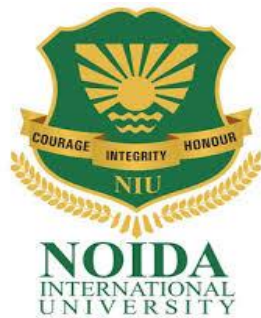


# **Noida International University**



## **Evaluation Scheme & Syllabus**

**For**

**UNDERGRADUATE DEGREE COURSE IN**

# **ELECTRICAL & ELECTRONICS ENGINEERING**

**On**

**AICTE MODEL CURRICULUM**

**(Effective from the Session: 2019-20)**

**Undergraduate Degree Course in  
Engineering & Technology  
ELECTRICAL & ELECTRONICS  
ENGINEERING  
CONTENTS**

Sl. No.	Chapter	Title
1	1	General, Course Structure, Theme & Credit Distribution
2	2	Detailed 4-YEAR Curriculum Contents
	(i)	<b>Basic Science Courses</b>
		BSC 101: Mathematics – I (Calculus and Differential Equations)
		BSC 102: Physics-I (Waves and Optics and Introduction to Quantum Mechanics)
		BSC 103: Mathematics-II (Linear Algebra, Transform Calculus and Numerical Methods)
		BSC 104: Chemistry –I
		BSC 201: Mathematics-III (Probability and Statistics)
		BSC 202: Biology-I
	(ii)	<b>Engineering Science Courses</b>
		ESC 101: Problem Solving through Programming (with C)
		ESC 102: Workshop/ Manufacturing Practices
		ESC 103: Engineering Graphics
		ESC 104: Basic Electrical Engineering
		ESC 201: Engineering Mechanics
	(iii)	<b>Humanities And Social Sciences Including Management</b>
		HSMC101: English
	(iv)	<b>Program Core Courses</b>
		EE01: Electrical Circuit Analysis
		EE02: Analog Electronic Circuits
		EE03: Analog Electronic Circuits Laboratory
		EE04: Electrical Machines-I
		EE05: Electrical Machines Laboratory
		EE06: Electromagnetic Fields
		EE07: Digital Electronics
		EE08: Digital Electronics Laboratory
		EE09: Electrical Machines – II
		EE10: Electrical Machines Laboratory– II
		EE11: Power Electronics
		EE12: Power Electronics Laboratory
		EE13: Signals and Systems

Sl. No.	Chapter	Title
		EE14: Power Systems-I
		EE15: Power Systems – I Laboratory
		EE16: Control Systems
		EE17: Control Systems Laboratory
		EE18: Microprocessors
		EE19: Microprocessor Laboratory
		EE20: Power Systems – II
		EE21: Power Systems-II Laboratory
		EE22: Measurements and Instrumentation Laboratory
		EE23 : Electronics Design Laboratory
	<b>(v)</b>	<b>Professional Elective Courses</b>
		PEC-EE01: Wind and Solar Energy Systems
		PEC-EE02: Line-Commutated and Active PWM Rectifiers
		PEC-EE03 : Electrical Drives
		PEC-EE04 : Electrical and Hybrid Vehicles
		PEC-EE05: Electrical Machine Design
		PEC-EE06: Power System Protection
		PEC-EE07: HVdc Transmission Systems
		PEC-EE08: Power Quality and FACTS
		PEC-EE09: High Voltage Engineering
		PEC-EE10: Electrical Energy Conservation and Auditing
		PEC-EE11: Industrial Electrical Systems
		PEC-EE12: Power System Dynamics and Control
		PEC-EE13: Digital Control Systems
		PEC-EE14: Digital Signal Processing
		PEC-EE15: Computer Architecture
		PEC-EE16: Electromagnetic waves
		PEC-EE17: Computational Electromagnetics
		PEC-EE18: Control Systems Design
		PEC-EE19: Advanced Electric Drives
	<b>(vi)</b>	<b>Project/Internship</b>
		PROJ-EE01: Project Work –I
		PROJ-EE02: Project Work II & Dissertation
		PROJ-EE: Summer Industry Internship

**Undergraduate Degree Course in  
Engineering & Technology  
ELECTRICAL & ELECTRONICS  
ENGINEERING**

**Chapter -1  
General, Course structure &  
credit distribution**

**Section -1****A. Definition of Credit:**

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical(Lab)/week	1 credit

**B. Range of credits** -A range of credits from 150 to 160 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

**C. Structure of Undergraduate Engineering program :**

Sl. No.	Topic	Credits of the EE Curriculum
1.	Humanities and Social Sciences including Management	<b>12</b>
2.	Basic Sciences	<b>26</b>
3.	Engineering Sciences including workshop, drawing, basics of electrical/mechanical/computer etc.	<b>20</b>
4.	Professional Core Subjects	<b>53</b>
5.	Professional Subjects: Subjects relevant to chosen specialization/branch	<b>18</b>
6.	Open Subjects: Electives from other technical and/or emerging subjects	<b>18</b>
7.	Project work, seminar and internship in industry or elsewhere	<b>12</b>
8.	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	<b>Non-credit</b>
	<b>Total</b>	<b>159</b>

**D. Credit distribution in the First year of Undergraduate Engineering program :**

	Lecture	Tutorial	Laboratory/Practical	Total credits
Chemistry-I	3	1	3	5.5
Physics-I	3	1	3	5.5
Mathematics-I	3	1	0	4
Mathematics –II	3	1	0	4
Programming for Problem solving	3	0	4	5
English	2	0	2	3
Engineering Graphics	1	0	4	3
Workshop/ Practical	1	0	4	3
Basic Electrical Engg.	3	1	2	5

**E. Course code and definition:**

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
EE	Professional core courses
PEC-EE	Professional Elective courses
OEC-EE	Open Elective courses
LC	Laboratory course
MC	Mandatory courses
PROJ-EE	Project

**Section 2:****BASIC SCIENCE COURSES**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Hrs. /Week L: T: P</b>	<b>Credits</b>
1	BSC 101	Mathematics – I (Calculus and Differential Equations)	3:1:0	4
2	BSC 102	Physics (Waves and Optics, and Introduction to Quantum Mechanics)	3:1:3	5.5
3	BSC 103	Mathematics – II (Linear Algebra, Transform Calculus and Numerical Methods)	3:1:0	4
4	BSC 104	Chemistry – I	3:1:3	5.5
5	BSC 201	Mathematics – III (Probability and Statistics)	3:1:0	4
6	BSC 202	Biology – I	2:1:0	3
		Total		26

**ENGINEERING SCIENCE COURSES**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Hrs. /Week L: T: P</b>	<b>Credits</b>
1	ESC 101	Programming for Problem Solving	3:0:4	5
2	ESC 102	Workshop/Manufacturing Practices	1:0:4	3
4	ESC 103	Engineering Graphics	1:0:4	3
5	ESC 104	Basic Electrical Engineering	3:1:2	5
6	ESC 201	Engineering Mechanics	3:1:0	4
		Total		20

**HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Hrs. /Week L: T: P</b>	<b>Credits</b>
1	HSMC 101	English	2:0:2	3
2	HSMC 201	Human Psychology	3:0:0	3
3	HSMC 202	Human values	3:0:0	3
4	HSMC 301	Management	3:0:0	3
		Total		12

**MANDATORY COURSES**

Sr. No.	Course Code	Course Title	Credits
1	MC	[Environmental Sciences, Constitution of India /Essence of Indian Knowledge Tradition]	Nil
Total			

**PROFESSIONAL CORE COURSES [ELECTRICAL ENGINEERING]**

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits
1	EE01	Electrical Circuit Analysis	3:1:0	4
2	EE02	Analog Electronics	3:0:0	3
3	EE03	Analog Electronics Laboratory	0:0:2	1
4	EE04	Electrical Machines – I	3:0:0	3
5	EE05	Electrical Machines Laboratory - I	0:0:2	1
6	EE06	Electromagnetic Fields	3:1:0	4
7	EE07	Digital Electronics	3:0:0	3
8	EE08	Digital Electronics Laboratory	0:0:2	1
9	EE09	Electrical Machines – II	3:0:0	3
10	EE10	Electrical Machines Laboratory - II	0:0:2	1
11	EE11	Power Electronics	3:0:0	3
12	EE12	Power Electronics Laboratory	0:0:2	1
13	EE13	Signals and Systems	2:1:0	3
14	EE14	Power Systems -I	3:0:0	3
15	EE15	Power Systems Laboratory -I	0:0:2	1
16	EE16	Control Systems	3:0:0	3
17	EE17	Control Systems Laboratory	0:0:2	1
18	EE18	Microprocessors	3:0:0	3
19	EE19	Microprocessors Laboratory	0:0:2	1
20	EE20	Power Systems - II	3:0:0	3
21	EE21	Power Systems Laboratory - II	0:0:2	1
22	EE22	Measurements and Instrumentation Lab	2:0:2	3
23	EE23	Electronic Design Laboratory	1:0:4	3
Total				53

**PROFESSIONAL ELECTIVE COURSES [ELECTRICAL ENGINEERING]**

<b>Sr. No</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Hrs. /Week L: T: P</b>	<b>Credits</b>
1	PEC-EE01	Wind and Solar Energy Systems	3:0:0	3
2	PEC-EE02	Line Commutated and Active Rectifiers	3:0:0	3
3	PEC-EE03	Electrical Drives	3:0:0	3
4	PEC-EE04	Electrical and Hybrid Vehicles	3:0:0	3
5	PEC-EE05	Electrical Machine Design	3:0:0	3
6	PEC-EE06	Power System Protection	3:0:0	3
7	PEC-EE07	HVDC Transmission Systems	3:0:0	3
8	PEC-EE08	Power Quality and FACTS	3:0:0	3
9	PEC-EE09	High Voltage Engineering	3:0:0	3
10	PEC-EE10	Electrical Energy Conservation and Auditing	3:0:0	3
11	PEC-EE11	Industrial Electrical Systems	3:0:0	3
12	PEC-EE12	Power System Dynamics and Control	3:0:0	3
13	PEC-EE13	Digital Control Systems	3:0:0	3
14	PEC-EE14	Digital Signal Processing	3:0:0	3
15	PEC-EE15	Computer Architecture	3:0:0	3
16	PEC-EE16	Electromagnetic Waves	3:0:0	3
17	PEC-EE17	Computational Electromagnetics	3:0:0	3
18	PEC-EE18	Control Systems Design	3:0:0	3
19	PEC-EE19	Advanced Electric Drives	3:0:0	3

**OPEN ELECTIVE COURSES [ELECTRICAL ENGINEERING]**

<b>Sl. No</b>	<b>Code No.</b>	<b>Subject</b>	<b>Credits</b>
01	OEC-EE01	Electronic Devices	3
02	OEC-EE02	Data Structures and Algorithms	3
03	OEC-EE03	Analog and Digital Communication	3
04	OEC-EE04	Computer Networks	3
05	OEC-EE05	Embedded Systems	3
06	OEC-EE06	VLSI circuits	3
07	OEC-EE07	Image Processing	3
08	OEC-EE08	Wavelet Transforms	3
09	OEC-EE09	Power Plant Engineering	3
10	OEC-EE10	Thermal and Fluid Engineering	3
11	OEC-EE11	Strength of Materials	3
12	OEC-EE12	Fluid Machinery	3
13	OEC-EE13	Automobile Engineering	3
14	OEC-EE14	Electrical Materials	3
15	OEC-EE15	Modern Manufacturing Processes	3
16	OEC-EE16	Internet of Things	3
17	OEC-EE17	Big Data Analysis	3

**Section 3:**

**4 year Curriculum structure Undergraduate Degree in  
Engineering & Technology**

**Branch / Course: Electrical Engineering Total credits (4 year  
course)159**

**I. Induction Program**

<b>Induction program (mandatory)</b>	<b>2 weeks duration</b>
Induction program for students to be offered right at the start of the first year.	<ul style="list-style-type: none"><li>• Physical activity</li><li>• Creative Arts</li><li>• Universal Human Values</li><li>• Literary</li><li>• Proficiency Modules</li><li>• Lectures by Eminent People</li><li>• Visits to local Areas</li><li>• Familiarization to Dept./Branch &amp; Innovations</li></ul>











**SIXTH SEMESTER**

S. No	Course Code	Subject	Period			Evaluation Scheme					Total Credits
			L	T	P	Sessional Exam			End Exams	Subject Total	
						CA	TA	Total			
<b>THEORY</b>											
1	EE20	Power Systems – II (Operation and Control)	3	0	0	20	20	40	60	100	3
2	EE22	Measurements and Instrumentation	3	0	0	20	20	40	60	100	3
3	PEC-EE02	Program Elective – 2	3	0	0	20	20	40	60	100	3
4	PEC-EE03	Program Elective – 3	3	0	0	20	20	40	60	100	3
5	OEC-EE02	Open Elective-2	3	0	0	20	20	40	60	100	3
<b>PRACTICALS</b>											
1	EE21P	Power Systems – II Lab	0	0	4	-	-	40	60	100	2
2	EE23P	Measurements and Instrumentation Lab	0	0	2	-	-	40	60	100	1
<b>Total</b>											<b>18</b>
PROJ EE		Summer Internship	During Summer Vacations / Non-credit								

**SEVENTH SEMESTER**

S. No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Total Credits
			L	T	P	CA	TA	Total	End Exams		
1	PEC-EE04	Program Elective – 4	3	0	0	20	20	40	60	100	3
2	PEC-EE05	Program Elective – 5	3	0	0	20	20	40	60	100	3
3	OEC-EE03	Open Elective-3	3	0	0	20	20	40	60	100	3
4	OEC-EE04	Open Elective-4	3	0	0	20	20	40	60	100	3
<b>PRACTICALS</b>											
1	PROJ-EE01	Project Stage-I	0	0	8	-	-	40	60	100	4
<b>Total</b>											<b>16</b>



## **CHAPTER 2**

### **DETAILED 4-YEAR CURRICULUM CONTENTS**

#### **Undergraduate Degree in Engineering & Technology**

**Branch/Course: ELECTRICAL & ELECTRONICS  
ENGINEERING**

<b>BASIC SCIENCE COURSES</b>
------------------------------

<b>BSC 101</b>	<b>Mathematics – I (Calculus and Differential Equations)</b>	<b>3L:1T:0P</b>	<b>4 credits</b>
----------------	--	-----------------	------------------

### **Contents**

#### **Module 1: Calculus (8 hours)**

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.

#### **Module 2: Sequences and Series (7 hours)**

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

#### **Module 3: Multivariable Calculus: Differentiation (6 hours)**

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

#### **Module 4: Multivariable Calculus: Integration (7 hours)**

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

#### **Module 5: First Order Ordinary Differential Equations (3 hours)**

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

#### **Module 6: Ordinary Differential Equations of Higher Order (6 hours)**

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.

#### **Module 7: Partial Differential Equations: First Order (3 hours)**

First order partial differential equations, solutions of first order linear and non-linear PDEs.

**Text / References:**

1. G.B. Thomas and R.L. Finney, “Calculus and Analytic geometry”, Pearson, 2002.
2. T. Veerarajan, “Engineering Mathematics” , McGraw-Hill, New Delhi, 2008.
3. B. V. Ramana, “ Higher Engineering Mathematics”, McGraw Hill, New Delhi, 2010.
4. N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, 2010.
5. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 2000.
6. E. Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, 2006.
7. W. E. Boyce and R. C. DiPrima, “Elementary Differential Equations and Boundary Value Problems”, Wiley India, 2009.
8. S. L. Ross, “Differential Equations”, Wiley India, 1984.
9. E. A. Coddington, “ An Introduction to Ordinary Differential Equations”, Prentice Hall India, 1995.
10. E. L. Ince, “Ordinary Differential Equations”, Dover Publications, 1958.
11. G.F. Simmons and S.G. Krantz, “Differential Equations”, McGraw Hill, 2007.

<b>BSC 102</b>	<b>Physics-I (Waves and Optics and Introduction to Quantum Mechanics)</b>	<b>3L:1T:3P</b>	<b>5.5 credits</b>
----------------	---	-----------------	--------------------

**Module 1: Waves (3 hours)**

Mechanical and electrical simple harmonic oscillators, damped harmonic oscillator, forced mechanical and electrical oscillators, impedance, steady state motion of forced damped harmonic oscillator

**Module 2: Non-dispersive transverse and longitudinal waves (4 hours)**

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves

**Module 3: Light and Optics (3 hours)**

Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster’s angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them

**Module 4: Wave Optics (5 hours)**

Huygens’ principle, superposition of waves and interference of light by wavefront splitting and amplitude splitting; Young’s double slit experiment, Newton’s rings, Michelson interferometer, Mach Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power

### **Module 5: Lasers (5 hours)**

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO<sub>2</sub>), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity

### **Module 6: Introduction to Quantum Mechanics (5 hours)**

Wave nature of Particles, Time-dependent and time-independent Schrodinger equation for wave function, Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle.

### **Module 7: Solution of Wave Equation(6 hours)**

Solution of stationary-state Schrodinger equation for one dimensional problems–particle in a box, particle in attractive delta-function potential, square-well potential, linear harmonic oscillator. Scattering from a potential barrier and tunneling; related examples like alpha-decay, field-ionization and scanning tunneling microscope, tunneling in semiconductor structures. Three-dimensional problems: particle in three dimensional box and related examples.

### **Module 8: Introduction to Solids and Semiconductors.(9 hours)**

Free electron theory of metals, Fermi level, density of states in 1, 2 and 3 dimensions, Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p -n junction.

### **Text / References:**

1. I. G. Main, "Vibrations and waves in physics", Cambridge University Press, 1993.
  2. H. J. Pain, "The physics of vibrations and waves", Wiley, 2006.
  3. E. Hecht, "Optics", Pearson Education, 2008.
  4. A. Ghatak, "Optics", McGraw Hill Education, 2012.
  5. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.
  6. D. J. Griffiths, "Quantum mechanics", Pearson Education, 2014.
  7. R. Robinett, "Quantum Mechanics", OUP Oxford, 2006.
  8. D. McQuarrie, "Quantum Chemistry", University Science Books, 2007.
  9. D. A. Neamen, " Semiconductor Physics and Devices", Times Mirror High Education Group, Chicago, 1997.
  10. E.S. Yang, "Microelectronic Devices", McGraw Hill, Singapore, 1988.
  11. B.G. Streetman, "Solid State Electronic Devices", Prentice Hall of India, 1995.
-

<b>BSC 103</b>	<b>Mathematics-II (Linear Algebra, Transform Calculus and Numerical Methods)</b>	<b>3L:1T:0P</b>	<b>4 credits</b>
----------------	--	-----------------	------------------

**Module 1: Matrices (10 hours)**

Algebra of matrices, Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms.

**Module 2: Numerical Methods-I (10 hours)**

Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Interpolation using Newton's forward and backward difference formulae. Central difference interpolation: Gauss's forward and backward formulae. Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

**Module 3: Numerical Methods-II (10 hours)**

Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predictor-corrector methods. Partial differential equations: Finite difference solution two dimensional Laplace equation and Poisson equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.

**Module 4: Transform Calculus (10 hours)**

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method. Fourier transforms.

**Text / References:**

1. D. Poole, "Linear Algebra: A Modern Introduction", Brooks/Cole, 2005.
2. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2008.
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2010.
4. V. Krishnamurthy, V. P. Mainra and J. L. Arora, "An introduction to Linear Algebra", Affiliated East-West press, 2005.

---

<b>BSC 104</b>	<b>Chemistry -I</b>	<b>3L:1T:3P</b>	<b>5.5 credits</b>
----------------	---------------------	-----------------	--------------------

### Contents

#### **Module 1: Atomic and molecular structure (12 hours)**

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multi-centre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. 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.

#### **Module 2: Spectroscopic techniques and applications (8 hours)**

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

#### **Module 3: Intermolecular forces and potential energy surfaces (4 hours)**

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H<sub>3</sub>, H<sub>2</sub>F and HCN and trajectories on these surfaces.

#### **Module 4: Use of free energy in chemical equilibria (6 hours)**

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.

#### **Module 5: Periodic properties (4 hours)**

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

#### **Module 6: Stereochemistry (4 hours)**

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.

#### **Module 7: Organic reactions and synthesis of a drug molecule (4 hours)**

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

### **Text / References:**

1. B. H. Mahan, "University chemistry", Addison-Wesley Publishing Company, 1975.
2. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications", McGraw Hill International, 1974.
3. C. N. Banwell, "Fundamentals of Molecular Spectroscopy", McGraw Hill Education, 1994.
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry" (NPTEL).
5. K. P. C. Volhardt and N. E. Schore, "Organic Chemistry: Structure and Function" Freeman, 2010.

### **Course Outcomes**

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications.

Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- Rationalise bulk properties and processes using thermodynamic considerations.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
- List major chemical reactions that are used in the synthesis of molecules.

### **Chemistry Laboratory (0:0:3 - 1.5 credits)**

Choice of 10-12 experiments from the following

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

17. Use of the capillary viscosimeters to demonstrate the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg

**Laboratory Outcomes**

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:
- Estimate rate constants of reactions from concentration of reactants/products as a function of time
- Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
- Synthesize a small drug molecule and analyse a salt sample

<b>BSC 201</b>	<b>Mathematics-III (Probability and Statistics)</b>	<b>3L:1T:0P</b>	<b>4 credits</b>
----------------	---	-----------------	------------------

**Module 1: Basic Probability (12 hours)**

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

**Module 2: Continuous Probability Distributions (4 hours)**

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

**Module 3: Bivariate Distributions (4 hours)**

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

**Module 4: Basic Statistics (8 hours)**

Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

**Module 5: Applied Statistics (8 hours)**

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

**Module 6: Small samples (4 hours)**

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

**Text / References:**

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

<b>BSC 202</b>	<b>Biology-I</b>	<b>2L:1T:0P</b>	<b>3 credits</b>
----------------	------------------	-----------------	------------------

**Module 1: Introduction (2 hours)**

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 18<sup>th</sup> 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.

**Module 2: Classification (3 hours)**

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. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes 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

**Module 3: Genetics (4 hours)**

Purpose: To convey that “ Genetics is to biology what Newton’s laws are to Physical Sciences” . Mendel’s laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

#### **Module 4: Biomolecules (4 hours)**

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.

#### **Module 5: Enzymes (4 Hours)**

Purpose: To convey that without catalysis life would not have existed on earth.

Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

#### **Module 6: Information Transfer (4 hours)**

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.

#### **Module 7: Macromolecular analysis (5 hours)**

Purpose: To analyse 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.

#### **Module 8: Metabolism (4 hours)**

Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of  $K_{eq}$  and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to  $CO_2 + H_2O$  (Glycolysis and Krebs cycle) and synthesis of glucose from  $CO_2$  and  $H_2O$  (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.

#### **Module 9. Microbiology (3 hours)**

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.

#### **Text / References:**

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.

**Course Outcomes**

After studying the course, the student will be able to:

- Describe how biological observations of 18<sup>th</sup> Century that lead to major discoveries.
  - Convey that classification *per se* is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
  - Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
  - Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
  - Classify enzymes and distinguish between different mechanisms of enzyme action.
  - Identify DNA as a genetic material in the molecular basis of information transfer.
  - Analyse biological processes at the reductionistic level
  - Apply thermodynamic principles to biological systems.
  - Identify and classify microorganisms.
-

**ENGINEERING SCIENCE COURSES**

---

<b>ESC 101</b>	<b>Problem Solving through Programming (with C)</b>	<b>3L:0T:4P</b>	<b>5 credits</b>
----------------	---	-----------------	------------------

**Course Outcomes:** The course will enable the students.

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely root finding of function, differentiation of function and simple integration.

**Unit 1: Introduction to Programming (3 hours)**

Introduction to the idea of algorithm; Introduction to Programming (Flow chart/pseudocode); the compilation process, object code and executables, Variables (including data types), Mapping of variables to memory locations, Syntax and logical error

**Unit 2: Arithmetic expressions, precedence, Conditional Branching and Loops (10 hours)**

Writing and evaluation of conditionals and consequent branching, Iteration and loops.

**Unit 3: Arrays (6 hours)**

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

**Unit 4: Basic Algorithms (6 hours)**

Searching: Linear and Binary, Basic Sorting Algorithms, Finding roots of equations (two algorithms)

**Unit 5: Function and Recursion (10 hours)**

Functions (including using built in libraries), Parameter passing, Call by value, Passing Arrays to functions, Call by reference. Introduction to Recursion; Base condition, example programs such as Factorial, Fibonacci series, Quick sort, Ackerman function etc.

**Unit 6: Structures and Pointers (5 hrs)**

Structures, typedef, Array of structures; notional introduction to pointers including self-referential structures.

**File handling should be done in laboratory.**

**Tutorial and Lab combined: (total 4 contact hours per week) (outline of topics)**

- 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, memory structure: 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: Numerical methods problems  
 Tutorial 10: Recursion, structure of recursive calls: Lab 10: Recursive functions  
 Tutorial 11: Pointers explained Lab 11: Implementing and accessing array of structures  
 Tutorial 12: File handling: Lab 12: File operations

**Text / References:**

1. B. Gottfried, “Programming with C”, McGraw-Hill Professional, 1996.
2. E. Balagurusamy, “Programming in ANSI C”, McGraw-Hill Education, 2008.
3. B. W. Kernighan and D. M. Ritchie, “The C Programming Language”, Prentice Hall of India, 1990.

<b>ESC 102</b>	<b>Workshop/ Practices</b>	<b>Manufacturing</b>	<b>1L:0T:4P</b>	<b>3 credits</b>
----------------	--------------------------------	----------------------	-----------------	------------------

Manufacturing is fundamental to the development of any engineering product. The course on Engineering Workshop Practice is intended to expose engineering students to different types of manufacturing/ fabrication processes, dealing with different materials such as metals, ceramics, plastics, wood, glass etc. While the actual practice of fabrication techniques is given more weightage, some lectures and video clips available on different methods of manufacturing are also included.

**Course Outcomes:**

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

- Understanding different manufacturing techniques and their relative advantages/ disadvantages with respect to different applications.
- Selection of a suitable technique for meeting a specific fabrication need.
- Acquire a minimum practical skill with respect to the different manufacturing methods and develop the confidence to design & fabricate small components for their project work and also to participate in various national and international technical competitions.
- Introduction to different manufacturing methods in different fields of engineering.

- Practical exposure to different fabrication techniques.
- Creation of simple components using different materials.
- Exposure to some of the advanced and latest manufacturing techniques being employed in the industry.

**Lectures& videos: (10 hours)**

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

**Workshop Practice: (60 hours)**

1. Machine shop - 10 hours
2. Fitting shop - 8 hours
3. Carpentry - 6 hours
4. Electrical & Electronics - 8 hours
5. Welding shop - 8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting - 8 hours
7. Smithy - 6 hours
8. Plastic moulding&Glass Cutting - 6 hours

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

-----

<b>ESC 103</b>	<b>Engineering Graphics</b>	<b>1L:0T:4P</b>	<b>3 credits</b>
----------------	-----------------------------	-----------------	------------------

All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software.

This course is designed to address:

- to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare you to communicate effectively
- to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Course Outcomes:**

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

- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modelling
- Exposure to computer-aided geometric design
- Exposure to creating working drawings
- Exposure to engineering communication

**Proposed Syllabus**

Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling

---

---

<b>ESC 104</b>	<b>Basic Electrical Engineering</b>	<b>3L:1T:2P</b>	<b>5 credits</b>
----------------	-------------------------------------	-----------------	------------------

**Course Outcomes:**

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

- To understand and analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines and power converters.
- To introduce the components of low-voltage electrical installations.

**Module 1 : DC Circuits (8 hours)**

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.

**Module 2: AC Circuits (8 hours)**

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.

**Module 3: Transformers (6 hours)**

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

**Module 4: Electrical Machines (8 hours)**

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.

**Module 5: Power Converters (6 hours)**

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

**Module 6: Electrical Installations (6 hours)**

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.

**List of Laboratory Experiments/Demonstrations(any Ten):**

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Verification of Kirchoff's Law (KVL & KCL). Verification of superposition theorem
3. Verification of Thevenin's theorem.
4. Verification of Norton's theorem.

5. Verification of maximum power transfer theorem.
6. Measurement of power in a three phase circuit by two wattmeter method.
7. Measurement of efficiency of a single phase transformer by load test.
8. Determination of parameters and losses in a single phase transformer by OC and SC test.
9. Study running and reversing of a three phase induction motor.
10. Study of phenomenon of resonance in RLC series circuit.
11. Demonstration of cut-out sections of machines
12. Demonstration of Components of LT switchgear.

**Text / References:**

1. D. P. Kothari and I. J. Nagrath, “ Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
3. L. S. Bobrow, “ Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
4. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
5. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

**Laboratory Outcomes:** The students are expected to

- Get an exposure to common electrical components and their ratings.
  - Make electrical connections by wires of appropriate ratings.
  - Understand the usage of common electrical measuring instruments.
  - Understand the basic characteristics of transformers and electrical machines.
  - Get an exposure to the working of power electronic converters.
-

---

<b>ESC 201</b>	<b>Engineering Mechanics</b>	<b>3L:1T:0P</b>	<b>4 credits</b>
----------------	------------------------------	-----------------	------------------

**Course Outcomes:** At the end of this course, students will demonstrate the ability to

- Understand the concepts of co-ordinate systems.
- Analyse the three-dimensional motion.
- Understand the concepts of rigid bodies.
- Analyse the free-body diagrams of different arrangements.
- Analyse torsional motion and bending moment.

**Module 1: Introduction to vectors and tensors and co-ordinate systems (5 hours)**

Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indicical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.

**Module 2: Three-dimensional Rotation (4 hours)**

Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

**Module 3: Kinematics of Rigid Body (6 hours)**

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.

**Module 4: Kinetics of Rigid Bodies (5 hours)**

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.

**Module 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.

**Module 6: General Motion (9 hours)**

Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.

**Module 7: Bending Moment (5 hours)**

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.

**Module 8: Torsional Motion (2 hours)**

Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

**Module 9: Friction (3 hours)**

Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

**Text / References:**

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.
-

**HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT**

---

<b>HSMC101</b>	<b>English</b>	<b>2L:0T:2P</b>	<b>3 credits</b>
----------------	----------------	-----------------	------------------

### **Detailed contents**

#### **1. Vocabulary Building**

- 1.1 The concept of Word Formation
- 1.2 Root words from foreign languages and their use in English
- 1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
- 1.4 Synonyms, antonyms, and standard abbreviations.

#### **2. Basic Writing Skills**

- 2.1 Sentence Structures
- 2.2 Use of phrases and clauses in sentences
- 2.3 Importance of proper punctuation
- 2.4 Creating coherence
- 2.5 Organizing principles of paragraphs in documents
- 2.6 Techniques for writing precisely

#### **3. Identifying Common Errors in Writing**

- 3.1 Subject-verb agreement
- 3.2 Noun-pronoun agreement
- 3.3 Misplaced modifiers
- 3.4 Articles
- 3.5 Prepositions
- 3.6 Redundancies
- 3.7 Clichés

#### **4. Nature and Style of sensible Writing**

- 4.1 Describing
- 4.2 Defining
- 4.3 Classifying
- 4.4 Providing examples or evidence
- 4.5 Writing introduction and conclusion

#### **5. Writing Practices**

- 5.1 Comprehension
- 5.2 Précis Writing
- 5.3 Essay Writing

#### **6. Oral Communication**

(This unit involves interactive practice sessions in Language Lab)

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

**Suggested Readings:**

- (i) *Practical English Usage*. Michael Swan. OUP. 1995.
- (ii) *Remedial English Grammar*. F.T. Wood. Macmillan.2007
- (iii) *On Writing Well*. William Zinsser. Harper Resource Book. 2001
- (iv) *Study Writing*. Liz Hamp-Lyons and Ben Heasley. Cambridge University Press. 2006.
- (v) *Communication Skills*. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
- (vi) *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

**Course Outcomes**

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

---

**PROGRAM CORE COURSES**

---

<b>PCC-EE01</b>	<b>Electrical Circuit Analysis</b>	<b>3L:1T:0P</b>	<b>4 credits</b>
-----------------	------------------------------------	-----------------	------------------

**Course Outcomes:**

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

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behavior.

**Module 1: Network Theorems (10 Hours)**

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks.

**Module 2: Solution of First and Second order networks (8 Hours)**

Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

**Module 3: Sinusoidal steady state analysis (8 Hours)**

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

**Module 4: Electrical Circuit Analysis Using Laplace Transforms (8 Hours)**

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

**Module 5: Two Port Network and Network Functions (6 Hours)**

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

**Text / References:**

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
  2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
  3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
  4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
  5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
-

---

<b>PCC-EE02</b>	<b>Analog Electronic Circuits</b>	<b>3L:0T:0P</b>	<b>3 credits</b>
-----------------	-----------------------------------	-----------------	------------------

**Course Outcomes:**

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

- Understand the characteristics of transistors.
- Design and analyse various rectifier and amplifier circuits.
- Design sinusoidal and non-sinusoidal oscillators.
- Understand the functioning of OP-AMP and design OP-AMP based circuits.

**Module 1: Diode circuits (4 Hours)**

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

**Module 2: BJT circuits (8 Hours)**

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

**Module 3: MOSFET circuits (8 Hours)**

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, transconductance, high frequency equivalent circuit.

**Module 4: Differential, multi-stage and operational amplifiers (8 Hours)**

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

**Module 5: Linear applications of op-amp (8 Hours)**

Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift).

Analog to Digital Conversion.

**Module 6: Nonlinear applications of op-amp (6 Hours)**

Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector. Monoshot.

**Text/References:**

1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.

4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

***PCC-EE03: Analog Electronic Circuits Laboratory (0:0:2 – 1 credit)***

1. To study the characteristics of p-n junction diode.
2. To study half wave and full wave rectifier circuit.
3. To study VI characteristics of zener diode.
4. To study the zener diode as constant voltage regulator.
5. Determine the input output characteristics of BJT in CB and CE configuration.
6. Determine the input output characteristics of FET in CS and CD configuration.
7. To study of BJT as single stage amplifier and determination of  $A_i$ ,  $A_v$ ,  $R_i$  and  $R_v$ .
8. To study the opamp as an inverting and non-inverting amplifier.
9. To use the opamp as an adder, subtractor, integrator and differentiator.
10. To design a square wave generator.
11. To study i) Wein bridge oscillator, ii) phase shift oscillator.
12. To design low pass, high pass and band pass filters using opamp and plot frequency response.
13. To construct 3 bit R-2 R ladder type D/A converter using opamp- IC-741.

<b>PCC-EE04</b>	<b>Electrical Machines-I</b>	<b>3L:0T:0P</b>	<b>3 credits</b>
-----------------	------------------------------	-----------------	------------------

**Course Outcomes:**

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

- Understand the concepts of magnetic circuits.
- Understand the operation of dc machines.
- Analyse the differences in operation of different dc machine configurations.
- Analyse single phase and three phase transformers circuits.

**Magnetic fields and magnetic circuits (6 Hours)**

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.

**Module 2: Electromagnetic force and torque (9 Hours)**

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

**Module 3: DC machines (8 Hours)**

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.

**Module 4: DC machine - motoring and generation (7 Hours)**

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

**Module 5: Transformers (12 Hours)**

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.

**Text / References:**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery" , New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines" , CBS Publishers, 2004.
3. M. G. Say, " Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

***PCC-EE05: Electrical Machines Laboratory– I (0:0:2 – 1 credit)***

1. To obtain magnetization characteristics of a d.c. shunt generator.
  2. To obtain load characteristics of a d.c. shunt generator and compound generator (A) Cumulatively compounded (B) Differentially compounded.
  3. To obtain efficiency of a dc shunt machine using Swinburn's test.
  4. To perform Hopkinson's test and determine losses and efficiency of DC machine.
  5. To obtain speed-torque characteristics of a dc shunt motor.
  6. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field Control.
  7. To obtain speed control of dc separately excited motor using Conventional Ward-Leonard/Static Ward – Leonard method.
  8. To study polarity and ratio test of single phase and 3-phase transformers
  9. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using C.C. and S.C. tests.
  10. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
  11. To obtain 3-phase to 2-phase conversion by Scott connection.
  12. To determine excitation phenomenon (B.H. loop) of single phase transformer using C.R.O
-

---

<b>PCC-EE06</b>	<b>Electromagnetic Fields</b>	<b>3L:1T:0P</b>	<b>4 credits</b>
-----------------	-------------------------------	-----------------	------------------

**Course Outcomes:**

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

- To understand the basic laws of electromagnetism.
- To obtain the electric and magnetic fields for simple configurations under static conditions.
- To analyse time varying electric and magnetic fields.
- To understand Maxwell's equation in different forms and different media.
- To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

**Module 1: Review of Vector Calculus (6 hours)**

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

**Module 2: Static Electric Field (6 Hours)**

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

**Module 3: Conductors, Dielectrics and Capacitance (6 Hours)**

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

**Module 4: Static Magnetic Fields (6 Hours)**

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

**Module 5: Magnetic Forces, Materials and Inductance (6 Hours)**

Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

**Module 6: Time Varying Fields and Maxwell's Equations (6 Hours)**

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.

**Module 7: Electromagnetic Waves (6 Hours)**

Derivation of Wave Equation, Uniform Plane Waves, Maxwell’s equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

**Text / References:**

1. M. N. O. Sadiku, “Elements of Electromagnetics”, Oxford University Publication, 2014.
2. A. Pramanik, “Electromagnetism - Theory and applications”, PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, “Electromagnetism-Problems with solution”, Prentice Hall India, 2012.
4. G. W. Carter, “The electromagnetic field in its engineering aspects”, Longmans, 1954.
5. W. J. Duffin, “Electricity and Magnetism”, McGraw Hill Publication, 1980.
6. W. J. Duffin, “Advanced Electricity and Magnetism”, McGraw Hill, 1968.
7. E. G. Cullwick, “The Fundamentals of Electromagnetism” , Cambridge University Press, 1966.
8. B. D. Popovic, “Introductory Engineering Electromagnetics”, Addison-Wesley Educational Publishers, International Edition, 1971.
9. W. Hayt, “Engineering Electromagnetics”, McGraw Hill Education, 2012.

<b>PCC-EE07</b>	<b>Digital Electronics</b>	<b>3L:0T:0P</b>	<b>3 credits</b>
-----------------	----------------------------	-----------------	------------------

**Course Outcomes:**

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

- Understand working of logic families and logic gates.
- Design and implement Combinational and Sequential logic circuits.
- Understand the process of Analog to Digital conversion and Digital to Analog conversion.
- Be able to use PLDs to implement the given logical problem.

**Module 1: Fundamentals of Digital Systems and logic families (7Hours)**

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.

**Module 2: Combinational Digital Circuits (7Hours)**

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.

**Module 3: Sequential circuits and systems (7Hours)**

A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D- types flip flops, applications of flip flops, shift registers, applications of shift registers, serial 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.

**Module 4: A/D and D/A Converters (7Hours)**

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

**Module 5: Semiconductor memories and Programmable logic devices. (7Hours)**

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).

**Text/References:**

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

**PCC-EE08: Digital Electronics Laboratory (0:0:2 – 1 credit)**

1. Verification of NAND, NOR, Ex-OR, AND & OR Gates.
  2. Implementation of half Adder & Full Adder
  3. Implementation of half Subtractor & Full Subtractor.
  4. Implementation of Demultiplexer / Decoder operation using IC-74138.
  5. Implementation of Seven segment display.
  6. Implementation of Binary to gray converter.
  7. Implementation of Arithmetic algorithms.
  8. Implementation of various flip-flops.
  9. Implementation of Counters.
  10. Implementation of shift register.
  11. Verification of Transfer characteristics of TTL inverters & TTL Schmitt Trigger inverter.
- 

<b>PCC-EE09</b>	<b>Electrical Machines – II</b>	<b>3L:0T:0P</b>	<b>3 credits</b>
-----------------	---------------------------------	-----------------	------------------

**Course Outcomes:**

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

- Understand the concepts of rotating magnetic fields.
- Understand the operation of ac machines.
- Analyse performance characteristics of ac machines.

**Module 1: Fundamentals of AC machine windings (8 Hours)**

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

### **Module 2: Pulsating and revolving magnetic fields (4 Hours)**

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.

### **Module 3: Induction Machines (12 Hours)**

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.

### **Module 4: Single-phase induction motors (6 Hours)**

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

### **Module 5: Synchronous machines (10 Hours)**

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.

### **Text/References:**

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

### ***PCC-EE10: Electrical Machines Laboratory– II (0:0:2 – 1 credit)***

### **LIST OF EXPERIMENTS ( Any Ten)**

#### **List of experiments**

1. Voltage regulation of alternators.
2. Determination of  $X_d$  and  $X_q$ .
3. Determination of positive, Negative and Zero sequence reactance's of synchronous machines.
4. Synchronization and parallel operation of alternators.
5. Determination of V curves.
6. Power angle characteristic of synchronous machine.
7. Circle diagram of induction motor.

8. Load test on 3-phase induction motor.
  9. Load test on 1-phase induction motor.
  10. Speed control of squirrel cage induction motor by variable frequency.
  11. Rotor Rheostat speed control of slip ring induction motor.
- 

<b>PCC-EE11</b>	<b>Power Electronics</b>	<b>3L:0T:0P</b>	<b>3 credits</b>
-----------------	--------------------------	-----------------	------------------

**Course Outcomes:**

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

- Understand the differences between signal level and power level devices.
- Analyse controlled rectifier circuits.
- Analyse the operation of DC-DC choppers.
- Analyse the operation of voltage source inverters.

**Module 1: Power switching devices (8Hours)**

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

**Module 2: Thyristor rectifiers (7Hours)**

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

**Module 3: DC-DC buck converter (5Hours)**

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

**Module 4: DC-DC boost converter (5Hours)**

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

**Module 5: Single-phase voltage source inverter (10Hours)**

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

**Module 6: Three-phase voltage source inverter (8Hours)**

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

**Text/References:**

1. M. H. Rashid, “*Power electronics: circuits, devices, and applications*”, Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, “*Power Electronics: Converters, Applications and Design*”, John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, “*Fundamentals of Power Electronics*”, Springer Science & Business Media, 2007.
4. L. Umanand, “*Power Electronics: Essentials and Applications*”, Wiley India, 2009.

---

**PCC-EE12: Power Electronics Laboratory (0:0:2 – 1 credit)**

**Note: The minimum of 10 experiments is to be performed out of which at least three should be software based.**

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without free wheeling diode.
4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converter
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor
9. To study operation of IGBT/MOSFET chopper circuit
10. To study MOSFET/IGBT based single-phase series-resonant inverter.
11. To study MOSFET/IGBT based single-phase bridge inverter.

**Software based experiments(PSPICE/MATLAB)**

12. To obtain simulation of SCR and GTO thyristor.
  13. To obtain simulation of Power Transistor and IGBT.
  14. To obtain simulation of single phase fully controlled bridge rectifier and draw load voltage and loadcurrent waveform for inductive load.
  15. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and loadcurrent waveforms for inductive load.
  16. To obtain simulation of step down dc chopper with L-C output filter for inductive load and Determine steady-state values of output voltage ripples in output voltage and load current.
-

---

<b>PCC-EE13</b>	<b>Signals and Systems</b>	<b>2L:1T:0P</b>	<b>3 credits</b>
-----------------	----------------------------	-----------------	------------------

**Course Outcomes:**

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

- Understand the concepts of continuous time and discrete time systems.
- Analyse systems in complex frequency domain.
- Understand sampling theorem and its implications.

**Module 1: Introduction to Signals and Systems (3 hours):**

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

**Module 2: Behavior of continuous and discrete-time LTI systems (8 hours)**

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

**Module 3: Fourier, Laplace and z- Transforms (10 hours)**

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

**Module 4: Sampling and Reconstruction (4 hours)**

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

**Text/References:**

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

5. A. V. Oppenheim and R. W. Schafer, “ Discrete-Time Signal Processing”, Prentice Hall, 2009.
  6. M. J. Robert “ Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
  7. B. P. Lathi, “ Linear Systems and Signals”, Oxford University Press, 2009.
-

