GURU KASHI UNIVERSITY

Bachelor of Technology in Electrical Engineering

Session: 2024-2025

Department of Electrical Engineering

GRADUATE OUTCOME OF THE PROGRAMME

The programme focuses on electrical principles with their applications to design, analyze and troubleshoot electrical systems and components which help them to have strong analytical and problem-solving skills to identify and solve complex engineering problems in order to develop sustainable solutions in broader economic, societal and environmental contexts.

PROGRAMME LEARNING OUTCOMES

After completion of the course, B.Tech Electrical Engineering graduates will have ability to:

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Identify, formulate and analysis complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

5. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

6. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

7. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

8. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Structure

Program: Bachelor of Technology in Electrical Engineering

Semester: I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE116	Engineering Chemistry	Basic Science Course	3	0	0	3
BEE112	Engineering Mathematics–I	Basic Science Course	3	1	0	4
BEE117	Programming for Problem Solving	Engineering Science Course	3	0	0	3
BEE118	Communication Skills	Humanities	3	0	0	3
BEE119	Basics of Domestic Appliances	Engineering Science Course	2	0	0	2
BEE120	Manufacturing Practices	Practical	1	0	4	3
BEE121	Engineering Chemistry Lab	Basic Science Course	0	0	2	1
BEE122	Programming for Problem Solving Lab	Engineering Science Course	0	0	2	1
BEE123	Communication Skills Lab	Humanities	0	0	2	1
BEE124	Basics of Domestic Appliances Lab	Engineering Science Course	0	0	2	1
Total			**15**	**1**	**12**	**22**

Semester: II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE217	Basic Electrical Engineering	Engineering Science Course	3	1	0	4
BEE218	Engineering Physics	Basic Science Course	3	1	0	4
BEE215	Engineering Mathematics – II	Basic Science Course	3	1	0	4
BEE219	Engineering Graphics & Drawing	Practical	1	0	4	3
BEE220	Engineering Physics Lab	Basic Science Course	0	0	2	1
BEE221	Basic Electrical Engineering Lab	Engineering Science Course	0	0	2	1
BEE222	Fundamentals of Computer & IT Lab	Engineering Science Course	0	0	2	1
BEE223	*Indian Constitution	VAC	2	0	0	NC
Total			**12**	**3**	**10**	**18**

NOTE*: The mandatory courses are non-credit courses which are to be evaluated as Satisfactory/Unsatisfactory.

NOTE: The training will be imparted in the institution at the end of 2nd semester for four week duration.

Semester: III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE301	Electrical Circuit Analysis	Program Core course	3	1	0	4
BEE302	Electrical Machines – I	Program Core course	3	0	0	3
BEE303	Electrical and Electronic Measurements	Program Core course	3	0	0	3
BEE315	Analog Electronics	Program Core course	3	0	0	3
BEE316	Mathematics -III	Basic Science Course	3	1	0	4
BEE307	Electrical and Electronic Measurements Lab	Program Core course	0	0	2	1
BEE308	Electrical Machines – I Lab	Program Core course	0	0	2	1
BEE317	Analog Electronics Lab	Program Core course	0	0	2	1
BEE309	*Institutional Training	Internship	0	0	0	2
Total			**15**	**2**	**6**	**22**

NOTE*: The students will submit their reports for the institutional training taken at the end of the 2nd semester.

Semester: IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE401	Electrical Machines – II	Program Core course	3	0	0	3
BEE402	Power Electronics	Program Core course	3	0	0	3
BEE403	Digital Electronics	Program Core course	3	0	0	3
BEE415	Electromagnetic Fields	Program Core course	3	0	0	3
BEE418	Signals & Systems	Program Core course	3	0	0	3
BEE405	Digital Electronics Lab	Program Core course	0	0	2	1
BEE406	Electrical Machines – II Lab	Program Core course	0	0	2	1
BEE407	Power Electronics Lab	Program Core course	0	0	2	1
BEE419	Generation of Electrical Power	Program Core course	3	0	0	3
BEE420	Programmable Logic Controllers Lab	Program Core course	0	0	2	1
BEE416	*Environmental Science	VAC	2	0	0	NC
Total			**20**	**0**	**8**	**22**

NOTE*: The mandatory courses are non-credit courses which are to be evaluated as satisfactory/Unsatisfactory.

Semester: V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE501	Power System -I (Apparatus and Modeling)	Program Core course	3	0	0	3
BEE502	Control Systems	Program Core course	3	1	0	4
BEE513	Microprocessors	Program Core course	4	0	0	4
BEE505	Power System-I Lab	Program Core course	0	0	2	1
BEE506	Control Systems Lab	Program Core course	0	0	2	1
BEE514	Microprocessors Lab	Program Core course	0	0	2	1
BEE515	Soft Skills- I	Humanities	3	0	0	3
Professional Elective Course – I (Any one of the following)						
BEE504	Wind and Solar Energy	Professional Elective course	3	0	0	3
BEE516	Electrical Materials					
		Open Elective Course - I	3	0	0	3
Total			**19**	**1**	**6**	**23**
Open Elective Course - I (Any one of the following)						
OEC083	Power Plant Engineering	Open Elective Course	3	0	0	3
OEC093	Substation Equipment & Design					

Semester: VI						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE601	Power Systems-II (Operation and Control)	Program Core course	3	0	0	3
BEE622	Estimating & Costing in Electrical Engineering	Program Core course	3	0	0	3
BEE605	Power Systems-II Lab	Program Core course	0	0	2	1
BEE623	HVDC Transmission Systems	Program Core course	3	0	0	3
BEE624	Estimating & Costing in Electrical Engineering Lab	Program Core course	0	0	2	1
BEE625	Soft Skills-II	Humanities	3	0	0	3
Professional Elective course - II (Any one of the following)						
BEE607	Electric Drives	Professional Elective course	3	0	0	3
BEE626	Digital Signal Processing					
XXX	XXX	Open Elective course -II	3	0	0	3
Total			**18**	**0**	**4**	**20**
Open Elective course -II (Any one of the following)						
OEC094	Internet of Things	Open Elective course	3	0	0	3
OEC095	Non-conventional Energy Sources					
NOTE*: Industrial training to be imparted at the end of 6th semester for six weeks.						

Semester: VII						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE714	Utilization of Electrical Energy	Program Core course	3	0	0	3
BEE715	Electrical Energy Conservation and Auditing	Program Core course	3	0	0	3
BEE716	Introduction to MATLAB Lab	Program Core course	0	0	2	1
BEE717	Introduction to Industry 4.0	Program Core course	3	0	0	3
BEE709	Minor Project	Project	0	0	6	3
BEE706	Industrial Training	Internship	0	0	0	4
Professional Elective course -III (Any one of the following)						
BEE702	High Voltage Engineering	Professional Elective course	3	0	0	3
BEE718	Power System Dynamic & Control					
XXX	XXX	Open Elective course – III	3	0	0	3
Total			**15**	**0**	**8**	**18**
Open Elective course – III (Any one of the following)						
OEC096	Introduction to Industrial Management	Open Elective course	3	0	0	3
OEC097	Biomedical Instrumentation					

NOTE*: Students will undergo 6 weeks industrial training after the end of 6th semester examinations and present a seminar along with submission of report in 7th semester.

Semester: VIII						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BEE808	Power System Analysis & Design	Program Core course	3	0	0	3
BEE809	MATLAB & Simulink Lab	Program Core course	0	0	4	2
BEE802	Major Project	Project	0	0	12	6
Professional Elective course -IV (Any one of the following)						
BEE810	Power System Protection	Professional Elective course	3	0	0	3
BEE811	Electric & Hybrid Vehicles					
XXX	XXX	Open Elective course – IV	3	0	0	3
Total			**15**	**0**	**6**	**17**
Open Elective course – IV (Any one of the following)						
OEC098	Intellectual Property Rights	Open Elective course	3	0	0	3
OEC099	Industrial Automation					
Grand Total			**132**	**07**	**60**	**169**

Evaluation Criteria for Theory Courses

A. Continuous Assessment (25 Marks)

CA1 Surprise Test (Two best out of three) (10 Marks)

CA2 Assignment (10 Marks)

CA3 Case Study/Portfolio (5 Marks)

B. Attendance (5 marks)

C. Mid Semester Test (30 Marks)

D. End Semester Exam (40 Marks)

Evaluation Criteria for Practical Courses

Performance of each practical-(10 Marks)

Report- (5 Marks)

Practical Viva – (5 Marks)

Total - (20 Marks) (Each Practical)

SEMESTER-I

Course Title: ENGINEERING CHEMISTRY

Course Code: BEE116

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Demonstrate Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nano particles,
2. Evaluate band structure of solids and the role of doping on band structures.
3. Distinguish the ranges of Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging
4. Rationalize periodic properties such as ionization potential, electro-negativity, Oxidation states and electro-negativity.

Course Content

UNIT1 **15 Hours**

Atomic and molecular structure: Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nanoparticles, Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

UNIT II **10 Hours**

Spectroscopic techniques and applications: Principles of spectroscopy and selection rules, electronic spectroscopy, Fluorescence and its applications in medicine, Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques, Diffraction and scattering.

Ionic, Dipolar and Vander Waals interactions, Equations of state of real gases and Critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibriums, Water

chemistry, Corrosion, Use of free energy considerations in metallurgy through Ellingham diagrams.

UNIT III **10 Hours**

Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

UNIT IV **10 Hours**

Organic reactions and synthesis of a drug molecule: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Mahan, B. H. (1987). University chemistry.*
- *Sienko, M. J. & Plane, R. A. Chemistry. (1979): Principles and Applications. New York: McGraw-Hill.*
- *Banwell, C. N. (1966). Fundamentals of Molecular Spectroscop. New York, McGraw-Hill.*
- *Tembe, B. L., Kamaluddin& Krishnan, (2008). M. S. Engineering Chemistry (NPTEL Web-book).*

SEMESTER-I

Course Title: ENGINEERING MATHEMATICS – I

Course Code: BEE112

L	T	P	Credits
3	1	0	4

Total hours 60

Learning Outcomes: After completion of this course, the learner will be able to:
1. Apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2. Classify of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. Illustrate the Tool of power series and Fourier series for learning advanced Engineering Mathematics.
4. Use of functions of several variables that is essential in most branches of engineering and tools of matrices and linear algebra in a comprehensive manner.

Course Content

UNIT I **16 Hours**

Calculus: Evaluates and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.
Rolle 's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and Hospital's rule; Maxima and minima.
Advanced Calculus: Differentiation: Limit continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Integration: Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.

UNIT II **14 Hours**

Trigonometry: Hyperbolic and circular functions, logarithms of complex number resolving real and imaginary parts of a complex quantity, De Moivre's Theorem.

Theory of equations: Relation between roots and coefficients, reciprocal Equations, transformation of equations and diminishing the roots.

UNIT III **15 Hours**

Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

UNIT IV **15 Hours**

Algebra: Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank- nullity theorem, composition of linear maps, Matrix associated with a linear map.
Eigen values, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

· *G.B. Thomas and R.L. Finney. (2002). Calculus and Analytic geometry. Pearson.*
· *Veerarajan T. (2008). Engineering Mathematics for first year. Tata McGraw-Hill, New Delhi.*
· *Ramana B.V. (2010). Higher Engineering Mathematics. Tata McGraw Hill New Delhi.*
· *N.P. Bali and Manish Goyal. (2010). A text book of Engineering Mathematics. Laxmi Publications.*
· *B.S. Grewal. (2000). Higher Engineering Mathematics. Khanna Publishers.*
· *V. Krishnamurthy, V.P. Mainra and J.L. Arora. (2005). An introduction to Linear Algebra. Affiliated East–West press.*
· *Erwin Kreyszig. (2006). Advanced Engineering Mathematics. John Wiley & Sons.*

SEMESTER-I

Course Title: PROGRAMMING FOR PROBLEM SOLVING

Course Code: BEE117

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design the algorithms to write programs.
2. Illustrate arrays, pointers and structures to formulate algorithms and programs
3. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration
4. Implement conditional branching, iteration and recursion.

Course Content

UNIT I **15 Hours**

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory Locations, Syntax and Logical Errors in compilation, object and executable code-

UNIT II **15 Hours**

Arithmetic expressions and precedence: Conditional Branching and Loops Writing and evaluation of conditionals and consequent branching

Iteration and loops

Arrays: Arrays (1-D, 2-D), Character arrays and Strings

Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of Equations, notion of order of complexity through example programs (no formal definition requirement.

UNIT III **8 Hours**

Function: Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference.

Recursion: Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT IV **7 Hours**

Structure: Structures, Defining structures and Array of Structures

Pointers: Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

File handling (only if time is available, otherwise should be done as part of the lab.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Byron Gottfried, Schaum's (1995), Outline of Programming with C, McGraw-Hill.*
- *E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill.*

SEMESTER-I

Course Title: COMMUNICATION SKILLS

Course Code: BEE118

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Develop vocabulary and improve the accuracy in Grammar.
2. Apply the concepts of accurate English while writing and become equally ease at using good vocabulary and language skills.
3. Develop and Expand writing skills through Controlled and guided activities.
4. Compose articles and compositions in English.

Course Content

UNIT I **16 Hours**

Vocabulary Building: The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

UNIT II **14 Hours**

Basic Writing Skills: Sentence Structures, use of phrases and clauses in sentences, Importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents, Techniques for writing precisely.

UNIT III **8 Hours**

Identifying Common Errors in Writing: Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Cliché

UNIT IV **7 Hours**

Nature and Style of sensible Writing: Describing, Defining, Classifying, providing examples or evidence, writing introduction and conclusion

Writing Practices: Comprehension, Précis Writing, Essay Writing.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Swan, Michael. (1995). Practical English. OUP.*
- *Wood, F.T. (2007). Remedial English Grammar. Macmillan.*
- *Zinsser, W. (2001). On Writing Well. Harper Resource Book.*
- *Lyons, L. H. &Heasly, B. (2006). Study Writing. Cambridge University Press.*
- *Kumar, S &Lata, P. (2011). Communication Skills. Oxford University Press.*
- *CIEFL, Hyderabad. Exercises in Spoken English. Parts. I-III. Oxford University Press.*

SEMESTER-I

Course Title: BASICS OF DOMESTIC APPLIANCES

Course Code: BEE119

L	T	P	Credits
2	0	0	2

Total hours: 30

Course Outcomes: On successful completion of this course, the students will be able to:

1. Acquire necessary skills/hand on experience/ working knowledge on multimeters, galvanometers, ammeters, voltmeters, ac/dc generators, motors, transformers, single phase and three phase connections, basics of electrical wiring with electrical protection devices.
2. Understand the working principles of different household domestic appliances.
3. Check the electrical connections at house-hold.
4. To learn the skills to repair the electrical appliances for the general troubleshooting and wiring faults.

Course Content

UNIT-I **7 Hours**

Basics of House wiring, Principles of working, parts and servicing of Electric fan, Electric Iron box, Water heater; Induction heater, Microwave oven; Refrigerator, Concept of illumination, Electric bulbs, CFL, LED lights, Energy efficiency in electrical appliances.

UNIT-II **8 Hours**

Electric Iron:

Type of Electric Iron – Ordinary type and automatic/Thermostat Control type/steam iron, Construction and working principle of electric irons; common defects, testing and repairs

Electric Stove:

Types of Electric Stoves- Coiled type, covered type, Hot Plate, Grill/Oven,
Cooking Range- Construction and working principle of electric stoves, common defects, testing and repairs; Induction heater; OTG and Microwave oven; Three phase heater, star and Delta connections.

UNIT-III **7 Hours**

Table Lamp and Tube Light:

Construction, working principles and use of Table Lamp, Night Lamp and Tube Light; Common faults, their causes, testing and repair, LED Table lamp.

Electric Fan:

Type of Fans – ceiling fan, Pedestal fan, Bracket Fan, Exhaust Fan; Construction working principles, special characteristics and applications of Electric fans; Common faults, their causes, testing and repairs; Installation of Bracket Fan and Exhaust Fan.

UNIT-IV **8 Hours**

Electric Mixer, Grinder and Blender:

Construction, working principles, special characteristics and applications of Electric Mixer, Common Faults, their causes, Servicing maintenance and overhauling of Electric Mixer.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- A Text book on Electrical Technology, B.L.Theraja, S.Chand& Co.,
- A Text book on Electrical Technology, A.K.Theraja.
- Handbook of Repair & Maintenance of domestic electronics appliances; BPB Publications.
- Consumer Electronics, S.P.Bali, Pearson.
- Domestic Appliances Servicing, K.P.Anwer, Scholar Institute Publications

SEMESTER-I

Course Title: MANUFACTURING PRACTICES

Course Code: BEE120

L	T	P	Credits
1	0	4	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Apply the various manufacturing methods in different fields of engineering.
2. Use the different fabrication techniques
3. Learn about the practices in manufacturing of simple components using different materials.
4. Understand the advanced and latest manufacturing techniques being used in engineering industry

Course Content

UNIT I **8 Hours**

Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.

UNIT II **6 Hours**

CNC machining, Additive manufacturing, Fitting operations & power tools

UNIT III **6 Hours**

Electrical & Electronics Carpentry, Plastic moulding, glass cutting

UNIT IV **10 Hours**

Metal casting, welding (arc welding & gas welding), brazing [More hours can be given to Welding for Civil Engineering students as they may have to deal with Steel structures fabrication and erection; 3D Printing is an evolving manufacturing technology and merits some lectures and hands-on training.]

Workshop Practice:

1. Machine shop - 10 hours
2. Fitting shop - 8 hours
3. Carpentry - 6 hours
4. Electrical & Electronics - 8 hours
5. Welding shop - 8 hours (Arc welding 4 hrs. + gas welding 4 hrs.)

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- Raghuwanshi, B.S. (2009*). A Course in Workshop Technology, Vol 1 &II*. Dhanpat Rai & Sons.
- Jain, R.K. (2010*). Production Technology. Khanna* Publishers.
- Singh, S. (2003). *Manufacturing Practice*. S.K. Kataria & Sons.

SEMESTER-I

Course Title: ENGINEERING CHEMISTRY LABORATORY

Course Code: BEE121

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Evaluate the estimate rate constants of reactions from concentration of reactants/products as a function of time.
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
3. Apply the theoretical concepts for result analysis and interpret data obtained from experimentation.
4. Identify the compound using a combination of qualitative test and analytical methods.

Course Content

List of Experiments

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions
8. Potentiometry - determination of redox potentials and emfs
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Models of potential energy surfaces
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

SEMESTER-I

Course Title: PROGRAMMING FOR PROBLEM SOLVING LABORATORY

Course Code: BEE122

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Create read and write to and from simple text files.
2. Identify and correct logical errors encountered at run time
3. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.
4. Represent data in arrays, strings and structures and manipulate them through a program

Course Content

1. Problem solving using computers
2. Familiarization with programming Environment
3. Variable types and type conversions
4. Simple computational problems using arithmetic expressions
5. Branching and logical expressions
6. Problems involving if-then-else structures
7. Loops, while and for loops
8. Iterative problems e.g., sum of series
9. 1D Arrays: searching, sorting
10. 1DArray manipulation
11. 2D arrays and Strings, memory structure
12. Matrix problems, String operations
13. Functions, call by value
14. Simple functions
15. Numerical methods (Root finding, numerical differentiation, numerical integration)
16. Numerical methods problems
17. Recursion, structure of recursive calls
18. Recursive functions
19. Pointers, structures and dynamic memory allocation
20. Pointers and structures
21. File handling
22. File operations

Suggested Readings

- *Byron Gottfried, Schaum's (1995), Outline of Programming with C, McGraw-Hill*
- *E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill.*

SEMESTER-I

Course Title: COMMUNICATION SKILLS LABORATORY

Course Code: BEE123

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Illustrate the importance of pronunciation and apply the same day to day conversation.
2. Apply verbal and non-verbal communication techniques in the Professional Environment.
3. Develop coherence, cohesion and competence in Oral discourse.
4. Evaluate the interview process confidently.

Course Content

Oral Communication

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

SEMESTER-I

Course Title: BASICS OF DOMESTIC APPLIANCES LABORATORY
Course Code: BEE124

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: On successful completion of this course, the students will be able to:

1. Acquire necessary skills/hand on experience/ working knowledge on multimeters, galvanometers, ammeters, voltmeters, ac/dc generators, motors, transformers, single phase and three phase connections, basics of electrical wiring with electrical protection devices.
2. Understand the working principles of different household domestic appliances.
3. Check the electrical connections at house-hold.
4. To learn the skills to repair the electrical appliances for the general troubleshooting and wiring faults.

Course Content

Co-curricular Activities (Hands on Exercises):

1. Identifying Phase, Neutral and Earth on power sockets.
2. Observing the connections of elements and identify current flow and voltage drops.
3. Studying electrical circuit protection using MCBs.
4. Dismantling and reassemble of reflector type room Heater.
5. Dismantling and reassembling of Electric Iron (i) Ordinary type (ii)Automatic/Thermostat control type.
6. Testing and repair of Electric Iron (i) Ordinary type (ii) Automatic/Thermostat control type.
7. Dismantling and reassembling of Electric Stove (i) Coiled type (ii) Covered type (a) Hot plate (b) Grill (iii) Induction Heater (iv) Microwave oven, (v) Three-phase heater star and delta connection.
8. Connection of Fluorescent tube light (FTL) circuit.
9. Testing and repair of (i) Table Lamp (ii) Night Lamp and (ii) Tube Light (iv) LED table lamp.
10. Testing fault finding, repair and overhauling of electric fans.
11. Testing fault finding, repair and overhauling of electric mixer.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- A Text book on Electrical Technology, B.L. Theraja, S. Chand & Co.,
- A Text book on Electrical Technology, A.K. Theraja.
- Performance and design of AC machines, M.G. Say, ELBSEdn.,
- Handbook of Repair & Maintenance of domestic electronics appliances; BPB Publications.
- Consumer Electronics, S.P. Bali, Pearson.
- Domestic Appliances Servicing, K.P. Anwer, Scholar Institute Publications

SEMESTER- II

Course Title: BASIC ELECTRICAL ENGINEERING

Course Code: BEE217

L	T	P	Credits
3	1	0	4

Total Hours: 60

Course Outcomes: After completion of this course, the learner will be able to:

1. Understand the DC and AC electrical circuit elements with RLC.
2. Analysis of simple circuits with dc excitation. Superposition, The venin and Norton Theorems.
3. Use Single Phase AC Circuits and representation of alternating quantities and determining the power in these circuits.
4. Classify the different types of Electrical machines.

Course Content

UNIT I **15 Hours**

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

UNIT II **15 Hours**

AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three- phase balanced circuits, voltage and current relations in star and delta connections.

Transformers: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT III **15 Hours**

Electrical Machines: Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor, Construction, working, torque-speed characteristic and speed

control of separately excited dc motor. Construction and working of synchronous generators.

UNIT IV **15 Hours**

Electrical Installations: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Kothari, D. P. and Nagrath, I. J. (2010). Basic Electrical Engineering. Tata McGraw Hill.*
- *Kulshreshtha, D. C. (2009). Basic Electrical Engineering. McGraw Hill.*
- *Bobrow, L. S. (2011). Fundamentals of Electrical Engineering. Oxford University Press.*
- *Hughes, E. (2010). Electrical and Electronics Technology. Pearson.*

SEMESTER-II

Course Title: ENGINEERING PHYSICS

Course Code: BEE218

L	T	P	Credits
3	1	0	4

Total hours 60

Course Outcomes: After completion of this course, the learner will be able to:

1. Apply knowledge of electricity and magnetism to explain natural physical processes and related technological advances.
2. Use the knowledge regarding calculus along with physical principles to effectively solve problems encountered in everyday life, further study in science, and in the professional world.
3. Design experiments and acquires data in order to explore physical principles, effectively communicate results, and evaluate related scientific studies.
4. Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context.

Course Content

UNIT I **15 Hours**

Electrostatics: Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential, Boundary conditions of electric field and electrostatic potential; method of images. Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; solving simple electrostatics problems in presence of dielectrics – Point charge at the center of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

UNIT II **15 Hours**

Magneto statics: Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; vector potential and its solution for given current densities. Properties of magnetic materials: magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials.

Time Varying Field and Maxwell's Equation: Laws of Electromagnetic Induction, Self and Mutual induction, Concept of Displacement Current, Difference between Conduction Current and Displacement Current, Eddy Current, Maxwell's Equations,

Derivation of Maxwell's Equations, Propagation of Electromagnetic Waves in Free Space, Solution of propagation of Plane Electromagnetic Wave in free space.

UNIT III **15 Hours**

Semiconductors: Intrinsic and extrinsic semiconductors, Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Semiconductor materials of interest for optoelectronic devices.

Modern Physics: Particle properties of wave: Planck's hypothesis, Qualitative discussion of Photoelectric effect and Compton Effect. Wave properties of particle: De Broglie wave as mater waves, Heisenberg's uncertainty principle and its application. Quantum Mechanics: Interpretation of wave function, Schrödinger equation (time dependent and time independent), particle in a box,

UNIT IV **15 Hours**

Wave Optics: Interference due to division of wavefront, Young's double slit expt., Principle of Superposition, Interference from parallel thin films, Newton rings, Michelson interferometer. Diffraction: Fresnel Diffraction, Diffraction at a straight edge, Fraunh offer diffraction due to N slits, Diffraction grating, dispersive and resolving power of Grating. Polarization**:** production of plane polarized light by different methods, Brewster and Malus Laws. Double refraction, Quarter & half wave plate, Nicol prism, specific rotation, Laurent's half shade polarimetry.

Laser: Introduction, principle of Laser, stimulated and spontaneous emission, Einstein's Coefficients, He-Ne Laser, Ruby Laser, Application of Lasers.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *David J Griffths. (1999). Introduction to Electrodynamics. Prentice Hall.*
- *Walker, Jearl, David Halliday, and Robert Resnick. (2011). Fundamentals of Physics. Hoboken, N.J: Wiley.*
- *Saslow, W. (2008). Electricity, magnetism and light. e-book.*

SEMESTER - II

Course Title: ENGINEERING MATHEMATICS–II

Course Code: BEE215

L	T	P	Credits
3	1	0	4

Total hours 60

Course Outcomes: After completion of this course, the learner will be able to:

1. Apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2. Classify of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. Illustrate the Tool of power series and Fourier series for learning advanced Engineering Mathematics.
4. Use of functions of several variables that is essential in most branches of engineering and tools of matrices and linear algebra in a comprehensive manner.

Course Content

UNIT I **16 Hours**

Calculus: Evaluates and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Rolle 's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and Hospital's rule; Maxima and minima.

Advanced Calculus: Differentiation: Limit continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Integration: Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.

UNIT II **14 Hours**

Trigonometry: Hyperbolic and circular functions, logarithms of complex number resolving real and imaginary parts of a complex quantity, De Moivre's Theorem.

Theory of equations: Relation between roots and coefficients, reciprocal Equations, transformation of equations and diminishing the roots.

UNIT III **15 Hours**

Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

UNIT IV **15 Hours**

Algebra: Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank- nullity theorem, composition of linear maps, Matrix associated with a linear map.

Eigen values, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *G.B. Thomas and R.L. Finney. (2002). Calculus and Analytic geometry. Pearson.*
- *Veerarajan T. (2008). Engineering Mathematics for first year. Tata McGraw-Hill, New Delhi.*
- *Ramana B.V. (2010). Higher Engineering Mathematics. Tata McGraw Hill New Delhi.*
- *N.P. Bali and Manish Goyal. (2010). A text book of Engineering Mathematics. Laxmi Publications.*
- *B.S. Grewal. (2000). Higher Engineering Mathematics. Khanna Publishers.*
- *V. Krishnamurthy, V.P. Mainra and J.L. Arora. (2005). An introduction to Linear Algebra. Affiliated East–West press.*
- *Erwin Kreyszig. (2006). Advanced Engineering Mathematics. John Wiley & Sons.*

SEMESTER - II

Course Title: ENGINEERING GRAPHICS & DRAWING

Course Code: BEE219

L	T	P	Credits
1	0	4	3

Total hours 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Understand about engineering drawing applications and its importance in society.
2. Learn about the visual aspects of engineering design.
3. Discuss the engineering graphics standards.
4. Classify the concept of solid modeling techniques.

Course Content

UNIT I **9 Hours**

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involutes; Scales – Plain, Diagonal and Vernier Scales;
Orthographic Projections covering, Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

UNIT II **12 Hours**

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

UNIT III **14 Hours**

Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound

Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;
Overview of Computer Graphics covering, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, shares, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];
Customization& CAD Drawing consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

UNIT IV **10 Hours**

Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to Credits ate drawings, Credits ate, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling;
Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: Creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerance; Use of solid-modeling software for Credits eating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Gill, P.S. (2001). Engineering Drawing. S.K; Kataria and Sons, Ludhiana.*
- *Bhatt, N.D. (2012). Engineering Drawing. Charotar Book Stall, Tulsi Sadan, Anand.*
- *French, T.E. and Vierck. C.J. (1993). Graphic Science. McGraw-Hill, New York.*
- *Zozzora, F. (1958). Engineering Drawing. McGraw Hill, New York.*
- *(Corresponding set of) CAD Software Theory and User Manuals.*

SEMESTER - II

Course Title: ENGINEERING PHYSICS LAB

Course Code: BEE220

L	T	P	Credits
0	0	2	1

Total hours 15

Learning Outcomes On successful completion of this course, the students would be able to:

1. Illustrate the working p-n junction diode.
2. Analyse and solve various engineering problems.
3. Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
4. Design new instruments with practical knowledge.

Course Content

List of experiments **15 Hours**

1. To study the V-I characteristics of P-N junction.
2. To verify the logic gates.
3. To calculate the acceleration due to gravity “g” using simple pendulum.
4. To find the moment of inertia of flywheel.
5. To measure the diameter of a small spherical/cylindrical body using Vernier calipers/screw gauge.
6. To draw V-I characteristics of Zener diode and determine reverse breakdown voltage.
7. To study the controls and obtain a wave using Cathode Ray Oscilloscope.
8. To find the resolving power of the prism.
9. To determine the angle of the given prism.
10. To determine the refractive index of the material of a prism.
11. To understand the phenomenon Photoelectric effect as a whole.
12. To draw kinetic energy of photoelectrons as a function of frequency of incident radiation.
13. To determine the Planck's constant from kinetic energy versus frequency graph.
14. To plot a graph connecting photocurrent and applied potential.
15. To determine the stopping potential from the photocurrent versus applied potential graph.

Note: Students will perform any 7-8 experiments from the syllabus.

SEMESTER - II

Course Title: BASIC ELECTRICAL ENGINEERING LAB

Course Code: BEE221

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Analysis of Resistive Circuits and Solution of resistive circuits with independent sources.
2. Understand the Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuits.
3. Analysis of Single-Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits.
4. Compare different types of Electrical machines and classify different electrical measuring equipment's and understanding their principles

List of Experiments:

1. To study basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. real-life resistors, capacitors and inductors.
2. To verify Ohm's law.
3. To verify Kirchhoff's voltage and current laws.
4. To verify Superposition Theorem.
5. To verify Thevenin Theorem.
6. To obtain the sinusoidal steady state response of R-L circuit – impedance calculation and verification. Observation of phase differences between current and voltage.
7. To obtain the sinusoidal steady state response of R-C circuit – impedance calculation and verification. Observation of phase differences between current and voltage.
8. To study resonance phenomenon in R-L-C series circuits.
9. To perform open circuit and short circuit test on a single-phase transformer and calculate the efficiency.
10. Demonstration of cut-out sections of machines: Induction machine (squirrel cage rotor and slip ring arrangement) and single-phase induction machines.
11. To connect, start and reverse the direction of rotation by change of phase-sequence of connections of three phase induction motor.

12. To connect, start and reverse the direction of rotation of single-phase induction motor.
13. To demonstrate working of DOL starter for three-phase induction motor.

SEMESTER - II

Course Title: Fundamentals of Computer and IT Laboratory	**L**	**T**	**P**	**Credits**
Course Code: BEE222	**0**	**0**	**2**	**1**

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Familiarizing with Open Office (Word processing, Spreadsheets and Presentation).
2. To acquire knowledge on editor, spread sheet and presentation software.
3. The students will be able to perform documentation and accounting operations.
4. Students can learn how to perform presentation skills.

Course Content

Word Orientation: The instructor needs to give an overview of word processor. Details of the four tasks and features that would be covered Using word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter.

1. Using word to create Resume Features to be covered: - Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colors, Inserting Header and Footer, Using Date and Time option in Word.

2. Creating an Assignment Features to be covered: - Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.

3. Creating a Newsletter Features to be covered :- Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes and Paragraphs.

4. Creating a Feedback form Features to be covered :- Forms, Text Fields, Inserting objects, Mail Merge in Word.

Excel Orientation: The instructor needs to tell the importance of Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered Excel – Accessing, overview of toolbars, saving excel files,

1. Creating a Scheduler Features to be covered :- Gridlines, Format Cells, Summation, auto fill, Formatting Text.

2. Calculations Features to be covered :- Cell Referencing, Formulae in excel – average, std.deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function, LOOKUP/VLOOKUP

3. Performance Analysis Features to be covered :- Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting

4. Game (like Cricket, badminton) Score Card Features to be covered :- Pivot Tables, Interactive Buttons, Importing Data, Data Protection, Data Validation.

5. Students will be working on basic power point utilities and tools which help them create basic power point presentation. Topic covered includes :- PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows

6. This session helps students in making their presentations interactive.

SEMESTER - II

Course Title: CONSTITUTION OF INDIA	**L**	**T**	**P**	**Credits**
Course Code: BEE223	**2**	**0**	**0**	**NC**

Course Outcomes: After completion of this course, the learner will be able to:

1. Knowledge and legal literacy and thereby to take up competitive examinations
2. Understand state and central policies, fundamental duties, Electoral Process, and special provisions
3. Analyze powers and functions of Municipalities, Panchayats and Co-operative Societies, and
4. Classify the engineering ethics and responsibilities of Engineer and an awareness about basic human rights in India

Course Content

Unit I **5 Hours**

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution.

Preamble to the Indian Constitution Fundamental Rights & its limitations.

Unit II **10 Hours**

Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties.

Union Executives – President, Prime Minister Parliament Supreme Court of India.

State Executives – Governor Chief Minister, State Legislature High Court of State.

Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th &91st Amendments.

Unit III **10 Hours**

Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India

Powers and functions of Municipalities, Panchayats and Co – Operative Societies.

Unit IV **5 Hours**

Scope & Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility.

Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Singh Mahendra, P. (2000). VN Shukla's Constitution of India. Eastern Book Company, Lucknow.*
- *Agrawal, P. K., & Gupta, V. (2023). The Constitution of India Bare Act with Short Notes-Useful for Competitive Examinations: Bestseller Book by Dr. PK Agrawal; Virag Gupta: The Constitution of India Bare Act with Short Notes-Useful for Competitive Examinations. Prabhat Prakashan.*
- *Ghosh, P. K. (1966). Constitution of India (Prabhat Prakashan): How it Has Been Framed. Prabhat Prakashan.*

SEMESTER - III

Course Title: ELECTRICAL CIRCUIT ANALYSIS

Course Code: BEE301

L	T	P	Credits
3	1	0	4

Total hours: 60

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the network theorems for the analysis of electrical circuits.
2. Evaluate the transient and steady-state response of electrical circuits.
3. Analyze circuits in the sinusoidal steady-state (single-phase and three-phase) and two port circuit behaviors.
4. Synthesize networks and filters to improve skills in network functions and two port network in electrical circuits

Course Content

UNIT-1 **15 Hours**

Basic Network Analysis

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

UNIT-2 **15 Hours**

Electrical circuit and steady state analysis

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot convention in coupled circuits, Ideal Transformer. Analysis of electrical circuits using Laplace Transform for

standard inputs, transformed network with initial conditions. Frequency response (magnitude and phase plots), series and parallel resonances.

UNIT-3 **15 Hours**

Network functions and two port network

Driving point impedance and admittance, natural response of a network, transfer impedance and admittance, concept of pole and zeros in a network function, Routh Hurwitz criterion of stability.

Two Port Networks: terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

UNIT-4 **15 Hours**

Network Synthesis and Filters

Network synthesis techniques for 2-terminal network, Foster and Cauer forms.
Filters: Classification of filters, characteristics impedance and propagation constant of pure reactive network, ladder network, T-section, π-section, terminating half section, pass bands and stop bands, Design of constant-K, m-derived filters.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

· *Van Valkenburg, M. E. (2006). Network Analysis. Prentice Hall.*
· *Choudhury, D. Roy. (1998). Networks and Systems. New Age International Publication.*
· *Hayt W. H. and Kemmerly J. E. (2013). Engineering Circuit Analysis. McGraw Hill Education.*
· *Alexander C. K. and Sadiku, M. N. O. (2004). Electric Circuits. McGraw Hill Education.*

SEMESTER - III

Course Title: ELECTRICAL MACHINES - I
Course Code: BEE302

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Interpret the concept of magnetic fields and magnetic circuits.
2. Analyze the response of the dc machine on the basis of Armature Reaction and commutation.
3. Analyze the concept of starters and speed control of dc motors and evaluate the performance of dc machine by performing Swinburne' and Hopkinson's test.
4. Evaluate the performance of single-phase transformer by performing open circuit test, short circuit test and Sumpner's test.

Course Content

UNIT-I **5 Hours**

Magnetic fields and magnetic circuits

Review of magnetic circuits - MMF, flux, reluctance, inductance; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

UNIT-II **8 Hours**

DC machines

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

UNIT-III **7 Hours**

DC machine - motoring and generation

Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

UNIT-IV **10 Hours**

Transformers

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency, Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses, Three- phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Fitzgerald E. and Kingsley, C. (2013). Electric Machinery. New York, McGraw Hill Education.*
- *Clayton E. and Hancock, N. N. (2004). Performance and design of DC machines. CBS Publishers.*
- *Say, M. G. (2002). Performance and design of AC machines. CBS Publishers.*
- *Bimbhra, P. S. (2011). Electrical Machinery. Khanna Publishers.*
- *Electric Machinery Fundamentals 4th Edition by Stephen Chapman.*
- *Electrical Machinery 7th Edition P. S. Bimbhra.*
- *Electric Machines and Power System by Del Toro.*

SEMESTER - III

Course Title: ELECTRICAL AND ELECTRONIC MEASUREMENTS
Course Code: BEE303

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Acquire knowledge of the characteristics of measuring instruments and their classification.
2. Examine and reproduce in construction, working of measuring instruments and their proficient use.
3. Acquire knowledge various methods of electrical parameters measurement.
4. Demonstrate various instruments for the measurement of electrical quantities, Cathode Ray Oscilloscope (CRO) and recorders.

Course Content

UNIT-1 **10 Hours**

Introduction

Functional Elements of generalized measurement system, Characteristics of instruments, errors in measurements and their statistical analysis: Limiting errors, combination of quantities with errors, types of errors.

Basic Indicating Instruments

Classification of analog instruments, concept of deflecting, controlling and damping torque, control and damping system, construction and principle of moving iron and moving coil instruments, construction of ammeter and voltmeter, Principles of operation Permanent Magnet Moving Coil (PMMC) ohm meters and their types.

UNIT-II **15 Hours**

Measurement of Resistance

Wheat stone bridge, Kelvin double bridge, Carey-Foster Bridge, Measurement of Insulation resistance.

AC bridges:

General equation for bridge balance, Measurement of Inductance (L): Maxwell Inductance Bridge, Hay's Bridge, Measurement of Capacitance (C): De-Sauty's Bridge, Schering's bridge, Measurement of frequency (f) by and Wein's bridge.

UNIT-III **5 Hours**

Instrument Transformers

Theory and construction of Current Transformer (CT) and Potential Transformer (PT), ratio and phase angle errors and their minimization, Characteristics of CT's. & PT's., Testing of CT's & PT's.

UNIT-IV **15 Hours**

Cathode ray Oscilloscope (CRO) and Recorders

Construction and working of cathode ray tube (CRT), Block diagram of CRO, measurement of voltage and frequency with CRO, basic CRO circuit, measurement of voltage, current, phase, frequency, time period. Dual track oscilloscope, specification of a CRO and their significance, front panel controls. Study of various recorders

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *A.K. Sawhney and Puneet Sawhney, A course on electrical and electronic measurements and Instrumentation, Dhanpat Rai, 2012.*
- *J.B Gupta, A Course in Electronic and Electrical Measurements & Instrumentation, S K Kataria and Sons, 1996.*

SEMESTER - III

Course Title: ANALOG ELECTRONICS

Course Code: BEE315

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Demonstrate electronics component and equipments like C.R.O., Function Generator and power supplies.
2. Analyze the V-I characteristics of PN-Junction diode and determine static resistance and dynamic resistance.
3. Interpret the zener diode and study the characteristics of zener diode.
4. Design and plot the input and output characteristics of common emitter transistor and calculate its input and output resistance.

Course Content

UNIT-I **10 Hours**

Diodes and its Applications: Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications.

UNIT-II **10 Hours**

Transistor Characteristics: Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration; Field Effect Transistor (FET) – Construction, Characteristics of Junction FET, Depletion and Enhancement type Metal Oxide Semiconductor (MOS) FETs, Introduction to CMOS circuits;

UNIT-III **15 Hours**

Transistor Amplifiers and Oscillators: Classification, Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC

Equivalent Circuit; Feedback Amplifiers – Principle, Advantages of Negative Feedback, Topologies, Current Series and Voltage Series Feedback Amplifiers; Oscillators – Classification, RC Phase Shift, Wien Bridge, High Frequency LC and Non-Sinusoidal type Oscillators;

UNIT-IV **10 Hours**

Operational Amplifiers and Applications: Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground;

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *David. A. Bell. (2003). Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India.*
- *L. Floyd and R. P. Jain (2009). Digital Fundamentals. Pearson Education.*
- *Paul B. Zbar, A.P. Malvino and M.A. Miller. (2009). Basic Electronics – A Text-Lab. Manual, TMH.*

SEMESTER - III

Course Title: Mathematics-III (Probability and Statistics)
Course Code: BEE316

L	T	P	Credits
3	1	0	4

Total hours: 60

Course Outcomes: After completion of this course, the learner will be able to:

1. Basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables.
2. How to derive the probability function of transformations of random variables and use these techniques to generate data from various distributions.
3. How to calculate and apply measures of location and measures of dispersion in grouped and ungrouped data cases.
4. Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases

Course Content

UNIT I **15 Hours**

Basic Probability : Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.

UNIT II **15 Hours**

Continuous Probability Distributions: Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

Bivariate Distributions: Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

UNIT III **15 Hours**

Basic Statistics: Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical

parameters for these three distributions, Correlation and regression – Rank correlation.

UNIT–IV **15 Hours**

Applied Statistics: Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Small samples: Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *E. Kreyszig, —Advanced Engineering Mathematics‖ , John Wiley & Sons, 2006.*
- *P. G. Hoel, S. C. Port and C. J. Stone, —Introduction to Probability Theory‖ , Universal Book Stall, 2003.*
- *S. Ross, —A First Course in Probability‖ , Pearson Education India, 2002.*
- *W. Feller, —An Introduction to Probability Theory and its Applications‖ , Vol. 1, Wiley, 1968.*
- *N.P. Bali and M. Goyal, —A text book of Engineering Mathematics‖ , Laxmi Publications, 2010.*
- *B.S. Grewal, —Higher Engineering Mathematics‖ , Khanna Publishers, 2000.*
- *T. Veerarajan, —Engineering Mathematics‖ , Tata McGraw-Hill, New Delhi, 2010.*

SEMESTER - III

Course Title: ELECTRICAL AND ELECTRONIC MEASUREMENTS LABORATORY
Course Code: BEE307

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design and validate DC and AC bridges.
2. Interpret the characteristics of measuring instruments and their classification.
3. Acquire knowledge of various methods of electrical parameters measurement.
4. Evaluate and demonstrate various instruments for the measurement of electrical quantities, Cathode Ray Oscilloscope (CRO) and recorders.

Course Content **15 Hours**

LIST OF EXPERIMENTS:

1. Measurement of resistance using Wheatstone bridge.
2. To measure the unknown Inductance in terms of capacitance and resistance by using Maxwell's Inductance Bridge.
3. To measure unknown Inductance using Hay's bridge.
4. To measure unknown capacitance of small capacitors by using Schering's bridge.
5. To measure unknown capacitance using De-Sauty's bridge.
6. Measurement of capacitance using Schering Bridge
7. To measure unknown frequency using Wein's frequency bridge.
8. To test the soil resistance using Meggar (Ohm meter).
9. To convert the Voltmeter into Ammeter using Potentiometer.
10. Determination of frequency and phase angle using CRO.

SEMESTER - III

Course Title: ELECTRICAL MACHINES - I LABORATORY
Course Code: BEE308

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:
1. Interpret the basic concept of single and three-phase transformer/system connections.
2. Evaluation of equivalent circuit parameters, efficiency and voltage regulation by performing various tests on transformer.
3. Analyze parallel operation of transformers.
4. Analyze the performance characteristics of DC generators and performance of starters.

Course Content **15 Hours**

Hands-on experiments related to the course contents

Note: A student to perform any 8-10 Experiments and make one minor working model project.

Suggested List of Experiments:

1. To perform the load test on a single phase transformer.
2. To perform open circuit and short circuit tests on a single phase transformer and hence draw the equivalent circuit, calculate the voltage regulation and efficiency.
3. To find the efficiency and voltage regulation of single phase transformer under different loading conditions.
4. To perform parallel operation of two single phase transformers.
5. To study the various connections of a three phase transformer.
6. To perform Scott connections on three phase transformer to get two phase supply.

7. To study the constructional details of DC machine and to draw sketches of different components.

8. To measure armature and field resistance of DC shunt generator and to obtain its open circuit characteristics.

9. To obtain load characteristics of DC

(i) shunt

(ii) series

(iii) compound generator.

10. To draw speed-torque and torque-speed characteristics of DC shunt/series /compound generator.

11. To study the three point and four-point DC motor starters.

12. To perform Swinburne's test (no load test) to determine various losses of DC shunt motor.

SEMESTER - III

Course Title: ANALOG ELECTRONICS LABORATORY

Course Code: BEE317

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Demonstrate electronics component and equipment's like C.R.O., Function Generator and power supplies.
2. Analyze the V-I characteristics of PN-Junction diode and determine static resistance and dynamic resistance.
3. Interpret the Zener diode and study the characteristics of Zener diode.
4. Design and plot the input and output characteristics of common emitter transistor and calculate its input and output resistance.

Course Content **15 Hours**

Laboratory Sessions covering

1. To study the characteristics of V-I Characteristics of Silicon & Germanium PN Junction diodes
2. V-I Characteristics of Zener Diode
3. Characteristics of BJT in Common Emitter Configuration
4. Characteristics of JFET in Common Source Configuration
5. To study the characteristics of Half Wave Rectifier.
6. To study the characteristics of Full Wave Rectifier.
7. To study the characteristics of Half Wave and Full Wave Rectifier with Filter circuits.
8. Common Emitter BJT Amplifier
9. To study the characteristics of RC oscillators namely:

i) Phase shift oscillators.

ii) Wein bridge oscillators.

10. Implement a non-Inverting (NI) amplifier circuit using op-amp
11. Implement an inverting amplifier circuit using op-amp.
12. Performance evolution of a summing amplifier circuit.

SEMESTER-IV

Course Title: ELECTRICAL MACHINES – II

Course Code: BEE401

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the concepts of rotating magnetic fields.
2. Evaluate the operation of AC machines.
3. Analyze performance characteristics of AC machines.
4. Compare synchronous machines and asynchronous machines and interpret the equivalents circuits and phasor of induction machines.

Course Content

UNIT-I **10 Hours**

Fundamentals of AC machine windings

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

UNIT-II **10 Hours**

Pulsating and revolving magnetic fields

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

UNIT-III **10 Hours**

Induction Machines

Concept of rotating magnetic field, Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and maximum torque, power flow diagram, 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.

Single phase induction motors: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.

UNIT-IV **15 Hours**

Synchronous machines

Constructional features, cylindrical rotor and salient pole synchronous machine - generated EMF, coil span and distribution factor, equivalent circuit and phasor diagram, armature reaction at different power factor loads, voltage regulation by synchronous impedance and zero power factor method, concept of short circuit ratio, Operating characteristics of synchronous machines, V- curves and inverter-V curves. Hunting. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Fitzgerald A. E. and Kingsley C. (2013) Electric Machinery Mc Graw Hill Education*
- *Alexander S. Langsdorf, (1955) Theory of A.C. Machines, Mc Graw Hill Education*

SEMESTER- IV

Course Title: POWER ELECTRONICS

Course Code: BEE402

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Compare signal level and power level devices.
2. Analyse controlled rectifier circuits.
3. Evaluate the operation of DC-DC choppers.
4. Interpret Diode, Thyristor, MOSFET, IGBT and V-I characteristics.

Course Content

UNIT-I **10 Hours**

Power switching devices

Diode, Thyristor, MOSFET, IGBT: V-I characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

UNIT-II **10 Hours**

Thyristor rectifiers

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R- load and highly inductive load; Input current wave shape and power factor.

UNIT-III **10 Hours**

DC-DC converter

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage. DC-DC boost converter: Power circuit of a

boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

UNIT-IV **15 Hours**

Voltage source inverter

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage. Three-phase voltage source inverter: Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Reddi S R. (2002) Fundamentals of Power Electronics, Narosa Publishing House Pvt. Ltd, New Delhi*
- *Mohammad H. (2005) Power Electronics, Circuits Devices and Applications Khanna Publishers, New Delhi*
- *Bhattacharya S.K. (1998), Industrial Electronics & Control New Age International Publications(P) Ltd, New Delhi.*

SEMESTER- IV

Course Title: DIGITAL ELECTRONICS

Course Code: BEE403

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the basic fundamental of digital system and logic families
2. Realize working of logic families and logic gates.
3. Design and implement Combinational and Sequential logic circuits
4. Compute the process of Analog to Digital conversion and Digital to Analog conversion.

Course Content

UNIT-I **5 Hours**

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 lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

UNIT-II **15 Hours**

Combinational Digital Circuits

Standard representation for logic functions, K-map representation, 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.

UNIT-III **10 Hours**

Sequential circuits and systems

A 1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K- T and D- types flip flops, applications of flip flops, shift registers, applications of shift registers, serial o parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

UNIT-IV **15 Hours**

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 ICs, 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, concept of memories.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Malvino, (1998) Digital principle and applications, (TMH)*
- *Jain, R. P. (2002) Modern digital electronics, (PHI)*
- *Mano, M.M. (2001) Digital Design. (PHI)*

SEMESTER- IV

Course Title: ELECTROMAGNETIC FIELDS

Course Code: BEE415

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the basic mathematical concepts related to electromagnetic vector fields.
2. Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.
3. Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.
4. Interpret the concepts related to Faraday‘s law, induced emf and Maxwell‘s equations.

Course Content

UNIT-I **10 Hours**

Review of Vector Calculus

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus- differentiation, partial differentiation, integration, vector operator, del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

UNIT-II **10 Hours**

Static Electric Field

Coulomb’s law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density. Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance,

Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

UNIT-III **10 Hours**

Magnetic Forces, and Inductance

Biot-Savart's law, Ampere's law of force, Ampere's circuital law, Faraday's law, Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic circuits, calculations of inductances and mutual inductances for a solenoid and toroid.

UNIT-IV **15 Hours**

Maxwell's Equations in Time Varying Fields and Wave theory

Concept of displacement current and conduction current, Maxwell's equation-differential and integral form, Poynting's theorem, its significance and Poynting's vector, Boundary Conditions. Wave theory: Derivation of wave equation, uniform plane waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Attenuation, phase and propagation constant, intrinsic impedance, Relation between E & H, wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Edward C. Jordan and Keith G. Balmain, (2003) Electromagnetic Waves and Radiation System, Prentice Hall of India. Pvt. Ltd.*
- *Kraus/ Fleisch, (1999) Electromagnetics, Tata McGraw Hill.*
- *Fraser, W. (2003) Telecommunications, CBS Publication and Distributor.*

SEMESTER- IV

Course Title: Signals and Systems	**L**	**T**	**P**	**Credits**
Course Code: BEE418	**3**	**0**	**0**	**3**

Total hours: 45

Course Outcomes: On successful completion of this course, the students will be able to:

1. Understand the concepts of continuous time and discrete time systems.
2. Analyse systems in complex frequency domain.
3. Understand sampling theorem and its implications.
4.

Course Content

UNIT-I **8 Hours**

Introduction to Signals and Systems: Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. 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. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.

UNIT-II **9 Hours**

Behavior of continuous and discrete-time LTI systems: Impulse response and step response, convolution, input-output behavior with aperiodic 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.

UNIT-III **10 Hours**

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.

UNIT-IV **8 Hours**

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.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- A. V. Oppenheim, A. S. Willsky and S. H. Nawab, ―Signals and systems‖ , Prentice Hall India, 1997.
- J. G. Proakis and D. G. Manolakis, ―Digital Signal Processing: Principles, Algorithms, and Applications‖ , Pearson, 2006.
- H. P. Hsu, ―Signals and systems‖ , Schaum‘s series, McGraw Hill Education, 2010.
- S. Haykin and B. V. Veen, ―Signals and Systems‖ , John Wiley and Sons, 2007.
- A. V. Oppenheim and R. W. Schafer, ―Discrete-Time Signal Processing‖ , Prentice Hall, 2009.
- M. J. Robert ―Fundamentals of Signals and Systems‖ , McGraw Hill Education, 2007.
- B. P. Lathi, ―Linear Systems and Signals‖ , Oxford University Press, 2009.

SEMESTER- IV

Course Title: DIGITAL ELECTRONICS LABORATORY

Course Code: BEE405

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Demonstrate the basic electronic components and circuits.
2. Verify truth tables of TTL gates.
3. Design and fabrication and realization of all gates and basic circuits.
4. Design the truth tables and basic circuits and evaluate the basic electronics circuits.

Course Content **15 Hours**

Hands-on experiments related to the course contents

Note: A student to perform any 8-10 Experiments and make one working minor project.

Suggested List of Experiments:

1. Verification of the truth tables of TTL gates viz; 7400 (NAND Gate), 7408 (AND Gate), 7432(OR Gate), 7402 (NOR Gate), 7486 (XOR Gate) and 7404 (NOT Gate), 7486 (XOR Gate).
2. Design and fabrication and realization of all gates using NAND/NOR gates.
3. Verification of truth table of Mutiplexer (74150)
4. Verification of truth table of Demultiplexer (74154)
5. Design and verification of truth tables of half-adder circuits using gates 7483 and 7486(controlled inverter).
6. Design and verification of truth tables of full-adder circuit using gates 7483 and

7486(controlled inverter).

7. Design and verification of truth tables of subtractor circuits using gates 7483 and 7486(controlled inverter).

8. To study the operation of Arithmetic Logic Unit IC 74181.

9. Design and test S-R flip-flop using NOR/NAND gates.

10. Verify the truth table of a JK flip flop using IC 7476,

11. Verify the truth table of a D flip flop using IC 7474 and study its operation in the toggle and asynchronous mode.

SEMESTER- IV

Course Title: ELECTRICAL MACHINES-II LABORATORY
Course Code: BEE406

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Construct equivalent circuit's induction motors by routine tests.
2. Comprehend the requirement of starting and speed control methods of induction motors in the various applications of industry.
3. Construct equivalent circuits of synchronous generator and motor.
4. Apply knowledge to show utility of alternator, synchronous motors and synchronous condenser for various applications in power system.

Course Content **15 Hours**

Hands-on experiments related to the course contents

Note: A student to perform any 8-10 Experiments and make one hardware/software based minor project.

Suggested List of Experiments:

1. To perform load-test on three-phase Induction motor and to plot torque versus speed characteristics.
2. To perform no-load and blocked–rotor tests on three-phase Induction motor to obtain equivalent circuit.
3. To study the speed control of three-phase Induction motor by Kramer's Concept.
4. To study the speed control of three-phase Induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor.
5. To study star- delta starters physically and

a) To draw electrical connection diagram
b) To start the three-phase Induction motor using it.
c) To reverse the direction of three-phase Induction motor

6. To start a three-phase slip –ring induction motor by inserting different levels of resistance in the rotor circuit and plot torque –speed characteristics.
7. To perform no-load and blocked–rotor test on single-phase Induction motor and to determine the parameters of equivalent circuit drawn on the basis of double

revolving field theory.

8. To perform no load and short circuit. Test on three-phase alternator and draw open and short circuit characteristics.

9. To find voltage regulation of an alternator by zero power factor (ZPF.) method.

10. To study effect of variation of field current upon the stator current and power factor with synchronous motor running at no load and draw Voltage and inverted Voltage curves of motor.

11. Parallel operation of three phase alternators using

(i) Dark lamp method (ii) Two-Bright and one dark lamp method

12. To study synchroscope physically and parallel operation of three-phase alternators using synchroscope.

13. Starting of synchronous motors using:

(i) Auxiliary motor (ii) Using Damper windings

SEMESTER- IV

Course Title: POWER ELECTRONICS LABORATORY

Course Code: BEE407

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Interpret the properties and characteristics of thyristors.
2. Classify the types of waveforms of inverter and chopper circuits.
3. Analyze speed and direction control of single phase and three phase electric motors using ac and dc drive.
4. Evaluate the effect of free-wheeling diode on pf with RL load and check the performance of a choppers, and inverter.

Hands-on experiments related to the course contents.

Note: A student to perform any 8-10 Experiments and make one hardware/software based minor project.

Suggested List of Experiments:

1. To plot V-I characteristics and study the effect of gate triggering on turning on of SCR.
2. To study the effect of free-wheeling diode on power factor for single phase half-wave rectifier with R-L load.
3. To plot waveforms for output voltage and current, for single phase full-wave, fully controlled bridge rectifier, for resistive and resistive cum inductive loads.
4. Study of the microprocessor-based firing control of a bridge converter.
5. To study three phase fully controlled bridge converter and plot waveforms of output voltage, for different firing angles.
6. To study Jones chopper or any chopper circuit to check the performance.
7. Thyristorised speed control of a D.C. Motor.
8. Speed Control of induction motor using thyristors.
9. Study of series inverter circuit and to check its performance.
10. To check the performance of a McMurray half-bridge inverter.

SEMESTER- IV

Course Title: GENERATION OF ELECTRICAL POWER

Course Code: BEE419

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Interpret the India's power scenario, power system structure and related agencies.
2. Select the methods and size of plant generating power for overall economy.
3. Decide the tariff structure for different type of users.
4. Comprehend the Energy and environment, Air pollution, Aquatic impacts, nuclear plant and hydro plant impacts.

Course Content

UNIT-I **10 Hours**

Introduction: Electrical energy sources, organization of power sector in India, single line diagram of thermal, hydro and nuclear power stations.

UNIT-II **10 Hours**

Loads and Load curves: Maximum demand, Group diversity factor, Peak diversity factor, Types of load, chronological load curves, load-duration Curve, mass curves, load factor, capacity factor, utilization factor, base load and peak load plants, load forecasting.

Power Plant Economics: Capital cost of plants, annual fixed cost, operating costs and effect of load factor on cost of energy, depreciation.

UNIT-3 **15 Hours**

Tariffs and power factor improvement: Objectives of tariff making, different types of tariff for domestic, commercial, agricultural and Industrial loads. Need for p.f. improvement, p.f. improvement using capacitors, determination of economic p.f.

Selection of plant: Plant location, plant size, no. and size of units in plants, economic comparison of alternatives, annual cost, rate of return, present worth and capitalized cost methods.

Economic operation of steam plants: Methods of loading turbo-generators, input-output curve, heat rate, incremental cost, method of lagrangian multiplier, effect of transmission losses, co ordination equations, iterative procedure to solve co-ordination equations.

UNIT-IV **10 Hours**

Hydro-thermal co-ordination: Advantages of combined working of runoff river plant and steam plant, reservoir hydro plants and thermal plants-long term operational aspects, scheduling methods.

Pollution and environmental problems: Energy and environment, Air pollution, Aquatic impacts, nuclear plant and hydro plant impacts.

Cogeneration: Definition and scope, Topping and Bottoming Cycles, Benefits, cogeneration technologies.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Gupta, B. R. (2000). Generation of Electric Energy. S. Chand & Co. Delhi.*
- *Dom, K. (1998) Power Plant Engineering S. Chand & Co. Delhi.*

Semester: IV

Course Title: PROGRAMMABLE LOGIC CONTROLLERS LAB **Course Code: BEE420**	**L**	**T**	**P**	**Credits**
	0	**0**	**2**	**1**

Total Hours: 15

Course Content

Learning Outcomes: After completion of this course, the learner will be able to:

1. Perform different types of PLC programming schemes.
2. Implement ladder diagrams for process control.
3. Evaluate and use PLCs for different applications.
4. Correlate PLCs with drives in achieving required control.

Course Content

LIST OF PRACTICALS

1. Familiarization with the working of PLC.
2. Components/Sub-Components of a PLC, learning functions of different modules of PLC System.
3. Introduction to step 5 programming language, ladder diagram concepts, instruction list syntax.
4. Basic logic operations, AND, OR, NOT functions.
5. Logic control systems with time response as applied to clamping operation.
6. Sequence control system e.g. In lifting a dense for packaging and counting.
7. Wiring, entering and testing programs wiring a hand-held programmer for the following operations: - Ladder Logic, Timers, Counters, Sequencers
8. Wiring, entering and testing programs using computers for the following operations: Ladder logic, timers, counters, sequencers
9. Assembly language programming.
10. Write a program for LCD interface.
11. Write a program for A/D converter, result on LCD.
12. Write a program for D/A converter, showing the result on LCD.
13. Write a program for serial data transmission from kit to PC.
14. Development of a small working programs using PLC.

SEMESTER-IV

Course Title: ENVIRONMENTAL SCIENCE

Course Code: BEE416

L	T	P	Credits
2	0	0	NC

Total hours: 30

Course Outcomes: After completion of this course, the learner will be able to:

1. Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
2. Estimate the population - economic growth, energy requirement and demand
3. Analyze material balance for different environmental systems.
4. Realize the importance of ecosystem and biodiversity for maintaining ecological balance. Identify the major pollutants and abatement devices for environmental management and sustainable development

Course Content

UNIT-I **5 Hours**

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

UNIT-II **10 Hours**

Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity.

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: Floods, earthquake, cyclone and landslides.

UNIT-III **10 Hours**

Social Issues and the Environment from Unsustainable to Sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

UNIT-IV **5 Hours**

Human Population and the Environment, Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Goyal, A. (2020) Environmental Studies. Notion Press, New Delhi.*
- *Kaur, N & Goyal, A. (2014) Disaster Management. PBS Education, Jalandhar.*
- *Agarwal, K. C.(1998) Environment Biology, Nidi Publ. Ltd. Bikaner.*
- *Jadhav, H & Bhosale, V.M. (2001) Environment Protection and Laws. Himalaya Pub House, Delhi*
- *Rao M. N. & Datta A.K.(1997) Waste Water Treatment. Oxford & IBH Publ. Co. Pvt. Ltd.*

SEMESTER- V

Course Title: POWER SYSTEM -I (APPARATUS AND MODELLING)
Course Code: BEE501

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the basic concepts of power systems.
2. Classify the various power system components.
3. Evaluate fault currents for different types of faults.
4. Comprehend the generation of over-voltages and insulation coordination.

Course Content

UNIT-1 **10 Hours**

Basic Concepts

Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.

Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.

UNIT-II **15 Hours**

Power System Components

Conductor Materials; ACSR, hollow and bundle conductor. Different types of tower, Stringing of conductor, spacing, sag, clearance from ground, overhead line insulator, concept of string efficiency. Choice & variation of frequency & voltage. Benefits of double circuit lines.

Parameters and performance of transmission lines

Introduction to Line Parameters, Resistance of Transmission Line, inductance of single phase two wire line, concept of G.M.D, Transposition of power lines, Effect of earth on capacitance of conductors. Representation of short Transmission Line, medium length line, long length line, Diagram of Power Flow through transmission lines, ABCD constants.

UNIT-III **10 Hours**

Circle Diagram, Line Compensation and underground cables

Receiving end circle diagram for long transmission line based on ABCD constants. Power loci, Surge impedance loading, Reactive power requirement of system series and shunt compensation, synchronous phase modifiers, rating of phase modifiers. Types of Cables based upon voltage & current rating, dielectric stress, capacitance of cable.

UNIT-IV **10 Hours**

Introduction to DC Transmission

DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC) based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission. 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.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Elgerd O.L. (2001) Electrical Energy System Theory - An introduction, (TMH)*
- *Stevenson Jr W.D. (1999) Elements of Power System Analysis, TMH*
- *Wadhwa C.L. (2000) Course in Electrical Power, New Age Int.(P)Ltd.*
- *Nagrath and Kothari. (2003) Power System Analysis, (TMH)*
- *Gupta, B.R. (2001) Power System Analysis & Design, Wheeler Publishing.*

SEMESTER- V

Course Title: CONTROL SYSTEMS

Course Code: BEE502

L	T	P	Credits
3	1	0	4

Total hours: 60

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the modelling of linear-time-invariant systems using transfer function and state-space representations.
2. Analyze electromechanical systems by mathematical modelling.
3. Evaluate the Transient and Steady State behavior of systems using standard test signals.
4. Analyze linear and non-linear systems for steady state errors, absolute stability and relative stability.

Course Content

UNIT-I **15 Hours**

Introduction to control problem

Industrial control examples. Control hardware and their models. Transfer function models of linear time-invariant systems.

Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

UNIT-II **15 Hours**

Time Response Analysis

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response.

Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

UNIT-III **15 Hours**

Frequency-response analysis

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Introduction to Controller Design

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design.

UNIT-IV **15 Hours**

State variable Analysis

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Ogata, K. (1999) Modern Control Engg. Prentice Hall, New Delhi.*
- *Gibsen, J.F. (2007) Control System Components, Mc Graw Hill.*
- *Kuo, B.C. (1998) Automatic Control System, Prentice Hall.*
- *Nagrath, I. J. (2004) Control System Engineering, Wiley Eastern Ltd., New Delhi.*

SEMESTER- V

Course Title: MICROPROCESSORS

Course Code: BEE513

L	T	P	Credits
4	0	0	4

Total hours: 60

Course Outcomes: After completion of this course, the learner will be able to:

1. To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
2. Understand and classify the instruction set of the 8085/8086 microprocessor and distinguish the use of different instructions and apply it in assembly language programming.
3. Write the assembly language programming.
4. Relate the addressing modes used in the instructions.

Course Content

UNIT-I **10 Hours**

Fundamentals of Microprocessors:

Digital Computers: General architecture and brief description of elements, programming system, Buses and CPU Timings. Evolution of Microprocessor, Architecture advancements of microprocessors.

UNIT-II **20 Hours**

The 8085 Architecture

Microprocessor architecture and its operations, Pin configuration, internal architecture. Timing & Signals: control and status, interrupt: ALU, machine cycles, Instruction format, op-codes, mnemonics.

Instruction Set of 8085: Addressing Modes: Register addressing, direct addressing; register indirect addressing, immediate addressing, and implicit addressing.

Instruction Classification: Data transfer, arithmetic operations, logical operations, branching operation, machine control; Writing assembly Language programs, Assembler directives.

UNIT-III **15 Hours**

The 8086 Architecture

8086 Microprocessors Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation,

UNIT-IV **15 Hours**

Instruction Set of 8086, Addressing Modes, Instruction format, Interrupts: Hardware and software interrupts.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *A K. Ray & K M Bhurchandi. (2000) Advanced Microprocessor and peripherals. McGraw Hill.*
- *Ramesh. S. Gaonkar, (2000) Microprocessor Architecture, Programming and applications with the 8085, Pen Ram International Publishing*
- *B Ram. (2001) Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications.*

SEMESTER- V

Course Title: POWER SYSTEMS - I LABORATORY	L	T	P	Credits
Course Code: BEE505	0	0	2	1

Total hours: 15

Learning Outcomes:

1. Perform hardware based experiments on various power system components including renewable energy sources.
2. Simulate, analyze and evaluate different transmission lines parameters.
3. Simulate, analyze a network under balanced and unbalanced fault conditions and interpret the results.
4. Simulate and analyze the reactive power requirement of lines, voltage profile along the line and VAR compensation.

Course Content **15 Hours**

Suggested List of Experiments:

1. Introduction to different types of cables, insulators and substation layout and arrangement in power system.
2. To observe the voltage distribution across an insulator string and evaluate string efficiency
3. Performance and Analysis of Short Transmission line
4. Performance and Analysis of Medium Transmission line
5. To validate and compensate Ferranti effect on an unloaded transmission line
6. Simulation of performance analysis of transmission line for shunt compensation
7. Simulation of performance analysis of transmission line for series compensation
8. Simulation and Analysis of Symmetrical Faults
9. Simulation and Analysis of Symmetrical Components
10. Simulation and Analysis of Unsymmetrical Faults
11. To test Polarity, Ratio and magnetization characteristics of CT/PT
12. Floating Neutral of a unbalanced three-phase distributing systems
13. Performance of Solar PV modules in series and parallel configurations
14. Ground Constant of Circuit Breaker 15. Visit to substation, power station, solar, wind power installations or related firm /industry

SEMESTER- V

Course Title: CONTROL SYSTEMS LAB

Course Code: BEE506

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. To understand the basics concepts of MATLAB software.
2. To introduce variety of control system strategies.
3. To comment about the stability of designed systems.
4. Understand to Compare and analyze linear and non-linear systems for steady state errors, absolute stability and relative stability.

Course Content **15 Hours**

Note: A student to perform any 7 Experiments.

1. Familiarization with MATLAB control system toolbox, MATLAB Simulink toolbox

and PSPICE.

2. Determination of step response for first order and second order system with unity

feedback. Calculation and verification of time constant, peak overshoot, setting time etc. from the response.

3. Simulation of step response and impulseresponsefortype-0, type-1and type-2 systems

with unity feedback using MATLAB.

4. Determination of Root Locus, Bode-Plot, Nyquist Plot using MATLAB-Control system

toolbox for 2nd order system.

5. Determination of different control system performance indices from the plots.

6. Experimental determination of approximate transfer function from Bode plot.

7. Evaluation of steady state error, settling time, percentage peak overshoot, gain margin,

phase margin, with addition of lead compensator and by compensator in forward path transfer function for unity feedback control system.

8. Design of a second order linear time invariant control system and study of system response with unit step input.

9. To design a Lag compensator and test its performance characteristics.

SEMESTER- V

Course Title: MICROPROCESSORS LAB

Course Code: BEE514

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Interpret the 8085 and 8086 Microprocessors.
2. Prepare assembly language programmes.
3. Develop systems using different microprocessors.

Course Content **15 Hours**

Suggested List of Experiments:

1. To study 8085 based microprocessor system
2. To study 8086 and 8086A based microprocessor system
3. To study Pentium Processor
4. To develop and run a program for finding out the largest number from a given set of numbers.
5. To develop and run a program for finding out the smallest number from a given set of numbers.
6. To develop and run a program for arranging in ascending order of a set of numbers
7. To develop and run a program for arranging in descending order of a set of numbers
8. To perform multiplication of given numbers
9. To perform division of given numbers
10. To perform conversion of temperature from 0 F to 0 C and vice-versa
11. To perform 2's compliment of a given number
12. To perform floating point mathematical operations (addition, subtraction, multiplication and division)
13. To obtain interfacing of RAM chip to 8085 based system
14. To perform microprocessor-based stepper motor operation through 8085 kit
15. To perform microprocessor-based traffic light control

SEMESTER- V

Course Title: SOFT SKILLS-I	**L**	**T**	**P**	**Credits**
Course Code: BEE515	**3**	**0**	**0**	**3**

Total hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Learning how to identify your communication style and how to adapt it to different situations and audiences. Soft skills training can help you express yourself better and understand others.
2. Learning how to approach a situation analytically and creatively to resolve it.
3. Learning how to develop empathy for interpersonal interactions.
4. The student will be able to develop his/her personal traits and expose their personality effectively.

Course Content

UNIT-1 **12 Hours**

Soft Skills: Introduction to Soft Skills, Aspects of Soft Skills, Identifying your Soft Skills, Negotiation skills, Importance of Soft Skills, Concept of effective communication. Self-Discovery: Self-Assessment, Process, Identifying strengths and limitations, SWOT Analysis Grid.

UNIT-2 **10 Hours**

Forming Values: Values and Attitudes, Importance of Values, Self-Discipline, Personal Values - Cultural Values-Social Values-some examples, Recognition of one's own limits and deficiencies

UNIT-3 **10 Hours**

Art of Listening: Proxemics, Haptics: The Language of Touch, Meta Communication, Listening Skills, Types of Listening, Listening tips.

UNIT-4 **13 Hours**

Etiquette and Manners: ETIQUETTE- Introduction, Modern Etiquette, Benefits of Etiquette, Taboo topics, Do's and Don'ts for Men and Women. MANNERS- Introduction,

Importance of manners at various occasions, Professional manners, Mobile manners. CORPORATE GROOMING TIPS- Dressing for Office: Do's and Don'ts for Men and Women, Annoying Office Habits.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- K. Alex, S. Chand Publishers.
- Butterfield, Jeff, 'Soft Skills for Everyone', Cengage Learning, New Delhi, 2010.
- G.S. Chauhan and Sangeeta Sharma, 'Soft Skills', Wiley, New Delhi, 2016.
- Klaus, Peggy, Jane Rohman & Molly Hamaker, 'The Hard Truth About Soft Skills', Harper Collins E-books, London, 2007.
- S.J. Petes, Francis, 'Soft Skills and Professional Communication', Tata McGraw Hill Education, New Delhi, 2011

SEMESTER- V

Course Title: WIND AND SOLAR ENERGY
Course Code: BEE504

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Identify with the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Analyze the issues related to the grid-integration of solar and wind energy systems.
3. Realize the basic physics of wind and solar power generation.
4. Interpret the power electronic interfaces for wind and solar generation.

Course Content

UNIT-I **10 Hours**

Physics of Wind Power:

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

UNIT-II **10 Hours**

Wind generator topologies:

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

UNIT-III **10 Hours**

The Solar Resource:

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Solar photovoltaic:

Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

UNIT-IV **15 Hours**

Network Integration Issues:

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Ackermann, T. (2005) Wind Power in Power Systems. John Wiley and Sons Ltd.*
- *Masters, G. M. (2004). Renewable and Efficient Electric Power Systems. John Wiley and Sons.*
- *Sukhatme, S. P. (1984). Solar Energy: Principles of Thermal Collection and Storage. McGraw Hill.*

SEMESTER- V

	L	T	P	Credits
Course Title: ELECTRICAL MATERIALS				
Course Code: BEE516	**3**	**0**	**0**	**3**

Total hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Evaluation the fundamental concepts of materials into conducting, semi conducting and insulating materials
2. Apply preliminary cost estimating techniques to prepare building cost plans.
3. Use estimating techniques to build unit prices.
4. Analyse price conforming tenders with available information. Develop and apply appropriate cost planning bidding strategies that are ethically appropriate.

Course Content

UNIT-I **13 Hours**

Classification

Classifications of materials into conducting, semi conducting and insulating materials through a brief reference to their atomic structure and energy bands.

Conducting Material

Introduction, Resistance and factors affecting it such as alloying and temperature etc. Classification of conducting material as low resistivity and high resistivity materials, Low resistance materials;

Copper: General properties as conductor: Resistivity, temperature coefficient, density, mechanical properties of hard-drawn and annealed copper, corrosion, contact resistance. Applications in the field of electrical engineering;

Aluminium: General properties as conductor: Resistivity, temperature coefficient, density, mechanical properties of hard and annealed aluminium, solder ability, contact resistance. Applications in the field of electrical engineering;

Steel: General properties as conductor: Resistivity, corrosion, temperature coefficient, density, mechanical properties, solderability, Applications in the field of electrical engineering. Introduction to bundle conductors and its applications. Low resistivity copper alloys: Brass, Bronze (cadmium and Beryllium), their practical applications

with reasons for the same. Applications of special metals e.g. Silver, Gold, and Platinum etc. High resistivity materials and their applications e.g., manganin, constantan, Nichrome, mercury, platinum, carbon and tungsten. Superconductors and their applications.

UNIT-II **10 Hours**

Review of Semi-Conducting Materials Semi-conductors and their properties, Materials used for electronic components like resistors, capacitors, diodes, transistors and inductors etc.

Insulating materials; General Properties:
Electrical Properties: Volume resistivity, surface resistance, dielectric loss, dielectric strength (breakdown voltage) dielectric constant

Physical Properties: Hygroscopicity, tensile and compressive strength, abrasive resistance, brittleness.

Thermal Properties: Heat resistance, classification according to permissible temperature rise. Effect of overloading on the life of an electrical appliance, increase in rating with the use of insulating materials having higher thermal stability, Thermal conductivity, Electro-thermal breakdown in solid dielectrics

Chemical Properties: Solubility, chemical resistance, weatherability, Mechanical properties, mechanical structure, tensile structure

UNIT-III **7 Hours**

Insulating Materials and their applications:
Plastics: Definition and classification.

Thermosetting materials: Phenol-formaldehyde resins (i.e. Bakelite) amino resins (urea- formaldehyde and Malamine-formaldehyde), epoxy resins - their important properties and applications.

Thermo-plastic materials: Polyvinyl chloride (PVC), polyethylene, silicon, their important properties and applications.

UNIT-IV **15 Hours**

Magnetic Materials:
Introduction - ferromagnetic materials, permeability, B-H curve, magnetic saturation, hysteresis loop including coercive force and residual magnetism, concept of eddy current and hysteresis loss, curie temperature, magneto-striction effect.

Soft Magnetic Materials: Alloyed steels with silicon: High silicon, alloy steel for transformers, low silicon alloy steel for electric rotating machines
Cold rolled grain-oriented steels for transformer, non-oriented steels for rotating machine Nickel-iron alloys Soft Ferrites

Hard magnetic materials: Tungsten steel, chrome steel, hard ferrites and cobalt steel, their applications

Special Materials: Thermocouple, bimetals, leads soldering and fuses material, mention their applications. Introduction of various engineering materials necessary for fabrication of electrical machines such as motors, generators, transformers etc

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

· *Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.*
· *Electrical Properties of Materials, 8th Edition by Solymar, L, Oxford University Press New Delhi.*
· *Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi.*
· *Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi.*

Semester - V

Course Title: POWER PLANT ENGINEERING	**L**	**T**	**P**	**Credits**
Course Code: OEC083	**3**	**0**	**0**	**3**

Total hours: 45

Course Outcomes: On successful completion of this course, the students will be able to:

1. Find out the efficiency and output of Rankine cycle Steam Power Plant from given data, including, super heat, reheat, regeneration and reversibility's.
2. Explicate the blade shapes, and calculate work output of typical turbine stages.
3. Explain major types of hydro power and wind power turbines.
4. Clarify the basic principal of thermal fission and fast breeder nuclear power plant.

Course Content

UNIT-I **15 Hours**

Steam Generators, Condensers and Turbines:

Classification of steam generators, selection, operation of locomotive, Babcock Wilcox, Cochran boilers, Types of condensers, effect of air in condensers, Dalton's law of partial pressure, cooling water calculations, steam nozzles, types of steam turbine efficiencies, compounding, governing and control.

Steam Power Plant:

Classification, Operation, Description of Rankine cycle, Regenerative cycle, Reheat-Regenerative Cycle, Binary Vapour Cycle, Selection of plant site and its layout, coal handling system, combustion system, Fluidized bed combustion, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.

UNIT-II **10 Hours**

Hydro-Electric Power Plants: Hydrological Cycle, Hydrograph, Flow duration curve, Selection of site, Essential features, Classification of hydro plants, Selection of water

turbines for hydro power plant, Automatic and remote control of hydro station, layout of hydro power plant.

Nuclear power plants: Nuclear physics, Binding energy, Radioactive decay. Fertile material, Mass defect, Nuclear reactions type and application, Generation of nuclear energy by fission, Nuclear reactors. Site selections, safety measures, plant layout, Fusion reaction, Future of nuclear power.

UNIT-III **10 Hours**

Gas Turbine: Elements of gas turbines, Open and closed cycles for gas turbines, Performance terms, Thermal refinement to gas turbines cycle, Plant layout, applications, gas turbines Cycle calculations.

Diesel Power Plants: Classifications of IC Engines and their performance, Four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Celane number, knocking, super charging, operation and layout of diesel power plant.

UNIT-IV **10 Hour**

Combined Operation of Different Power Plants: Advantages of combined operation of plants, load division between power stations, coordination of different types of Power Plants.

Pollution Control: Pollution from thermal & nuclear plants, Particulate emission and control, electrostatic precipitator, solid waste disposal.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Sharma, P.C. (1999) Power Plant Engineering (Kataria & Sons)*
- *Skrotzki, B.G.A. & Vapot, W. (2001) A Power Station Engineering and Economy (TMH)*
- *Rajput*, R.K. (1997) Power Plant Engineering (Luxmi Publications)

Semester - V

Course Title: SUBSTATION EQUIPMENT & DESIGN **Course Code: OEC093**	**L**	**T**	**P**	**Credits**
	3	**0**	**0**	**3**

Total hours: 45

Course Outcomes: On successful completion of this course, the students will be able to:

1. Describe the main consideration in the process of substation design.
2. Outline the working principles of substation switching equipment.
3. Explain the different types of bus configurations.
4. Design criteria of substation grounding and protection.

Course Content

UNIT-I **15 Hours**

INTRODUCTION

Background, Need Determination, Budgeting, Financing, Traditional and innovative Substation Design, Site Selection and Acquisition, Design, Construction and Commissioning Process

UNIT-II **10 Hours**

HIGH VOLTAGE SWITCHING EQUIPMENT

Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers.

UNIT-III **10 Hours**

TYPES OF SUBSTATIONS & BUS/SWITCHING CONFIGURATIONS

Transmission substation, distribution substation, collector substation, switching substations, gas insulated substations, air insulated substations, bus configurations: single bus, double bus, double break, main and transfer bus, double bus, single breaker, ring bus, break-and-a-half, Comparison of configurations.

UNIT-IV **10 Hour**

DESIGN OF SUBSTATION GROUNDING AND PROTECTION

Reasons for substation grounding system, accidental ground circuit, Design criteria-Actual Touch and step voltage, soil resistivity, grid resistance, grid current, use of the design equations, selection of conductors, grounding fence, other design considerations. Lightning stroke protection-lightning parameters, empirical design methods. Substation fire protection-Fire hazards, fire protection measures, fire protection selection criterion.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- R. S. Dahiya, VinayAttri,"Sub-Station Engineering Design & Computer Applications" S K Kataria and sons Publications, 1 st Edition, 2013.
- P. S. Satnam, P. V. Gupta, "Substation Design and Equipment" Dhanapat Rai Publications, 1 st Edition, 2013.
- Turan Gonen, "Electric Power Distribution Engineering" CRC press, third edition, 2014.

SEMESTER- VI

Course Title: POWER SYSTEMS - II (OPERATION AND CONTROL)
Course Code: BEE601

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Develop small scale model of alternator, excitation and governing systems.
2. Decide the scheduling of thermal units and hydro-thermal units for overall economy.
3. Design and apply control for frequency and voltage of power system represented by multi area
4. Compute the factors affecting power system security and voltage stability.

Course Content

UNIT-I **10 Hours**

Economic Operation of Power Systems: Fuel consumption, Characteristics of thermal unit, Incremental fuel rate and their approximation, Minimum and maximum power generation limits.

UNIT-II **10 Hours**

Economic Dispatch: Economic dispatch problem with and without transmission line losses, Unit Commitment, methods for their solutions. Hydrothermal Co-ordination: Hydro-scheduling, Plant models, Scheduling problems, Hydro-thermal scheduling problems and its approach.

UNIT-III **10 Hours**

Power System Control: Ideas of load frequency and voltage control, Reactive power control, Block diagrams of P-f and Q-V controllers, ALFC control, Static and dynamic performance characteristics of ALFC and AVR controllers, Excitation systems model, concept of area and Tie-line operations.

UNIT-IV **20 Hours**

Power System Security: Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivity method and linear

programming. Small Scale Stability Analysis: d-q model of generator, State space representation, Eigen value and participation factor analysis.

Voltage Stability: Basic concepts, Voltage collapse, P-V and Q-V curves, Impact of load, Static and dynamic analysis of voltage stability, Prevention of voltage collapse.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Rao, S. (2001). Testing, Commissioning, Operation and Maintenance of Electrical Equipment by Khanna Technical Publication. New Delhi*
- *Wadhwa, C.L. (1996) Electrical Power Systems. Wiley Eastern Ltd. New Delhi*
- *Uppal, S.L. (2003). Electrical Power. Dr. Khanna Publications. Delhi.*
- *A.J. Wood, B.F. Woolenberg (2013). Power Generation Operation and Control. John Wiley and Sons.*
- *Chakrabarty Abhijit (2006). Power System Analysis, Operation and Control. PHI Learning, New Delhi.*

Semester - VI

.

Course Title: ESTIMATING AND COSTING in ELECTRICAL ENGINEERING **Course Code: BEE622**	**L**	**T**	**P**	**Credits**
	3	**0**	**0**	**3**

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the basic principles of estimating and costing.
2. Use the preliminary cost estimating techniques to prepare building cost plans.
3. Apply estimating techniques to build unit prices.
4. Develop and apply appropriate cost planning bidding strategies that are ethically appropriate.

Course Content

UNIT-I **10 Hours**

Introduction

Purpose of estimating and costing, preformed for making estimates, preparation of materials schedule, costing, price list, tender document, net price list, market survey, overhead charges, labour charges, electrical point method and fixed percentage method, contingency, profit, purchase system, enquiries, comparative statements, orders for supply, payment of bills. Tenders – its constituents, finalization, specimen tender.

UNIT-II **10 Hours**

Estimating and Costing:

Domestic installations:

Standard practice as per IS and IE rules. Planning of circuits, sub-circuits and position of different accessories, electrical layout, preparing estimates including cost as per schedule rate pattern and actual market rate (single storey and multi-storey buildings having similar electrical load)

UNIT-III **10 Hours**

Estimating and Costing:

Industrial installations: relevant IE rules and IS standard practices, planning, designing and estimation of installation for single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials, estimating and costing exercises on workshop with singe-phase, 3-phase motor load and the light load (3-phase supply system)

UNIT-IV **15 Hours**

Service line connections: estimate for domestic and Industrial loads (over-head and underground connections) from pole to energy meter

Estimating the material required for:

Transmission and distribution lines (overhead and underground): Planning and designing of lines with different fixtures, earthing etc. based on unit cost calculations

Substation: Types of substations, substation schemes and components, estimate of 11/0.4 KV pole mounted substation up to 200 KVA rating, earthing of substations, Key Diagram of 66 KV/11KV Substation.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

· *Gupta, J.B. (2000). Electrical Installation, Estimating and Costing. SK Kataria and Sons, New Delhi*
· *Bhattacharya, S.K. (1998). Estimating and Costing. Tata McGraw Hill, New Delhi*
· *Singh, Surjeet. (1999). Estimating and Costing. Dhanpat Rai & Co. New Delhi*

Semester - VI

Course Title: POWER SYSTEMS-II LAB

Course Code: BEE605

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Interpret various abnormal conditions that could occur in power system
2. Design various protective devices in power system for protecting equipment and personnel.
3. Classify the various types of existing circuit breakers, their design and constructional details.
4. Comprehend the various conventional relays, their design and latest developments.

Course Content

15 Hours

Laboratory Work:

1. Simulation of thermal scheduling with and without losses
2. Unit commitment by dynamic programming
3. Simulation of hydro-thermal scheduling by gradient method
4. Stability analysis of single area frequency control
5. Bias control of two area system and AVR.

Semester- VI

Course Title: HVdc Transmission Systems

Course Code: BEE623

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

- Understand the advantages of dc transmission over ac transmission.
- Understand the operation of Line Commutated Converters and Voltage Source Converters.
- Understand the control strategies used in HVdc transmission system.
- Understand the improvement of power system stability using an HVdc system.

Course Content

UNIT-I **5 Hours**

DC Transmission Technology:

Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVdc Systems. Components of a HVdc system. Line Commutated Converter and Voltage Source Converter based systems.

UNIT-II **15 Hours**

Analysis of Line Commutated and Voltage Source Converters:

Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap.

Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.

UNIT-III **10 Hours**

Control of HVdc Converters:

Principles of Link Control in a LCCHVdc system. Control Hierarchy, Firing Angle Controls – PhaseLocked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.

UNIT-IV **15 Hours**

Components of HVdc systems:

Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.
Stability Enhancement using HVdc Control
Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Pillai, S.K. (2000) A First Course On Electrical Drives, New Age Publications.*

Semester - VI

Course Title: ESTIMATION AND COSTING IN ELECTICAL ENGINEERING LAB
Course Code: BEE624

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:
1. The students will become familiar with the layout of wiring circuits of electrical installations and those of motor control circuits.
2. They will be able to estimate the various costs involved in these electrical installations.
3. They will learn to do energy audit of a small utility.
4. They will understand wiring arrangements of motor control circuits.

Course Content

15 Hours

Laboratory Work:

1. To study Indian electricity act 2003.
2. To carry out wiring diagram of residential building/educational institute/industry.
3. To study design parameters of electrical panel boards.
4. To estimate the cost of a domestic installation (Residential building/laboratory/drawing hall) with concept of illumination design.
5. To estimate the cost of industrial installation.
6. To estimate the cost of overhead service connection.
7. To estimate the cost of underground service connection.
8. To estimate the load and cost of any five electrical appliances.
9. To estimate the cost of repair and maintenance of any five domestic appliances.
10. To study various types of light sources and lighting schemes.
11. To draw wiring diagrams of motor control circuits for starting of induction and synchronous motors.
12. To carryout electrical energy audit of laboratory/office/workshop.

Semester- VI

Course Title: SOFT SKILLS-II

Course Code: BEE625

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

- Understand the advantages of dc transmission over ac transmission.
- Understand the operation of Line Commutated Converters and Voltage Source Converters.
- Understand the control strategies used in HVdc transmission system.
- Understand the improvement of power system stability using an HVdc system.

Course Content

UNIT-I **5 Hours**

Developing Positive Attitude: Introduction. Formation of attitude. Attitude in workplace. Power of positive attitude. Examples of positive attitudes. Negative attitudes. Examples of negative attitude. overcoming negative attitude and its consequences. **Improving Perception:** Introduction. Understanding perception. perception and its application in organizations.

UNIT-II **15 Hours**

Career Planning: Introduction. Tips for successful career planning. Goal setting immediate, short term and long term. Strategies to achieve goals. Myths about choosing career.

UNIT-III **10 Hours**

Art of Reading: Introduction. Benefits of reading. Tips for effective reading. the SQ3R technique. Different stages of reading. determining reading rate of students. Activities to increase the reading rate. Problems faced. Becoming an effective reader.

UNIT-IV **15 Hours**

Stress Management: Introduction. meaning. positive and negative stress. Sources of stress. Case studies. signs of stress. Stress management tips. Teenage stress.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *K. Alex, S. Chand Publishers.*
- *Rizvi, M. Ashraf, 'Effective Technical Communication', McGraw Hill.*
- *Mohan Krishna & Meera Banerji, 'Developing Communication Skills', Macmillan.*
- *Kamin, Maxine, 'Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams & Leaders', Pfeiffer & Amp; Company, Washington, DC, 2013.*

Semester- VI

Course Title: ELECTRICAL DRIVES

Course Code: BEE607

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Interpret the basic concept of dynamics of Electric Drives.
2. Analyze the multi-quadrant operations of dc and motors.
3. Evaluate the motor rating for duty cycles.
4. Recognize the various drive mechanisms and methods for energy conservation.

Course Content

UNIT-I **10 Hours**

Definitions, Dynamics of Electric Drives: Concept of electric drive and its classifications, Types of loads, Four-quadrant drive, and dependence of load torque on various factors, Dynamics of motor-load combination, Steady state stability of an electric drive system. Load Equalization

UNIT-II **10 Hours**

Drive Features of Importance: Multi-quadrant operations of DC and AC motors. Energy relations during starting and braking.

Static Control of Motors: Contactors and relays for electric drives. Control circuits for automatic starters of DC and AC motors including definite time accelerating type.

UNIT-III **10 Hours**

Estimation of Motors Rating: Types of duty cycles, Calculation of motor rating for duty cycles, Use of load diagrams.

UNIT-IV **15 Hours**

Semiconductor Controlled Drives: Control of DC drives fed through single-phase and three-phase semi converter and full-converter phase-controlled configurations. Their analysis, Regeneration and braking through static power converters, Control of three phase induction motors by stator voltage and frequency control for speeds below and

above synchronous speed. Static Rotor resistance control, Static Kramer and Scherbius drives.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Pillai, S.K. (2000) A First Course On Electrical Drives, New Age Publications.*

Semester - VI

Course Title: DIGITAL SIGNAL PROCESSING
Course Code: BEE626

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: On successful completion of this course, the students will be able to:

1. Interpret, represent and process discrete/digital signals and systems.
2. Thorough understanding of frequency domain analysis of discrete time signals.
3. Ability to design & analyze DSP systems like FIR and IIR Filter etc
4. Practical implementation issues such as computational complexity, hardware resource limitations as well as cost of DSP systems or DSP Processors.

Course Content

UNIT-I **10 Hours**

Introduction

Basic elements of DSP system, Advantages and disadvantage of DSP over analog processing, Application of Digital signal processing.

Discrete Time Signal and Systems

Elementary discrete time signals, Manipulation of discrete time signals, Classification of discrete time LTI system using convolution sum method, properties of LTI system, Analysis of LTI system using Difference equation.

UNIT-II **10 Hours**

Z-Transform

Direct Z-Transform and importance of ROC, properties of Z-Transform, Inverse Z-transform methods, system function of LTI systems in Z-domain, Relationship between Z-transform and Fourier transform, one sided Z –Transform.

Discrete Fourier Transform

Frequency domain sampling and reconstruction of discrete time signal, DFT as linear transformation, properties of DFT, use of DFT in linear filtering, fast fourier transform (FFT), decimation in time, decimation in frequency algorithm, Goertzel algorithm.

UNIT-III **15 Hours**

Implementation of Discrete Time System

Structures for realization of discrete time system, Direct form, cascade form, parallel form and lattice form structures for FIR and IIR systems, Representation of numbers, errors resulting for rounding and truncation.

Application in DSP

Digital Audio and instrumentation Digital Audio, Digital Control, Digital frequency oscillator. Telecommunication- Touch tone generator, DTMF detection using Goertzel algorithm.

UNIT-IV **10 Hours**

Design of Digital Filters

Fundamentals of filter design, Design of FIR filter using Window method, Design of IIR filter by Impulse invariance, bilinear transformation and matched Z transform technique, Analog and digital domain frequency transformation.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

· *John G. Proakis and Dimitris G. Manolakis. (2001). Digital Signal Processing Principles, Algorithm and Application. Prentice Hall India Pvt. Ltd.*

· *Emmanuel C. Ifeachor and Barrie W. Jervis. (1999). Digital signal processing. Pearson Education.*

Semester - VI

Course Title: Internet of Things
Course Code: OEC094

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Describe IOT and its networking and communication aspects.
2. Analyze the challenges in IoT Design.
3. Design IoT applications on different embedded platform.
4. Develop an insight about the better human-machine interface.

Course Content

UNIT-I **10 Hours**

Introduction to IoT:
Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models and APIs IoT and M2M, Difference between IoT and M2M, Software define Network.

UNIT-II **10 Hours**
Network and Communication aspects:
Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment, Node discovery, Data aggregation and Dissemination.

UNIT-III **15 Hours**
Challenges in IoT Design:
challenges, Development challenges, Security challenges, Other Challenges Domain specific applications: IoT Home automation, Industry applications, Surveillance applications, Other IoT applications.

UNIT-IV **10 Hours**

Developing IoTs:

Developing applications through IoT tools including Python/Arduino/Raspberry pi, Developing sensor based application through embedded system platform.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Madisetti, V., & Bahga, A. (2015). Internet of Things: A Hands-On Approach, New Delhi: Orient Blackswan Pvt. Ltd.*
- *Dargie, W., & Poellabauer, C. (2010). Fundamentals of Wireless Sensor Networks: Theory and Practice. United States: Wiley-Blackwel.*
- *DaCosta, F., & Henderson B. (2014). Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, New York: Apress Publications.*
- *Holler, J., Tsiatsis V., Mulligan, C., Avesand, S., Karnouskos, S., & Boyle, D. (2014). From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Massachusetts: Academic Press.*
- *Research Articles from SCI & Scopus indexed Journals.*

Semester – VI

Course Title: NON-CONVENTIONAL SOURCES OF ENERGY
Course Code: OEC095

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: On successful completion of this course, the students will be able to:

1. Discuss non-conventional sources of energy and explain the working of different solar energy application.
2. Discuss wind energy conversion systems and explain sources of geothermal energy.
3. Describe different biogas plants and working of different gasifiers.
4. Explain the working principle of different fuel cells and ocean thermal energy conversion systems

Course Content

UNIT-I **10 Hours**

Introduction to Energy Sources: Energy sources and their availability, non-conventional sources, advantages of renewable energy sources, prospects of renewable energy sources.

Solar Energy: Solar energy collectors – flat plate collectors and concentrating collectors, solar energy storage systems – mechanical, electrical, chemical and electro-magnetic, solar pond, applications of solar energy – solar water heating, solar distillation, solar cooking.

UNIT-II **6 Hours**

Wind Energy: Basic principles of wind energy conversion, site selection considerations, basic components of Wind Energy Conversion System (WECS), classification of WEC systems, wind energy collectors – horizontal axis machines and vertical axis machines, generating systems, applications of wind energy.

Geothermal Energy: Geothermal sources, hydrothermal resources – vapor dominated and liquid dominated systems, hybrid plants – geothermal preheat and fossil superheat; applications of geothermal energy, advantages and disadvantages of geothermal energy.

UNIT-III **8 Hours**

Energy from Biomass: Biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants – floating drum plants and fixed dome plants, selection of site for biogas plant, utilization of biogas; Methods for obtaining energy from biomass, biomass gasification, classification of biomass gasifiers, fixed bed gasifiers and fluidized bed gasifiers, applications of gasifiers, advantages and limitations of gasifiers.

UNIT-IV **9 Hours**

Chemical Energy sources: Fuel cells -principle of operation of fuel cell, types of fuel cells –hydrogen oxygen, solid-oxide, alkaline, polymer electrolyte membrane fuel cells, advantages, disadvantages and conversion efficiency of fuel cells, applications of fuel cells.

Energy from the oceans: Ocean thermal energy conversion-open cycle and closed cycle systems, energy from tides – basic principle of tidal power, components of tidal power plants, single basin and double basin systems, ocean waves – wave energy conversion systems.

Energy Conservation: Economic concept of energy, principles of energy conservation and energy audit, energy conservation technologies, co-generation, waste heat utilization, combined cycle power generation.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *D.P. Kothari, R. Rakesh and K.C. Singal, Renewable Energy Resources and Emerging Technologies, 2nd Edition, Prentice India Pvt. Ltd, 2011.*
- *G.S. Sawhney, Non-Conventional Energy Sources, 1st Edition, Prentice India Pvt. Ltd, 2012.*
- *G.N. Tiwari and M.K. Ghosal, Renewable Energy Resources: Basic Principles and Applications, 1st Edition, Alpha Science International Ltd, 2004.*

Semester - VII

Course Title: Utilization of Electrical Engineering

Course Code: BEE714

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: On successful completion of this course, the students will be able to**:**

1. Understand basic principles of electric heating and welding.
2. Determine the lighting requirements for flood lighting, household and industrial needs.
3. Calculate heat developed in induction furnace.
4. Evaluate speed time curves for traction.

Course Content

UNIT-I **10 Hours**

Illumination:

Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light. Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux. Laws of illumination – simple numericals. Different type of lamps, construction and working of incandescent and discharge lamps – their characteristics, fittings required for filament lamp, mercury vapour sodium lamp, fluorescent lamp, halogen lamp, neon lamp, compact filament lamp(CFL).Calculation of number of light points for interior illumination, calculation of illumination at different points, considerations involved in simple design problems. Illumination schemes; indoor and outdoor illumination levels. Main requirements of proper lighting; absence of glare, contrast and shadow. General ideas about time switches, street lighting, flood lighting. Monument lighting and decorative lighting, light characteristics etc.

UNIT-II **10 Hours**

Electric Heating

Advantages of electrical heating; Heating methods: Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating appliances, thermostat control circuit Induction heating; principle of core type and coreless induction furnace, their construction and applications Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace Dielectric heating, applications in various industrial fields Infra-red heating and its applications (construction and working of two appliances) Microwave heating and its applications (construction and working of two appliances) Solar Heating; Calculation of resistance heating elements (simple problems)

UNIT-III **10 Hours**

Electric Welding:

Advantages of electric welding; Welding method, Principles of resistance welding, types – spot, projection, seam and butt welding, welding equipment, Principle of arc production, electric arc welding, characteristics of arc; carbon arc, metal arc, hydrogen arc welding method and their applications. Power supply requirement. Advantages of using coated electrodes, comparison between AC and DC arc welding, welding control circuits, welding of aluminum and copper

UNIT-IV **15 Hours**

Electrolytic Processes:

Need of electro-deposition; Laws of electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing and buffing; Equipment and accessories for electroplating; Factors affecting electro-deposition; Principle of galvanizing and its applications; Principles of anodizing and its applications; Electroplating of non-conducting materials; Manufacture of chemicals by electrolytic process.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *S. Borlase,* **"***Smart Grids, Infrastructure, Technology and Solutions***"**, *CRC Press, 1st Edition, 2013***.**

- *G. Masters, "Renewable and Efficient Electric Power System", Wiley–IEEE Press, 2nd Edition, 2013.*

Reference Books:

- *Partap, H. (1999). Art and Science of Utilization of Electrical Energy. Dhanpat Rai & Sons, Delhi.*
- *Gupta, JB. (1998). Utilization of Electrical Energy. Kataria Publications, Ludhiana.*
- *Sahdev. (2003). Utilization of Electrical Energy. Uneek Publication, Jalandhar.*

SEMESTER- VII

Course Title: Electrical Energy Conservation and Auditing
Course Code: BEE715

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of different energy efficient devices.

Course Content

UNIT-I **10 Hours**

Energy Scenario

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

UNIT-II **10 Hours**

Basics of Energy and its various forms

Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-III **10 Hours**

Energy Management & Audit

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy

requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT-IV **15 Hours**

Energy Efficiency in Electrical Systems

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)*
- *Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)*
- *S. C. Tripathy, —Utilization of Electrical Energy and Conservation‖ , McGraw Hill, 1991.*
- *Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)*

Semester - VII

Course Title: Introduction to MATLAB Lab

Course Code: BEE716

L	T	P	Credits
0	0	2	1

Total hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. The students will learn the basics of the MATLAB for the enhance the knowledge.
2. The students will learn powerful support MATLAb provides for working with matrices.
3. The students will learn about various data types and how to handle them in MATLAB.
4. The students will learn about about file input/output.

Course Content

Following experiments to be conducted using Sci Labs / MATLAB

1. Introduction to Sci Labs /MATLAB environment and types of Sci Labs / MATLAB files.

2. Use of help command to get help about different inbuilt functions.

3. Write a program to show the output of various unary and binary operators.

4. Write programs for Matrix Manipulations, (reshaping matrices, expanding matrix size, appending or deleting a row/column to a matrix, concatenation of matrices).

5. Write programs which demonstrate the use special matrices.

6. Write programs to show output for various matrix and array operations.

7. Write programs for demonstrating the use for various control statements.

8. Write a MATLAB code for computing factorial of a number n. Assume n is already defined. The code should return a scalar, not a vector.

9. Write programs using functions and plot results.

Semester - VII

Course Title: INTRODUCTION TO INDUSTRY 4.0

Course Code: BEE717

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Cope up with the upcoming demand of the industry.
2. Illustrate the emerging areas of importance like Internet of Things (IoT), Cloud, Big Data, Robotics, Block Chain, Artificial Intelligence (AI), Machine Learning etc.
3. Understanding about the emerging demands of the industry.
4. Develop an insight about the better human-machine interface.

Course Content

UNIT-I **10 Hours**

Various Industry Revolutions:
Define Data, meaning of going digital, Difference between Digitisation & Digitalisation, Interdependence of technologies in the digital world, Role of Digital, Digitisation and Digitalisation in our lives.

Internet of Things (IoT):
Definition and working of IoT, Integration of different components of IoT, Impact of IoT on Industries, Machine to Machine communication (M2M), Limitations of IoT.

UNIT-II **10 Hours**

Cloud:
Definition of cloud computing, Laas, PaaS, SaaS & Bpaas, Importance of cloud, Advantages and disadvantages of cloud, Meaning of a Cloud-based Open IoT Operating System (PaaS).

Big Data:
Difference between data and bigdata, Characteristic of bigdata; Volume, Velocity, Variety, Veracity and Value.

Data Analysis:
Descriptive analysis, Predictive analysis, Prescriptive analysis

Block chain:
Mechanism of Cryptocurrency, working of block chain technology, Mining and miner.

UNIT-III **15 Hours**

Artificial Intelligence (AI):
Tasks of AI: visual perception, speech recognition, decision making, translation between languages, Subfields of Artificial Intelligence, such as; Machine Learning, Neural Network, Deep Learning, Cognitive Computing, Computer vision, Natural Language Processing, Benefits of Artificial Intelligence in Industries.

Machine Learning (ML): Relationship between ML and AI, Importance of ML for individuals and companies, Use of ML for; Interpretation of past customer behaviour, Simplification of product marketing, Accurate sales forecasting, Accurate medical prediction and diagnosis, Simplification in documentation and data entry, Improvement in precision of financial rules and models, Detection of Spam, Increasing the efficiency of predictive maintenance in manufacturing
industry, Better customers segmentation and accurate lifetime value prediction, Recommendation of the right product.

Machine Learning Algorithms Categories: Supervised, Unsupervised and Reinforcement

UNIT-IV **10 Hours**

Plant Integration:
Standardization; Open network Interface, M2M communication, Combination of individual machines in to asynchronized production line, Manage of dark data i.e. Complex data Management.

Virtual Commissioning/Digital Twin:
End-to-end engineering, Mechanical design to electrical layout and automation, Detecting mechanical problems/ software errors at an early stage?

Industrial Edge:

Local and cloud computing/on-premise and off-premise, Industrial Edge and its Benefits to Industry

Recommended Text Books:

- *Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress Publishers, June 2016.*
- *Sudip Misra, "Introduction to Industry 4.0 and Industrial Internet of Things" SWAYAM Course.*
- *Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing Systems", Springer*

Semester - VII

Course Title: MINOR PROJECT
Course Code: BEE709

L	T	P	Credits
0	0	6	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Apply the theoretical and practical knowledge gained so far, by taking up the study in the form of a project work.

2. Provide a good initiation for the students in R&D work.

The aim of the Project work to enable the student to take up an investigative study in the broad field of Electrical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor.

Course Content

The assignment to normally include:

1. Survey and study of published literature on the assigned topic;

2. Working out a preliminary Approach to the Problem relating to the assigned topic.

3. Conducting the preliminary Analysis, Modelling, Simulation, Experiment, Design and Feasibility

4. Preparing a Written Report on the Study conducted for presentation to the Department

5. Final Seminar, as oral Presentation before a departmental committee.

Semester - VII

Course Title: HIGH VOLTAGE ENGINEERING

Course Code: BEE702

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Understand the problem of power system stability and its impact on the system.
2. Analyse linear dynamical systems and use of numerical integration methods.
3. Model different power system components for the study of stability.
4. Understand the methods to improve stability.

Course Content

UNIT-I **15 Hours**

Introduction to Power System Operations:
Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.

UNIT-II **10 Hours**

Analysis of Linear Dynamical System and Numerical Methods:

Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

UNIT-III **10 Hours**

Modeling of Synchronous Machines and Associated Controllers:

Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation

and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

UNIT-IV **10 Hours**

Modeling of other Power System Components:

Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

Enhancing System Stability:

Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures Preventive Control. Emergency Control.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *K.R. Padiyar, ―Power System Dynamics, Stability and Control‖ , B. S. Publications, 2002.*
- *P. Kundur, ―Power System Stability and Control‖ , McGraw Hill, 1995.*
- *P. Sauer and M. A. Pai, ―Power System Dynamics and Stability‖ , Prentice Hall, 1997.*

Semester - VII

Course Title: Power System Dynamics and Control

Course Code: BEE718

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Conceptualize the idea of high voltage and safety measures involved.
2. Analyse the breakdown mechanism of solids, liquids and gases.
3. Calculate the circuit parameters involved in generation of high voltages.
4. Measure direct, alternating and impulse high voltage signals, dielectric loss and partial discharge involved in non-destructive high voltage tests.

Course Content

UNIT-I **15 Hours**

Introduction: Introduction to AC and DC impulse voltages and their use, Problems in dealing with high voltages.

Breakdown in Gases: Elementary ideas on ionization by electron collision, Townsend mechanism, Townsend first and second ionization coefficients, Paschen law, breakdown in non-uniform fields and corona discharges, vacuum breakdown mechanisms, breakdown in liquids, fundamentals of insulating oils, conduction and breakdown in pure and commercial liquids.

Breakdown in Solids: Fundamentals of solid insulating materials intrinsic, electromechanical and thermal breakdown, breakdown in simple and composite dielectrics, types of insulating materials, temperature classification, factor affecting dielectric strength, insulation design of rotating machines, transformers, transmission lines, Switch gear, etc.

UNIT-II **10 Hours**

Generation of High Voltages: Generation of high voltages, testing transformers in cascade, series resonant circuits and their advantages, half and full wave rectifier

circuits, voltage doubler and cascade circuits, electrostatic generator, characteristics parameters of impulse voltages, single stage impulse generator circuits, multistage impulse generation circuits.

UNIT-III **10 Hours**

Measurement of High Voltages: Measurement of direct, alternating and impulse voltages by electrostatic voltmeters, sphere gap, uniform field gap, ammeter in series with high voltage resistors and voltage divider.

UNIT-IV **10 Hours**

Non-Destructive High Voltage Tests: Loss in a dielectric and its measurement, dielectric loss measurement by Schering bridge, partial discharges at alternating voltages, external and internal partial discharges and discharge measurements.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Khalifa, M., High Voltage Engineering: Theory and Practice, Marcel Dekker Inc. (2000).*
- *Naidu, M.S. and Kamraju, V., High Voltage Engineering, Tata McGraw−Hill (2008).*
- *Wadhwa, C. L., High Voltage Engineering, New Age International (P) Limited, Publishers (2006).*
- *Dass, R., Extra High Voltages, Tata McGraw−Hill (2006).*
- *Kind, D. and Feser, K, High Voltage Test Techniques, Reed Educational and Professional Publishing Limited (2001).*

Semester: VII

Course Title: Introduction to Industrial Management	**L**	**T**	**P**	**Credits**
Course Code: OEC096	**3**	**0**	**0**	**3**

Total Hours: 45

Course Outcomes

1.To introduce the concepts of Industrial Management

2. To provide knowledge about various Costs and Inventory Management

3. To highlight the latest trend in Industrial Management

UNIT-I **10 Hours**

Concepts of Industrial Management: Introduction: Concept and scope of Industrial Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership. Functions of Management, Evolution of Management Thought: Taylor" s Scientific Management, Fayol" s,Principles of Management, Douglas Mc-Gregor" s Theory X and Theory Y, Mayo" s Hawthorne, Experiments, Hertzberg" s Two Factor Theory of Motivation, Maslow" s Hierarchy of Human Needs

Introduction to Human resources management: Nature of HRM, functions and importance of HRM.

UNIT-II **10 Hours**

Designing Organizational Structures: Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority.
Work Study: Introduction, Definition, Objectives, Steps in Work Study, Method Study: Definition, Objectives, Steps of Method Study,
Work Measurement: Purpose, Types of study: Stop Watch Methods-Steps, allowances, Standard Time Calculations, Work Sampling, Production Planning and Control

UNIT-III **11 Hours**

Cost Analysis: Cost classification: Prime cost, Overhead cost, Selling and Distribution Cost, Fixed cost, Variable cost, Implicit cost, Explicit cost, Replacement cost, Opportunity cost, Marginal cost

Inventory Control: Inventory, Cost, Models of inventory control: EOQ, ABC, VED

UNIT-IV **14 Hours**

Quality Control: Statistical Quality Control, Control charts for variables and attributes, Acceptance Sampling- Single sampling- Double sampling plans,

Recent Trends in Industrial Management–Material Requirement Planning (MRP), Enterprise Resource Planning (ERP), Just in Time (JIT), Six Sigma-Concept and benefits.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- O.P Khanna, Industrial Engineering.
- M.S. Saiyada, „Minappa and Personnel Managements". Tata Mc Graw Hill
- C.B. Mamoria, „Personnel Management" , Himalaya Publications
- Ravi Shankar, „Industrial Engineering" , Galgotia

Semester: VII

Course Title: Biomedical Instrumentation	**L**	**T**	**P**	**Credits**
Course Code: OEC097	**3**	**0**	**0**	**3**

Total Hours: 45

Course Outcomes:

On successful completion of this course, the students will be able to**:**

1. To provide basic knowledge of human anatomy and physiology.
2. Introduce the student with the introductory concepts of Bio signals, Biosensors, transducers and Bio-instrumentation.
3. To familiarize the student with modern imaging systems.

UNIT-I **11 Hours**

Human Anatomy and Physiology Basic elements of human body–cardio vascular system, respiratory system, circulatory system, nervous system, digestive, nervous, immune, and reproductive systems, Basics of cell and molecular biology.

UNIT-II **12 Hours**

Bio Signals: Origin, nature, and types of Bio signals: ECG, EMG, EEG. Principles of measuring blood pressure, temperature, volume & flow in arteries, veins and tissues, respiration and cardiac rate.

Bio Sensors and Transducers: Principles of sensing physiological parameters, types of transducers and their characteristics, Pressure transducers, Photoelectric transducers, optical fibre sensors, Biosensors, smart sensors.

UNIT-III **11 Hours**

Biomedical Instrumentation: Role of technology in modern healthcare, classification of biomedical instruments, performance parameters of instruments, constraints in design of medical instrumentation system.

UNIT-IV **11 Hours**

Modern Imaging Systems: Introductory concepts of X-ray Imaging, Nuclear Medical Imaging, Magnetic Resonance Imaging, Ultrasonic Imaging and Thermal Imaging systems.

Patient Safety issues: Electric shock hazards, leakage currents, safety codes for electromedical equipment, electrical safety analyzer, testing of biomedical equipment.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill.
- J. G. Webster, Medical Instrumentation, Application and Design, John Wiley and Sons.
- L. Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson education, Delhi, 1990.
- Marvin D. Weisis, Biomedical Instrumentation, Chilton Book Company, 1973.
- J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education.
- Harry E. Thomas, Handbook of Biomedical Instrumentation and Measurement, Reston Publishing Company, 1974.
- M. Singh, Introduction to Biomedical Instrumentation, PHI Learning, Pvt. Ltd., 2nd edition, 2014.

Semester - VIII

Course Title: POWER SYSTEM ANALYSIS & DESIGN
Course Code: BEE808

L	T	P	Credits
3	0	0	3

Total Hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Demonstrate the ability to conduct experiments in the Electrical Engineering Laboratory in accordance with Health and Safety Regulations and to record, interpret and report on the experimental results.
2. Apply load flow analysis to an electrical power network and interpret the results of the analysis
3. Per Unit representation of entire power system network. Practical symmetrical and unsymmetrical fault analysis study.
4. Analysis of Power System Stability, Steady State Stability and Transient Stability and the associated problems.

Course Content

UNIT I **8 Hours**

Understand the basic concept of transmission lines, generating stations, receiving stations, industrial applications of meters, performance of transmission lines, VAR compensators and prediction of power flow, faults in the line etc.

UNIT II **15 Hours**

Reactance diagram, impedance diagram. Load flow problem, y bus, formulation of problem, solution technique using Gauss seidel method.

Short circuit of synchronous machine on No load, short circuit of loaded synchronous machine, Thevenin's equivalent circuit approach for short circuit analysis.

UNIT III **15 Hours**

Transformation, phase shift in star delta transformer, Sequence impedance and sequence network of transmission line, synchronous machine, transformer and power system.

Symmetrical component analysis of unsymmetrical short circuits, single line to ground fault, double line to ground fault and line to line fault.

UNIT IV **7 Hours**

Swing Equation, system response to small disturbances, power angle equation and diagram Equal area criterion, Measures for improving transient stability

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *'Elements of Power System Analysis by Stevenson and Grainger (McGraw Hill).*
- *Electrical Energy Systems Theory and Introduction by Olle I.Elgerd.*
- *Power System Analysis by Hadi Saadat.*

Semester - VIII

Course Title: MATLAB & SIMULINK	**L**	**T**	**P**	**Credits**
Course Code: BEE809	**0**	**0**	**4**	**2**

Total hours: 45

Course outcomes: At the end of this course, the student will be able to

1. Students will know about BASIC built in functions of MATLAB and blocks of SIMULINK.
2. They will learn to do various programming operations in MATLAB and develop Simulink models in SIMULINK.
3. They will be able to draw 2-D and 3-D plots in MATLAB.

Course Content

1. Introduction to Fundamentals of MATLAB Programming.

2. To perform Arithmetic and logic operations in MATLAB.

3. To perform branch and loop operations in MATLAB.

4. To use basic built-in function of Matrices in MATLAB.

5. To develop a user defined function file in MATLAB.

6. To plot 2-D & 3-D graphs in MATLAB, such as plots, subplots, logarithmic plots and multiple plots etc.

7. To plot 3-phase AC supply voltage in MATLAB.

8. To develop MATLAB program to calculate ABCD parameters of transmission line.

9. Introduction to commonly used blocks of SIMULINK.

10. To develop Simulink model to show series resonance phenomenon and to plot voltage & current waveforms and frequency vs impedance graph.

11. To develop Simulink model to show parallel resonance phenomenon and plot voltage & current waveforms and frequency vs admittance graph.

12. To develop a Simulink model of symmetrical three phase power system supplying a three phase balanced load and to display the three phase voltage, current, active and reactive power.

13. To develop Simulink model of three phase transformer and to display the primary and secondary voltages and currents.

14. To develop Simulink model for speed control of dc motors.

Semester - VIII

Course Title: MAJOR PROJECT
Course Code: BEE802

L	T	P	Credits
0	0	12	6

Total hours: 90

The objective of Major Project Work & Dissertation is to enable the student to extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership.

The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under EEP1.
2. Review and finalization of the Approach to the Problem relating to the assigned topic.
3. Preparing an Action Plan for conducting the investigation, including team work.
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
5. Final development of product/process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference presentation/Publication in Journals, if possible.
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.

Semester - VIII

Course Title: POWER SYSTEM PROTECTION	**L**	**T**	**P**	**Credits**
Course Code: BEE810	**3**	**0**	**0**	**3**

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Calculate both symmetrical and unsymmetrical fault currents.
2. Comprehend the fundamentals of electromechanical relays and digital protective relaying
3. Interpret the basic methods of calculating the magnitude and angle of voltage and current for the digital relaying
4. Apply suitable current transformer, voltage transformer and circuit breakers etc for fulfilling power system protection

Course Content

UNIT-I **10 Hours**

Circuit Breakers:

Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers.

Fuses:

Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination.

UNIT-II **10 Hours**

Introduction to Power System Protection:

Need for protective schemes, Nature and Cause of Faults, Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection.

Relay Construction and Operating Principles:

Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.

UNIT-III **15 Hours**

Overcurrent Protection:

Introduction, Time – current Characteristics, Current Setting, Time Setting. Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.

Distance Protection:

Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays.

UNIT-IV **10 Hours**

Protection of Rotating Machines

Differential Protection:

Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection.

Rotating Machines Protection:

Introduction, Protection of Generators.

Transformer and Buszone Protection:

Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection.

Protection against over voltages:

Protection of Transmission Lines against Direct Lightning Strokes,

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Elgerd O. L. (2001) Electrical Energy System Theory - An introduction, (TMH)*
- *Stevenson Jr W. D. (1999) Elements of Power System Analysis, TMH*
- *Wadhwa C.L. (2000) Course in Electrical Power, New Age Int.(P)Ltd.*
- *Nagrath and Kothari. (2003) Power System Analysis, (TMH)*
- *Gupta, B.R. (2001) Power System Analysis & Design, Wheeler Publishing.*

Semester - VIII

Course Title: ELECTRIC AND HYBRID VEHICLES

Course Code: BEE811

L	T	P	Credits
3	0	0	3

Total hours: 45

Course Outcomes: After completion of this course, the learner will be able to:

1. Interpret the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
2. Evaluate the hybrid drive-train topologies
3. Comprehend the DC motor drives configuration and control
4. Analyze the selection and sizing of energy storage systems. Compare different energy management strategies

Course Content

UNIT-I **10 Hours**

History of Hybrid and Electric Vehicles**:** Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics.

UNIT-II **10 Hours**

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

UNIT-III **10 Hours**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance, Drive system efficiency.

UNIT-IV **15 Hours**

Matching the Electric Machine and Internal Combustion Engine: Sizing the propulsion motor, selecting the energy storage technology, sizing the power electronics devices for energy storage, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Ramirez S., Ortigoza R. S. (2011) Control Design Techniques in Power Electronics Devices. Springer.*
- *Tan S. C., Y. M. Laiand & C. K. Tse (2012) Sliding mode control of switching Power Converters. CRC press.*

Semester - VIII

Course Title: Intellectual Property Rights
Course Code: OEC098

L	T	P	Credits
3	0	0	3

Total hours: 45

Course outcomes: At the end of this course, the student will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

Course Content

Unit I **10 Hours**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II **10 Hours**

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit III **10 Hours**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting

Unit IV **15 Hours**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"*
- *Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"*
- *Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.*
- *Mayall, "Industrial Design", McGraw Hill, 1992. Niebel, "Product Design", McGraw Hill, 1974.*
- *Asimov, "Introduction to Design", Prentice Hall, 1962. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.*
- *T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008*

Semester - VIII

Course Title: Industrial AUTOMATION
Course Code: OEC099

L	T	P	Credits
3	0	0	3

Total hours: 45

Course outcomes: At the end of this course, the student will be able to

1. Understanding principles of operation, types and applications of stepper motors
2. Understanding principles of operation, types and applications of switched reluctance motors
3. Knowledge in evaluating the performance of dc motors
4. Evaluate knowledge in permanent magnet synchronous motors.

Course Content

Unit I **10 Hours**

STEPPER MOTORS

Types, Constructional features, principle of operation, variable reluctance motor, single and Multistack configurations. Permanent Magnet Stepper motor. Hybrid stepper motor. Different modes of Excitation, theory of torque predictions, Drive systems and circuit for open loop and closed loop control of stepper motor.

Unit II **10 Hours**

SWITCHED RELUCTANCE MOTORS

Constructional features, principle of operation, Torque Equation, Power Converters for SR Motor, Rotor Sensing Mechanism & Logic Controller, Sensor less Control of SR motor, Applications

Unit III **10 Hours**

PERMANENT MAGNET BRUSHLESS D.C. MOTORS

Principle of operation: Types, Magnetic circuit analysis, EMF and torque equations – Power controllers – Motor characteristics and control – Applications.

Unit IV **15 Hours**

PERMANENT MAGNET SYNCHRONOUS MOTORS

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power Controllers, Torque speed characteristics, Self control, Vector control, Current control Schemes, Applications

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Kenjo T, "Stepping Motors and their Microprocessor Controls", Clarendon Press London, 2003. 181*
- *Miller T J E, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989 .*
- *Floyd E Saner," Servo Motor Applications", Pittman USA, 1993.*
- *WILLIAM H YEADON, ALAN W YEADON, Handbook of Small Electric Motors, McGraw Hill, INC,2001*