

1 st Year 1 st Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	CC-1	BCHMC101	Chemistry-I	3	1	0	4	4
2	CC-2	BMTMC101B	Mathematics –IB	3	1	0	4	4
3	CC-3	BEEC101	Basic Electrical Engineering	3	1	0	4	4
Total of Theory							12	12
B. PRACTICAL								
1	CC-1	BCHMC191	Chemistry-I Laboratory	0	0	3	3	1.5
2	CC-3	BEEC191	Basic Electrical Engineering Laboratory	0	0	2	2	1
3	SEC-1	BCES181	Engineering Graphics & Design	1	0	4	5	3
Total of Practical							10	5.5
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

1 st Year 2 nd Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	CC-4	BPHY201	Physics-I	3	1	0	4	4
2	CC-5	BMTMC201B	Mathematics –IIB	3	1	0	4	4
3	CC-6	BTCSC201	Programming for Problem Solving	3	0	0	3	3
4	AECC-1	HU201	Communicative English	2	0	0	2	2
Total of Theory							13	13
B. PRACTICAL								
1	CC-4	BPHY291	Physics-I Laboratory	0	0	3	3	1.5
2	CC-6	BTCSC291	Programming for Problem Solving	0	0	4	4	2
3	SEC-2	BMES281	Workshop/Manufacturing Practices	1	0	4	5	3
4	AECC-1	HU291	Language Laboratory	0	0	2	2	1
Total of Practical							14	7.5
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

2nd Year 3rd Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	C-2	BEEC301	Electric Circuit Theory	3	1	0	4	4
2	C-3	BEEC302	Analog Electronics	3	0	0	3	3
3	C-3	BEEC303	Electromagnetic field theory	3	0	0	3	3
4	C-4	BEEC304	Engineering Mechanics	3	0	0	3	3
5	C-5	BEEC305	Mathematics-III	3	0	0	3	3
6	C-6	BEEC306	Biology for Engineers	3	0	0	3	3
7	C-7	BEEC307	Indian Constitution	3	0	0	3	3
Total of Theory							22	22
B. PRACTICAL								
1	C-2	BEEC391	Electric Circuit Theory Laboratory	0	0	2	2	1
2	SEC-1	BEEC392	Analog Electronics laboratory	0	0	2	2	1
3	C-5	BEEC395	Numerical Methods laboratory	0	0	2	2	1
Total of Practical							6	3
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

2nd Year 4th Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	C-8	BEEC401	Electric machine-I	3	0	0	3	3
2	C-9	BEEC402	Digital Electronic	3	0	0	3	3
3	C-10	BEEC403	Electrical and Electronics Measurement	3	0	0	3	3
4	S-1	BEES401	Thermal Power Engineering	3	0	0	3	3
5	A-2	BEEA401	Values and Ethics in profession	3	0	0	3	3
6	A-3	EVS401	Environmental Science	3	0	0	3	0
Total of Theory							18	15
B. PRACTICAL								
1	C-8	BEEC491	Electric Machine-I laboratory	0	0	2	2	1
2	C-9	BEEC492	Digital Electronics laboratory	0	0	2	2	1
3	C-10	BEEC493	Electrical and electronic measurement laboratory	0	0	2	2	1
4	S-1	BEES491	Thermal Power Engineering laboratory	0	0	2	2	1
Total of Practical							8	4
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

3rd Year 5th Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	C-11	BEEC501	Electric Machine-II	3	0	0	3	3
2	C-12	BEEC502	Power System-I	3	0	0	3	3
3	C-13	BEEC503	Control system	3	0	0	3	3
4	C-14	BEEC504	Power Electronics	3	0	0	3	3
5	D-1	BEED501A/ BEED501B/ BEED501C	High Voltage Engineering/Power Plant Engineering/Renewable & Non-Conventional Energy	3	0	0	3	3
6	G-1	BEEG501A/ BEEG501B/ BEEG501C	Data Structure & Algorithm/Object Oriented Programming/Computer Organization	3	0	0	3	3
Total of Theory							18	18
B. PRACTICAL								
1	C-11	BEEC591	Electric Machine-II laboratory	0	0	2	2	1
2	C-12	BEEC592	Power System-I laboratory	0	0	2	2	1
3	C-13	BEEC593	Control system laboratory	0	0	2	2	1
4	C-14	BEES594	Power Electronics laboratory	0	0	2	2	1
Total of Practical							8	4
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

3rd Year 6th Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	C-15	BEEC601	Power System-II	3	0	0	3	3
2	S-2	BEES601	Microprocessor & microcontroller	3	0	0	3	3
3	D-2	BEED601A/ BEED601B/ BEED601C	Digital Control System/HVDC Transmission Systems/ Electrical Machine Design	3	0	0	3	3
4	D-3	BEED602A / BEED602B / BEED602C	Electrical And Hybrid Vehicle/ Power Quality And Facts/ Industrial Electrical Systems	3	0	0	3	3
5	G-3	BEEG601A/ BEEG602B	Digital Signal Processing /VLSI and MICRO Electronics	3	0	0	3	3
6	A-4	BEEA601	Economics For Engineers	3	0	0	3	3
Total of Theory							18	18
B. PRACTICAL								
1	C-15	BEEC691	Power system-II laboratory	0	0	2	2	1
2	S-2	BEES691	Microprocessor & microcontroller laboratory	0	0	2	2	1
3	C-16	BEEC692	Electrical & Electronic design laboratory	1	0	4	5	3
Total of Practical							9	5
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

4 th Year 7 th Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	S-5	BEES701	Analog and digital communication	3	0	0	3	3
2	D-4	BEED701A/ BEED701B/ BEED701C	Power Generation Economics / Advanced Power Electronics/ Battery Management System	3	0	0	3	3
3	G-4	BEEG701A/B EEG701B	Bigdata Analytics / Internet of Things	3	0	0	3	3
4	G-5	BEEG702A/ BEEG702B	Machine Learning/ Soft Computing	3	0	0	3	3
5	A-5	BTCSS704	Project Management and Entrepreneurship	3	0	0	3	3
Total of Theory							15	15
B. PRACTICAL								
1	S-5	BEES791	Analog and digital Communication laboratory	0	0	2	2	1
2	Project (Summer internship)	BEES781	Project stage-I	0	0	4	4	2
3	Project (Summer internship)	BEES782	Seminar	0	0	0	0	1
Total of Practical							6	4
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

4 th Year 8 th Semester								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	S-6	BEES801	Electric Drives	3	0	0	3	3
2	D-6	BEED801A/ BEED801B	Sensors and Transducers/ Fuzzy Control System	3	0	0	3	3
3	G-6	BEEG801A/ BEEG801B	E-Commerce and ERP/ Economic Policies in India	3	0	0	3	3
Total of Theory							9	9
B. PRACTICAL								
1	S-6	BEES891	Electric Drives Lab	0	0	2	2	1
2	Project (Summer Internship)	BEES881	Project stage-II	0	0	16	16	8
Total of Practical							18	9
C. SESSIONAL								
10								
11								
Total of Theory, Practical and Sessional								

Course Name: Chemistry-I	Duration: 6 Months
Course Code: BCHMC101	Contact:
Semester: 1st	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

1. To understand the nature electromagnetic radiation and quantum theory.
2. To understand the periodic law and significance of atomic no and electronic configuration as the basic for periodic classification.
3. To classify elements into a s,p,d and f blocks and learn their main characteristics.
4. To understand the concept of organic reactions mechanism.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** This course gives the student idea about the nature and purity of the crystal.
- CO2.** This course is very important for the student. This course gives student idea about the way a reaction proceeds and kinetics in details, specially for inorganic reaction.
- CO3.** This course is more related to biochemistry. This course gives the student idea about the effect of metal ions in living system and also with different drugs.

Course Content

Unit No	Module Name	Content	Hrs
1	Atomic and molecular structure	Schrodinger equation. Particle in a box solution and their applications for simple sample. Molecular orbitals of diatomic molecules (e.g.H ₂). 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.	12
2	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 characterisation techniques. Diffraction and scattering.	9
3	Intermolecular forces and potential energy surfaces	Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena.	5

4	Use of free energy in chemical equilibria	First and second laws of thermodynamics and 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 equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.	9
5	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	9
6	Stereochemistry	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	8
7	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.	8

Text Books:

1. Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
2. University chemistry, by B. H. Mahan

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Mathematics –IB	Duration: 6 months
Course Code: BMTMC101B	Contact:
Semester: 1st	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

1. Students will be able to understand and interpret the concepts of matrices, complex numbers, and differential calculus. Students will be able to compare and analyze the methods in matrices, complex numbers, and differential calculus.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Apply the concept and techniques of differential and integral calculus to determine curvature and evaluation of different types of improper integrals.
- CO2.** Understand the domain of applications of mean value theorems to engineering problems.
- CO3.** Learn different types of matrices, concept to frank, method so matrix in version and the applications. Understand linear spaces, its basis and dimension with corresponding applications in the field of computer science.

Course Content

Unit No	Module Name	Content	Hrs
1	Calculus (Integration)	Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma function sand their properties; Application so definite integrals to evaluate surface areas and volume so revolutions.	8
2	Calculus (Differentiation)	Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate form sand L Hospital's rule; Maxima and minima.	8
3	Matrices	Matrices, Vectors: addition and scalar multiplication, matrix multiplication; Linear systems of equations, linear Independence, rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gausse limination and Gauss-Jordan Elimination.	7
4	Vector Spaces	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.	9

5	Vector Spaces(Continued)	Eigen values, Eigenvectors, Symmetric, skew-symmetric, and Orthogonal Matrices, Diagonalization; Inner product spaces, orthogonalization.	Skew-Eigen bases. Gram-Schmidt	9
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Text Books:

1. Reena Garg, Engineering Mathematics-I, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

Reference Books:

1. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
3. S.K. Mapa, Higher Algebra: Abstract and Linear, Sarat Book House Pvt. Ltd.
4. Hoffman and Kunze: Linear algebra, PHI

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Basic Electrical Engineering	Duration: 6 months
Course Code: BEEC101	Contact:
Semester: 1st	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.

1. Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
2. To explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
3. Highlight the importance of transformers in transmission and distribution of electric power.

Course Outcome: On successful completion of the course, student will be able to Predict the behavior of any electrical and magnetic circuits.

CO1. Formulate and solve complex AC, Dc circuits.

CO2. Identify the type of electrical machine used for that particular application.

CO3. Realize the requirement of transformers in transmission and distribution of electric power and other applications.

CO4. Function on multi-disciplinary teams.

Course Content

Unit No	Module Name	Content	Hrs
1	DC Circuits	Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff 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.	9
2	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.	8
3	Transformers	Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.	7

4	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.	7
5	Power Converters	DC-DC buck and boost converters, duty ratio control. Single-phase and three- phase voltage source inverters; sinusoidal modulation.	9
6	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.	7

Text Books:

1. Ritu Sahdev, Basic Electrical Engineering, Khanna Book Publishing Co. (P) Ltd., Delhi.
2. D. P. Kothari and I. J. Nagrath, —Basic Electrical Engineering, Tata McGraw Hill, 2010.

Reference Books:

1. D. C. Kulshreshtha, —Basic Electrical Engineering, McGraw Hill, 2009.
2. L. S. Bobrow, —Fundamentals of Electrical Engineering, Oxford University Press, 2011.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-

Course Name: Chemistry-I Laboratory	Duration: 6 months
Course Code: BCHMC191	Contact:
Semester: 1st	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

1. To understand the nature electromagnetic radiation and quantum theory.
2. To understand the periodic law and significance of atomic no and electronic configuration as the basic for periodic classification.
3. To classify elements into a s,p,d and f blocks and learn their main characteristics.
4. To understand the concept of organic reactions mechanism.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** This course gives the student idea about the nature and purity of the crystal.
- CO2.** This course is very important for the student. This course gives student idea about the way a reaction proceeds and kinetics in details, specially for inorganic reaction.
- CO1.** This course is more related to biochemistry. This course gives the student idea about the effect of metal ions in living system and also with different drugs.

Choose 10 experiments from the following

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
3. Determination of dissolved oxygen present in a given water sample.
4. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)
5. Determination of surface tension and viscosity
6. Thin layer chromatography
7. Ion exchange column for removal of hardness of water
8. Determination of the rate constant of a reaction
9. Determination of cell constant and conductance of solutions
10. Potentiometry - determination of redox potentials and emfs
11. Saponification/acid value of an oil
12. Chemical analysis of a salt
13. Determination of the partition coefficient of a substance between two immiscible liquids
14. Adsorption of acetic acid by charcoal
15. Use of the capillary visco meters to the demonstrate of the is electric points
16. The pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

CO	PO1	PO2	PO3		PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2		-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Basic Electrical Engineering Laboratory	Duration: 6 months
Course Code: BEEC191	Contact:
Semester: 1st	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.

1. Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
2. To explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
3. Highlight the importance of transformers in transmission and distribution of electric power.

Course Outcome: On successful completion of the course, student will be able to Predict the behavior of any electrical and magnetic circuits.

- CO1.** Formulate and solve complex AC, Dc circuits.
CO2. Identify the type of electrical machine used for that particular application.
CO3. Realize the requirement of transformers in transmission and distribution of electric power and other applications. Function on multi-disciplinary teams.

Choose 10 experiments from the following

1. First activity: Introduction to basic safety precautions and mentioning of the do's and Don'ts. Noting down list of experiments to be performed, and instruction for writing the laboratory reports by the students. Group formation. Students are to be informed about the modalities of evaluation.
2. Introduction and uses of following instruments:
 - a) Voltmeter
 - b) Ammeter
 - c) Multimeter
 - d) Oscilloscope
3. Demonstration of real- life resistors, capacitors with color code, inductors and autotransformer.
4. Demonstration of cut-out sections of machines: DC machine, Induction machine, Synchronous machine.
5. Calibration of ammeter and Wattmeter.
6. Determination of steady state and transient response of R-L, R-C and R-L-C circuit to a step change in voltage.
7. Determination of steady state response of R-L and R-C and R-L-C circuit and calculation of impedance and power factor.
8. Determination of resonance frequency and quality factor of series and parallel R-L-C circuit.
9.
 - a) Open circuit and short circuit test of a single-phase transformer
 - b) Load test of the transformer and determination of efficiency and regulation

10. Demonstration of three phase transformer connections. Voltage and current relationship, phase shifts between the primary and secondary side.
11. Measurement of power in a three-phase unbalanced circuit by two wattmeter method.
12. Determination of Torque –Speed characteristics of separately excited DC motor.
13. Determination of Torque speed characteristics and observation of direction reversal by change of phase sequence of connection of Induction motor.
14. Determination of operating characteristics of Synchronous generator.
15. Demonstration of operation of (a) DC-DC converter (b) DC-AC converter (c) DC-AC converter for speed control of an Induction motor
16. Demonstration of components of LT switchgear.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Engineering Graphics & Design	Duration: 6 months
Course Code: BCES181	Contact:
Semester: 1st	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.

1. To learn detailed drawing and modeling of a system, component, or process which meets desired needs within realistic constraints.
2. To help students with the use of the techniques, skills, and modern engineering tools and communicate effectively.

Course Outcome: On successful completion of the course, student will be able to Predict the behavior of any electrical and magnetic circuits.

- CO1.** Get introduced with Engineering Graphics and visual aspects of design..
- CO2.** Know and use common drafting tools with the knowledge of drafting standards.
- CO3.** Apply computer aided drafting techniques to represent line, surface or solid models in different engineering viewpoints.
- CO4.** Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.

Choose 10 experiments from the following

1. Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.
2. Lettering, Dimensioning, Scales: Plain scale, Diagonal scale and Vernier Scales.
3. Geometrical Construction and Curves: Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archimedean Spiral.
4. Projection of Points, Lines, Surfaces: Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes - Auxiliary Planes.
5. Projection of Regular Solids: Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).
6. Combination of Regular Solids, Floor Plans: Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.
7. Isometric Projections: 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.
8. Sections and Sectional Views of Right Angular Solids: 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)
9. Overview of Computer Graphics, Customisation & CAD Drawing: 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, Crosshairs, 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]; 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 tolerancing; 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

10. Annotations, Layering & Other Functions: applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, 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, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling.
11. Demonstration of A Simple Team Design Project: 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 tolerancing; Use of solid- modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Following is the list of drawing instruments that required for making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter/ Set-squares (45° – 45° & 60° – 90°), T-square
3. Protractor (180° , 360°)
3. Scales (Plain, Diagonal)
4. Compass (Small and Large)
5. Divider (Small and Large)
6. French Curves
7. Drawing paper (A1 Size)
8. Drawing pencil (H, HB, B)
9. Sharpener
10. Eraser
11. Drawing pins & clips
12. Duster or handkerchief etc.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-

Course Name: Physics-I	Duration: 6 Months
Course Code: BPHY201	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites:

1. Basic Science
2. Mathematics

Course Objective: The purpose of this course is to provide...

1. To develop the capability of the students for understanding fundamental aspects of physics.
2. To give students theoretical background, the key prerequisite for performing laboratory experiments.
3. To build up the foundations for further studies in physics and engineering.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Understand the basics of vector calculus, its application in mechanics, and different harmonic motions.
- CO2.** Acquire the knowledge of physical optics and related application.
- CO3.** Develop the basic concepts of electromagnetic theory and em wave.
- CO4.** Gather the fundamental knowledge of basic quantum mechanics and statistical mechanics.
- CO5.** Acquire the basic information about LASER and fibre optics.
- CO6.** Develop the qualitative idea of solid state physics.

Course Content

Unit No	Module Name	Content	Hrs
1	Mechanics	Problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Potential energy function $F = -\text{grad } V$, equipotential surfaces and meaning of gradient. Conservative and non-conservative forces. Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonic oscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D. Angular velocity vector. Moment of inertia.	12
2	Optics	Distinction between interference and diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits (only the expressions for max; min, & intensity and qualitative discussion of fringes); diffraction grating(resolution formulac only), characteristics of diffraction grating and its applications. Polarisation: Introduction, polarisation by reflection, polarisation by double reflection, scattering of light, circular and elliptical polarisation, optical activity.	12

		Lasers: Principles and working of laser: population inversion, pumping, various modes, threshold population inversion with examples.	
3	Electromagnetism and Dielectric Magnetic Properties of Materials	Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius- Mossotti equation(expression only), applications of dielectrics. Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.	12
4	Quantum Mechanics	Introduction to quantum physics, black body radiation, explanation using the photon concept, Compton effect, de Broglie hypothesis, wave- particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.	12
5	Statistical Mechanics:	Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics.	12

Text Books:

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley

Reference Books:

1. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
2. Engineering Mechanics (In SI Units) (SIE), S. Timoshenko, D.H. Young,

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Mathematics –IIB	Duration: 6 Months
Course Code: BMTMC201B	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites:

1. Basic Science
2. Mathematics

Course Objective: The purpose of this course is to provide...

1. To help the student to understand basic concept of abstract and vector algebra with its uses in engineering science.
2. To give emphasis about concepts of differential calculus and enable students to apply these topics in real life problems.
3. To give the students a perspective to learn integral calculus and its importance in advanced study in engineering science.
4. To enable students acquire fundamental concept of ordinary differential equation and its applications in engineering science.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Learn the methods for evaluating multiple integrals and their applications to different physical problems.
- CO2.** Understand different techniques to solve first and second order ordinary differential equations with its formulation to address the modelling of systems and problems of engineering sciences.
- CO3.** Learn different tools of differentiation and integration of functions of a complex variable that are used with various other techniques for solving engineering problems.
- CO4.** Apply different types of transformations between two 2- dimensional planes for analysis of physical or engineering problems.

Course Content

Un it No	Module Name	Content	Hrs
1	Multivariate Calculus (Integration)	Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to Polar), Applications: Areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Orthogonal curve linear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.	11
2	First order ordinary differential equations	Exact, linear and Bernoulli's equations, Equations no to first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.	5
3	Ordinary differential equations of higher orders	Second order linear differential equations with constant coefficients, Use of D-operators, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.	9

4	Complex Variable– Differentiation	Differentiation of complex functions, Cauchy Riemann equations, Analytic functions, Harmonic functions, determination of harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithmic) and their properties; Conformal mappings, Mobius transformations and their properties.	6
5	Complex Variable– Integration	Contour integrals, Cauchy- Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville’s theorem and Maximum- Modulus theorem (without proof); Taylor’s series, Zeros of analytic functions, Singularities, Laurent’s series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	9

Text Books:

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

Reference Books:

1. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cengage Learning.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
3. E.L. Ince, Ordinary Differential Equations, Dover Publications.
4. J.W. Brown and R.V. Churchill, Complex Variables and Applications, Mc-Graw Hill.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-

Course Name: Programming for Problem Solving	Duration: 6 Months
Course Code: BTCSC201	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites:

Mathematics

Course Objective: The purpose of this course is to provide...

1. To understand the nature of programming as human activity.
2. To give emphasis about concepts of differential calculus and enable students to apply these topics in real life problems.
3. To practice the programming construct to solve multi-dimensional problems.
4. To relate and implement mathematical concepts through programming in order to solve computational problems.
5. To enable students to acquire structure and written expression required for their profession.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Define basics concepts of programming structure and implement the basics concepts of Programming.
- CO2.** Solve and execute various problems using programming language and select the best solution.
- CO3.** Implement modularized solution and design such programs to appraise the solution.
- CO4.** Understand the basic usage of memory and construct such memory interms of array in a program.
- CO5.** Students will also be able to define user defined data types using structure and Union. Create and manipulate permanent storage access through File Handling.
- CO6.** Define and construct different data structures for various collection of data.

Course Content

Unit No	Module Name	Content	Hrs
1	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/Pseudocode 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	8
2	Arithmetic expressions and precedence		3
3		Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops	3
4	Arrays	Arrays (1-D, 2-D), Character arrays and Strings	6
5	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 required)	6
6	Function	Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.	5

7	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.	6
8	Structures	Structures, Defining structures and Array of Structures	2
9	Pointers	Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)	3
10	File handling	File handling (only if time is available, otherwise should be done as part of the lab)	3

Text Books:

1. R. S. Salaria, Computer Concepts and Programming in C, Khanna Publishers
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

Reference Books:

1. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Communicative English	Duration: 6 months
Course Code: HU201	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites:

Course Objective: The purpose of this course is to provide...

1. To know the importance and techniques of communication skills in order to improve professional skills
2. To enhance the knowledge of the students on vocabulary, syntax, and grammatical skills
3. To improve writing skills by applying writing techniques, tools in practice sessions
4. To achieve an overall enhancement in terms of reading, listening and speaking

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Define basics concepts of programming structure and implement the basics concepts of Programming.
- CO2.** Solve and execute various problems using programming language and select the best solution.
- CO3.** Implement modularized solution and design such programs to appraise the solution.
- CO4.** Understand the basic usage of memory and construct such memory interms of array in a program.
- CO5.** Students will also be able to define user defined data types using structure and Union. Create and manipulate permanent storage access through File Handling.
- CO6.** Define and construct different data structures for various collection of data.

Course Content

Unit No	Module Name	Content	Hrs
1	Vocabulary Building	The concept of Word Formation: Compounding, Backformation, Clipping, Blending. Root words from foreign languages and their use in English Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.	9
2	Basic Writing Skills	Sentence Structures & Types: Simple, Compound, Complex Use of phrases and clauses in sentences: Transformation of sentences, active, passive, narration Importance of proper punctuation Creating coherence: Arranging paragraphs & Sentences in logical order Creating Cohesion: Organizing principles of paragraphs in documents Techniques for writing precisely	9

3	Identifying Common Errors in Writing	Subject-verb agreement Noun-pronoun agreement Misplaced modifiers Articles Prepositions Redundancies Clichés	9
4	Nature and Style of sensible Writing	Describing Defining Classifying Providing examples or evidence Writing introduction and conclusion	9
5	Writing Practices	Comprehension Précis Writing Essay Writing Business Letter, Cover Letter & CV; E-mail	9

Addendum

Some examples of English words with foreign roots

Greek Root/Affix	Examples
Anti	Antisocial, antiseptic
Auto	Automatic, autograph
Anthropos	Anthropology, philanthropy
Bio	Biography
Chronos	Time
Di	Dilemma
Bio	Biology
Biblio	Bibliography
Chron	Chronology
Cracy	Contradiction
Geo	Geology
Hyper	Hyperactive
Mania	Kleptomania
Mega	Megaserial
Eu	Eulogy, euphoria
Geo	Geology
Graph	autograph, photograph
Hetero	Heterogeneous
Hyper	Hyperactive
Hypo	hypodermic, hypoglycemia
Macro	Macrocosm
Mega	megalomania
Micro	Microcosm
Mono	Monarch
Pan	Panorama

Pathos	Pathetic
Phobia	Hydrophobia
Pod (Gk), ped (Latin)	Pseudopodia
Poly	polyglot
Tele	Telephone
Theo	Theology, theist

Latin Root	Examples
Aud	Audible
Bene	Beneficial
Brev	abbreviate, brief
Circum	Circulate
Contra	Contradict
Cred	Credible
Dict Femina	Diction Feminine
Inter	Internet, interval
Magna	Magnificent
Mal Multi	Malnutrition multinational
Nova	Novel
Multi	Multiple, multiplex
Non	Nonstop
Pre	Previous, predicate
Re	Redo, rewind
Scrib	Scripture
Spect	Spectator
Trans	Transport
Uni	Unity
Omni	Omnipotent
Semi	Semicircle
Sub	Subway
Somnus	Insomnia,
Super	Superman
Sym	Sympathy
Scribe	Describe, scribble(write illegibly), inscribe
Trans	Transform
Un	Unnecessary
Uni	Universal

Text Books:

1. Kulbushan Kumar, R S Salaria, Effective Communication Skills, Khanna Publishing House, Delhi.
2. Practical English Usage. Michael Swan. OUP. 1995.

Reference Books:

1. Remedial English Grammar. F.T. Wood. Macmillan.2007
2. On Writing Well. William Zinsser. Harper Resource Book. 2001 Hall of India

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Physics -I Laboratory	Duration: 6 months
Course Code: BPHY291	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

1. To develop the capability of the students for understanding fundamental aspects of physics.
2. To give students theoretical background, the key prerequisite for performing laboratory experiments.
3. To build up the foundations for further studies in physics and engineering.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Understand the basics of vector calculus, its application in mechanics, and different harmonic motions.
- CO2.** Acquire the knowledge of physical optics and related application.
- CO3.** Develop the basic concepts of electromagnetic theory and em wave.
- CO4.** Gather the fundamental knowledge of basic quantum mechanics and statistical mechanics.
- CO5.** Acquire the basic information about LASER and fibre optics.
- CO6.** Develop the qualitative idea of solid state physics.

Experiments

Experiments in Optics

1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton's ring
3. Determination of wavelength of a monochromatic light by Fresnel's bi-prism
4. Determination of wavelength of the given laser source by diffraction method

Electricity & Magnetism experiments

1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.
5. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.
6. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
7. Determination of unknown resistance using Carey Foster's bridge
8. Study of Transient Response in LR, RC and LCR circuits using expeyes
9. Generating sound from electrical energy using expeyes

Experiments in Quantum Physics

1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

Miscellaneous experiments

1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure
2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5. To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseulle's capillary flow method

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Programming for Problem Solving	Duration: 6 months
Course Code: BTCSC291	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites: Basic Science

Course Objective: The purpose of this course is to provide...

1. To understand the nature of programming as human activity.
2. To give emphasis about concepts of differential calculus and enable students to apply these topics in real life problems.
3. To practice the programming construct to solve multi-dimensional problems.
4. To relate and implement mathematical concepts through programming in order to solve computational problems.
5. To enable students to acquire structure and written expression required for their profession.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Define basics concepts of programming structure and implement the basics concepts of Programming.
- CO2.** Solve and execute various problems using programming language and select the best solution.
- CO3.** Implement modularized solution and design such programs to appraise the solution.
- CO4.** Understand the basic usage of memory and construct such memory interms of array in a program.
- CO5.** Students will also be able to define user defined data types using structure and Union. Create and manipulate permanent storage access through File Handling.
- CO6.** Define and construct different data structures for various collection of data.

Experiments

Tutorial 1: Problem solving using computers:

Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:

Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:

Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:

Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:

Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings

Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:

Lab 7: Simple functions

Tutorial 8 & 9: Numerical methods (Root finding, numerical differentiation, numerical integration):

Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls

Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation Lab

11: Pointers and structures

Tutorial 12: File handling Lab

12: File operations

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Workshop/Manufacturing Practices	Duration: 6 months
Course Code: BMES281	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites: Basic Science

Course Outcome: After completion of this course, the learners will be able to

- CO1.** Demonstrate the basic operations in pattern and mould making
- CO2.** Perform different metal fitting works
- CO3.** Perform basic forging and welding works
- CO4.** Understand the operations of machine tools
- CO5.** Select the appropriate tools required for specific operation
- CO6.** Comprehend the safety measures required to be taken while using the tools

Experiments

Module 1 [15H]

i) Lectures & videos:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical & Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

Module 2 [45H]

ii) Workshop Practice:

- Machine shop

Typical jobs that may be made in this practice module:

1. To make a pin from a mild steel rod in a lathe.
2. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

- Fitting shop

Typical jobs that may be made in this practice module:

1. To make a Gauge from MS plate.

- Carpentry

Typical jobs that may be made in this practice module:

1. To make wooden joints and/or a pattern or like.

- Welding shop (Arc welding + gas welding) Typical jobs that may be made in this practice module:

1. ARC WELDING: To join two thick (approx 6mm) MS plates by manual metal arc welding.

2. GAS WELDING: To join two thin mild steel plates or sheets by gas welding.

- Casting

Typical jobs that may be made in this practice module:

1. One/ two green sand moulds to prepare, and a casting be demonstrated.

- Smithy

Typical jobs that may be made in this practice module:

1. A simple job of making a square rod from a round bar or like.

- Plastic moulding & Glass cutting

Typical jobs that may be made in this practice module:

1. For plastic moulding, making at least one simple plastic component should be made.

2. For glass cutting, three rectangular glass pieces may be cut to make a kaleidoscope using a black colour diamond cutter, or similar other components may be made.

- Electrical & Electronics

1. Familiarization with LT switchgear elements, making its sketches and noting down its specification. Kitkat fuse, Glass cartridge fuse, Plastic fuse holders (optional), Iron clad isolators, MCB style isolators, Single phase MCB, Single-phase wire, wiring cable.

2. Demonstration of domestic wiring involving two MCB, two piano key switches, one incandescent lamp, one LED lamp and plug point.

3. Simple wiring exercise to be executed to understand the basic electrical circuit. Simple soldering exercises to be executed to understand the basic process of soldering.

4. Fabrication of a single-phase full wave rectifier with a step down transformer using four diodes and electrolytic capacitor and to find its volt-ampere characteristics to understand basic electronic circuit fabrication.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Language Laboratory	Duration: 6 months
Course Code: HU291	Contact:
Semester: 2nd	Credit: 4+1

Prerequisites: Basic Science

Course Outcome: After completion of this course, the learners will be able to

- CO1.** Demonstrate the basic operations in pattern and mould making
- CO2.** Perform different metal fitting works
- CO3.** Perform basic forging and welding works
- CO4.** Understand the operations of machine tools
- CO5.** Select the appropriate tools required for specific operation
- CO6.** Comprehend the safety measures required to be taken while using the tools

Experiments

1. Honing _Listening Skill‘ and its sub skills through Language Lab Audio device;
2. Honing _Speaking Skill‘ and its sub skills
3. Helping them master Linguistic/Paralinguistic features (Pronunciation/Phonetics/
4. Voice modulation/ Stress/ Intonation/ Pitch &Accent) of connected speech
5. Honing _Conversation Skill‘ using Language Lab Audio –Visual input; Conversational Practice Sessions (Face to Face / via Telephone, Mobile phone & Role Play Mode)
6. Introducing _Group Discussion‘ through audio –Visual input and acquainting them with key strategies for success
7. G D Practice Sessions for helping them internalize basic Principles (turn- taking, creative intervention, by using correct body language, courtesies & other soft skills) of GD
8. Honing _Reading Skills‘ and its sub skills using Visual / Graphics/ Diagrams /Chart Display/Technical/Non Technical Passages, Learning Global / Contextual / Inferential Comprehension;
9. Honing _Writing Skill‘ and its sub skills by using Language Lab Audio –Visual input; Practice Sessions

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: ELECTRIC CIRCUIT THEORY	Duration: 6 Months
Course Code: BEEC301	Contact:
Semester: 3rd	Credit: 4+1

Prerequisites:

1. Basic Electrical Engineering
2. Mathematics

Course Objective: The purpose of this course is to provide...

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analyzing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks..
4. To solve problems of electrical circuits.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** describe different type of networks, sources and signals with examples.
CO2. explain different network theorems, coupled circuit and tools for solution of networks.
CO3. apply network theorems and different tools to solve network problems.
CO4. select suitable techniques of network analysis for efficient solution.
CO5. estimate parameters of two-port networks.
CO6. design filter circuits.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Continuous & Discrete, Fixed & Time varying, Linear and Nonlinear, Lumped and Distributed, Passive and Active networks and systems. Independent & Dependent sources, Step, Ramp, Impulse, Sinusoidal, Square, Saw tooth signals	8
2	Graph theory and Networks equations	Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials. Duality, Solution of Problems	4
3	Coupled circuits	Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Solution of problems.	3
4	Laplace transforms	Impulse, Step & Sinusoidal response of RL, RC, and RLC circuits. Transient analysis of different electrical circuits with and without initial conditions. Concept of Convolution theorem and its application. Solution of Problems with DC & AC sources.	8
5	Fourier method of waveform analysis	Fourier series and Fourier Transform (in continuous domain only). Application in circuit analysis, Solution of Problems	6
6	Network Theorems	Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis. Network theorem: Superposition, Thevenin's, Norton's & Maximum power transfer theorem. Millman's theorem and its application in three phase unbalanced circuit analysis. Solution of Problems with DC& AC sources.	8
7	Two port networks analysis	Open circuit Impedance & Short circuit Admittance parameter, Transmission parameters, Hybrid parameters	4

		and their inter relations. Driving point impedance & Admittance. Solution of Problems	
8	Filter Circuits	Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier. Solution of Problems	4

Text Books:

1. Networks & Systems, Ashfaq Husain, Khanna Book Publishing, New Delhi
2. Networks and Systems, D. Roy Chowdhury, New Age International Publishers
3. Network Analysis and Synthesis, C.L. Wadhwa, New Age International Publishers
4. Circuit and Networks: Analysis and synthesis, A. Sudhakar & S.S. Palli 4th edition. Tata Mc Graw Hill Education Pvt. Ltd.
5. Circuit theory, Dr. Abhijit Chakrabarty, Dhanpat Rai & Co Pvt. Ltd.

Reference Books:

1. Network Analysis, M.E. Valkenburg, Pearson Education .
2. Fundamental of Electric circuit theory, D. Chattopadhyay & P.C. Rakshit, S. Chand
3. Engineering Circuit Analysis, W.H. Hyat, J.E. Kemmerly & S.M. Durbin, The Mc Graw Hill Company.
4. Problems and Solutions of Electric Circuit Analysis, R.K. Mehta & A.K. Mal, CBS, New Delhi

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Electric circuit theory Lab	Duration: 6 months
Course Code: BEEC391	Contact:
Semester: 3rd	Credit: 1

Prerequisites: Basic Science

- Course Outcome:** After completion of this course, the learners will be able to determine
- CO1.** transient response of different electrical circuit, parameters of two port network, frequency response of filters. Laplace transform and inverse Laplace transform
- CO2.** Generate different signals in both discrete and analog form
- CO3.** Analyze amplitude and phase spectrum of different signals.
- CO4.** Verify network theorems.
- CO5.** Construct circuits with appropriate instruments and safety precautions.
- CO6.** Simulate electrical circuit experiments using suitable software.

Laboratory experiments

1. Transient response of R-L and R-C network: simulation with software & hardware
2. Transient response of R-L-C series and parallel circuit: simulation with software & hardware
3. Determination of Impedance (Z) and Admittance (Y) parameter of two-port network: simulation & hardware.
4. Frequency response of LP and HP filters: simulation & hardware.
5. Frequency response of BP and BR filters: simulation & hardware.
6. Generation of Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, Ramp signal using MATLAB in both discrete and analog form.
7. Determination of Laplace transform and Inverse Laplace transform using MATLAB.
8. Amplitude and Phase spectrum analysis of different signals using MATLAB.
9. Verification of Network theorems using software & hardware

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: ANALOG ELECTRONICS	Duration: 6 Months
Course Code: BEEC302	Contact:
Semester: 3rd	Credit: 3+1

Prerequisites:

Physics (10+2)

Course Objective: The purpose of this course is to provide...

1. To understand the structure and properties of different components of analog electronics.
2. To explain principle of operation of analog electronics components and circuits.
3. To understand the application of operational amplifier
4. To solve problems of analog electronic components and circuits
5. To analyze amplifiers, oscillators and other analog electronic circuits.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** describe analog electronic components and analog electronics circuits
- CO2.** explain principle of operation of analog electronic components, filters, regulators and analog electronic circuits.
- CO3.** compute parameters and operating points of analog electronic circuits.
- CO4.** determine response of analog electronic circuits.
- CO5.** distinguish different types amplifier and different types oscillators based on application.
- CO6.** construct operational amplifier based circuits for different applications.

Course Content

Unit No	Module Name	Content	Hrs
1	Filters & Regulators	Review of half wave and full wave rectifier, Capacitor filters, π -section filter, ripple factor, series and shunt voltage regulator, percentage regulation.	4
2	BJT circuits	Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits	8
3	MOSFET circuits	MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.	8
4	Feed back amplifier & Oscillators	Concept of Feed back, Negative & Positive feedback, Voltage/Current, Series/Shunt feedback, Barkhausen criterion, Colpitts, Hartley's, Phase shift, Wien bridge, & Crystal oscillators.	5
5	Operational amplifier	Ideal OPAMP, Differential amplifier, Constant current source (Current mirror etc), Level shifter, CMRR, Open & closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers, Voltage follower/Buffer circuits.	5
6	Application of Operational amplifiers	Adder, Integrator & Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Log & Antilog amplifier, Trans-conductance	5

		multiplier, Precision rectifier, Voltage to current & Current to voltage converter.	
7	Power amplifier	Class A, B, AB, C, Conversion efficiency	2
8	Multivibrator	Monostable, Bistable multivibrator, Monostable & Astable operation using 555 timer.	2
9	Special function circuits	VCO & PLL	2

Text Books:

1. Malvino—Electronic Principles , 6/e ,TMH
2. Nagrath, Electronics: Analog and Digital, PHI, 2004
3. Mottershed, Electronics Devices & Circuits, Wiley Eastern
4. Millman & Halkias – Integrated Electronics, Tata McGraw Hill.
5. Gayakwad R.A -- OpAmps and Linear IC's, 4/e, Pearson-PHI
6. Franco—Design with Operational Amplifiers & Analog Integrated Circuits , 3/e,TMH
7. Coughlin and Drisscol – Operational Amplifier and Linear Integrated Circuits – Pearson Education Asia.
8. A.K. Maini, Analog Electronics, Khanna Publishing House, 2019
9. L.K. Maheswari, Analog Electronics, Laxmi Publications

Reference Books:

1. Nagchoudhuri , Microelectronic Devices, 1/e, Pearson Education, 2001
2. Natarajan, Microelectronics: Analysis & Design, 1/e 2005, TMH
3. Maheshwari and Anand , Analog Electronics, PHI
4. Boyle'stead , Nashelsky: & Kishore, Electronic Devices & Circuit theory, 1/e, PHI/Pearson.
5. Millman & Halkias: Basic Electronic Principles; TMH.
6. Tobey & Grame – Operational Amplifier: Design and Applications, Mc Graw Hill.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: Analog electronic laboratory	Duration: 6 months
Course Code: BEEC392	Contact:
Semester: 3rd	Credit: 1

Prerequisites: Basic Science

Course Outcome: After completion of this course, the learners will be able to determine

CO1.

- i. characteristics of full wave rectifier with filter and without filter
- ii. characteristics of BJT and FET
- iii. characteristics of Zener diode as voltage regulator
- iv. characteristics of class A, C and push pull amplifiers

CO2. verify function of DAC and ADC

CO3. construct

- i. function generator using IC
- ii. R-C coupled amplifier
- iii. linear voltage regulator using regulator IC chip.
- iv. timer circuit using 555 for monostable, astable and multistable multivibrator.
- v. V to I and I to V converter with Op amps.
- vi. phase locked loop using Voltage Controlled Oscillator (VCO)

CO4. work in a team

CO5. validate theoretical learning with practical

CO6. Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Laboratory experiments

1. Study of ripple and regulation characteristics of full wave rectifier with and without capacitor filter.
2. Study of Zener diode as voltage regulator.
3. Study of characteristics curves of B.J.T & F.E.T .
4. Construction of a two-stage R-C coupled amplifier & study of it's gain & Bandwidth.
5. Study of class A, C & Push-Pull amplifiers.
6. Study of timer circuit using NE555 & configuration for monostable & astable and bistable multivibrator
7. Study of Switched Mode Power Supply & construction of a linear voltage regulator using regulator IC chip
8. Construction of a simple function generator using IC.
9. Realization of a V-to-I & I-to-V converter using Op-Amps.
10. Realization of a Phase Locked Loop using Voltage Controlled Oscillator (VCO).
11. Study of D.A.C & A.D.C.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: ELECTRO MAGNETIC FIELD THEORY	Duration: 6 Months
Course Code: BEEC303	Contact:
Semester: 3rd	Credit: 3

Prerequisites:

1. Basic Electrical Engineering
2. Mathematics
3. Physics

Course Objective: The purpose of this course is to provide...

1. To understand the basic mathematical tools to deal with Electromagnetic field Problem.
2. To understand properties and application of Electric and magnetic field.
3. To analyze electromagnetic wave propagation
4. To solve problem related to Electromagnetic field.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** relate different coordinate systems for efficient solution of electromagnetic problems.
- CO2.** describe mathematical s tools to solve electromagnetic problems.
- CO3.** explain laws applied to electromagnetic field.
- CO4.** apply mathematical tools and laws to solve electromagnetic problems.
- CO5.** analyze electromagnetic wave propagation
- CO6.** estimate transmission line parameters

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Co-ordinate systems and transformation, Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems	4
2	Introduction to Vector calculus	DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields, Helmholtz's theorem. Solution of problems	4
3	Electrostatic field	Coulomb's law, field intensity, Gauss's law, Electric potential and Potential gradient, Relation between E and V, an Electric dipole and flux lines. Energy density in electrostatic field. Boundary conditions: Dielectric-dielectric, Conductor –dielectric, Conductor-free space. Poisson's and Laplace's equation, General procedure for solving Poisson's and Laplace's equation. Solution of problems	8
4	Magneto static fields	Biot- savart law, Ampere's circuit law, Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Magnetic torque and moments, Magnetisation in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy, Force on magnetic material. Solution of problems	8

5	Electromagnetic fields	Faraday's law, Transformer and motional emf, Displacement current, Maxwell's equations, Time varying Potential, Time harmonic fields. Solution of problems	6
6	Electromagnetic wave propagation	Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector, Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, Polarisation. Solution of problems	6
7	Transmission line	Concept of lump & distributed parameters, Line parameters, Transmission line equation & solutions, Physical significance of solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Solution of problems	4

Text Books:

1. Elements of Electromagnetic, Mathew N.O. Sadiku, 4th edition, Oxford university press.
2. Engineering Electromagnetic, W.H. Hyat & J.A. Buck, 7th Edition, TMH
3. Theory and problems of Electromagnetic, Edminister, 2nd Edition, TMH
4. Electromagnetic field theory fundamentals, Guru & Hizroglu, 2nd edition, Cambridge University

Reference Books:

1. relate different coordinate systems for efficient solution of electromagnetic problems.
2. describe mathematical tools to solve electromagnetic problems.
3. explain laws applied to electromagnetic field.
4. apply mathematical tools and laws to solve electromagnetic problems.
5. analyze electromagnetic wave propagation
6. estimate transmission line parameters

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	3	-	-	1	-	2	1	-	1	-	3	3

Course Name: ENGINEERING MECHANICS	Duration: 6 Months
Course Code: BEEC304	Contact:
Semester: 3rd	Credit: 3

Prerequisites:

1. Mathematics
2. Physics
- 3.

Course Objective: The purpose of this course is to provide...

1. To understand the basic mathematical tools to deal with the physical bodies.
2. To learn different mathematical techniques to analyze physical bodies.
3. To learn analysis techniques of rigid bodies.
4. To solve problem of general motion.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the co-ordinate system, principle of three dimensional rotation, kinematics and kinetics of rigid bodies.
- CO2.** elaborate the theory of general motion, bending moment, torsional motion and friction.
- CO3.** develop free body diagram of different arrangements.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction to vectors and tensors and co-ordinate systems	Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.	5
2	Three-dimensional Rotation	Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.	4
3	Kinematics of Rigid Body	Kinematics of rigid bodies: Definition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two- and three dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.	6
4	Kinetics of Rigid Bodies	Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Definition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.	5
5	Free Body Diagram (1 hour)	Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.	1
6	General Motion	Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.	9

7	Bending Moment	Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.	5
8	Torsional Motion	Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.	2
9	Friction	Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.	3

Text Books:

1. J. L. Meriam and L. G. Kraige, —Engineering Mechanics: Dynamics, Wiley, 2011.
2. M. F. Beatty, —Principles of Engineering Mechanics, Springer Science & Business Media, 1986.
3. Manoj K. Harbola, — Engineering Mechanics, Cengage Learning India Pvt. Ltd, 2018
4. D.S. Bedi & M.P. Poonia, —Engineering Mechanics, Khanna Publishing House, 2019
5. R.S. Khurmi, —Engineering Mechanics, S.Chand Publications
6. R.K. Bansal, —Engineering Mechanics, Laxmi Publications

Reference Books:

1. explain the co-ordinate system, principle of three dimensional rotation, kinematics and kinetics of rigid bodies.
2. elaborate the theory of general motion, bending moment, torsional motion and friction.
3. develop free body diagram of different arrangements.
4. solve problems with the application of theories and principle of motion , friction and rigid bodies.
5. analyze torsional motion and bending moment.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: MATHEMATICS-III	Duration: 6 Months
Course Code: BEEC305	Contact:
Semester: 3rd	Credit: 3

Prerequisites:

Mathematics (10+2)

Course Objective: The purpose of this course is to provide...

1. To understand Probability theory required an Electrical Engineer to apply in profession.
2. To understand numerical methods to solve engineering problem
3. To understand basics of Z transform to solve engineering problems.

Course Outcome: On successful completion of the course, student will be able to**CO1.** explain basics of probability theories, rules, distribution and properties of Z transform**CO2.** describe different methods of numerical analysis.**CO3.** solve numerical problems based on probability theories, numerical analysis and Z transform**CO4.** apply numerical methods to solve engineering problems.**CO5.** solve engineering problems using z transform and probability theory.**Course Content**

Unit No	Module Name	Content	Hrs
1	Probability	Basic Probability Theory: Classical definition and its limitations. Axiomatic definition. Some elementary deduction: i) $P(O)=0$, ii) $0 \leq P(A) \leq 1$, iii) $P(A^c)=1-P(A)$ etc. where the symbols have their usual meanings. Frequency interpretation of probability.	1
		Addition rule for 2 events (proof) & its extension to more than 2 events (statement only). Related problems. Conditional probability & Independent events. Extension to more than 2 events (pair wise & mutual independence). Multiplication Rule. Examples. Baye's theorem (statement only) and related problems.	3
		Random Variable & Probability Distributions. Expectation: Definition of random variable. Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties (without proof). Examples. Definitions of Expectation & Variance, properties & examples.	2
		Some important discrete distributions: Binomial & Poisson distributions and related problems. Some important continuous distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson & Uniform distributions only.	2

2	Numerical Methods	Approximation in numerical computation: Truncation and Rounding errors, Fixed and floating-point arithmetic, Propagation of errors.	4
		Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.	5
		Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.	3
		Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method.	6
		Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton-Raphson method.	4
		Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method.	6
3	Z transform:	Sequence, Representation of sequence, Basic operations on sequences, Z-transforms, Properties of Z-transforms, Change of scale, Shifting property, Inverse Z-transform, Solution of difference equation, Region of convergence.	4

Text Books:

1. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.
2. C.Xavier: C Language and Numerical Methods.
3. Dutta & Jana: Introductory Numerical Analysis.
4. J.B.Scarborough: Numerical Mathematical Analysis.
5. Jain, Iyengar, & Jain: Numerical Methods (Problems and Solution).
6. Hwei P Hsu, —Signal and system, (Schaum's Outline Series), Mc Graw Hill education.

Reference Books:

1. Balagurusamy: Numerical Methods, Scitech.
2. R.S. Salaria: Numerical Methods, Khanna Publishing House.
3. S.S. Sashtry: Numerical Methods, PHI
4. Baburam: Numerical Methods, Pearson Education.
5. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
6. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
7. Srimanta Pal: Numerical Methods, OUP.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3

Course Name: NUMERICAL METHODS LABORATORY	Duration: 6 Months
Course Code: BEEC395	Contact:
Semester: 3rd	Credit: 1

Course Outcome: After completion of this course, the learners will be able to

CO1. solve

- i. problems with Newton forward /backward, Lagrange's interpolation
- ii. problems of numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule
- iii. problems to find numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
- iv. problems to find numerical solution of Algebraic Equation by Regular- falsi and Newton Raphson methods.
- v. ordinary differential equation by Euler's and Runge-Kutta methods.

CO2. find appropriate numerical methods to solve engineering problems.

CO3. use software package to solve numerical problems.

Laboratory experiments

1. Assignments on Newton forward /backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations
4. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
5. Assignments on ordinary differential equation: Euler's and Runge-Kutta methods.
6. Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: BIOLOGY FOR ENGINEERS	Duration: 6 Months
Course Code: BEEC306	Contact:
Semester: 3rd	Credit: 3

Prerequisites:

NIL

Course Objective: The purpose of this course is to provide

1. To introduce modern biology with an emphasis on evolution of biology as a multi- disciplinary field.
2. To make students aware of application of engineering principles in biology and engineering robust solution inspired by biological examples.

Course Outcome: On successful completion of the course, student will be able to**CO1.** describe with examples the biological observations lead to major discoveries.**CO2.** explain

- i. the classification of kingdom of life
- ii. the building blocks of life
- iii. different techniques of bio physics used to study biological phenomena.
- iv. the role of imaging in the screening, diagnosis, staging, and treatments of cancer.

CO3. identify DNA as a genetic material in the molecular basis of information transfer**CO4.** analyze biological processes at the reductionistic level.**CO5.** apply thermodynamic principles to biological systems.**CO6.** identify microorganisms.**Course Content**

Unit No	Module Name	Content	Hrs
1	Introduction	Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry	2

2	Classification	<p>Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification.</p> <p>Discuss classification based on (a) cellularity- Unicellular multicellular (b) ultrastructureprokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricotelic, ureotelic (e) Habitata- aquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus.</p>	3
3	Biomolecules	<p>Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine. Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.</p>	4
4	Macromolecular analysis	<p>Purpose: To analyze biological processes at the reductionistic level. Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.</p>	5
5	Metabolism	<p>Purpose: The fundamental principles of energy transactions are the same in physical and biological world.</p> <p>Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO₂ + H₂O (Glycolysis and Krebs cycle) and synthesis of glucose from CO₂ and H₂O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.</p>	4
6	Microbiology	<p>Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.</p>	3
7	Immunology	<p>Purpose: How does the immune system work? What are the molecular and cellular components and pathways that protect an organism from infectious agents or cancer? This comprehensive course answers these questions as it explores the cells and molecules of the immune system.</p> <p>Immunology- Self vs Non-self, pathogens, human immune system, antigen-antibody reactions.</p>	5

8	Information transfer	Purpose: The molecular basis of coding and decoding genetic information is universal. Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	4
9	Cancer Biology	Purpose: A basic understanding of cancer biology and treatment. The course is not designed for patients seeking treatment guidance – but it can help to understand how cancer develops and provides a framework for understanding cancer diagnosis and treatment. –cell Identification of the major types of cancer worldwide. Description of how genes contribute to the risk and growth of cancer. List and description of the ten cellular hallmarks of cancer. Definition of metastasis, and identification of the major steps in the metastatic process. Description of the role of imaging in the screening, diagnosis, staging, and treatments of cancer. Explanation of how cancer is treated.	5
10	Techniques in bio physics	Purpose: Biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. The techniques including microscopy, spectroscopy, electrophysiology, single-molecule methods and molecular modeling	3
11	Stem cell	Purpose: Stem cells and derived products offer great promise for new medical treatments. Learn about stem cell types, current and possible uses, ethical issues.	2

Text / Reference Books:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, —Biology: A global approach, Pearson Education Ltd, 2014.
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, —Outlines of Biochemistry, John Wiley and Sons, 2009.
3. D. L. Nelson and M. M. Cox, —Principles of Biochemistry, W.H. Freeman and Company, 2012.
4. G. S. Stent and R. Calendar, —Molecular Genetics, Freeman and company, 1978.
5. L. M. Prescott, J. P. Harley and C. A. Klein, —Microbiology, McGraw Hill Higher Education, 2005.
6. Lewis J. Kleinsmith. —Principles of cancer biology, Pearson, 2016

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	-	3	-	3	-	-	1	-		1	2	3

Course Name: INDIAN CONSTITUTION	Duration: 6 Months
Course Code: BEEC307	Contact:
Semester: 3rd	Credit: 0

Prerequisites:

NIL

Course Objective: The purpose of this course is to provide...

1. To have basic knowledge about Indian Constitution.
2. To understand the structure and functioning of union, state and local self-government.
3. To understand the structure, jurisdiction and function of Indian judiciary.

Course Outcome: On successful completion of the course, student will be able to**CO1.** describe

- a. different features of Indian constitution..
- b. power and functioning of Union, state and local self-government.
- c. structure, jurisdiction and function of Indian Judiciary.
- d. basics of PIL and guideline for admission of PIL.
- e. Functioning of local administration starting from block to Municipal Corporation.

CO2. identify authority to redress a problem in the profession and in the society.**Course Content**

Unit No	Module Name	Content	Hrs
1	Indian Constitution	Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy	5
2	Government and its administration	Union government and its administration: Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. State government and its administration: Governor: Role and Position, CM and Council of ministers, State Secretariat: Organisation, Structure and Functions.	10
3	Courts	Supreme court: Organization of supreme court, procedure of the court, independence of the court, jurisdiction and power of supreme court. High court: Organization of high court, procedure of the court, independence of the court, jurisdiction and power of supreme court. Subordinate courts: constitutional provision, structure and jurisdiction. National legal services authority, Lok adalats, family courts, gram nyayalays. Public interest litigation (PIL): meaning of PIL, features of PIL, scope of PIL, principle of PIL, guidelines for admitting PIL	10

4	Local Administration	District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.	10
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Text Books:

1. Indian polity, M, Laxmikanth, MC Graw Hill education, 5th Edition.

Reference Books:

1. DD Basu, — Introduction to the constitution of India, 21st Edition, Lexis Nexis Books Publication Ltd, India

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3

Course Name: ELECTRIC MACHINE-I	Duration: 6 Months
Course Code: BEEC401	Contact:
Semester: 4th	Credit: 3

Prerequisites:

1. Basic Electrical Engineering
2. Electric Circuit Theory
3. Electromagnetic Field Theory

Course Objective: The purpose of this course is to provide...

1. To review the concept of magnetic fields and magnetic circuits
2. To learn the principle of production of electromagnetic force and torque.
3. To learn the basic principle of operation of DC machine
4. To learn the principle of operation and characteristics of DC motor and generator
5. To learn the principle of operation, connections and different tests on Transformers
6. To acquire problem solving skills to solve problems of DC machines and Transformers

Course Outcome: On successful completion of the course, student will be able to

- CO1.** describe the function of different components of magnetic circuit, DC machines and transformers
- CO2.** explain the principle of operation of different types of DC machines and transformers
- CO3.** solve numerical problems of DC machines and transformers.
- CO4.** estimate the parameters and efficiency of transformer.
- CO5.** determine the characteristics of DC machines
- CO6.** recommend methods to control output of DC machines.

Course Content

Unit No	Module Name	Content	Hrs
1	Magnetic fields and magnetic circuits	Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; 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.	3
2	Electromagnetic force and torque	B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency	5

3	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.	8
4	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.	7
5	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.	12

Text Books:

1. Electrical Machines-I, P.S. Bimbhra, Khanna Publishing House (AICTE)
2. Electrical Machinery, P.S. Bimbhra, 7th Edition, Khanna Publishers
3. Electric machines, D.P. Kothari & I.J Nagrath, 3rd Edition, Tata Mc Graw-Hill Publishing Company Limited
4. Electrical Machines, P.K. Mukherjee & S. Chakrabarty, 2nd edition, Dhanpat Rai Publication.

Reference Books:

1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K. Srivastava, Cengage Learning
3. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition.
4. The performance and Design of Alternating Current Machines, M.G.Say, CBS Publishers &

Distributors.

5. Electric Machinery & transformer, Irving L Koskow, 2nd Edition, Prentice Hall India

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	-	3	-	3	-	-	1	-		1	2	3

Course Name: DIGITAL ELECTRONICS	Duration: 6 months
Course Code: BEEC402	Contact:
Semester: 4th	Credit: 3

Prerequisites:

Analog Electronics

Course Objective: The purpose of this course is to provide...

1. To learn the fundamentals of Digital systems and principle of operation of Logic families.
2. To learn the principle of operation of Combinational digital circuits.
3. To learn the principle of operation of sequential circuit and systems.
4. To learn the principle of operation of A/D and D/A converter
5. To learn the principle of operation of semiconductor memories and Programmable logic devices.
6. To acquire problem solving skills to solve problems of Digital circuits

Course Outcome: After completion of this course, the learners will be able to

- CO1.** describe the function of different building blocks of digital electronics, semiconductor memories and programmable logic devices.
- CO2.** explain the principle of operation of combinational and sequential digital circuits, A/D and D/A converter
- CO3.** solve numerical problems of Boolean algebra, number system, combinational & sequential digital circuits and A/D and D/A converter.
- CO4.** specify applications of combinational and sequential digital circuits.
- CO5.** determine specifications of different digital circuits.
- CO6.** design combinational and sequential digital circuits

Course Content

Unit No	Module Name	Content	Hrs
1	Fundamentals of Digital Systems and logic families	Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital ICs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.	7
2	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, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.	7

3	Sequential circuits and systems	A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flipflops, applications of flipflops, shift registers, applications of shift registers, serial to 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.	7
4	A/D and D/A Converters	Digital to analog converters: weighted resistor/converter, R-2R Ladder, D/A converter, specifications for D/A converters, examples of D/A converter, 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.	7
5	Semiconductor memories and Programmable logic devices	Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).	7

Text Books:

1. Digital Principles & Application, 5th Edition, Leach & Malvino, Mc Graw Hill Company.
2. Modern Digital Electronics, 4th Edition, R.P. Jain. Tata Mc Graw Hill Company Limited
3. Fundamental of Digital Circuits, A. Anand Kumar, 4th Edition, PHI.
4. Digital Electronics, R. Anand, Khanna Publishing House (2018).

Reference Books:

1. Digital Logic Design, Morris Mano, PHI.
2. Digital Integrated Electronics, H. Taub & D. Shilling, Mc Graw Hill Company.
3. Digital Electronics, James W. Bignell & Robert Donovan, Thomson Delman Learning.
4. Fundamental of logic Design, Charles H. Roth, Thomson Delman Learning.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	-	3	-	3	-	-	1	-		1	2	3

Course Name: ELECTRICAL & ELECTRONICS MEASUREMENTS	Duration: 6 Months
Course Code: BEEC403	Contact:
Semester: 4th	Credit: 3

Prerequisites:

1. Basic Electrical Engineering
2. Electric Circuit Theory

Course Objective: The purpose of this course is to provide...

1. To learn methods of measurement, errors in measurement and its classification.
2. To learn the principle of operation of analog and digital meters.
3. To learn the basic principle of operation of instrument transformers.
4. To learn the principle of operation of cathode ray oscilloscope and different sensors and transducers.
5. To learn the principle of measurement of power, energy and different electrical parameters
6. To acquire problem solving skills to solve problems on the topics studied.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the terms accuracy, precision, resolution, speed of response, errors in measurement, loading effect
- CO2.** describe methods of measurement of power, energy by instruments and resistance, capacitance and inductance by bridges and potentiometer
- CO3.** explain the principle of operation of analog meters, instrument transformer, digital multimeter, digital voltmeter, digital frequency meter, signal generator, strain gauge, LVDT and temperature transducers.
- CO4.** explain the different building block, principle of operation of oscilloscope and measurement techniques of voltage, current, frequency and phase by oscilloscope
- CO5.** solve numerical problems related to analog meters, instrument transformer, measurement of power, energy, resistance, inductance and capacitance
- CO6.** specify applications of analog and digital measuring instruments, sensors and transducers

Course Content

Unit No	Module Name	Content	Hrs
1	Measurements & Analog meters	<p>Measurements:</p> <ul style="list-style-type: none"> • Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments. <p>Analog meters:</p> <ul style="list-style-type: none"> • General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments, Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multipliers. 	7

2	Instrument transformer, Measurement of Power & Measurement of Energy	<p>Instrument transformer:</p> <ul style="list-style-type: none"> Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of Current & Potential transformer, errors. <p>Measurement of Power:</p> <ul style="list-style-type: none"> Principle of operation of Electrodynamic & Induction type wattmeter, Wattmeter errors <p>Measurement of Energy:</p> <ul style="list-style-type: none"> Construction, theory and application of AC energy meter, testing of energy meters. 	9
3	Measurement of resistance, Potentiometer & AC Bridges	<p>Measurement of resistance:</p> <ul style="list-style-type: none"> Measurement of medium, low and high resistances, Megger <p>Potentiometer:</p> <ul style="list-style-type: none"> Principle of operation and application of Crompton's DC potentiometer, Polar and Co-ordinate type AC potentiometer, applications <p>AC Bridges:</p> <ul style="list-style-type: none"> Measurement of Inductance, Capacitance and frequency by AC bridges 	8
4	Cathode ray oscilloscope (CRO) & Electronic Instruments	<p>Cathode ray oscilloscope (CRO):</p> <ul style="list-style-type: none"> Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO. <p>Electronic Instruments:</p> <ul style="list-style-type: none"> Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator, Digital Storage oscilloscope. 	7
5	Sensors & Transducers	<ul style="list-style-type: none"> Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Flow measurement using magnetic flow measurement. 	4

Text Books:

1. A course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, Dhanpat Rai & sons.
2. Electrical Measurement & Measuring Instruments, E.W. Golding & F.C. Wides, Wheeler Publishing
3. Sensors & Transducers, D. Patranabis, PHI, 2nd edition.

Reference Books:

1. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.
2. Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments, A.D. Heltric & W.C. Copper, Wheeler Publication
4. Instrument transducers, H.K.P. Neubert, Oxford University press.
5. All-in One Electronics Simplified, A.K. Maini, Khanna Book Publishing Co. (2018)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	-	3	-	3	-	-	1	-		1	2	3

Course Name: THERMAL POWER ENGINEERING	Duration: 6 months
Course Code: BEES401	Contact:
Semester: 4th	Credit: 3

Prerequisites: Mathematics

Course Objective: The purpose of this course is to provide...

1. To learn the principle of operation of different types of boilers and Turbines
2. To learn the principle of operation of IC engines and Gas turbines
3. To acquire problem solving skills to solve problems of boilers, turbines, IC engines and Gas Turbines.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** describe the function of different components of boilers. Engines and turbines
CO2. explain the principle of operation of different types of boilers, turbines, IC engines and Gas turbines.
CO3. solve numerical problems of boilers, turbines, IC engines and Gas turbines.
CO4. analyze the performance of boilers, engines and turbines.
CO5. determine efficiency of boilers, engines and turbines.
CO6. explain methods to control boiler, engines and turbines parameters.

Course Content

Unit No	Module Name	Content	Hrs
1	Boilers	Water Tube & Fire Tube boilers, Circulating Principles, Forced Circulation, Critical pressure, Superheaters, Reheaters, attemperators, induced draught, forced draught and secondary air Fans, Boiler performance analysis and heat balance. Combustion Systems, Environmental Protection – ESP, Cyclone Separator, Dust Collector etc.	12
2	Turbines	Rotary Thermodynamic devices – Steam turbines & their classifications – Impulse & Reaction type Turbines, Thermodynamics of compressible fluid-flow, equation and continuity – Isentropic flow through nozzles, velocity diagram, Blade efficiency, optimum velocity ratio, multi- staging, velocity & pressure compounding, losses in turbines, erosion of turbine blades, turbine governing, performance analysis of turbine, Condensing system.	12
3	IC Engines	IC Engines – classification, Analysis of a standard cycle, fuel characteristic of SI & CI Engine, Combustion, Engine performance Automotive Engine exhaust emission and their control	6
4	Gas Turbines	Gas turbine Analysis – Regeneration - Reheating, Isentropic efficiency Combustion efficiency	5

Text Books:

1. Engineering Thermodynamics, P.K. Nag, 6th Edition , Mc Graw Hill Education Pvt. Ltd
2. Power Plant Engineering, P K Nag, 4th Edition, Mc Graw Hill Education Pvt. Ltd
3. Thermal Engineering , P.S. Ballaney, 25th Edition, , Khanna publishers
4. Power Plant Engineering, Domkundwar, Arora, Dhanpat Rai & Co.

Reference Books:

1. Thermodynamics , Cengel , 6th Edition, Tata Mc Graw- Hill Education.
2. Power Plant Technology ,M M Ei-Wakil 1st Edition, Tata McGraw Hill
3. Heat and Thermodynamics, M W Zemansky & R.H.Dittman , 8th Edition, McGraw Hill

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3
6	-	3	-	3	-	-	1	-		1	2	3

Course Name: VALUES AND ETHICS IN PROFESSION	Duration: 6 Months
Course Code: BEEA401	Contact:
Semester: 4th	Credit: 3

Prerequisites:

NIL

Course Objective: The purpose of this course is to provide...

1. To inculcate Human values to grow as a responsible human beings with a proper personality.
2. To instill Professional Ethics to maintain ethical conduct and discharge professional duties.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** illustrate different aspects of human values, ethics, engineers' responsibility and duties
CO2. explain different principles, different theories and laws of engineering ethics and social experimentation
CO3. identify different factors in the light of Engineers' responsibility towards safety and risk
CO4. correlate ethics of different work environment.
CO5. explain the need for intellectual property rights.

Course Content

Unit No	Module Name	Content	Hrs
1	Human values	Morals, Values, and Ethics – Integrity –Trustworthiness – Work Ethics – Service-Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Value Time – Co-operation – Commitment – Empathy – Self-confidence – Spirituality-Character.	5
2	Principles for harmony	Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties – Aspirations and Harmony (I, We & Nature) – Gender Bias – Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness	5
3	Engineering ethics and social experimentation	History of Ethics – Need of Engineering Ethics – Senses of Engineering Ethics- Profession and Professionalism —Self Interest – Moral Autonomy – Utilitarianism – Virtue Theory – Uses of Ethical Theories – Deontology- Types of Inquiry – Kohlberg's Theory – Gilligan's Argument – Heinz's Dilemma – Comparison with Standard Experiments — Learning from the Past – Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law – Role of Codes – Codes and Experimental Nature of Engineering.	8
4	Engineers' responsibility towards safety and risk for sustainable development	The concept of Safety – Safety and Risk – Types of Risks – Voluntary v/s Involuntary Risk – Consequences – Risk Assessment –Accountability – Liability – Reversible Effects – Threshold Levels of Risk – Delayed v/s Immediate Risk – Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis-Accidents.	5

5	Engineers' duties and rights	Concept of Duty – Professional Duties – Collegiality – Techniques for Achieving Collegiality – Senses of Loyalty – Consensus and Controversy – Professional and Individual Rights – Confidential and Proprietary Information – Conflict of Interest-Ethical egoism – Collective Bargaining	7
		– Confidentiality – Gifts and Bribes – Problem solving- Occupational Crimes- Industrial Espionage- Price Fixing- Whistle Blowing.	
6	Global issues	Globalization and MNCs –Cross Culture Issues – Business Ethics – Media Ethics – Environmental Ethics – Endangering Lives – Bio Ethics – Computer Ethics – War Ethics – Research Ethics - Intellectual Property Rights.	5

Text Books:

1. Professional Ethics & Human Values, Premvir Kapoor, Khanna Publishing House, Delhi (AICTE Recommended Textbook).
2. A text book on professional Ethics & Human values, R.S. Naagarazan, New Age international Publishing.
3. Engineering Ethics, M. Govindarajan, S. Natarajan , V.S. Senthilkumar, Prentice Hall India.
4. Human value and professional Ethics, Jayshree Suresh, B.S. Raghvan, S. Chand Publishing

Reference Books:

1. Ethics in Science and Engineering, James G. Speight & Russel Foote, Wiley.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	2	3	2	3	-	-	-	-	1	1	2	3

Course Name: ENVIRONMENTAL SCIENCE	Duration: 6 Months
Course Code: BEEA402	Contact:
Semester: 4th	Credit: 0

Prerequisites:

Basic knowledge of science

Course Objective: The purpose of this course is to provide...

1. To understand the environment and its relationships with human activities
2. To be able to apply the fundamental knowledge of science and engineering to assess environmental and health risk
3. To understand environmental laws and regulations to develop guidelines and procedures for health and safety issues
4. To acquire the skill to solve problem related to environment and pollution

Course Outcome: On successful completion of the course, student will be able to

- CO1.** understand the natural environment and its relationships with human activities
CO2. apply the fundamental knowledge of science and engineering to assess environmental and health risk
CO3. develop guidelines and procedures for health and safety issues obeying the environmental laws and regulations
CO4. acquire skills for scientific problem-solving related to air, water, noise& land pollution.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	<p>Basic ideas of environment, basic concepts, man, society & environment, their interrelationship (1L)</p> <p>Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development (2L).</p> <p>Materials balance: Steady state conservation system, steady state system with non-conservative pollutants, step function (1L).</p> <p>Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering (2L)</p>	6

2	Elements of ecology	<p>System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem-components types and function (1L).</p> <p>Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web (2L)</p> <p>Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur] (1L)</p> <p>Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.(2L)</p>	6
3	Atmospheric Composition	<p>Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause (1L) Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.(1L)</p> <p>Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget.(1L)</p> <p>Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion).(2L) Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model.(2L) Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate,PAN (2L) Smog, Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green-house gases, effect of ozone modification. (1L) Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statment with brief reference). (1L)</p>	11

4	Hydrosphere, Hydrological cycle and Natural water	<p>Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L)</p> <p>River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L)</p> <p>Lake: Eutrophication [Definition, source and effect]. (1L)</p> <p>Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)(1L)</p> <p>Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. (2L)</p> <p>Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic (1L)</p>	9
5	Environmental impact assessment	<p>Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol. (3L)</p>	3

Text Books:

1. Environmental Studies, M.P. Poonia & S.C. Sharma, Khanna Publishing House
2. Introduction to Environmental Engineering and Science, G.M. Masters, Prentice-Hall of India Pvt. Ltd.,1991.

Reference Books:

1. Environmental Chemistry, A. De, New Age International
2. Text Book for Environmental Studies, Erach Bharucha, UGC
3. Elements of Environmental Pollution Control, O.P. Gupta, Khanna Publishing House (AICTE Recommended Book).

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-

Course Name: ELECTRIC MACHINE-I LABORATORY	Duration: 6 Months
Course Code: BEEA402	Contact:
Semester: 4th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1.** identify appropriate equipment and instruments for the experiment.
- CO2.** test the instrument for application to the experiment.
- CO3.** construct circuits with appropriate instruments and safety precautions
- CO4.** validate different characteristics of DC machine , methods of speed control of DC motor and parallel operation of the transformer
- CO5.** work effectively in a team

Laboratory experiments

1. Determination of the characteristics of a separately excited DC generator.
2. Determination of the characteristics of a DC motor
3. Study of methods of speed control of DC motor
4. Determination of the characteristics of a compound DC generator (short shunt)
5. Determination of speed of DC series motor as a function of load torque.
6. Polarity test on a single phase transformer
7. Determination of equivalent circuit of a single phase transformer and efficiency.
8. Study of different connections of three phase transformer.
9. Study of Parallel operation of a single phase transformers.
10. Determination of temperature rise and efficiency of the transformer.(Back to back test)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	-	3	-	-	-	-	-	1	1	-	3

Course Name: DIGITAL ELECTRONICS LABORATORY	Duration: 6 Months
Course Code: BEEC492	Contact:
Semester: 4th	Credit: 1

Course Outcome: After completion of this course, the learners will be able to

- CO1.** identify appropriate equipment and instruments for the experiment
- CO2.** test the instruments for application to the experiment
- CO3.** construct decoder , multiplexer, adder and subtractor circuits with appropriate instruments and precaution
- CO4.** realize RS-JK and D flip flop, universal register with gates, multiplexer and flip-flops and asynchronous and synchronous up down counters
- CO5.** validate the operation of code conversion circuit –BCD to Excess 3 & vice versa, 4 bit parity generator & comparator circuits,
- CO6.** work effectively in a team

Laboratory experiments

1. Realization of basic gates using Universal logic gates.
2. Code conversion circuits- BCD to Excess-3 & vice-versa.
3. 4-bit parity generator & comparator circuits.
4. Construction of simple Decoder & Multiplexer circuits using logic gates.
5. Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer.
6. Construction of simple arithmetic circuits-Adder, Subtractor.
7. Realization of RS-JK & D flip-flops using Universal logic gates.
8. Realization of Universal Register using JK flip-flops & logic gates.
9. Realization of Universal Register using multiplexer & flip-flops.
10. Construction of Adder circuit using Shift Register & full Adder.
11. Realization of Asynchronous Up/Down counter
12. Realization of Synchronous Up/Down counter
13. Design of Sequential Counter with irregular sequences.
14. Realization of Ring counter & Johnson's counter.
15. Familiarization with A/D and D/A circuits

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	-	3	-	-	-	-	-	1	1	-	3
6	-	2	-	1	-	2	1	-	1	-	3	3

Course Name: ELECTRICAL & ELECTRONICS MEASUREMENT LABORATORY	Duration: 6 Months
Course Code: BEEC493	Contact:
Semester: 4th	Credit: 3

Course Outcome: On successful completion of the course, student will be able to

- CO1.** identify appropriate equipment and instruments for the experiment
CO2. test the instrument for application to the experiment
CO3. construct circuits with appropriate instruments and safety precautions
 1. evaluate and adjust the precision and accuracy of AC energy meter, moving iron and dynamometer type ammeter, voltmeter and wattmeter by potentiometer
 2. measure voltage, current, power, energy, phase , frequency, resistance, inductance, capacitance
CO4. work effectively in a team

Laboratory experiments

1. Instrument workshop- Observe the construction of PMMC, Dynamometer, Electrothermal and Rectifier type of instruments, Oscilloscope and Digital multimeter.
2. Calibrate moving iron and electro-dynamometer type ammeter/voltmeter by potentiometer.
3. Calibrate dynamometer type wattmeter by potentiometer.
4. Calibrate AC energy meter.
5. Measurement of resistance using Kelvin double bridge.
6. Measurement of power using Instrument transformer.
7. Measurement of power in Polyphase circuits.
8. Measurement of frequency by Wien Bridge.
9. Measurement of Inductance by Anderson bridge
10. Measurement of capacitance by De Sauty Bridge.
11. Measurement of capacitance by Schering Bridge.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-

Course Name: THERMAL POWER ENGINEERING LABORATORY	Duration: 6 Months
Course Code: BEES491	Contact:
Semester: 4th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1.** identify appropriate equipment and instruments for the experiment
- CO2.** construct experimental setup with appropriate instruments and safety precautions
- CO3.** identify different parts of Lanchashire Boiler, Bahcock & Willcox Boiler, Cochran Boiler, Vertical Tubular Boiler, Locomotive Boiler, 4S Diesel Engine, 4S Petrol Engine, 2S Petrol engine
- CO4.** Test 4 stroke petrol engine by electrical load box and diesel engine by electrical load box and rope brake dynamometer
- CO5.** find calorific value, flash point, fire point, cloud point, pour point of fuel.
- CO6.** work effectively in a team

Laboratory experiments

1. Study of Cut Models – Boilers IC Engines: Lanchashire Boiler, Bahcock & Willcox Boiler, Cochran Boiler, Vertical Tubular Boiler, Locomotive Boiler, 4S Diesel Engine, 4S Petrol Engine, 2S Petrol Engine
2. Load Test on 4 Stroke Petrol Engine & Diesel Engine by Electrical Load Box.
3. Load Test on 4 Stroke Diesel Engine by Rope Brake Dynamometer.
4. Heat Balance on 4 Stroke Diesel Engine by Rope Brake Dynamometer & by Electrical Load Box.
5. Valve Timing Diagram on 4S Diesel Engine Model & 4S Petrol Engine Model
6. To find the Calorific Value of Diesel Fuel & Coal by Bomb Calorimeter
7. To find the Flash Point & Fire Point of Petrol & Diesel Fuel
8. To find the Cloud Point & Pour Point of Petrol & Diesel Fuel
9. To find Carbon Particle Percentage in Diesel Engine Exhaust Smoke by Smokemeter and trace the BHP Vs. % Carbon Curve
10. Measurement of the Quality of Steam – Enthalpy & Dryness fraction

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: ELECTRIC MACHINE-II	Duration: 6 Months
Course Code: BEEC501	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Basic Electrical Engineering
2. Electric Circuit Theory
3. Electromagnetic Field Theory
4. Electric Machine-I

Course Objective: The purpose of this course is to provide...

1. To understand the arrangement of windings of AC machines.
2. To understand the principle of production of pulsating and revolving magnetic fields.
3. To understand the principle of operation and characteristics of three phase Induction machines
4. To understand the principle of operation and characteristics of single phase Induction machines
5. To understand the principle of operation and characteristics of synchronous machine
6. To understand the principle of operation and characteristics of special electromechanical devices.
7. To solve problems of Induction machines, synchronous machines and special eletromechanical devices.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** describe the arrangement of winding of AC machines.
- CO2.** explain the principle of operation of Induction machines, Synchronous machines and special machines.
- CO3.** solve numerical problems of Induction machines, Synchronous machines and Special machines.
- CO4.** estimate the parameters and efficiency of Induction machines and Synchronous machines.
- CO5.** determine the characteristics of Induction machines and Synchronous machines.
- CO6.** select appropriate methods for starting , braking and speed control of Induction machines.

Course Content

Unit No	Module Name	Content	Hrs
1	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	5
2	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.	5

3	Induction Machines	Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.	10
4	Single-phase induction motors	Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split- phase starting methods and applications	5
5	Synchronous machines	Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	10
6	Special Electromechanical devices	Principle and construction of switched Reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper motor, Tacho generators.	5

Text Books:

1. Electrical Machinery, P.S. Bhimra, Khanna Publishers.
2. Electrical Machines, Nagrath & Kothary, TMH
3. Electrical Machines, P.K. Mukherjee and S. Chakravorti, Dhanpat Rai Publications.
4. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI

Reference Books:

1. Electric Machinery & Transformer, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electric Machinery & Transformes, Irving L. Kosow, PHI
3. Electric Machinery, A.E.Fitzgerald, Charles Kingsley, Jr. & Stephen D. Umans, 6th Edition, Tata McGraw Hill Edition.
4. Electrical Machines, R.K. Srivastava, Cengage Learning
5. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition
6. The performance and Design of Alternating Current Machines, M.G.Say, CBS publishers & distributors
7. Electric Machines, Charles A. Gross, CRC press.
8. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: POWER SYSTEM-I	Duration: 6 months
Course Code: BEEC502	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Basic Electrical Engineering
2. Electric Circuit Theory
3. Electromagnetic field theory

Course Objective: The purpose of this course is to provide...

1. To understand the basic principle of generation of Electricity from different sources
2. To find parameters and characteristics of overhead transmission lines and cables.
3. To find different parameters for the construction of overhead transmission line
4. To determine the performance of transmission lines.
5. To understand the principle tariff calculation.
6. To solve numerical problems on the topics studied.

Course Outcome: After completion of this course, the learners will be able to

- CO1.** explain the principle of generation of Electric power from different sources
- CO2.** determine parameters of transmission lines and its performance
- CO3.** explain the principle of formation of corona and methods of its reduction
- CO4.** conduct electrical tests on insulators
- CO5.** solve numerical problems related to overhead transmission line, cable, insulators and tariff
- CO6.** analyze overhead transmission line based on short medium and longlines.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Basic Concepts: Evolution of Power System and present day Scenario. Structure of power system: Bulk power grid and Micro Grid. Generation of Electric Power: General layout of a typical coal fired power station, Hydro electric power station, Nuclear power station, their components and working principles, comparison of different methods of power generation. Introduction to Solar & Wind energy system. Indian Electricity Rule-1956: General Introduction.	10
2	Overhead transmission line	Overhead transmission line: Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phase symmetrical and unsymmetrical configurations. Bundle conductors. Transposition. Concept of GMD and GMR. Influence of earth on conductor capacitance. Overhead line construction: Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers.	12

		Corona: Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.	
3	Insulators	Types, Voltage distribution across a suspension insulator string, String efficiency, Arching shield & rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators.	5
4	Cables	Types of cables, cable components, capacitance of single core & 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.	4
5	Performance of lines	Short, medium (nominal, T) and long lines and their representation. A.B.C.D constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.	6
6	Tariff	Guiding principle of Tariff, different types of tariff.	3

Text Books:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power System Engineering, Nagrath & Kothery, TMH
3. Elements of power system analysis, C.L. Wodhwa, New Age International.
4. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors

Reference Books:

1. explain the principle of generation of Electric power from different sources
2. determine parameters of transmission lines and its performance
3. explain the principle of formation of corona and methods of its reduction
4. conduct electrical tests on insulators
5. solve numerical problems related to overhead transmission line, cable, insulators and tariff
6. analyze overhead transmission line based on short medium and longlines.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: CONTROL SYSTEM	Duration: 6 Months
Course Code: BEEC503	Contact:
Semester: 4th	Credit: 3

Prerequisites:

1. Basic Electrical Engineering
2. Electric Circuit Theory
3. Electromagnetic field theory
4. Electric Machine-I

Course Objective: The purpose of this course is to provide...

1. To find mathematical representation of LTI systems.
2. To find time response of LTI systems of different orders
3. To find the frequency response of LTI systems of different orders
4. To understand stability of different LTI systems.
5. To analyze LTI systems with state variables.
6. To solve problems of mathematical modelling and stability of LTI systems

Course Outcome: On successful completion of the course, student will be able to

- CO1.** develop mathematical model of mechanical, electrical, thermal, fluid system and different control system components like servomotors, synchros, potentiometer, tachogenerators etc.
- CO2.** analyse stability of LTI system using routh-hurwitz (RH) criteria, root locus techniques in time domain and bode plot and nyquist technique in frequency domain.
- CO3.** design different control law or algorithms like proportional control, proportional plus derivative (PD) control, proportional plus integration (PI) control, and proportional plus integration plus derivative (PID) control and compensators like lag, lead, lag-lead for LTI systems.
- CO4.** apply state variable techniques for analysis of linear systems.
- CO5.** analyze the stability of linear discrete system.
- CO6.** solve numerical problems on LTI system modelling, responses, error dynamics and stability.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction to control system	Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servomechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function.	4

2	Mathematical modeling of dynamic systems	<p>Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason’s gain formula.</p> <p>Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tacho-generators. Actuators. Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, voltage control of an Alternator.</p>	8
3	Time domain analysis	<p>Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications.</p> <p>Error Analysis: Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.</p>	8
4	Stability Analysis	<p>Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. Frequency domain analysis of linear system: Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. M-circle and M-Contours in Nichols chart.</p>	10
5	Control System performance measure	<p>Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.</p>	5
6	State variable Analysis	<p>Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability.</p> <p>Pole-placement by state feedback.</p> <p>Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems.</p> <p>Stability of linear discrete-time systems.</p>	10

Text Books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education
2. Control System Engineering, I. J. Nagrath & M. Gopal. New Age International Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Automatic Control Systems, B.C. Kuo & F. Golnaraghi, 8th Edition, PHI

Reference Books:

1. Control Engineering Theory & Practice, Bandyopadhyaya, PHI
2. Control systems, K.R. Varmah, Mc Graw hill
3. Control System Engineering, Norman Nise, 5th Edition, John Wiley & Sons
4. Modern Control System, R.C. Dorf & R.H. Bishop, 11th Edition, Pearson Education.

5. Control System Design, C. Goodwin Graham, F. Graebe F. Stefan, Salgado.E. Mario, PHI
6. Modeling & Control of dynamic system, Macia&Thaler, Thompson
7. Modern Control Technology Components & Systems, 3rd edition, C.T Kilian, Cengage Learning
8. Modern Control Engineering, Y. Singh & S. Janardhanan, Cengage Learning
9. Control System Engineering, R. Anandanatarajan& R. Ramesh Babu,,SCITECH
10. Automatic Control system, A. William, Wolovich, Oxford

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: POWER ELECTRONICS	Duration: 6 months
Course Code: BEEC504	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Electric Circuit Theory
2. Analog Electronics
3. Electromagnetic field theory
4. Digital Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the functioning and characteristics of power switching devices.
2. To understand the principle of operation of converters.
3. To understand different triggering circuits and techniques of commutation of SCR
4. To find external performance parameter of converters.
5. To analyze methods of voltage control, improvement of power factor and reduction of harmonics of the converter
6. To solve numerical problems of converters

Course Outcome: On successful completion of the course, student will be able to

- CO1.** differentiate between signal level and power level devices.
- CO2.** construct triggering and commutation circuits of SCR.
- CO3.** explain the principle of operation of AC-DC, DC-DC and DC-AC converters.
- CO4.** analyse the performance of AC-DC, DC-DC and DC-AC converters.
- CO5.** apply methods of voltage control and harmonic reduction to inverters.
- CO6.** solve numerical problems of switching devices, AC-DC, DC-DC and DC-AC converters.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Concept of power electronics, application of power electronics, uncontrolled converters, advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS, IGBT and GTO.	4
2	PNPN devices	Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.	5
3	Phase controlled converters	Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters	6
4	DC-DC converters	Principle of operation, control strategies, step up	5

		choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers.	
5	Inverters	Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters.	10
6	Resonant Pulse Converters	Introduction, Series Resonant inverter, Parallel Resonant inverter, Zero-Current Switching Resonant converters, Zero-Voltage Switching Resonant converter, Two quadrant Zero-Voltage Switching Resonant converter, Resonant DC link inverter.	5
7	Applications	Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS, static VAR controller.	5

Text Books:

1. Power Electronics, M.H. Rashid, 4th Edition, Pearson
2. Power Electronics, P.S. Bhimra, , 3rd Edition, Khanna Publishers
3. Power Electronics, V.R. Moorthi, Oxford.
4. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc Graw Hill.

Reference Books:

1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
2. Power Electronics, Mohan, Undeland & Robbins, Wiley India
3. Element of power Electronics, Phillip T Krein, Oxford.
4. Power Electronics systems, J.P. Agarwal, Pearson Education.
5. Analysis of Thyristor power conditioned motor, S.K. Pillai, University Press.
6. Power Electronics, M.S. Jamal Asgha, PHI.
7. Power Electronics : Principles and applications, J.M. Jacob, Thomson

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: ELECTRIC MACHINE-II LABORATORY	Duration: 6 Months
Course Code: BEEC591	Contact:
Semester: 5th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1.** identify appropriate equipment and instruments for the experiment.
- CO2.** test the instrument for application to the experiment.
- CO3.** construct circuits with appropriate instruments and safety precautions.
- CO4.** validate different characteristics of single phase Induction motor, three phase Induction motor, Induction generator and synchronous motor, methods of speed control of Induction motors and parallel operation of the 3 phase Synchronous generator.
- CO5.** work effectively in a team

Laboratory experiments

1. Different methods of starting of a 3 phase Cage Induction Motor & their comparison [DOL, Auto transformer & Star-Delta]
2. Study of equivalent circuit of three phase Induction motor by no load and blocked rotor test.
3. Study of performance of wound rotor Induction motor under load.
4. Study of performance of three phase squirrel-cage Induction motor –determination of iron-loss, friction & windage loss.
5. Speed control of 3 phase squirrel cage induction motor by different methods & their comparison [voltage control & frequency control].
6. Speed control of 3 phase slip ring Induction motor by rotor resistance control
7. Determination of regulation of Synchronous machine by
 - i. Potier reactance method.
 - ii. Synchronous Impedance method.
8. Determination of equivalent circuit parameters of a single phase Induction motor.
9. Load test on single phase Induction motor to obtain the performance characteristics.
10. To determine the direct axis resistance [X_d] & quadrature reactance [X_q] of a 3 phase synchronous machine by slip test.
11. Load test on wound rotor Induction motor to obtain the performance characteristics.
12. To make connection diagram to full pitch & fractional slot winding of 18 slot squirrel cage Induction motor for 6 poles & 4 pole operation
13. To study the performance of Induction generator
14. Parallel operation of 3 phase Synchronous generators
15. V-curve of Synchronous motor

Reference Books:

1. Laboratory experiments on Electrical Machines, C.K. Chanda, A. Chakrabarti, Dhanpat Rai & Co.
2. Laboratory manual for Electrical Machines, D.P. Kothari, B.S. Umre, I K International Publishing House Pvt. Ltd.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: POWER SYSTEM-I LABORATORY	Duration: 6 Months
Course Code: BEEC592	Contact:
Semester: 5th	Credit: 1

Course Outcome: After completion of this course, the learners will be able to

- CO1.** identify appropriate equipment and instruments for the experiment.
- CO2.** test the instrument for application to the experiment.
- CO3.** construct circuits with appropriate instruments and safety precautions.
- CO4.** validate different characteristics of transmission line.
- CO5.** determine earth resistance, dielectric strength of insulating oil, breakdown strength of solid insulating material and dielectric constant of transformer oil.
- CO6.** analyze an electrical transmission line circuit with the help of software
- CO7.** work effectively in a team

Laboratory experiments

1. Determination of the generalized constants A, B, C, D of long transmission line and regulation of a 3- Φ transmission line model
2. Study of distribution system by network analyzer.
3. Measurement of earth resistance by earth tester.
4. Determination of dielectric strength of insulating oil.
5. Determination of breakdown strength of solid insulating material
6. Determination of parameter of 3- Φ transmission line model by power circle diagram
7. Study of different types of insulator.
8. Study of active and reactive power control of alternator.
9. Study and analysis of an electrical transmission line circuit with the help of software
10. Determination of dielectric constant, tan delta, resistivity of transformer oil.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2
7	1	-	-	2	-	3	2	-	-	-	-	2

Course Name: CONTROL SYSTEM LABORATORY	Duration: 6 Months
Course Code: BEEC593	Contact:
Semester: 4th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1.** identify appropriate equipment and instruments for the experiment. **CO2.** test the instrument for application to the experiment.
- CO3.** construct circuits with appropriate instruments and safety precautions.
- CO4.** use MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE for simulation of systems.
- CO5.** determine control system specifications of first and second order systems.
- CO6.** validate step response & impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
- CO7.** work effectively in a team

Laboratory experiments

1. Familiarization with MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE
2. Determination of Step response for first order & Second order system with unity feedback with the help of CRO & calculation of control system specification, Time constant, % peak overshoot, settling time etc. from the response.
3. Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
4. Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for a given system & stability by determining control system specification from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determination of approximate transfer functions experimentally from Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead, Lag, Lead-lag compensator.
8. Study of a practical position control system obtaining closed step responses for gain setting corresponding to over-damped and under-damped responses. Determination of rise time and peak time using individualized components by simulation. Determination of un-damped natural frequency and damping ratio from experimental data.
9. Analysis of performance of Lead, Lag and Lead-Lag compensation circuits for a given system using simulation.
10. Determination of Transfer Function of a given system from State Variable model and vice versa.
11. Analysis of performance of a physical system using State variable technique by simulation. Study of step response and initial condition response for a single input, two-output system in SV form by simulation.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2
7	1	-	-	2	-	3	2	-	-	-	-	2

Course Name: POWER ELECTRONICS LABORATORY	Duration: 6 Months
Course Code: BEEC594	Contact:
Semester: 5th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1.** identify appropriate equipment and instruments for the experiment. **CO2.** test the instrument for application to the experiment.
- CO3.** construct circuits with appropriate instruments and safety precautions.
- CO4.** validate characteristics of SCR, Triac, and performance of phase controlled converter, DC-DC converter, inverters and resonant pulse converters.
- CO5.** demonstrate the relation between the speed and firing angle of Universal motor.
- CO6.** work effectively in a team

Laboratory experiments

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a Triac
3. Study of different triggering circuits of an SCR
4. Study of firing circuits suitable for triggering SCR in a single phase full controlled bridge.
5. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
6. Study of performance of single phase half controlled symmetrical and asymmetrical bridge
7. converters.
8. Study of performance of step down chopper with R and R-L load.
9. Study of performance of single phase controlled converter with and without source inductance (simulation)
10. Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation)
11. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter.(simulation)
12. Study of performance of three phase controlled converter with R & R-L load. (simulation)
13. Study of performance of PWM bridge inverter using MOSFET as switch with R and R-L load.
14. Study of Zero Voltage Switching Resonant converter and Zero Current Switching Resonant Converter and to plot its output waveforms.
15. Study the speed control of universal motor to plot speed $v/s \alpha$

Reference Books:

1. Power Electronics Laboratory: Theory, Practice and Organization, O.P.Arora, Om Prakash Arora, Alpha science International.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Elective – II (Open Elective)

Course Name: DATA STRUCTURE & ALGORITHM	Duration: 6 months
Course Code: BEEG501A	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Programming for problem solving
2. Mathematics

Course Objective: The purpose of this course is to provide...

1. To understand the basics of abstract data types.
2. To understand the principles of linear and nonlinear data structures.
3. To build an application using sorting and searching

Course Outcome: On successful completion of the course, student will be able to

- CO1.** differentiate how the choices of data structure & algorithm methods enhance the performance of the program.
- CO2.** solve problems based upon different data structure & also write programs.
- CO3.** write programs based on different data structure
- CO4.** identify appropriate data structure & algorithmic methods in solving problem.
- CO5.** discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing
- CO6.** compare the benefits of dynamic and static data structures implementations.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Technique and their complexity analysis.	10
2	Stacks and Queues	ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	10

3	Linked Lists	Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis	10
4	Sorting and Hashing	Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	10

Text Books:

1. Data Structures and Program Design In C, 2/E by Robert L. Kruse, Bruce P. Leung. PHI
2. Data Structure & Algorithms Using C, R.S. Salaria, 5th Ed., Khanna Publishing House
3. Data Structures in C, Aaron M. Tenenbaum. Pearson.
4. Data Structure, S. Lipschutz.. Mc Graw Hill.

Reference Books:

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, MIT press
2. Expert Data Structures with C++, R.B Patel, Khanna Publishing House
3. Fundamentals of Data Structures of C, Ellis Horowitz, Sartaj Sahni, Susan Andersonfreed, MIT press
4. Data Structures Using C, Reema Thareja. Oxford University press
5. Data Structure Using C, 2/e by A.K. Rath, A. K. Jagadev. SCITECH
6. Data Structures through C, Yashwant Kanetkar, BPB Publications.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: OBJECT ORIENTED PROGRAMMING	Duration: 6 months
Course Code: BEEG501B	Contact:
Semester: 5th	Credit: 3

Prerequisites:

Programing for problem solving

Course Objective: The purpose of this course is to provide...

1. To understand simple abstract data types
2. To understand features of object-oriented design such as encapsulation, polymorphism, inheritance
3. To understand common object-oriented design patterns
4. To design applications with an event-driven graphical user interface.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** specify simple abstract data types.
CO2. recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.
CO3. apply common object-oriented design patterns
CO4. specify uses of common object oriented design patterns with examples.
CO5. design applications with an event-driven graphical user interface.

Course Content

Unit No	Module Name	Content	Hrs
1	Abstract data types and their specification	How to implement an ADT. Concrete state space, concrete invariant, abstraction function. Implementing operations, illustrated by the Text example.	8
2	Features of object-oriented programming	Encapsulation, object identity, polymorphism – but not inheritance.	8
3	Inheritance in OO design	Design patterns. Introduction and classification. The iterator pattern.	8
4	Model-view-controller pattern	Commands as methods and as objects. Implementing OO language features. Memory management.	8
5	Generic types and collections GUIs	Graphical programming with Scale and Swing . The software development process	8

Text Books:

1. Object Oriented Modelling and Design, Rambaugh, James Michael, Blaha Prentice Hall India.
2. The complete reference-Java2, Patrick Naughton, Herbert Schildt, TMH
3. Core Java For Beginners, R.K. Das, VIKAS PUBLISHING
4. Java How to Program, Deitel and Deitel, 6th ED, Pearson

Reference Books:

1. Object Oriented System Development, Ali Bahrami, McGraw Hill.
2. Ivor Horton's Beginning Java 2 SDK – Wrox

3. Programming With Java: A Primer, E. Balagurusamy 3rd Ed., TMH

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Elective – II (Open Elective)

Course Name: COMPUTER ORGANISATION	Duration: 6 months
Course Code: BEEG501C	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Programming for problem solving
2. Digital Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the analysis and design of various digital electronic circuits.
2. To understand how Computer Systems work & its basic principles
3. To understand how I/O devices are being accessed and its principles etc.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain basic structure of digital computer, stored program concept, different arithmetic and control unit operations, operating systems and compiler/assembler, memory and I/O operations.
- CO2.** differentiate between RISC vs CISC architectures, cache memory, virtual memory.
- CO3.** perform fixed point multiplication and division.
- CO4.** apply restoring and non-restoring algorithms, floating point - IEEE 754 standard.
- CO5.** design adder, memory unit and control unit, data path for read/write access.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Concept of operator, operand, registers and storage, Instruction format. Instruction sets and addressing modes. Commonly used number systems. Fixed and floating point representation of numbers.	8
2	Overflow and underflow	Overflow and underflow. Design of adders - ripple carry and carry look ahead principles. Design of ALU. Fixed point multiplication - Booth's algorithm. Fixed point division - Restoring and non-restoring algorithms. Floating point - IEEE 754 standard.	8
3	Memory unit design	Memory unit design with special emphasis on implementation of CPU-memory interfacing. Memory organization, static and dynamic memory, memory hierarchy, associative memory. Cache memory, Virtual memory. Data path design for read/write access.	10
4	Design of control unit	hardwired and microprogrammed control. Introduction to instruction pipelining. Introduction to RISC architectures. RISC vs CISC architectures. I/O operations - Concept of handshaking, Polled I/O, interrupt and DMA.	10

Text Books:

1. Computer System Architecture, Mano, M.M. PHI.
2. Computer Architecture & Organisation, Hayes J. P, McGraw Hill,
3. Computer Organisation & Design, Chaudhuri P. Pal, PHI,
4. Computer Organization & Architecture, Rajaraman , PHI

Reference Books:

1. Computer Architecture, BehroozParhami , Oxford University Press
2. Microprocessors and Microcontrollers, N. senthil Kumar, M. Saravanan, S. Jeevananthan OUP
3. Computer Organization & Architecture , P N BasuVikas Pub
4. Computer Organization & Architecture, B.Ram, Newage Publications
5. Computer Organisation, Hamacher, McGraw Hill,

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Elective – I

Course Name: HIGH VOLTAGE ENGINEERING	Duration: 6 months
Course Code: BEED501A	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Electric Circuit Theory
2. Electromagnetic field theory
3. Electric Machine-I
4. Electrical and Electronics measurement

Course Objective: The purpose of this course is to provide...

1. To understand the breakdown phenomenon of solid, liquid and gases.
2. To understand the method of generation of high voltage AC and DC.
3. To understand measurement techniques of high voltage and current
4. To understand the over voltage phenomenon and insulation coordination in Electric power systems
5. To understand different methods of high voltage testing.
6. To solve numerical problems of breakdown phenomena, generation and measurement of high voltage and currents, over voltage phenomena and high voltage testing.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain breakdown phenomenon of gas, liquid and solid and vacuum
CO2. suggest methods for generation and measurement of high voltage and currents.
CO3. determine the basic insulation level of substation equipment.
CO4. apply methods for protection of electrical apparatus against over voltage
CO5. test insulators, bushings, isolators, circuit breakers, cables and power transformers.
CO6. solve numerical problems of breakdown phenomena, generation and measurement of high voltage and currents, over voltage phenomena and high voltage testing.

Course Content

Unit No	Module Name	Content	Hrs
1	Breakdown phenomena	<p>Breakdown of Gases: Mechanism of Breakdown of gases, Charge multiplication, Secondary ionization, Townsend Theory, Streamer Theory, Paschen's Law, Determination of Minimum breakdown voltage, Breakdown in non- uniform field, Effect of polarity on corona inception and break down voltage.</p> <p>Partial Discharge: definition and development in solid dielectric. Break Down of Solids: Intrinsic breakdown, Electromechanical break down, Thermal breakdown, Streamer Breakdown.</p> <p>Breakdown of Liquid: Intrinsic Break down, Capitation Theory, Suspended particle Theory.</p> <p>Breakdown in Vacuum: Non-metallic electron emission mechanism, Clump mechanism, Effect of pressure on breakdown voltage.</p>	10
2	Generation of High Voltage and Currents	<p>Generation of high DC and AC voltages: half wave rectifier circuit, Cockroft-Walton voltage multiplier circuit, Electrostatic generator, Cascaded transformers, Series</p>	8

		resonant circuit. Generation of Impulse voltages and currents: standard impulse wave shapes, Multistage impulse generators, generation of switching surges, generation of impulse currents, tripping and control of impulse generators.	
3	Measurement of High Voltage and Currents	Sphere gap, Uniform field spark gap, Rod gap, Electrostatic voltmeter, Generating voltmeter, Impulse voltage measurements using voltage dividers, Measurement of High DC and Impulse currents. Cathode ray oscillographs for impulse voltage and current measurements.	8
4	Over voltage phenomenon and insulation coordination in Electric power systems	Lightning Phenomena, Electrification of cloud, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke. Protection of Electrical Apparatus against over voltage, Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Ground wires. Insulation Co-ordination, Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.	8
5	High Voltage Testing	Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers. High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.	6

Text Books:

1. High Voltage Engineering, C.L. Wadhawa, New Age International Publishers.
2. High Voltage Engineering, M.S. Naidu & V. Kamraju, Tata MC Graw Hill publication.

Reference Books:

1. High-Voltage Engineering : theory and practice, Mazen Abdel-Salam; Hussein Anis; Ahdab El-Morshedy; RoshdyRadwan, New York, N.Y. : Marcel Dekker, ©2000.
2. High Voltage Engineering, E. Kuffel, W.S. Zaengl, J. Kuffel, 2nd edition, Butterworth-Heinemann.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Elective – I

Course Name: POWER PLANT ENGINEERING	Duration: 6 months
Course Code: BEED501B	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Electric Circuit Theory
2. Electromagnetic field theory
3. Electric Machine-I
4. Electrical and Electronics measurement

Course Objective: The purpose of this course is to provide...

1. To understand methods of selection of power plant and its economic.
2. To understand the principle of operation different types of power plants.
3. To understand methods of site selection of different power plants.
4. To understand the cause of pollution and its remedy for power plants.
5. To understand methods of cooling of generators and transformers.
6. To solve numerical problems of load estimation, economics of power plants.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the principle of operational of Steam, Hydroelectric, Diesel, Gas turbine, Nuclear power and non-conventional power plant.
- CO2.** identify the cause of pollution for power generation and its remedy.
- CO3.** suggest location to set up Steam, Hydroelectric, Diesel, Gas turbine and Nuclear power plant.
- CO4.** compare Steam, Hydroelectric, Diesel, Gas turbine, Nuclear power and non-conventional power plant.
- CO5.** suggest methods of maintenance of Steam, Gas and Hydroelectric power plants
- CO6.** solve numerical problems of load estimation and economics of power plants.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	<p>Introduction:</p> <p>Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant.</p> <p>Power plant economics and selection:</p> <p>Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.</p>	8

2	Steam power plant	General layout of steam power plant, Power plant boilers including critical and supercritical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.	8
3	Diesel power plant & as turbine power plant	Diesel power plant: General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel Power plant, Comparative study of diesel power plant with steam power plant. Gas turbine power plant: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant .	8
4	Nuclear power plant, Hydro electric station & Non Conventional Power Plants	Nuclear power plant: Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. Hydro electric station: Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems. Non Conventional Power Plants: Introduction to non- conventional power plants (Solar, wind, geothermal, tidal)etc.	10
5	Electrical system	Generators and their cooling, transformers and their cooling. Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms. Pollution due to power generation and its remedy	6

Text Books:

1. Power Plant Engineering, P.K. Nag, McGraw Hill.
2. Power Plant Engineering, F.T. Morse, Affiliated East-West Press Pvt. Ltd.
3. Power Plant Technology El-Vakil, McGraw Hill.

Reference Books:

1. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.

2. An introduction to thermal power plant engineering and operation, P.K.Das and A.K.Das, Notion press.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Elective – I

Course Name: RENEWABLE & NON CONVENTIONAL ENERGY	Duration: 6 months
Course Code: BEED501C	Contact:
Semester: 5th	Credit: 3

Prerequisites:

1. Electric Circuit Theory
2. Electromagnetic field theory
3. Electric Machine-I
4. Electrical and Electronics measurement

Course Objective: The purpose of this course is to provide...

1. To understand the difference between Renewable and non-renewable energy sources
2. To understand methods of conversion of solar energy and wind energy to other form of energy.
3. To understand methods harnessing energy from Biomass, Geothermal and ocean
4. To understand the principle of operation of Magneto Hydrodynamic power generation:
5. To understand the principle and operation of fuel cell.
6. To solve numerical problems of Renewable and non-renewable energy sources

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the principle of conversion of solar energy, wind energy , biomass, Geothermal energy, Ocean energy and Hydrogen energy to other form of energy.
- CO2.** explain the principle of operation of magneto hydrodynamic power generation:
- CO3.** use Solar energy, Wind energy , Biomass, Geothermal energy, Ocean energy, Hydrogen energy and fuel cell for different applications.
- CO4.** suggest location to set up wind mill and biogas generation plant
- CO5.** estimate conversion efficiency of fuel cell.
- CO6.** solve numerical problems relating to conversion of Solar energy, Wind energy , Biomass, Ocean energy and Hydrogen energy to heat and electric energy.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction to Energy sources	Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	3
2	Solar Energy	Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems,	8

3	Wind Energy	Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations	5
4	Energy from Biomass	Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas	5
5	Geothermal Energy	Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.	5
6	Energy from Ocean	Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.	5
7	Magneto Hydrodynamic power generation	Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.	5
8	Hydrogen Energy	Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.	3
9	Fuel cell	Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells	3

Text Books:

1. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.
2. Renewable energy resources and emerging technologies, D.P. Kothari, PHI.
3. Non-conventional Energy sources, G.D. Rai, Khanna Publishers.

Reference Books:

1. Non-conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2

Course Name: POWER SYSTEM-II	Duration: 6 months
Course Code: BEEC601	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Electric Circuit Theory
2. Electromagnetic field theory
3. Power System-I

Course Objective: The purpose of this course is to provide...

1. To understand the method of representation of power system components
2. To know about location and components of a distribution substation.
3. To understand different methods of load flow studies.
4. To determine faults in Electrical systems.
5. To understand the principle of power system stability.
6. To understand the principle of relays and methods of protection of power system
7. To solve numerical problems on the topics studied.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Represent power system components in line diagrams.
- CO2.** Determine the location of distribution substation.
- CO3.** Determine the performance of power system with the help of load flow studies.
- CO4.** Analyse faults in Electrical systems.
- CO5.** Determine the stability of Power system.
- CO6.** Explain principle of operation of different power system protection equipments.
- CO7.** Solve numerical problems related to representation, load flow, faults, stability and protection of power system.
- CO8.** solve numerical problems relating to conversion of Solar energy, Wind energy, Biomass, Ocean energy and Hydrogen energy to heat and electric energy.

Course Content

Unit No	Module Name	Content	Hrs
1	Representation of Power system components	Single-phase representation of balanced three phase networks, the one-line diagram and the impedance or reactance diagram, per unit (PU) system.	2
2	Distribution substation	Types of substations, location of substations, substation equipments and accessories, earthing (system & equipment), feeder and distributors, radial and loop systems.	5
3	Load flow studies	Network model formulation, formation of Ybus, load flow problem, Gauss-Siedel method, Newton-Raphson method, Decoupled load flow studies, comparison of load flow methods.	5

4	Faults in Electrical systems	Transient on a transmission line, short circuit of a synchronous machine under no load & loaded condition. Symmetrical component transformation, sequence impedance and sequence network of power system, synchronous machine, transmission lines and transformers. Symmetrical component analysis of unsymmetrical faults, single line-to-ground fault, line-to-line fault, double line-to-ground fault	8
5	Power system stability	Steady state stability, transient stability, equal area criteria, swing equation, multi machine stability concept	4
6	Power system protection	Protective zones, Relaying elements and quantities. Protective relays, basic requirements and type of protection, phase and amplitude comparator, grading (time & current), classification of Electromagnetic relays, Directional relay, Distant relay, Differential relay, basic aspects of static and digital relays, relay protection scheme for transformer, feeder, generators and motors. Circuit breakers, circuit breaking transients, transient recovery voltage, current chopping and resistance switching, circuit breaker rating, arc and arc extinction, circuit breaker types, oil circuit breaker, vacuum circuit breaker, air blast circuit breaker, SF6 circuit breaker and operating mechanism, advantages and disadvantages of different types	12

Text Books:

1. Modern Power System Analysis, D.P. Kothari & I.J. Nagrath, 4th Edition, Tata McGraw Hill.
2. Electrical Power Systems, Subir Ray, PHI
3. Switchgear protection and power systems, Sunil S Rao, Khanna Publications.
4. A text book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S. Bhatnagar & A. Chakrabarti, Dhanpat Rai & CO.

Reference Books:

1. Protection & Switchgear, B. Bhalja, R.P. Maheshwari, N.G.Chothani, Oxford.
2. Power system protection & switchgear, B.Ram & D.N. Vishwakarma, Tata McGraw Hill.
3. Handbook of Electrical Power Distribution, G. Ramamurthy, University Press
4. Electric Power Transmission and Distribution, S. Sivanagaraju, S.Satyanarayana, Pearson Education.
5. Power Systems Stability, Vol. I,II & II, E.W. Kimbark, Wiley.
6. Power Engineering, D.P Kothari & I.J. Nagrath, Tata McGraw Hill.
7. Power Systems Analysis, A. R. Bergen & V. Vittal, Pearson Education. 8. Computer Aided Power systems analysis, Dr. G. Kusic, CEC press.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	2	1	-	2	1	-	1	-	3	2
7	2	2	-	-	1	2	3	-	-	1	-	-
8	2	3	-	2	-	1	3	-	1	-	3	1

Course Name: MICROPROCESSOR & MICRO CONTROLLER	Duration: 6 months
Course Code: BEES601	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Analog Electronics
2. Digital Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the architecture of 8086 microprocessor.
2. To understand the design aspects of I/O and Memory Interfacing circuits.
3. To interface microprocessors with supporting chips.
4. To understand the architecture of 8051 microcontroller.
5. To design a microcontroller based system

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the architecture of 8086 and 8051.
CO2. do assembly language programming of 8086, 8051
CO3. interface different peripheral with 8086 and 8051
CO4. develop micro processor/ microcontroller based systems.
CO5. compare microprocessor, microcontroller, PIC and ARM processors

Course Content

Unit No	Module Name	Content	Hrs
1	The 8086 Microprocessor	Introduction to 8086- Microprocessor architecture – Addressing modes – Instruction set and assembler directives – Assembly language programming – Modular Programming – Linking and Relocation – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.	8
2	8086 System bus structure	8086 signals – Basic configurations – System bus timing – System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.	8
3	I/O INTERFACING	Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Timer – Keyboard /display controller – Interrupt controller –DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.	8
4	Microcontroller	Architecture of 8051 – Special Function Registers(SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming.	8

5	Interfacing Microcontroller	Programming 8051 Timers – Serial Port Programming – Interrupts Programming – LCD & Keyboard Interfacing – ADC, DAC & Sensor Interfacing – External Memory Interface- Stepper Motor and Waveform generation – Comparison of Microprocessor, Microcontroller, PIC and ARM processors	6
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Text Books:

1. Advanced Microprocessors and Peripheral, Koshor M Bhurchandi, Ajay Kumar Ray, 3rd Edition, MC Graw hill education.
2. Microprocessor & Interfacing, D.V. Hall, Mc Graw Hill.
3. The 8051 microcontroller, Ayala, Thomson.

Reference Books:

1. Advanced Microprocessors, Y. Rajasree, New Age international Publishers.
2. An introduction to the Intel family of Microprocessors, James L. Antonakos, Pearson Education,
3. The 8051 Microcontroller and Embedded systems, Muhammad Ali Mazidi & J. G. Mazidi, Pearson Education.
4. The 8086 Microprocessors: Programming & Interfacing the PC, K.J.Ayala, Thomson.
5. Microprocessor & Peripherals, S.P. Chowdhury & S. Chowdhury, Scitech.
6. Microchip technology data sheet, www.microchip.comerence books

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: DIGITAL CONTROL SYSTEM	Duration: 6 months
Course Code: BEED601A	Contact:
Semester: 6th	Credit: 3

Prerequisites:

Control System

Course Objective: The purpose of this course is to provide...

1. To understand the principle of sampling and reconstruction of signals.
2. To find Z-transform and inverse Z-transform of systems.
3. To carry out the analysis and design of digital control systems
4. To design compensators for digital control system to achieve desired specifications.
5. To represent digital control systems using state space models.
6. To analyze the effect sampling on stability, controllability and observability.
7. To design digital controllers for industrial applications.
8. To solve numerical problems on the topics studied.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the principle of sampling and reconstruction of analog signal.
CO2. perform Z-transformation and inverse Z-transformation of systems.
CO3. analyse and design digital control systems.
CO4. design compensators for digital control system to achieve desired specifications.
CO5. represent digital control systems using state space models.
CO6. analyze the effect sampling on stability, controllability and observability.

Course Content

Unit No	Module Name	Content	Hrs
1	Sampling and reconstruction	Introduction, Examples of Data control systems – Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.	3
2	Z-transform	Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms	5
3	Z- Plane analysis of discrete-time control system	Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane.	5
4	State space analysis	State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and its Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations.	6
5	Controllability and observability	Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function	4

6	Stability analysis	Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.	5
7	Design of discrete time control system by conventional methods	Transient and steady – State response Analysis – Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers.	6
8	State feedback controllers and observers	Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman’s formula. State Observers – Full order and Reduced order observers.	5

Text Books:

1. Digital Control and State Variable Methods , M. Gopal, TMH Publishers
2. Discrete-time Control Systems, K. Ogata, Pearson Education,
3. Digital Control Systems, B.C. Kuo, Wiley Publications.
4. Control System Engineering, I.J. Nagrath, M. Gopal, New age International.

Reference Books:

1. Digital control of dynamic systems, Gene F. Franklin, J. David Powell, and Michael Workman 3rd ed, 1998, Addison-Wesley.
2. Digital Control Systems, design, identification and implementation, Landau, Ioan Doré, Zito, Gianluca, Springer-Verlag London.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	1	-	2	-	3	-	-	2	-	-	-	2

Course Name: HVDC TRANSMISSION	Duration: 6 months
Course Code: BEED601B	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Electric Circuit Theory
2. Power system-1
3. Control system
4. Power Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the basics of DC power transmission system
2. To analyse HVDC converters.
3. To understand methods of control of HVDC system
4. To understand causes of fault and protection against fault of converters.
5. To understand function of smoothing reactor and transient over voltage of DC line
6. To understand methods of reactive power control.
7. To solve numerical problems on the topics studied.

Course Outcome: On successful completion of the course, student will be able to

- CO1. choose intelligently AC and DC transmission systems for the dedicated application(s).
 CO2. identify the suitable two-level/multilevel configuration for high power converters.
 CO3. select the suitable protection method for various converter faults.
 CO4. identify suitable reactive power compensation method.
 CO5. decide the configuration for harmonic mitigation on both AC and DC sides..
 CO6. solve numerical problems related to converters, power flow analysis, reactive power control.

Course Content

Unit No	Module Name	Content	Hrs
1	DC power transmission technology	Introduction, Comparison of HVAC and HVDC transmission system, Applications of DC transmission, Description of DC transmission system, Configurations, Modern trends in DC transmission.	4
2	Analysis of HVDC converters	Pulse number, Choice of converter configuration, Simplified analysis of Graetz circuit, Converter bridge characteristics, Characteristics of a twelve-pulse converter, Detailed analysis of converters with and without overlap	6
3	Converter and HVDC system control	General, Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control, Higher level controllers.	6
4	Converter faults and protection	Converter faults, Protection against over-currents, Overvoltages in a converter station, Surge arresters, Protection against over-voltages.	5
5	Smoothing reactor and DC line	Introduction, Smoothing reactors, DC line, Transient over voltages in DC line, Protection of DC line, DC breakers, Monopolar operation, Effects of proximity of AC and DC transmission lines.	6

6	Reactive power control	Reactive power requirements in steady state, Sources of reactive power, Static VAR systems, Reactive power control during transients, Harmonics and filters, Generation of harmonics, Design of AC filters and DC filters.	6
7	Component models for the analysis of ac/dc systems & Power flow analysis in AC/DC systems	Component models for the analysis of ac/dc systems: General, Converter model, Converter control, Modelling of DC network, Modelling of AC networks. Power flow analysis in AC/DC systems: General, Modelling of DC links, Solution of DC load flow, Discussion, Per unit system for DC quantities.	6

Text Books:

1. HVDC Power transmission systems , K.R. Padiyar , Third Edition, New Age International Publishers

Reference Books:

1. Power Transmission by Direct Current, Erich Uhlmann, Fourth Indian Reprint, Springer International Edition, 2012.
2. HVDC Transmission, S Kamakshaiah, V Kamaraju , 2nd Edition, Mcgraw Hill Education, 2020.
3. Direct Current Transmission, E.W.Kimbark, Wiley–Blackwell; Volume 1 edition (1 January 1971)
4. H.V.D.C Transmission , J Arrillaga , 1st Edition, The Institution of Engineering and Technology, 1998

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	1	-	2	-	3	-	-	2	-	-	-	2

Course Name: ELECTRICAL MACHINE DESIGN	Duration: 6 months
Course Code: BEED601C	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Electric Machine-I
2. Electric Machine-II

Course Objective: The purpose of this course is to provide...

1. To understand the basic principle of design of Electric machines.
2. To understand basics of design of Transformer, Induction machine and Synchronous machines.
3. To understand different factors that influence design of Electric machines.
4. To understand the need and use software tools for design of Electric machines
5. To solve numerical problems on the topics studied

Course Outcome: On successful completion of the course, student will be able to

- CO1.** specify the rating of electrical machines with standard specifications.
- CO2.** explain the principles of electrical machine design and carry out basic design of an ac machine
- CO3.** determine the various factors which influence the design of electrical, magnetic and thermal loading of electrical machines
- CO4.** explain the construction and performance characteristics of electrical machines.
- CO5.** use software tools to do design calculations.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations – Heat flow – Temperature rise and Insulating Materials - Rating of machines – Standard specifications.	4
2	Transformer	Output Equations – Main Dimensions - kVA output for single and three phase transformers – Window space factor – Design of core and winding – Overall dimensions – Operating characteristics – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers.	10
3	Induction motors	Output equation of Induction motor – Main dimensions – Choice of Average flux density – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars & slots – Design of end rings – Design of wound rotor – Magnetic leakage calculations – Leakage reactance of polyphase machines- Magnetizing current - Short circuit current – Operating characteristics- Losses and Efficiency.	10

4	Synchronous machines	Output equations – choice of Electrical and Magnetic Loading – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor – Design of damper winding – Determination of full load field mmf – Design of field winding – Design of turbo alternators – Rotor design.	10
5	Computer aided Design (CAD)	Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation.	5

Text Books:

1. A Course in Electrical Machine Design, A.K. Sawhney, Dhanpat rai and sons.
2. Electrical machine design, V. rajini, V.S. Nagarajan, Pearson India education services Pvt. Ltd.
3. Computer Aided Design of Electrical Machine, K. M. V. Murthy, B.S. Publications.

Reference Books:

1. Design and Testing of Electrical Machines, M.V.Deshpande, PHI
2. Principles of Electrical Machine Design, 3rd Edition, S.K. sen, Oxf-Ibh
3. Computer Aided Design of Electrical Equipment, M. Ramamoorthy, East-West Press.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: ELECTRICAL AND HYBRID VEHICLE	Duration: 6 months
Course Code: BEED602A	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Electric Machine-I
2. Electric Machine-II

Course Objective: The purpose of this course is to provide...

1. To understand the basic difference between conventional and Hybrid vehicles.
2. To understand different configuration and control of Electric drives.
3. To understand energy storage system in Hybrid vehicles.
4. To understand different energy management strategies of Hybrid vehicles.
5. To solve numerical problems on the topics studied

Course Outcome: On successful completion of the course, student will be able to

- CO1.** explain the principle of Electric traction.
CO2. choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
CO3. design and develop basic schemes of electric vehicles and hybrid electric vehicles.
CO4. choose proper energy storage systems for vehicle applications
CO5. implement different energy management strategies for hybrid vehicle.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	<p>Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.</p> <p>Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive- trains on energy supplies.</p> <p>Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.</p>	9

2	Electric Trains	Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	10
3	Energy Storage	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems	9
4	Energy Management Strategies	Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	6
5	Case Studies	Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	5

Text Books:

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press.
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, .
3. Hybrid Electric Vehicles: Energy Management Strategies, Onori Simona, Serrao Lorenzo and Rizzoni Giorgio, Springer.
4. Electric and Hybrid Vehicles, T. Denton, Routledge.

Reference Books:

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi CRC Press, 2004.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: POWER QUALITY AND FACTS	Duration: 6 months
Course Code: BEED602B	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Power system-I
2. Control system
3. Power Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. To understand the working principles of FACTS devices and their operating characteristics.
3. To understand the basic concepts of power quality.
4. To understand the working principles of devices to improve power quality.
5. To solve numerical problems on the topics studied

Course Outcome: On successful completion of the course, student will be able to

- CO1.** analyse uncompensated AC transmission line.
- CO2.** explain the working principles of FACTS devices and their operating characteristics.
- CO3.** apply FACTS devices for power flow control and stability.
- CO4.** identify different issues of power quality in distribution system.
- CO5.** apply different compensation and control techniques for DSTATCOM
- CO6.** explain working principle of dynamic voltage restorer and UPQC

Course Content

Unit No	Module Name	Content	Hrs
1	Transmission Lines and Series/Shunt Reactive Power Compensation	Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid- point of an AC line. Comparison of Series and Shunt Compensation.	4
2	Thyristor-based Flexible AC Transmission Controllers (FACTS)	Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	6

3	Voltage Source Converter based (FACTS) controllers	Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.	8
4	Application of FACTS	Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.	4
5	Power Quality Problems in Distribution Systems	Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave- form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	4
6	DSTATCOM	Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques for DSTATCOM.	6
7	Dynamic Voltage Restorer and Unified Power Quality Conditioner	Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.	6

Text Books:

1. FACTS Controllers in Power Transmission and Distribution, N K. R. Padiyar, New Age International (P) Ltd. 2007.

Reference Books:

1. Understanding FACTS: Concepts and Technology of FACTS Systems, N. G. Hingorani and L. Gyugyi Wiley-IEEE Press, 1999.
2. Reactive Power Control in Electric Systems, T. J. E. Miller, John Wiley and Sons, New York, 1983.
3. Electrical Power Systems Quality, R. C. Dugan, McGraw Hill Education, 2012.
4. Electric Power Quality, G. T. Heydt, Stars in a Circle Publications, 1991

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: INDUSTRIAL ELECTRICAL SYSTEMS	Duration: 6 months
Course Code: BEED602B	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Power system-I
2. Control system
3. Power Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the electrical wiring systems with standard symbols , drawings and SLD for residential, commercial and industrial consumers
2. To understand various components of industrial electrical systems
3. To analyze and select the proper size of various electrical system components
4. To understand methods of automation of Industrial Electrical Systems
5. To solve numerical problems on the topics studied

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Represent electrical wiring system for residential, commercial and industrial consumers.
- CO2.** Determine the rating of components of residential and commercial electrical systems.
- CO3.** Design lighting scheme for a residential and commercial premises.
- CO4.** Select transformer, switchgear, protection equipments for industrial electrical systems.
- CO5.** explain methods of automation of Industrial Electrical Systems
- CO6.** Solve numerical problems related to earthing system, lighting scheme, power factor correction.

Course Content

Unit No	Module Name	Content	Hrs
1	Electrical System Components	LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices	6
2	Residential and Commercial Electrical Systems	Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.	8

3	Illumination Systems	Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.	6
4	Industrial Electrical Systems I	HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.	6
5	Industrial Electrical Systems II	: DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.	6
6	Industrial Electrical System Automation	Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.	6

Text book:

1. Electrical Wiring, Estimating & Costing, S. L. Uppal and G. C. Garg, Khanna publishers, 2008.
2. Electrical Design, Estimating & Costing, K. B. Raina, New age International, 2007.

Reference books

1. Electrical estimating and costing, S. Singh and R. D. Singh, Dhanpat Rai and Co., 1997.
2. Web site for IS Standards.
3. Residential Commercial and Industrial Systems, H. Joshi, McGraw Hill Education, 2008.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: DIGITAL SIGNAL PROCESSING	Duration: 6 months
Course Code: BEEG601A	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Electric circuit theory
2. Control system

Course Objective: The purpose of this course is to provide...

1. To understand sampling and reconstruction of signal
2. To understand the method of Z-transform and inverse Z- transform of signal and its properties
3. To understand Discrete Fourier Transform
4. To understand methods of design of Digital filters
5. To understand applications of Digital signal processing
6. To solve numerical problems on the topics studied

Course Outcome: On successful completion of the course, student will be able to

- CO1.** represent signals mathematically in continuous and discrete-time and in the frequency domain.
- CO2.** analyse discrete-time systems using z-transform.
- CO3.** explain the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- CO4.** design digital filters for various applications.
- CO5.** apply digital signal processing for the analysis of real-life signals.

Course Content

Unit No	Module Name	Content	Hrs
1	Discrete-time signals and systems	Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	6
2	Z-transform	z-Transform, Region of convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z- transforms.	6
3	Discrete Fourier Transform	Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	8
4	Design of Digital filters	Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Bandstop and High- pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing	12
5	Applications of Digital Signal Processing	Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	6

Text book:

1. Digital Signal Processing-A computer based approach, S. Mitra, TMH
2. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis & M.G. Manslakis, PHI
3. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.

Reference books :

1. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning
2. Digital Signal Processing, Chen, OUP
3. Digital Signal Processing, Johnson, PHI
4. Digital Signal Processing using MATLAB, Ingle, Vikas.
5. Digital Signal Processing, Ifeachor, Pearson Education.
6. Digital Signal Processing, A.V. Oppenheim & R.W. Shaffer, PHI
7. Theory and application of Digital Signal Processing, L.R. Rabiner & B. Gold, PHI
8. Digital Signal Processing, AshokAmbardekar, Cengage Learning.
9. Digital Signal Processing, S. Salivahanan, A. Vallavaris & C. Gnanpruja, TMH.
10. Xilinx FPGA user manual and application notes.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: VLSI AND MICRO ELECTRONICS	Duration: 6 months
Course Code: BEEG601B	Contact:
Semester: 6th	Credit: 3

Prerequisites:

1. Analog Electronics
2. Digital Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the concept of VLSI design
2. To understand the basics of MOS structure
3. To understand the process of VLSI fabrication
4. To understand the principle of logic circuit design with hardware description language

Course Outcome: On successful completion of the course, student will be able to

- CO1. explain the principle of design of VLSI circuits
- CO2. explain different MOS structure with characteristics
- CO3. apply different processes for VLSI fabrication
- CO4. use programming language for the design of logic circuits
- CO5. draw the stick diagram and layout for simple MOS circuits

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction to VLSI Design	VLSI Design Concepts, Moor's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA), Design principles (Digital VLSI – Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural, Physical), Y-Chart, Digital VLSI Design Steps.	8
2	MOS structure	E-MOS & D-MOS, Charge inversion in E-MOS, Threshold voltage, Flat band voltage, Potential balance & Charge balance, Inversion, MOS capacitances. Three Terminal MOS Structure: Body effect Four Terminal MOS Transistor: Drain current, I-V characteristics. Current-voltage equations (simple derivation) Scaling in MOSFET: Short Channel Effects, General scaling, Constant Voltage & Field scaling CMOS: CMOS inverter, Simple Combinational Gates - NAND gate and NOR Gate using CMOS.	12

3	Micro-electronic Processes for VLSI Fabrication	Silicon Semiconductor Technology- An Overview, Wafer processing, Oxidation, Epitaxial deposition, Ion- implantation & Diffusion, Cleaning, Etching, Photo- lithography – Positive & Negative photo- resist. Basic CMOS Technology – (Steps in fabricating CMOS), Basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator Layout Design Rule: Stick diagram with examples, Layout rules.	10
4	Hardware Description Language	VHDL or Verilog Combinational & Sequential Logic circuit Design.	8

Text book:

1. Digital Integrated Circuit, J.M.Rabaey, Chandrasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuit, S.M.Kang & Y.Leblebici, TMH.
3. Modern VLSI Design, Wayne Wolf, Pearson Education.
4. VHDL, Bhaskar, PHI.
5. Advance Digital Design Using Verilog , Michel D. Celliti, PHI

Reference books

1. Digital Integrated Circuits, Demassa & Ciccone, John Willey & Sons .
2. Modern VLSI Design: system on silicon, Wayne Wolf; Addison Wesley Longman Publisher
3. Basic VLSI Design, Douglas A. Pucknell & Kamran Eshranghian, PHI
4. CMOS Circuit Design, Layout & Simulation, R.J.Baker, H.W.Lee, D.E. Boyee, PHI

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: ECONOMICS FOR ENGINEERS	Duration: 6 months
Course Code: BEEA601	Contact:
Semester: 6th	Credit: 3

Prerequisites:

Basic understanding of Engineering processes

Course Objective: The purpose of this course is to provide...

1. To understand the process of economic decision making
2. To understand th basic financial management aspects
3. To develop the skills to analyze financial statements
4. To understand the basic of accounting

Course Outcome: On successful completion of the course, student will be able to

- CO1.** evaluate the economic theories, cost concepts and pricing policies **CO2.** explain the market structures and integration concepts
- CO3.** apply the concepts of financial management for project appraisal
- CO4.** explain accounting systems , the impact of inflation, taxation, depreciation
- CO5.** analyze financial statements using ratio analysis
- CO6.** explain financial planning, economic basis for replacement, project scheduling, legal and regulatory issues applied to economic investment and project-management problems

Course Content

Unit No	Module Name	Content	Hrs
1	Economic Decisions Making	Economic Decisions Making – Overview, Problems, Role, Decision making process. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - PerUnit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.	6

2	Cash Flow, Interest and Equivalence	Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest. Present Worth Analysis : End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives. Cash Flow & Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.	10
3	Uncertainty In Future Events	Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs	10
		Return, Simulation, Real Options. Depreciation - Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.	
4	Replacement Analysis	Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems. Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.	8
5	Accounting	Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	6

Text book:

1. Engineering Economics, James L.Riggs, David D. Bedworth, Sabah U. Randhawa 4e , McGraw- Hill Education.
2. Engineering Economics Analysis, Donald Newnan, Ted Eschembach, Jerome Lavelle , OUP
3. Principle of Engineering Economic Analysis, John A. White, Kenneth E.Case,David B.Pratt , Wiley

Reference books

1. Engineering Economy, Sullivan and Wicks, Koelling, Pearson
2. Engineering Economics, R.Paneer Seelvan, PHI
3. Engineering Economics Analysis, Michael R Lindeburg, ,Professional Pub

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: POWER SYSTEM-II LABORATORY	Duration: 6 Months
Course Code: BEEC691	Contact:
Semester: 6th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Identify appropriate equipment and instruments for the experiment.
- CO2.** Test the instrument for application to the experiment.
- CO3.** Construct circuits with appropriate instruments and safety precautions.
- CO4.** Validate the characteristics of under voltage relay, over current relay, earth fault relay, on load time delay relay, off load time delay relay, CT and PT.
- CO5.** Validate protection schemes of transformer, generator, motor and feeder.
- CO6.** Apply software tools to find bus voltage, currents and power flows throughout the electrical system.
- CO7.** work effectively in a team

Laboratory experiments

1. Study on the characteristics of on load time delay relay and off load time delay relay.
2. Test to find out polarity, ratio and magnetization characteristics of CT and PT.
3. Test to find out characteristics of
 - i. under voltage relay
 - ii. earth fault relay.
4. Study on DC load flow
5. Study on AC load flow using Gauss-seidel method
6. Study on AC load flow using Newton Raphson method.
7. Study on Economic load dispatch.
8. Study of different transformer protection schemes by simulation
9. Study of different generator protection schemes by simulation
10. Study of different motor protection schemes by simulation
11. Study of different characteristics of over current relay.
12. Study of different protection scheme for feeder.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-
7	1	-	-	2	-	3	-	-	-	1	-	2

Course Name: MICRO PROCESSOR AND MICRO CONTROLLER LABORATORY	Duration: 6 Months
Course Code: BEES691	Contact:
Semester: 6th	Credit: 1

- Course Outcome:** On successful completion of the course, student will be able to
- CO1.** identify appropriate equipment and instruments for the experiment
 - CO2.** test the instrument for application to the experiment
 - CO3.** construct circuits with appropriate instruments and safety precautions
 - CO4.** program 8086 for arithmetic operation, sorting of array, searching for a number in a string and string manipulation
 - CO5.** interface ADC/DAC, 8255, 8251 to 8086 and LCD, keyboard to 8051
 - CO6.** program 8051 using arithmetic, logical and bit manipulation instructions of 8051
 - CO7.** work effectively in a team

Laboratory experiments

1. Programs for 16 bit arithmetic operations for 8086 (using various addressing modes)
2. Program for sorting an array for 8086
3. Program for searching for a number or character in a string for 8086
4. Program for String manipulations for 8086
5. Program for digital clock design using 8086.
6. Interfacing ADC and DAC to 8086.
7. Parallel communication between two microprocessors using 8255.
8. Serial communication between two microprocessor kits using 8251.
9. Interfacing to 8086 and programming to control stepper motor.
10. Programming using arithmetic, logical and bit manipulation instructions of 8051
11. Program and verify Timer/Counter in 8051.
12. Program and verify interrupt handling in 8051.
13. UART operation in 8051.
14. Interfacing LCD to 8051.
15. Interfacing matrix or keyboard to 8051.
16. Data transfer from peripheral to memory through DMA controller 8237/8257

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-
7	1	-	-	2	-	3	-	-	-	1	-	2

Course Name: ELECTRICAL AND ELECTRONICS DESIGN LABORATORY	Duration: 6 Months
Course Code: BEEC692	Contact:
Semester: 6th	Credit: 3

Course Outcome: On successful completion of the course, student will be able to

- CO1. explain basic concept of measurement, noise in electronic system, sensor and signal conditioning circuits
- CO2. implement PC based data acquisition systems
- CO3. construct circuits with appropriate instruments and safety precaution
- CO4. design heating elements, air core grounding reactor, power distribution system for small township, double circuit transmission line and Electric machines
- CO5. do wiring and installation design of a multi-storied residential building with lift and pump
- CO6. design electronic hardware for controller of lift, speed of AC/DC motor, and for an application with analog, digital, mixed signal, microcontroller and PCB

Topics to be covered in the Lecture class:

1.	Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems,; System assembly considerations..	01
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Laboratory experiments

GROUP A

1. Designing a heating element with specified wattage, voltage and ambient temperature.
2. Designing an aircore grounding reactor with specified operating voltage, nominal current and fault current
3. Designing the power distribution system for a small township
4. Designing a double circuit transmission line for a given voltage level and power (MVA) transfer.
5. Wiring and installation design of a multistoried residential building (G+4, not less than 16 dwelling flats with a lift and common pump)

GROUP B

1. Designing an ONAN distribution transformer.
2. Designing a three phase squirrel cage induction motor.
3. Designing a three phase wound rotor induction motor.
4. Designing a split phase squirrel cage induction motor for a ceiling fan or a domestic pump.
5. Designing a permanent magnet fractional hp servo motor .

GROUP C

1. Design the control circuit of a Lift mechanism

2. Design a controller for speed control of DC machine.
3. Design a controller for speed control of AC machine.
4. Electronic system design employing electronic hardware (Analog, Digital, Mixed signal), microcontrollers, CPLDs, and FPGAs, PCB design and layout leading to implementation of an application

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: ANALOG AND DIGITAL COMMUNICATION	Duration: 6 months
Course Code: BEES701	Contact:
Semester: 7th	Credit:

Prerequisites:

1. Analog Electronics
2. Digital Electronics

Course Objective: The purpose of this course is to provide...

1. To understand the AM, FM and PM schemes with reference to SNR
2. To understand the performance of ASK, FSK, PSK, BPSK, QPSK in a digital communication system
3. To understand the source coding and channel coding schemes for a given communication link
4. To understand the band width requirement and probability of error in various digital modulation systems
5. To understand various digital modulation methods
6. To solve numerical problems on the topics studied
- 7.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** compare the performance of AM, FM and PM schemes with reference to SNR
- CO2.** explain noise as a random process and its effect on communication receivers
- CO3.** evaluate the performance of ASK, FSK, PSK, BPSK, QPSK in a digital communication system
- CO4.** identify source coding and channel coding schemes for a given communication link
- CO5.** analyze various digital modulation methods
- CO6.** compute band width requirement and probability of error in various digital modulation systems

Course Content

Unit No	Module Name	Content	Hrs
1	Elements of communication system	The elements of a communication system, origin of noise and its effect, importance of SNR in system design. Basic principle of linear (AM) modulation, Generation of AM waves, Demodulation of AM wave. Basic principle of nonlinear (FM, PM) modulation. Generation of FM waves. Demodulation of FM waves. Sampling theorem, sampling rate, impulse sampling, reconstruction from samples, Aliasing. Analog pulse modulation-PAM (natural & flat topped sampling), PWM, PPM. Basic concept of Pulse code modulation, Block diagram of PCM, Multiplexing-TDM, FDM.	

2	Digital transmission	Concept of Quantization & Quantization error, Uniform quantizer, Non-uniform quantizer, A-law and μ -law. Encoding, coding efficiency. Line coding & properties, NRZ & RZ, AMI, Manchester coding, PCM, DPCM. Base band pulse transmission, Matched filter, error rate due to noise, ISI, Raised cosine function, Nyquist criterion for distortion-less base band binary transmission, Eye pattern, Signal power in binary digital signal.
3	Digital carrier modulation & demodulation technique	Bit rate, Baud rate, Information capacity, Shannon's limit, M-ary encoding, Introduction to the different digital modulation techniques-ASK,FSK, PSK, BPSK, QPSK, mention of 8 BPSK, 16 BPSK. Introduction to QAM, basic of 8 QAM, 16 QAM. Basic concept of Delta modulating, Adaptive delta modulation. Introduction to the concept DPCM. Basic concept of spread spectrum modulation.
4	Introduction to coding theory	Introduction, News value & Information content, Entropy, Mutual information, Information rate, Shannon-Fano algorithm for encoding, Shannon's theorem- source coding theorem, Channel coding theorem, Information capacity theorem. Basic principle of Error control & coding.

Text book:

1. An Introduction to Analog and Digital communication, Simon Haykin, Wiley India.
2. Analog communication system, P. Chakrabarti, Dhanpat Rai & Co.
3. Principle of digital communication, P. Chakrabarti, Dhanpat Rai & Co.
4. Modern Digital and Analog Communication systems, B.P. Lathi, Oxford university press

Reference books

1. Digital and Analog communication Systems, Leon W Couch II, Pearson Education Asia.
2. Communication Systems, A.B. Calson, Mc Graw Hill.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: Power Generation Economics	Duration: 6 months
Course Code: BEED701A	Contact:
Semester: 7th	Credit: 3

Prerequisites:

Power System

Course Objective: The purpose of this course is to provide...

1. To introduce students to different aspects of power plant engineering.
2. To make them familiarize to the working of power plants based on different fuels.
3. Students have a better understanding about Load frequency control system.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Resolve the economic issues of various power plants.
- CO2.** Understand the guiding factors behind different electrical tariff systems.
- CO3.** Understand the basic techniques for unit commitment.
- CO4.** Apply optimization techniques for economic operation of electric power.
- CO5.** Get familiar with techniques for state estimation and load forecasting in power system.

Course Content

Unit No	Module Name	Content	Hrs
1	Cost of generation	Thermal, Hydro and Nuclear; types of consumers in a distribution system: domestic, commercial, industrial etc; concept of load factor, plant capacity factor, plant use factor, diversity factor, demand factor; choice of size and number of generation units.	10
2	Factors influencing tariff, types of consumers, different types of tariffs	block rate tariff, flat rate tariff, two part tariff, maximum demand tariff, power factor tariff and three part tariff; availability based tariff (ABT), availability based tariff of generation companies, pool tariff of transmission companies.	8
3	Constraints in unit commitment	Constraints in unit commitment, spinning reserve, thermal unit constraints, hydro constraints, fuel constraints, unit commitment solution methods.	8
4	Transmission loss formulae and its application	Transmission loss formulae and its application in economic load scheduling, computational methods in economic load scheduling, active and reactive power optimisation	10
5	methods of state estimation	Introduction, methods of state estimation, concept of load forecasting, load forecasting technique and application in power system.	9

Text book:

1. L.K. Kirchmayar, Economic Operation of Power System, John Wiley, Newyork.
2. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, Tata McGraw Hill.
3. P. S. R. Murthy, Operation and Control in Power System, BSP Publication.

Reference books

B. Tech. EE

1. A. J. Wood and B. F. Wollenberg, Power Generation Operation & Control, Wiley India.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: Advanced Power Electronics	Duration: 6 months
Course Code: BEED701B	Contact:
Semester: 7th	Credit: 3

Prerequisites:

Power Electronics

Course Objective: The purpose of this course is to provide...

1. The course focuses on presenting the fundamental concepts on conversion, control and monitoring of electric energy using power semiconductor devices.
2. Methods for analysing power electronic converters suitable for AC/DC, DC/DC and DC/AC

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Acquire knowledge on operation of non-isolated and isolated DC-DC converters
CO2. Develop analytical competence required for modeling and simulation of these converters.
CO3. Develop competence in design of circuit for different converters.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Introduction, power modules, intelligent power modules, gating circuits, thermal design, protection, digital signal processors used in their control	8
2	Buck boost, Cuk, Zeta in DCM and CCM	Buck boost, Cuk, Zeta in DCM and CCM, Isolated dc-dc converters, Flyback, push-pull bridge in DCM and CCM, Single-phase single-stage converters (SSSSC), power factor correction at ac mains in these converters, Their application in SMPS UPS welding and lighting systems.	10
3	Power Converters	Single-phase improved power quality ac-dc converters, buck boost, buck-boost, PWM VSC (Voltage source converters), multilevel VSCs, PWM CSC (Current voltage source converters), Three-phase improved power quality ac-dc converters, VSC , multilevel VSCs, multipulse VSCs, PWM CSC (Current voltage source converters), multipulse ac-dc converters: Diode and thyristor based converters.	10
4	Power quality mitigation devices	Power quality mitigation devices, passive filters, active filters, hybrid filters, DTSTCOM (Distribution static compensator), DVR (Dynamic voltage restorer), UPQC (Universal power quality conditioner).	8
5	Vector control and direct torque control	Vector control and direct torque control of induction, synchronous, permanent magnet sine fed, synchronous reluctance motors, permanent magnet brushless dc (PMLDC) and switched reluctance motors, LCI(load commutated inverter) fed large rating synchronous motor drives, energy conservation and power quality improvements in these drives.	9

Text book:

1. M. H. Rashid, *Power Electronics: Devices, Circuits and Applications*, 4th Ed., Pearson Education, 2017.
2. N. Mohan, T. M. Undeland and W. P. Robbins, *Power Electronics: Converter, Application and Design*, 3rdEd., Willey, 2007.
3. Daniel W. Hart, *Power Electronics*, Indian Edition, McGraw Hill Education, 2017.

Reference books

1. B. K. Bose, *Power Electronics and Variable Frequency Drive: Technology and Applications*, Wiley, 2010.
2. R. S. Ramshaw, *Power Electronics Semiconductor Switches*, 2nd Ed., Springer, 1993.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Battery Management System	Duration: 6 months
Course Code: BEED701C	Contact:
Semester: 7th	Credit: 3

Prerequisites:

Basic Electrical Engineering, Mathematics. Especially Differential Equations and Modelling, Control Systems, Feedback systems, transfer functions, stability Use of PID controllers, state-space models, Embedded Systems / Microcontrollers (Desirable), Microcontroller basics, ADC/DAC, sensors and interfacing Use of CAN, I2C, SPI protocols for communication

Course Objective: The purpose of this course is to provide...

1. To provide foundational knowledge of battery systems including cell configurations, charging/discharging mechanisms, and key parameters such as voltage, capacity, and C-rate.
2. To understand the functional requirements of a Battery Management System, including sensing techniques, safety protections, thermal management, and communication protocols.
3. To explore methods for estimating battery State of Charge (SOC) and State of Health (SOH) using voltage-based and model-based approaches, along with
4. insights into lithium-ion battery aging.
5. To develop the ability to model, simulate, and design efficient BMS systems, including the use of equivalent circuit models, electric vehicle simulations, and energy balancing in multi-battery configurations.

Course Outcome: On successful completion of the course, student will be able to

CO1: Describe battery systems, cell types, charging/discharging processes

CO2: Explain BMS functionalities and safety mechanisms

CO3: Analyze SOC and SOH estimation methods

CO4: Develop and simulate battery models and EV simulations

CO5: Design BMS and implement energy balancing.

Course Content

Unit No	Module Name	Content	Hrs
1	INTRODUCTION	Introduction to Battery Management System (BMS), Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.	4
2	BATTERY MANAGEMENT-SYSTEM REQUIREMENTS	Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation.	8
3	BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION	Preliminary definitions. - Battery state of charge estimation (SOC)-voltage-based methods to estimate SOC, Model-based state estimation - Battery State of Health Estimation (SOH) - Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode	9

4	MODELLING AND SIMULATION	Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics based modelling approach, simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs.	12
5	DESIGN OF BMS	Design of battery BMS: Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system	12

Text Books

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, G., Battery Management Systems: Volume II, Equivalent-Circuit Methods, Artech House, 2015
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L. "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.

Reference Books

1. Davide Andrea, " Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
2. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery powered applications. Vol. 9. Springer Science & Business Media, 2008.

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1:	3	2	-	-	-	-	-	-	-	-	-	1
CO2:	3	2	1	-	1	-	-	-	-	-	-	1
CO3:	3	3	1	2	1	-	-	-	-	-	-	1
CO4:	2	3	2	3	3	-	-	-	-	-	-	1
CO5:	2	3	3	2	2	-	1	-	-	-	-	1

Course Name: BIGDATA ANALYTICS	Duration: 6 months
Course Code: BEEG701A	Contact:
Semester: 7th	Credit: 3

Prerequisites:

Basic knowledge in data storage and retrieval, Knowledge in Quantitative Aptitude and Statistics, Proficiency in Algorithms and Computer Programming Skills.

Course Objective: The purpose of this course is to provide...

1. Understand the Big Data Platform and its Use cases
2. Provide an overview of Apache Hadoop
3. Provide HDFS Concepts and Interfacing with HDFS
4. Understand Map Reduce Jobs
5. Provide hands on Hadoop Eco System
- 6.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Identify Big Data and its Business Implications.
- CO2.** List the components of Hadoop and Hadoop Eco-System
- CO3.** Access and Process Data on Distributed File System
- CO4.** Manage Job Execution in Hadoop Environment

Course Content

Unit No	Module Name	Content	Hrs
1	INTRODUCTION TO BIG DATA AND HADOOP	Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.	8
2	HDFS(Hadoop Distributed File System)	The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.	10
3	Map Reduce	Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	8
4	Hadoop Eco System Pig	Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction.	8
5	Data Analytics with R Machine Learning	Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	11

Text book:

1. Tom White — Hadoop: The Definitive Guide| Third Edit on, O’reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference books

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis|, Springer, 2007.
2. Jay Liebowitz, —Big Data and Business Analytics| Auerbach Publications, CRC press (2013)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: INTERNET OF THINGS	Duration: 6 months
Course Code: BEEG701B	Contact:
Semester: 7th	Credit: 3

Prerequisites:

Operating System, Wireless Sensor Networks, Computer Networks, Cryptography, Communication Technology, Python Programming Language, and Cloud computing.

Course Objective: The purpose of this course is to provide...
Students will be explored to the interconnection and integration of the physical world and the cyber space.
They are also able to design & develop IOT Devices.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Able to understand the application areas of IOT.
- CO2.** Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
- CO3.** Able to understand building blocks of Internet of Things and characteristics.

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction & Concepts	Introduction to Internet of Things, Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels.	8
2	Domain Specific IOTs	Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style.	10
3	M2M & System Management with NETCONF-YANG	M2M, Difference between IOT and M2M, SDN and NFV for IOT, Software defined Networking, Network Function Virtualization, Need for IOT Systems Management, Simple Network Management Protocol, Limitations of SNMP, Network Operator Requirements, NETCONF, YANG, IOT Systems management with NETCONF-YANG.	10
4	Developing Internet of Things & Logical Design using Python	Introduction, IOT Design Methodology, Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time Operations, Classes, Python Packages	10
5	IOT Physical Devices & Endpoints	What is an IOT Device, Exemplary Device, Board, Linux on Raspberry Pi, Interfaces, and Programming & IOT Devices.	7

Text book:

1. Vijay Madiseti, Arshdeep Bahga,|| Internet of Things A Hands-On- Approach||,2014, ISBN:978 0996025515

Reference books

1. Adrian McEwen, —Designing the Internet of Things||, Wiley Publishers, 2013, ISBN: 978-1-118-43062-0 2.

2. Daniel Kellmerit, —The Silent Intelligence: The Internet of Thingsl. 2013, ISBN 0989973700

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: MACHINE LEARNING	Duration: 6 months
Course Code: BEEG702A	Contact:
Semester: 7th	Credit: 3

Prerequisites: NIL

Course Objective: The purpose of this course is to provide...

1. Acquire theoretical Knowledge on setting hypothesis for pattern recognition
2. Apply suitable machine learning techniques for data handling and to gain knowledge from it
3. Evaluate the performance of algorithms and to provide solution for various realworld applications

Course Outcome: On successful completion of the course, student will be able to

- CO1. Recognize the characteristics of Machine Learning techniques that enable to solve real world problems.
- CO2. Recognize the characteristics of machine learning strategies.
- CO3. Apply various supervised learning methods to appropriate problems.
- CO4. Identify and integrate more than one techniques to enhance the performance of learning.
- CO5. Create probabilistic and unsupervised learning models for handling unknown pattern.
- CO6. Analyze the co-occurrence of data to find interesting frequent patterns

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction	Introduction, Examples of Various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces, PAC Learning, VC Dimension	3
2	Decision Trees	ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Support vector machines: Linear and Non- Linear, Kernel Functions, KNearest Neighbours.	9
3	Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging	Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking	3
4	Introduction to clustering, Hierarchical	AGNES, DIANA, Partitional: K-means clustering, K-Mode Clustering, Expectation Maximization, Gaussian Mixture Models	5
5	Bayesian Learning	Bayesian Learning, Bayes Optimal Classifier, Naive Bayes Classifier, Bayesian Belief Networks	3
6	Mining Frequent Patterns	basic concepts -Apriori algorithm, FP- Growth algorithm, Associationbased Decision Trees	3
7	Design, Analysis and Evaluation of Machine Learning Experiments, Other Issues	Design, Analysis and Evaluation of Machine Learning Experiments, Other Issues: Handling imbalanced data sets	2
8	Recent Trends in Big Data Analytics	Recent Trends in Big Data Analytics	2

Text book:

1. Ethem Alpaydin, ||Introduction to Machine Learning||, MIT Press, Prentice Hall of India, Third Edition 2014.
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar ||Foundations of Machine Learning||, MIT Press, 2012.
3. Tom Mitchell, —Machine Learning||, McGraw Hill, 3rd Edition, 1997

Reference books

1. Charu C. Aggarwal, —Data Classification Algorithms and Applications||, CRC Press, 2014.
2. Charu C. Aggarwal, —DATA CLUSTERING Algorithms and Applications||, CRC Press, 2014.
3. Kevin P. Murphy ||Machine Learning: A Probabilistic Perspective||, The MIT Press, 2012.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: SOFT COMPUTING	Duration: 6 months
Course Code: BEEG702B	Contact:
Semester: 7th	Credit: 3

Prerequisites: NIL

Course Objective: The purpose of this course is to provide...

The objective of this course is to introduce methods for handling imprecise and uncertain data using Rough sets, Neuro Fuzzy Systems and foster their abilities in designing and implementing optimal solutions for real-world and engineering problems using derivative free optimization techniques.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Recognize the characteristics of Machine Learning techniques that enable to solve real world problems.
- CO2.** Recognize the characteristics of machine learning strategies.
- CO3.** Apply various supervised learning methods to appropriate problems.
- CO4.** Identify and integrate more than one techniques to enhance the performance of learning.
- CO5.** Create probabilistic and unsupervised learning models for handling unknown pattern.
- CO6.** Analyze the co-occurrence of data to find interesting frequent patterns

Course Content

Unit No	Module Name	Content	Hrs
1	Soft Computing Overview	Soft Computing Overview – Uncertainty in data, Hard vs Soft Computing	3
2	Introduction	Introduction, RBF Networks, Self-Organizing Map, Boltzmann Machines, Convolutional Neural Networks	6
3	Fuzzy Sets	Fuzzy Sets, Fuzzy Relations, and Membership functions, Properties of Membership functions, Fuzzification and Defuzzification.	3
4	Fuzzy Rule based systems	Fuzzy Rule based systems, Fuzzy Decision making, Fuzzy Classification, Fuzzy CMeans Clustering.	4
5	Rough Sets	Rough Sets – Definition, Upper and Lower Approximations, Boundary Region, Decision Tables and Decision Algorithms. Properties of Rough Sets. Rough K- means clustering, Rough	3
6	Algorithms	Introduction, Genetic Algorithm, Memetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization, Frog-Leaping.	4
7	Propagation Networks	D GA Based Back Propagation Networks, Fuzzy Back Propagation Networks, Evolutionary Ensembles	6

Text book:

1. S.N. Sivanandham and S.N.Deepa, —Principles of Soft Computing, 2nd Edition, Wiley Publications.
2. Andries P. Engelbrecht, "Computational Intelligence: An Introduction", John Wiley & Sons, 2007

Reference books

1. Laurene V. Fausett —Fundamentals of Neural Networks: Architectures, Algorithms And Applicationsl, Pearson,1993.
2. Simon Haykin "Neural Networks and Learning Machines" Prentice Hall,2008. Timothy Ross, —Fuzzy Logic with Engineering Applicationsl, Third Edition,Wiley.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2
6	2	1	-	-	2	-	-	-	-	-	3	-

Course Name: Electric Drives	Duration: 6 months
Course Code: BEES801	Contact:
Semester: 7th	Credit: 3

Prerequisites:

1. Electrical Motor,
2. Power Eletronics.

Course Objective: The purpose of this course is to provide... To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
- CO2.** To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
- CO3.** To provide strong foundation to asses performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities.

Course Content

Unit No	Module Name	Content	Hrs
1		Classifications, four quadrant operation of an electric drive, types of loads and components of load toques, dynamics of motor-load combination, equivalent value of drive parameters for loads with rotational and translational motion, steady state stability of an electric drive system, transient stability, multi quadrant operation of drives, load equalization.	10
2		Classes of Motor duty, determination of rating of motors for various applications, equivalent current and equivalent torque, effect of load inertia over motor rating, methods of determination of rating for fluctuating and intermittent loads, effect of load inertia and environmental factors.	8
3		Modification of characteristics of DC shunt and series motors, Methods of starting DC motor, fundamental parameters of speed control, methods of speed control of DC shunt and series motors, concept of electric braking, regenerative dynamic and counter current braking of DC motors, phase controlled and chopper controlled DC separately excited motor and series motor drives, closed loop control scheme for DC motor.	8

4		Modification of speed torque characteristics due to variation of stator voltage stator frequency and rotor resistance, methods of starting for squirrel cage and slip ring induction motors, methods of speed control of induction motors, slip power recovery, control of IM by three phase AC-AC voltage controller, chopper control of rotor resistance, speed control using slip power recovery schemes, PWM inverter fed induction motor drives, current source inverter fed induction motor drives, comparison of VSI & CSI fed drives.	10
5		Self control, voltage source inverter fed synchronous motor drive, vector control, introduction to solar and battery powered drive, stepper motor, switched reluctance motor drive industrial application, drive consideration for textile mills steel rolling mills cement mills paper mills machine tools, cranes and hoist drives.	9

Text book:

1. G. K. Dubey, *Fundamentals of Electrical Drives*, 2ndEd., Narosa, 2010.
2. Vedam Subrahmanyam, *Electric Drives: Concepts and Applications*, 2ndEd., McGraw Hill Education, 2017.

Reference books

1. Ned Mohan, *Electric Machines and Drives: A First Course*, Wiley, 2013.
2. S. K. Pillai, *A First Course on Electrical Drives*, 3rdEd., New Age International, 2012.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Sensors and Transducers	Duration: 6 months
Course Code: BEED801A	Contact:
Semester: 8th	Credit: 3

Prerequisites: Measurement and Instrumentation

Course Objective: The purpose of this course is to provide...
To gain knowledge about the measuring instruments and the methods of measurement and the use of different transducers

Course Outcome: On successful completion of the course, student will be able to

- CO1.** To get the basic idea of measurements and the errors associated with measurement.
- CO2.** To differentiate between the types of transducers available
- CO3.** To gain information about the function of various measuring instruments and using them

Course Content

Unit No	Module Name	Content	Hrs
1	Introduction to Sensor,	Introduction to Sensor, Transducer and Actuator, Sensor types and technologies. Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time. Frequency responses, calibration, feedback control.	
2		Electromechanical Sensor: Definition, principle of sensing & transduction, classification. Force Sensors: Proximity sensor: Piezoelectric element: piezoelectric effect, charge and voltage coefficient, crystal model, materials, natural & synthetic type, their comparison, force and stress sensing, ultrasonic sensors. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes. Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, construction and input output variable, Ferromagnetic plunger type, short analysis.	
3		Flow Sensors: Flow velocity (insertion type) measurement – Pilot tube, hot wire and hot film anemometers, Drag force and turbine flow meters, Flow rates by pressure variation measurement, venturi, flow nozzle and orifice meters, Ultrasonic and cross correlation flow meters. Displacement Sensors: LVDT: Construction, material, output input relationship, I/O curve, discussion. Thermal sensors: Bimetallic thermometers, RTD, Thermistor, Thermocouple and associated circuitry, Radiation and optical pyrometry, Digital IC thermometers, Accuracy, Errors and compensation, IR sensors Negative Temperature Coefficient (NTC) thermistor	

4	Typical applications of sensors. Weather Monitoring Systems, Water Monitoring Systems, Battery Monitoring Systems, Smart phone sensors.
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Text book:

1. Ernest Doebelin and Dhanesh N. Manik, *Doebelin's Measurement Systems*, 6th Ed., McGraw Hill Education, 2017.
2. Ian Sinclair, *Sensors and Transducers*, Elsevier, 2011.
3. D. Patranabis, *Sensors and Transducers*, 2nd Ed., Prentice Hall of India Learning Pvt. Ltd., 2003.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Fuzzy Control System	Duration: 6 months
Course Code: BEED801B	Contact:
Semester: 8th	Credit: 3

Prerequisites: Measurement and Instrumentation

Course Objective: The purpose of this course is to provide...
To gain knowledge about the measuring instruments and the methods of measurement and the use of different transducers

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Comprehend the concepts of feed forward neural networks.
- CO2.** Analyze the various feedback networks.
- CO3.** Understand the concept of fuzziness involved in various systems and fuzzy set theory.
- CO4.** Comprehend the fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.
- CO5.** Analyze the application of fuzzy logic control to real time systems.

Course Content

Unit No	Module Name	Content	Hrs
1		Introduction, intelligent control, fuzzy logic, fuzzy control, fuzzy mathematics, applications, rule base, fuzzy sets, fuzzy system, classic versus fuzzy control system design, an example of fuzzy control.	10
2		Fuzzy sets and membership functions, mathematical operations on fuzzy sets, fuzzy relations, linguistic variables, fuzzy rules, approximate reasoning.	8
3		Fuzzy rule base, fuzzy inference engine, fuzzifier, defuzzifier, mathematical representations of fuzzy systems, approximation properties of fuzzy systems.	8
4		Trial and error approach, control surface of a fuzzy controller, stable fuzzy controllers, fuzzy PID controllers, comparison with conventional PID controllers, fuzzy PID Controllers: stability analysis, optimal fuzzy controllers, robust fuzzy controllers.	8
5		Look-up table scheme, gradient descent training, batch algorithm, clustering.	8
6		Indirect adaptive fuzzy controller, direct adaptive fuzzy controller, self-organizing fuzzy logic control.	5

Text Books:

1. George J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, 1st Ed., Pearson Education, 2015.
2. S. S. Farinwata, D. P. Filev and R. Langari, *Fuzzy Control: Synthesis and Analysis*, 1st Ed., Wiley-Blackwell, 2000.

Reference Books:

1. Bernard Friedland, *Foundations of Fuzzy Control: A Practical Approach*, 2nd Ed., Wiley-Blackwell, B. Tech. EE

2013.

2. Li-Xin Wang, *A Course in Fuzzy Systems and Control*, Prentice Hall, 1996.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	2	-	-	1	2	3	-	-	-	-	-
5	3	3	-	2	-	2	3	-	1	-	3	2

Course Name: E-Commerce and ERP	Duration: 6 months
Course Code: BEEG801A	Contact:
Semester: 8th	Credit: 3

Prerequisites: NIL

Course Objective: The purpose of this course is to provide...

This course provides an introduction to information systems for business and management. It is designed to familiarize students with organizational and managerial foundations of systems, the technical foundation for understanding information systems

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Understand the basic concepts and technologies used in the field of management information systems;
- CO2.** Have the knowledge of the different types of management information systems;
- CO3.** Understand the processes of developing and implementing information systems; **CO4.** Be aware of the ethical, social, and security issues of information systems

Course Content

Unit No	Module Name	Content	Hrs
1	Overview	Overview, Definitions, Advantages & Disadvantages of E-Commerce, Threats of E-Commerce, Managerial Prospective, Rules & Regulations For Controlling E-Commerce, Cyber Laws.	4
2	Technologies	Model Based On Transaction Type, Model Based On Transaction Party B2B, B2C, C2B, C2C, E-Governance.	4
3	Business Models of e-commerce	Model Based On Transaction Type, Model Based On Transaction Party B2B, B2C, C2B, C2C, E-Governance.	4
4	E-strategy	Overview, Strategic Methods for developing E-commerce.	4
5	Four C's	(Convergence, Collaborative Computing, Content Management & Call Center). Convergence: Technological Advances in Convergence Types, Convergence and its implications, Convergence & Electronic Commerce. Collaborative Computing: Collaborative product development, contract as per CAD, Simultaneous Collaboration, Security. Content Management: Definition of content, Authoring Tools & Content Management, Content partnership, repositories, convergence, providers, Web Traffic & Traffic Management ; Content Marketing. Call Center: Definition, Need, Tasks Handled, Mode of Operation, Equipment, Strength & Weaknesses of Call Center, Customer Premises Equipment (CPE).	4
6	Supply Chain Management	E-logistics, Supply Chain Portal, Supply Chain Planning Tools (SCP Tools), Supply Chain Execution (SCE), SCE Framework, Internet's effect on Supply Chain Power.	4
7	E-Payment Mechanism	Payment through card system, E-Cheque, E-Cash, E-Payment Threats & Protections.	4

8	E-Marketing	Home shopping, E-Marketing, Tele-marketing	4
9	Electronic Data Interchange (EDI)	Overview, Security for E-Commerce, Security Standards, Firewall, Cryptography, Key Management, Password Systems, Digital certificates, Digital signatures	4
10	Risk of E-Commerce	Overview, Security for E-Commerce, Security Standards, Firewall, Cryptography, Key Management, Password Systems, Digital certificates, Digital signatures	4

Text Books

1. E-Commerce, M.M. Oka, EPH
2. Kalakotia, Whinston : Frontiers of Electronic Commerce , Pearson Education.

Reference Books

1. Bhaskar Bharat: Electronic Commerce Technologies & Applications. TMH
2. Loshin Pete, Murphy P.A. : Electronic Commerce , Jaico Publishing Housing.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3

Course Name: Economic Policies in India	Duration: 6 months
Course Code: BEEG801B	Contact:
Semester: 8th	Credit: 3

Prerequisites: NIL

Course Objective: The purpose of this course is to provide...

1. Develop an understanding of national income accounting, inflation and interest rates.
2. Possess deeper understanding of the concepts like multiplier, monetarism, the natural level of unemployment, and fiscal policy.

Course Outcome: On successful completion of the course, student will be able to

- CO1.** Develop an understanding of national income accounting, inflation and interest rates.
CO2. Possess deeper understanding of the concepts like multiplier, monetarism, the natural level of unemployment, and fiscal policy.

Course Content

Unit No	Module Name	Content	Hrs
1	Economic Development and its Determinants	Approaches to economic development and its measurement sustainable development; Role of State, market and other institutions; Indicators of development PQLI, Human Development Index (HDI), gender development indices.	6
2	Planning in India Objectives and strategy of planning	Failures and achievements of Plans; Developing grass root organizations for development Panchayats, NGOs and pressure groups. Demographic Features, Poverty and Inequality Broad demographic features of Indian population; rural urban migration; Urbanization and civic amenities; Poverty and Inequality. Resource Base and Infrastructure Energy; social infrastructure education and health; Environment; Regional imbalance; Issues and policies in financing infrastructure development.	6
3	The Agricultural Sector Institutional Structure	land reforms in India; Technological change in agriculture pricing of agricultural inputs and output; industry; Agricultural finance policy; Agricultural Marketing and Warehousing; Issues Terms of trade between agriculture and in food security policies for sustainable agriculture.	6
4	Industrial policy	Public Sector enterprises and their performance; Problem of sick units in India; Privatization and disinvestment debate; Growth and pattern of industrialization; Small scale sector; Productivity in industrial sector; Exit policy issues in labour market reforms; approaches for employment generation.	9

5	Public Finances Fiscal federalis	Centre State financial relations; Finances of central government; Finances of state governments; Parallel economy; Problems relating to fiscal policy; Fiscal sector reforms in India. Money, Banking and Prices Analysis of price behaviour in India; Financial sector reforms; Interest rate policy; Review of monetary policy of RBI; Money and capital markets; Working of SEBI in India.	6
6	External Sector	Structure and direction of foreign trade; Balance of payments; Issues in export import policy and FEMA; Exchange rate policy; Foreign capital and MNCs in India; The progress of trade reforms in India.	6
7	Economic Reforms Rationale of internal and external reforms	Economic Reforms Rationale of internal and external reforms; Globalization of Indian economy; WTO and its impact on the different sectors of the economy; Need for and issues in good governance; Issues in competition and safety nets in Indian economy.	6

Text Books

1. Ahluwalia, I. J. and I. M. D Little (Eds.) (1999), India's Economic Reforms and Development
2. (Essays in honour of Manmohan Singh), Oxford University Press, New Delhi.

Reference Books

1. Bardhan, P. K. (9th Edition) (1999), The Political Economy of Development in India, Oxford University Press, New Delhi.
2. Bawa, R. s. and P. S. Raikhy (Ed.) (1997), Structural Changes in Indian Economy, Guru Nanak Dev University Press, Amritsar.

After completion of this course, the learners will be able to

1. Student will be able to understand the links between household behavior and the economic models of demand.
2. It will also help in understanding the efficiency and equity implications of market interference, including government policy.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3

Course Name: ELECTRICAL AND ELECTRONICS DRIVES LABORATORY	Duration: 6 months
Course Code: BEE892	Contact:
Semester: 8th	Credit: 1

Course Outcome: On successful completion of the course, student will be able to

- CO1. Identify appropriate equipment and instruments for the experiment.
- CO2. Test the instrument for application to the experiment.
- CO3. Construct circuits with appropriate instruments and safety precautions.
- CO4. Apply different methods of control of Electric Drive in the laboratory
- CO5. Analyse experimental data obtained in the laboratory
- CO6. Work effectively in a team

Laboratory experiments

1. Simulation of six step inverter fed 3-phase Induction Motor Drive.
2. Simulation of Brushless DC Motor Drive.
3. Simulation of four quadrant Chopper fed DC Motor Drive.
4. Study of Thyristor Controlled DC drive.
5. Simulation of PWM inverter fed 3 phase Induction Motor drive using .
6. Speed Control of a separately excited DC Motor Drive fed by step-down chopper.
7. Study of Chopper fed DC Drive.
8. Speed Control of single phase Induction Motor using AC voltage controller.
9. Speed Control of DC Motor Using a Full Controlled converter.
10. Speed Control of Three Phase Induction Motor using V/f Control Technique.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	2	-	-	-	-	1	2	2	2
2	3	3	3	3	-	-	-	-	1	1	2	3
3	3	3	2	1	-	2	1	-	1	-	3	3
4	2	-	-	1	-	-	2	-	-	-	-	1
5	-	-	2	-	-	3	-	-	-	-	2	-
6	1	3	-	-	-	1	-	2	-	-	-	-