DEPARTMENT OF ELECTRICAL ENGINEERING

Structure: B.tech 4th sem structure and syllabus

Theory course

Sl. No	T/P	Course Type	Course code	Name of the Course	Hours per week			Credit
					L	T	P	C
1	T	PCC	BEL23205T	Electrical Machines II	3	0	0	3
2	T	PCC	BEL23206T	Power System I	3	0	0	3
3	T	PCC	BEL23207T	Digital Electronics	3	0	0	3
4	T	PCC	BEL23208T	Principles of Signal & Systems	3	0	0	3
5	T	PCC	BEL23209T	Renewable Energy Engineering	3	0	0	3
6	T	ESC	BEL23211T	Introduction to Machine Learning in Electrical Engineering	2	2	0	3
7	T	HSMC	BEL23212T	Indian Knowledge System	3	0	0	3
					20	**0**	**0**	**21**

Practical course

Sl. No	T/P	Course Type	Course code	Name of the Course	Hours per week			Credit
					L	T	P	C
1	P	PCC	BEL23205P	Electrical Machines II Lab	0	0	2	1
2	P	PCC	BEL23207P	Digital Electronics Lab	0	0	2	1
3	P	PCC	BEL23208P	Signal & Systems Lab	0	0	2	1
4	P	PCC	BEL23210P	Mini Project	0	0	2	1
					0	**0**	**8**	**4**

NOTE 2-3 weeks mandatory academic internship need to be done in the 4th semester summer break and the report is to be submitted and evaluated in 5th semester.

FOURTH SEMESTER

Course name: Electrical Machines II

Course Code: BEL23206T **L:T:P::3:0:0**

Course Objectives:

1. To understand the fundamentals concepts of AC machines.
2. To understand the constructional features and workings of AC machines.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of rotating magnetic fields.
2. Understand the operation of ac machines.
3. Analyze performance characteristics of ac machines.

Module No	Module Title	Details	Lecture hours
1	**FUNDAMENTALS OF AC MACHINE WINDINGS**	Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil, full-pitch coils, concentrated winding, distributed winding, Air-gap, Sinusoidally distributed winding, winding distribution factor	4
2	**POLYPHASE INDUCTION MOTORS**	Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.	14
3	**SINGLE PHASE INDUCTION MOTORS**	Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Splitphase starting methods and applications	8
4	**SYNCHRONOUS MACHINES**	Construction and principles of operation of synchronous generators, emf equation. Armature reaction, leakage reactance, synchronous reactance, and impendence of non-salient pole machines. Short circuit and open circuit tests, short circuit ratio, M M F in salient and non-salient pole machines. Calculation of regulation by synchronous impedance method. Introduction to two-reactance theory, locus diagram of	10

		synchronous impedance, slip test, damper winding and oscillation of synchronous machines, Synchronization, power angle diagram and synchronizing power. Sub-transient and transient reactance of synchronous machine. Parallel operation and load sharing of synchronous machines.	
5	**SYNCHRONOUS MOTORS**	Construction and principles of operation of synchronous motor. Phasor diagram, effect of varying excitation, effect of load variation, V-curve, O-curve, power angle diagram and stability, Hunting, Two-reaction theory of salient-pole motor, Starting. Use as synchronous phase modifiers.	5
	OTHER MOTORS	Single phase commutator motors, Universal and Repulsion motors (Construction and principle of operation), Reluctance Motor (Construction and principle of operation), Stepper Motor (Construction and principle of operation), Brushless DC Motor (Construction and principle of operation).	4
		Total	**45**

Textbooks:

A. E. Fitzgerald and C. Kingsley, "Electric Machinery‖, McGraw Hill Education, 2013.
1. M. G. Say, —Performance and design of AC machines‖, CBS Publishers, 2002.
2. P. S. Bimbhra, —Electrical Machinery‖, Khanna Publishers, 2011.
3. I. J. Nagrath and D. P. Kothari, —Electric Machines‖, McGraw Hill Education, 2010.
4. A. S. Langsdorf, —Alternating current machines‖, McGraw Hill Education, 1984.
5. P. C. Sen, —Principles of Electric Machines and Power Electronics‖, John Wiley & Sons, 2007

Course name: Power System-I

Course Code: BEL23206T **L:T:P::3:0:0**

Course Objectives:

1. To Identify and describe the basic structures of power systems.
2. To understand the fundamentals of transmission and distribution systems.
3. To evaluate the performance of transmission lines in terms of efficiency and regulation.
4. To analyze the integration of renewable energy into power distribution systems.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Explain the evolution of power systems, their basic structures, various energy sources, basics of transmission and distribution systems.
2. Derive the various parameters of transmission lines and evaluate their performance in terms of efficiency and regulation
3. Analyze various theoretical concepts related to underground cables and solve related numerical problems
4. Classify different types of insulators and design a transmission system with safe operating conditions by calculating sag and corona
5. Evaluate different schemes of DC distribution and understand the basic concepts behind solar PV systems and wind energy systems.

Module No	Module Title	Details	Lecture hours
1	**Introduction to Power Systems**	Basic structure of a power system. Historical evolution and present-day scenario. Traditional grid vs. micro grids, centralized vs. distributed generation. Power Generation Sources: Non-Renewable and Renewable Energy Sources. Basics of Storage Technology. Transmission and Distribution Systems: Single Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems).	5

2	**Tranmission Lines: Types, formation and Performance**	Types of transmission lines, Types of conductor materials used, Skin effect and proximity effect Inductance and capacitance calculation of transmission lines: single phase and three phase, related numerical problems. Classification of Transmission lines: Short, Medium and Long, their modeling and analysis, Calculation of Efficiency and Regulation. Evaluation of generalized network constants (ABCD parameters), mathematical modeling of short and medium lines to evaluate ABCD parameters. Surge impedance loading and Ferranti effect. Series and shunt compensation of transmission lines.	12
3	**Cables**	Different types. Insulating material used, High Voltage cables, Insulation resistance of cables, Capacitance of single and multi-core cables, Grading of cables, Testing of cables, Maximum current carrying capacity of cables	8
4	**INSULATORS, SAG, CORONA**	Different types of insulators and their construction, voltage ratings, string efficiency of an insulator string, methods of grading insulators and static shielding, Testing of insulators Calculation of sag with support at same and different levels, Effect of wind and ice loading on sag, conductor spacing and ground clearance Corona Phenomemon: Electric stress at the surface of overhead line conductors, Disruptive critical voltage, visual critical voltage, Factors responsible for Corona loss, Methods of reducing corona loss Electostatic and electromagnetic interference with communication lines.	12
5	**Introduction to DC Transmission & Renewable Energy Systems**	Various schemes of DC transmission and distribution-radial, ring and interconnected Solar PV systems: I-V and P-V characteristics of PV panels, power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines. Power Electronics interfaces of wind generators to the grid.	8
		Total	**45**

Textbooks:

1. Power System Engineering -Nagrath and Kothari
2. Electrical power system- C L Wadhwa
3. Principles of Power System-VK Mehta, Rohit Mehta

Reference Books:

1. A course in power systems-J B Gupta
2. Switchgear and Protection-SS Rao
3. Generation, Distribution and Utilization of Electrical Energy-C.L.Wadhwa

Course name: Digital Electronics

Course Code: BEL23207T **L:T:P::3:0:0**

Course Objectives:

1. To understand the fundamental principles underlying various logic families.
2. To designing Combinational logic circuits with a focus on minimizing gate count and optimizing performance.
3. To implement Sequential logic circuits, considering clocking, feedback, and memory elements.
4. To Implement and analyze practical examples of both conversion processes using appropriate tools and techniques.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the workings of logic families and logic gates.
2. Design and implement Combinational and Sequential logic circuits.
3. Discuss the Analog to Digital conversion and Digital to Analog conversion.
4. Make use of PLDs to implement the given logical problem.

Module No	Module Title	Details	Lecture hours
1	Fundamentals of Digital Systems and logic families	Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one‘s and two‘s complements arithmetic, codes, error detecting and correcting codes, characteristics of digital ICs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.	9
2	Combinational Digital Circuits	Standard representation for logic functions, K-map representation, and simplification of logic functions using K-map, minimization of logical functions. Don‘t care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.	9
3	Sequential circuits and systems	A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, JK-T and D types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous)	9

		counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.	
4	A/D and D/A Converters	Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.	9
5	Semiconductor memories and Programmable logic devices	Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).	9
		Total	**45**

Text Book:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

References:

1. G. K. Kharate, "Digital Electronics", Oxford University Press, 2010.
2. V.K. Puri, " Digital Electronics", Tata McGraw Hill, 1997

Course name: Principles of Signal & Systems

Course Code: BEL23208T **L:T:P::3:0:0**

Course Objectives:

1. To articulate the foundational concepts of continuous time and discrete time systems using appropriate terminology and descriptive language, demonstrating a thorough understanding through written and verbal explanations.
2. To develop analytical skills to assess and interpret the behavior of systems in the complex frequency domain.
3. To be proficient in applying the sampling theorem to analyze and address real-world signal processing challenges.
4. To design, simulate, and implement signal processing systems, fostering practical skills and real-world application of theoretical knowledge.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of continuous time and discrete time systems.
2. apply analytical skills to assess systems within the complex frequency domain.
3. employ the sampling theorem effectively, demonstrating their ability to apply theoretical knowledge.
4. Construct programs in signal processing, where they will design, simulate, and implement signal processing systems.

Module No	Module Title	Details	Lecture hours
1	**Introduction to Signals and Systems**	Signals and systems as seen in everyday life, and in various branches of engineering and science. Energy and power signals, Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.	5

2	**Behavior of continuous and discrete-time LTI systems**	Impulse response and step response, convolution, input-output behavior with periodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.	10
3	**Fourier, Laplace and z-Transforms**	Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.	15
4	**Sampling and Reconstruction**	The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.	10
		Total	**45**

Text Book:

1. A.V. Oppenheim, A. S. Willsky and S. H. Nawab, —Signals and systems‖, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, —Digital Signal Processing: Principles, Algorithms, and Applications, Pearson, 2006.
3. H. P. Hsu, —Signals and systems, Schaum‘s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, —Signals and Systems, John Wiley and Sons, 2007.
5. A Nagoor Kani, - Signals and Systems, McGraw Hill, 2013.

References:

1. A. V. Oppenheim and R. W. Schafer, —Discrete-Time Signal Processing, Prentice Hall, 2009.

2. M. J. Robert —Fundamentals of Signals and Systems, McGraw Hill Education, 2007.
3. B. P. Lathi, —Linear Systems and Signals, Oxford University Press, 2009.
4. P. Ramesh Babu, R. Anandanatarajan, - Signals and Systems, Scitech, 4th edition, 2014
5. Tarun Kumar Ranawat,- Signal & Systems, Oxford, 2010 (For MATLAB codes)

Course name: Renewable Energy Engineering

Course Code: BEL23209T **L:T:P::2:2:0**

Course Objectives:

1. To demonstrate Proficiency in Renewable Energy Technologies
2. To analyze and Design Renewable Energy Systems
3. To implement Sustainable Practices in Energy Engineering

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Identify and classify various renewable energy sources, including solar, wind, hydropower, and bioenergy.
2. Evaluate the efficiency and applicability of different renewable energy technologies in diverse settings.
3. Apply engineering principles to analyze and design renewable energy systems for specific requirements.

Module No	Module Title	Details	Lecture hours
1	**INTRODUCTION TO RENEWABLE ENERGY SOURCES**	Introduction to energy resources: overview of energy resources: renewable and non-renewable; various energy units; environmental impacts of fossil fuels	4
2	**SOLAR THERMAL ENERGY**	Solar spectrum, sun-path diagram and different angles, solar radiation and measuring instruments; fundamentals of solar thermal energy, basics of heat transfer, types of solar thermal collectors (flat-plate, evacuated tube, concentrating); solar thermal energy systems; solar thermal energy storage	6
3	**SOLAR PHOTOVOLTAIC ENERGY**	Solar photovoltaic: semiconductor physics, solar cells (mono-crystalline, poly-crystalline, thin-film); equivalent circuit; I-V, P-V characteristics of solar cell/modules; effect of temperature, light intensity on solar cell/module performance; solar module and array configurations; PV system components; off-grid and grid connected photovoltaic system	6
4	**WIND ENERGY**	Wind energy potential in India; power available in the wind; wind regimes analysis; wind speed statistics; statistical model for wind data analysis: Weibull distribution; energy estimation of wind regimes, capacity factor; Betz limit for maximum power coefficient; wind turbine: Horizontal and Vertical axis wind turbine, Power and torque characteristics; Power coefficient and tip speed ratio characteristics; Wind pump and Wind electric generator: Induction and synchronous generator	6

5	**BIOMASS ENERGY**	Basics of biomass energy: definition and types of biomass; principles of biomass energy conversion; thermochemical conversion technologies: combustion, gasification, and pyrolysis; biochemical conversion technologies: anaerobic digestion; types of anaerobic digesters (batch, continuous); fermentation: ethanol production from biomass; biodiesel production: transesterification process	6
6	**HYDRO ENERGY**	Fundamentals of hydropower; hydrological cycle, hydrographs and flow duration curve; elements of hydropower plants; pumped hydro storage power plants; environmental and ecological considerations of hydropower plant	6
7	**GEOTHERMAL ENERGY**	Geothermal energy resources; geothermal power plants: types and working principles; direct use applications and heat pumps	3
8	**OCEAN ENERGY**	Tidal power, components of tidal power plants, generation of tidal power, estimation of energy and power; ocean thermal energy conversion (OTEC): types, plants and specifications	3
9	**HYDROGEN ENERGY**	Introduction to Hydrogen Energy: Overview of hydrogen as an energy carrier; properties of hydrogen; Hydrogen production methods: Steam Methane Reforming (SMR), Electrolysis, Thermochemical processes, Biological processes; Green, Blue, and Grey Hydrogen; Hydrogen storage and transportation; applications of hydrogen energy	4
10	**MAGNETO-HYDRODYNAMIC (MHD) GENERATION**	Principles of MHD generation, MHD generator, equivalent circuits, MHD system	1
		Total	**45**

Text Book:

[1] Tiwari G. N. and Ghoshal M. K. (2007), Fundamental of Renewable Energy Sources, Narosa
[2] Kishore V. V. N. (2019), Renewable Energy Engineering and Technology: Principles and Practice. Earthscan
[3] Twidell J. (2021). Renewable Energy Resources. 4th Edition, Routledge, Taylor & Francis
[4] Garg H. P. and Prakash S. (2017), Solar Energy: Fundamentals and Applications. McGraw Hill
[5] Solanki C. S. (2009). Solar Photovoltaics: Fundamentals, Technologies and Applications. PHI, New Delhi

Course name: Introduction to Machine Learning in Electrical Engineering

Course Code: BEL23211T **L:T:P::2:2:0**

Course Objectives:

1. To Understand the basic concepts and terminologies in machine learning.
2. To Identify different types of machine learning algorithms and their applications.
3. To Apply machine learning techniques to solve problems in electrical engineering.
4. To Evaluate the performance of machine learning models and improve them.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Describe key machine learning concepts and algorithms.
2. Analyze data sets to identify patterns and relationships.
3. Implement machine learning models using programming tools.
4. Assess the effectiveness of machine learning models in various electrical engineering applications.

Module No	Module Title	Details	Lecture hours
1	**Introduction to Machine Learning**	Overview of machine learning, Types of machine learning: supervised, unsupervised, reinforcement learning, Applications in electrical engineering, Introduction to Python and R for machine learning	6
2	**Data Preprocessing and Visualization**	Data cleaning and normalization, Data visualization techniques, Tools: Pandas, Matplotlib, ggplot2	4
3	**Supervised Learning - Regression**	Linear regression, polynomial regression, Model evaluation metrics: MSE, RMSE, R-squared, Practical implementation in Python and R	6
4	**Supervised Learning - Classification**	Logistic regression, k-nearest Neighbors (k-NN), Decision Trees, Performance metrics: accuracy, precision, recall, F1-score, Practical implementation in Python and R	7
5	**Unsupervised Learning**	Clustering algorithms: K-means, Hierarchical clustering Dimensionality reduction: PCA, Practical implementation in Python and R	7
6	**Advanced Topics**	Ensemble methods: Random Forest, Gradient Boosting Introduction to neural networks and deep learning Practical implementation in Python and R	7

7	**Applications in Electrical Engineering**	Case studies: predictive maintenance, signal processing, smart grids, Project work: applying ML techniques to an electrical engineering problem	4
8	**Project Presentation and Evaluation**	Presentation of project findings	4
		Total	45

Text Book and References:

1. Big Data Analytics and Machine Learning by V.K.Jain, Khanna Publishers
2. An Introduction to Statistical Learning with application in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer (Available as e-book at https://www.stat.berkeley.edu/users/rabbee/s154/ISLR_First_Printing.pdf)
3. Introduction to Machine Learning with Python, Andreas C. Müller & Sarah Guido, O'REILLY (Available as e-book at https://www.nrigroupindia.com/e-book/Introduction%20to%20Machine%20Learning%20with%20Python%20(%20PDFDrive.com%20)-min.pdf)

Additional Resources

1. Online platforms: Kaggle, Coursera
2. Libraries and frameworks: Scikit-learn, TensorFlow, Keras (Python); caret, randomForest (R)

Course name: Indian Knowledge System (IKS IV): Indian Science, Engineering and Technology (Past, Present and Future)

Course Code: BEL23212T **L:T:P::3:0:0**

Course Objectives:

1. To familiarize learners with major sequential development in Indian science, engineering and technology.
2. To review & strengthen the ancient discovery and research in physics, chemistry, maths, metallurgy, astronomy, architecture, textile, transport, agriculture and Ayurveda etc.
3. To help students to trace, identify and develop the ancient knowledge systems to make meaningful contribution to development of science today.
4. To help to understand the apparently rational, verifiable and universal solution from ancient Indian knowledge system for the scientific, technological and holistic development of physical, mental and spiritual wellbeing.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Outline major sequential development in Indian science, engineering and technology.
2. Analyze ancient discovery and research in physics, chemistry, maths, metallurgy, astronomy, architecture, textile, transport, agriculture and Ayurveda etc.
3. Identify ancient knowledge systems to make meaningful contribution to development of science today.
4. Understand ancient Indian knowledge system for the scientific, technological and holistic development of physical, mental and spiritual wellbeing.

Module No	Module Title	Details	Lecture hours
1	**Indian Traditional Knowledge; Science and Practices**	Introduction to the Science and way of doing science and research in India, Ancient Science in Intra & Inter Culture Dialogue & coevolution. Traditional agricultural practices, Traditional water-harvesting practices, Traditional Livestock and veterinary Sciences Traditional Houses & villages, Traditional Forecasting, Traditional Ayurveda & plant based medicine, Traditional writing Technology	9
2	**Ancient Indian Science (Physics, Chemistry, Maths)**	Physics in India: Vaisheshika darshan -Atomic theory & law of motion, theory of panchmahabhoota, Brihath Shathaka (divisions of the time, unit of distance), bhaskarachaya (theory of gravity, surya siddhanta & sidhanta shriomani), Lilavati (gurutvakashan Shakti).	9

		Chemistry in India-Vatsyayana, Nagarjuna, Khanda, Al-Biruni, Vagbhaṭa –building of the Ras-shala (laboratory), working arrangements of ras-shala, material and equipment, Yaśodhara Bhaṭṭa-process of distillation, apparatus, saranasamskara, saranataila Mathematics in India: Baudhayana's Sulbasutras, Aryabhaṭa, Bhaskaracharya-I, Severus Sebokht, Syria, Brahmagupta, Bhaskaracharya-II, Jyeṣṭhadeva	
3	**Ancient Indian Science (metallurgy, Astronomy, Architecture)**	Metallurgy in India: Survarṇa(gold) and its different types, prosperities, Rajata(silver), Tamra(copper), Loha(iron), Vanga(tin), Naga / sisa(lead), Pittala(brass), Astronomy in India Vedang Jyotish, aryabhatta siddhanta, Mahabhaskriya, Laghubhaskariya, vatesvarasiddhanta, Sisyadhivrddhida, Grahashyay, Goladhyaya, Karabakutuhala (Aryabhaṭa, Varahamihira, Brahmagupta, Vaṭesvara, Bhaskara, Paramesvara, NilakaṇṭhaSomayaji, Jyeṣṭhadeva, ŚankaraVarman), Architecture in India: Nagara (northern style), Vesara (mixed style), and Dravida (southern style), Indian vernacular architecture, Temple style, cave architecture, rock cut architecture, kalinga architecture, chandels architecture, Rajput architecture, jain architecture, sikh architecture, Maratha architecture Indo-Islamic architectural, Indo-Saracenic revival architecture, Greco Buddhist style.	9
4	**Ancient Indian Science (Textile, Agriculture, Transport)**	Textile Technology in India: Cotton (natural cellulose fiber), silk, wool (natural protein fibers), bast and leaf fibers, mridhudhautadhupitambaram (meaning a practice of fumigating the fabric with incence smoke before use as a part of the finishing process), sitadhautavasanayugala (bleached white–a finishing process); suchhastah, sutradharah (needle and thread – tools for stiching). dyeing, washing spinning and weaving technology, Agriculture in India: krishisuktas, Krishiparashara, Brihatsamhita, Types of crops, Manures, Types of land-devamatruka, nadimatruka, use of animals in warfare, animal husbandry, Animals for medicines. Ancient transport in India	9
5	**Ancient Indian Science (Ayurveda & Yoga)**	Ayurveda for Life, Health and Well-being: Introduction to Ayurveda: understanding Human body and Pancha maha bhuta, the communication between body & mind, health	7

		regimen for wellbeing, introduction to yoga (raja yoga, astang yoga, gyan yoga), understanding of Indian psychological concept, consciousness, tridosha & triguna.	
		Total	45

References

1. Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru.
2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of Sankaracharya, Central Chinmay Mission Trust, Bombay, 1995.
3. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.
4. SK Das, The education system of Ancient Hindus, Gyan Publication House, India
5. R P Kulkarni, Glimpse of Indian Engineering and Technology (Ancient & Medieval period, Munshiram Manoharlal Publishers Pvt. Ltd. 2018
6. AK Pathak, Science and Technology in India, Anshika Prakashan Pratapgarh, 2016
7. PB Sharma, S. Narain, Doctors Scientists and Engineers of Ancient India, Kalpaz Publications 2017
8. NVP, Unithiri, Indian Scientific Traditions (Professor K.N. Neelakantan Elayath Felicitation Volume), publication division University of Calicut, 2006
9. Anonyms, History of Science in India- Volume-I Part-I (Physics, Mathematics and Statistics),the national academy of science, India & the Ramkrishna mission institute of culture, 2014
10. R N Basu, T K Bose, CS, Cakraborty History of Science in India - Agricultural Science (Volume V), the national academy of science, India & the Ramkrishna mission institute of culture 2014
11. A Gosh, History of Science in India (Volume-I Part-II Astronomy), the national academy of science, India & the Ramkrishna mission institute of culture, 2014
12. Dharmpal, Indian science and technology in the eighteen century, Rashtrottahana Sahitya, 1983
13. S Biswal, B L ray, Vedic Science and technology, DK Print world, 2009
14. A.K Bag, History of technology in Indian (Set 3 vol), Indian Nation Science Academy, 1997.
15. AR Vasudev Murty, Science and Technology in Ancient India as Reflected in the Mahabharata, Sanskrit Bharati, 2019

Course name: Electrical Machines II

Course Code: BEL23205P **L:T:P::0:0:2**

Course Objectives:

To analyze and Explain AC Machines

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Explain the characteristics and operations of a synchronous motor.
2. Test on induction motor and alternators
3. Test for different connections in a three-phase transformer.

LIST OF EXPERIMENTS:

1. Determination of voltage regulation of an alternator using the synchronous impedance method.
2. V-curves of a synchronous motor.
2. No load & block rotor test on 3-phase Induction motor.
3. Parallel operation of two alternators.
4. Study on Star/ Delta connections of three phases Transformer.

Course name: Digital Electronics Lab

Course Code: BEL23207P **L:T:P::0:0:2**

Course Objectives:

To Design and analyze digital circuits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

4. Understand the workings of logic gates.
5. Construct Combinational and Sequential logic circuits.
6. Design Analog to Digital and Digital to Analog converters

LIST OF EXPERIMENTS:

1. Realization of Basic gates using Universal gates.
2. Realization of EX-OR gate.
3. Combinational logic design using 74xx IC's.
4. Realization of half and full adder circuit using 74xx IC's.
5. Construction of 1-bit comparator using 74xx IC's.
6. Code-converters- Binary to gray and gray to Binary.
7. Verification of Truth-table for SR Flip-flop.
8. Verification of Truth-table for JK, D and T Flip-flop.
9. Design of counters.
10. Design and verification of A/D and D/A converters.

Reference:

1. Digital Electronics Laboratory manual

Course name: Signals & Systems Lab

Course Code: BEL23208P **L:T:P::0:0:2**

Course Objectives:

To apply the knowledge of signals and systems and analyze different signals.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Analyze various elementary signals and verify their independent variable properties.
2. Examine the concept of convolution of LTI system.
3. Apply Laplace Transform and Z Transform to represent a signal.

LIST OF EXPERIMENTS:

1. Introduction to SCILAB and XCOS
2. Generation of square wave, triangular, exponential, sinusoidal, step, impulse, and ramp function.
3. Verify time shifting, time scaling, and reflection operations on square wave, triangular, exponential, sinusoidal, step, impulse, and ramp functions.
4. Evaluate the convolution of finite discrete time signals and verify the commutative, associative, distributive, and identity properties.
5. Evaluate the discrete-time Fourier transform (DTFT) of a signal.
6. Computation of frequency response of LTI system from impulse response and difference equation.
7. Determination of frequency response from poles and zeroes.
8. Create Pole-zero plots on z-plane and determination of magnitude response.
9. Find the impulse response of a system described by Z transform.
10. Signal processing using XCOS.

Course name: MINI PROJECT (Practical-based course)

Course Code: BEL23210P **L:T:P::0:0:2**

Course Objectives:

1. To understand the fundamental concepts and theories related to electrical circuits and systems.
2. To apply electrical engineering concepts to design and implement a mini-project.
3. To evaluate the performance and efficiency of the designed electrical system.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Analyze the requirements and constraints of an electrical engineering mini-project.
2. Design a functional electrical circuit or system to meet specified project objectives.
3. Construct and test the designed electrical system or circuit.
4. Evaluate and improve the developed mini-project based on test results and feedback.

Module No	Course outline	Details	Practical hours
1	Project Management and Planning	• Overview of project management principles • Project selection and proposal development	4
2	Concept Development	• Literature review and feasibility study • Development of project specifications and constraints	4
3	Design Phase	• Detailed circuit/system design • Simulation and modeling	4
4	Implementation Phase	• Construction of the electrical system • Testing and debugging	6
5	Evaluation Phase	• Performance assessment • Iterative improvements based on test results	4
6	Final Report and Presentation Preparation	• Documentation of the project • Preparation for the final presentation	4
7	Final Presentation and Demonstration	• Presentation of project findings • Demonstration of the working project	4
		Total	**30**

Assessment and Grading

- Project Proposal: 10%
- Design Documentation: 20%
- Implementation: 30%

- Testing and Evaluation: 20%
- Final Report and Presentation: 20%

Required Materials

Textbook and References: as suggested by the project supervisor

Software: Simulation tools, MATLAB, SCILAB, CAD etc

Hardware: List of components required for the project as suggested by the project supervisor