriate to their professional activities is a never-ending process.</li> <li>4. This lab will help the students to understand and Introducing basic concepts via diffraction methods, lattice vibrations and free electrons, Hall Effect.</li> <li>5. Enhance the knowledge of students to the band structures for studying different materials.</li> </ol>                                                                                                                                                                                                                             |                                                                                                                                      |   |   |    |   |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                      |   |   |    |   |
| <p><b>CO1:</b> Students will gain in-depth knowledge about the molecular structure using various concepts.<br/> <b>CO2:</b> Students will be able to answer about various spectroscopic techniques and their modern developments.<br/> <b>CO3:</b> To increase the level of understanding of students about the various spectra of atoms, molecules and the use of electromagnetic radiation in understanding the tiny particles and the whole universe.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                      |   |   |    |   |
| <b>List of Experiments :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                      |   |   |    |   |
| <ol style="list-style-type: none"> <li>1) To determine the first excitation potential of a Gas by Frank-Hertz experiment.</li> <li>2) To find the wavelengths of the spectral lines of Hydrogen and hence determine the value of Rydberg constant.</li> <li>3) Measurement of Magneto resistance of the supplied material.</li> <li>4) Observe diffraction of the beam of electrons on a graphitized carbon target and calculate the intra-atomic spacing's in the graphite.</li> <li>5) Study of Dielectric constant and Curie temperature of a ferromagnetic sample.</li> <li>6) Determination of planks constant by planks blackbody radiation experiment.</li> <li>7) Determine the Band gap of a semiconductor by using four probe methods.</li> <li>8) Perform the Hall Effect experiment by recording the Hall voltage at different sample currents under different magnetic field strengths. Plot suitable graph and hence determine Hall coefficients. Identify conductivity type of the semiconductor.</li> <li>9) To study the dispersion relation for the monatomic and diatomic lattice.</li> </ol> |                                                                                                                                      |   |   |    |   |
| <b>Text Books :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                      |   |   |    |   |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B.L. FLINT AND H.T. WORKSHOP, 1971, ASIA PUBLISHING HOUSE                                   |   |   |    |   |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ADVANCED LEVEL PHYSICS PRACTICAL'S, MICHAEL NELSON AND JON M. OGBORN, 4TH EDITION, REPRINTED 1985, HEINEMANN EDUCATIONAL PUBLISHERS. |   |   |    |   |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | TEXTBOOK OF PRACTICAL PHYSICS, I. PRAKASH & RAMAKRISHNA, 11TH ED. 2011, KITAB MAHAL.                                                 |   |   |    |   |

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| <b>DCS</b> | <b>Advanced Research Laboratory</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|------------|-------------------------------------|----------|----------|----------|----------|



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                      | 0 | 0 | 8 | 6 |
| <b>Prerequisite : Graduate level Laboratory knowledge</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                      |   |   |   |   |
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                      |   |   |   |   |
| <p>This course aims at performing basic physics experiments by the students. The students will be able to :</p> <ol style="list-style-type: none"> <li>1) Understand and apply a broad range of measurement methods and techniques that are widely used in physics experiments;</li> <li>2) Design experiments and make appropriate choices of measurement techniques and equipment;</li> <li>3) Apply high-level computational and statistical techniques to datasets, including complex uncertainty analysis and model testing;</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                      |   |   |   |   |
| <b>Course Outcome:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                      |   |   |   |   |
| <p><b>CO1:</b> The students will be able to provide exposure in practical application of spectroscopic instruments.<br/> <b>CO2:</b> The students will be able to ascertain the atomic and molecular structures.<br/> <b>CO3:</b> Apply Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and understand basic models for phase transitions.<br/> <b>CO\$:</b> Students will be able to understand atomic energy level splitting in a magnetic field, calculate the specific charge (e/m) of an electron, and verify quantum mechanical space quantization</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                      |   |   |   |   |
| <b>List of Experiments :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                      |   |   |   |   |
| <ol style="list-style-type: none"> <li>1) <b>Velocity of an ultrasonic wave in a given liquid by using Spectrometer.</b></li> <li>2) <b>To study the elliptically polarized light by using Babinet's Compensator.</b></li> <li>3) <b>Determination of refractive index and Cauchy's Constants of prism using spectrometer</b></li> <li>4) <b>Find the Susceptibility of given paramagnetic substances (FeCl<sub>3</sub>) by Quinck's tube Method.</b></li> <li>5) <b>Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature</b></li> <li>6) <b>Plot Specific Heat of Solids</b> <ol style="list-style-type: none"> <li>(a) Dulong-Petit law</li> <li>(b) Einstein distribution function</li> <li>(c) Debye distribution function for high temperature and low temperature and compare them for these two cases by using Scilab.</li> </ol> </li> <li>7) <b>Plot the following functions with energy at different temperatures</b> <ol style="list-style-type: none"> <li>a) Maxwell-Boltzmann distribution</li> <li>b) Fermi-Dirac distribution</li> <li>c) Bose-Einstein distribution Course Code Course Title by using Scilab.</li> </ol> </li> <li>8) <b>Familiarization with ORIGIN Graphing and Analysis Software for analysis of absorption &amp; photoluminescence spectra and X-ray diffraction patterns (Demo).</b></li> <li>9) <b>Determination of e/m of an electron. (Zeeman effect).</b></li> <li>10) <b>To determine the Specific rotation of Sugar solution using Polarimeter.</b></li> </ol> |                                                                                                                                      |   |   |   |   |
| <b>Text Books :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |   |   |   |   |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B.L. FLINT AND H.T. WORKSHOP, 1971, ASIA PUBLISHING HOUSE                                   |   |   |   |   |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ADVANCED LEVEL PHYSICS PRACTICAL'S, MICHAEL NELSON AND JON M. OGBORN, 4TH EDITION, REPRINTED 1985, HEINEMANN EDUCATIONAL PUBLISHERS. |   |   |   |   |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | TEXTBOOK OF PRACTICAL PHYSICS, I. PRAKASH & RAMAKRISHNA, 11TH ED. 2011, KITAB MAHAL.                                                 |   |   |   |   |