College of Engineering, Pune
Department of Electrical Engineering

Second Year Curriculum Structure and Syllabus of B. Tech. (Electrical Engineering) program

Semester III [Structure for Regular Students]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Ordinary Differential Equations and Multivariate Calculus	2	1	0	3
2	MLC		Professional Laws, Ethics, Values and Harmony	1	0	0	0
3	HSMC		Innovation and Creativity	1	0	0	1
4	SBC		Circuit Simulation Laboratory	0	0	2	1
5	IFC - 1		Smart Materials	2	0	0	2
6	PCC		Solid State Devices and Linear Circuits	3	0	0	3
7	PCC		Electrical Circuit Analysis	3	0	0	3
8	PCC		Measurements and Communication Systems	3	0	0	3
9	LC		Solid State Devices and Linear Circuit Laboratory	0	0	2	1
10	LC		Measurements and Communication Systems Laboratory	0	0	2	1
11	LC		Numerical Methods and Computer Programming Laboratory	1	1	2	3
Total				16	2	8	21
Total Academic Engagement and Credits				**26**			**21**

Semester III [Structure for students directly admitted to Second Year B. Tech.]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Linear Algebra and Univariate Calculus	4	1	0	5
2	MLC		Professional Laws, Ethics, Values and Harmony	1	0	0	0
3	HSMC		Innovation and Creativity	1	0	0	1
4	BSC		Foundation of Physics	3	0	0	3
5	SBC		Circuit Simulation *Laboratory	0	0	2	1
6	IFC - 1		Smart Materials	2	0	0	2
7	PCC		Solid State Devices and Linear Circuits	3	0	0	3
8	PCC		Electrical Circuit Analysis	3	0	0	3
9	PCC		Measurements and Communication Systems	3	0	0	3
10	LC		Solid State Devices and Linear Circuit Laboratory	0	0	2	1
11	LC		Measurements and Communication Systems Laboratory	0	0	2	1
12	LC		Numerical Methods and Computer Programming Laboratory	1	1	2	3
Total				21	2	8	26
Total Academic Engagement and Credits				**31**			**26**

(MA) Ordinary Differential Equations and Multivariate Calculus

Teaching Scheme:
Lectures: 2 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Objectives:
Basic necessity for the foundation of Engineering and Technology being mathematics, the main aim is, to teach mathematical methodologies and models, develop mathematical skills and enhance thinking power of students.

Course Outcomes:
Students will be able to:

- Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type - define, identify, state, match, list, name etc.)
- Understand basic concepts. (To measure this outcome, questions may be of the type - explain, describe, illustrate, evaluate, give examples, compute etc.)
- Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
- Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
- Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

Unit 1
Introduction to Order of Differential Equation:
Review of first order differential equations, Reduction of order, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients and reducible to differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters), systems of differential equations, applications to orthogonal trajectories, mass spring systems and electrical circuits. **[11 Hrs]**

Unit 2
Laplace Transform:
Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform. **[08 hrs]**

Unit 3
Functions of Variables:
Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points, constrained optimization. **[07 Hrs]**

Text Books:

- Maurice D. Weir, Joel Hass, Frank R. Giordano, "Thomas' Calculus", 14th edition, Pearson Education.
- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley eastern Ltd.

Reference Books:

- K. D Joshi, "Calculus for Scientists and Engineers", CRC Press.
- Sudhir Ghorpade and Balmohan Limaye, "A Course in Multivariate Calculus and Analysis", Springer Science and Business Media.
- George Simmons, "Differential Equations with Applications and Historical notes", Tata McGraw Hill publishing company Ltd, New Delhi.
- C. R. Wylie, "Advanced Engineering Mathematics", McGraw Hill Publications, New Delhi
- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Thomson Brooks / Cole, Singapore.
- Michael D. Greenberg, "Advanced Engineering Mathematics", 2nd edition, Pearson Education.
- Chandrika Prasad and Reena Garg, "Advanced Engineering Mathematics", Khanna Publishing Company Private Limited, New Delhi.

Note:

All the course outcomes 1 to 3 will be judged by 75% of the questions and outcomes 4 and 5 will be judged by 25 % of questions.

(MA) Linear Algebra and Univariate Calculus

(For students directly admitted to Second Year B. Tech.)

Teaching Scheme:
Lectures: 4 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Objectives:

Basic necessity for the foundation of Engineering and Technology being mathematics, the main aim is, to teach mathematical methodologies and models, develop mathematical skills and enhance thinking power of students.

Course Outcomes:

Students will be able to:

- Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type - define, identify, state, match, list, name etc.)
- Understand basic concepts. (To measure this outcome, questions may be of the type - explain, describe, illustrate, evaluate, give examples, compute etc.)
- Analyze the problem and apply the appropriate concept.(To measure this outcome, questions will be based on applications of core concepts)
- Give reasoning. To measure this outcome, questions may be of the type - true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
- Apply core concepts to new situations. (To measure this outcome, questions will be based on self-study topics and also comprehension of unseen passages.)

Unit 1:

Matrices and linear equations: basic properties of matrices, row operations and Gauss elimination, Determinants and their basic properties. Basic concepts in linear algebra: vector spaces, subspaces, linear independence and dependence of vectors, bases, dimensions. Row and Column spaces, rank, Applications to systems of linear equations. **[15 Hrs]**

Unit 2:

Rank-nullity theorem, Eigen values, Eigen vectors and their basic properties, diagonalization. **[12 Hrs]**

Unit 3:

Review of limits, continuity and differentiability, Mean value theorems, Taylor's theorem, local extrema, increasing and decreasing functions, concavity, points of inflection. **[12 Hrs]**

Unit 4:

Surface area, integrals by special techniques: reduction formulae, arc length, solids of revolution, improper integrals, tests for convergence, Gamma and Beta functions. **[13 Hrs]**

Text Books:

- Maurice D. Weir, Joel Hass, Frank R. Giordano, "Thomas' Calculus", 14th edition, Pearson Education.
- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley eastern Ltd.

Reference Books:

- Serge Lang, "Introduction to Linear Algebra", (2nd edition)", Springer.
- Howard Anton and Chris Rorres, "Elementary Linear Algebra (10th edition)", John Wiley and sons.
- K. D Joshi, "Calculus for Scientists and Engineers", CRC Press.
- Sudhir Ghorpade and Balmohan Limaye, "A Course in Multivariate Calculus and Analysis", Springer Science and Business Media.
- C. R. Wylie, "Advanced Engineering Mathematics", McGraw Hill Publications, New Delhi
- Peter V. O'Neil, "Advanced Engineering Mathematics", (7th edition), Thomson Brooks / Cole, Singapore.
- Shanti Narayan, "Differential Calculus", S. Chand and company, New Delhi.
- P. N. Wartikar and J. N. Wartikar, "Applied Mathematics Vol. I", (Reprint July 2014), Pune Vidyarthi Griha Prakashan Pune.
- Chandrika Prasad and Reena Garg, "Advanced Engineering Mathematics", Khanna Publishing Company Private Limited, New Delhi.

Note:

All the course outcomes 1 to 3 will be judged by 75% of the questions and outcomes 4 and 5 will be judged by 25 % of questions.

(MLC) Professional Laws, Ethics, Values & Harmony

Teaching Scheme:
Lectures: 1 hr/week

Examination Scheme:
Total - 100 Marks
Continuous evaluation –
Assignments/ Presentations/ Test

Course Outcomes:
Student will be able to,

- Grasp the meaning of the concept - Law
- Get an overview of the laws relating to Engineers
- Apprehend the importance of being a law abiding person
- Self-explore by using different techniques to live in harmony at various levels
- Analyze themselves and understand their position with respect to the moral and ethical character needed for a successful and satisfactory work life

Unit 1
Concept of Law:
Understanding Essentials of a Valid Contract and the basics of contract law protecting rights and obligations. **[02 Hrs]**

Unit 2
Law of Torts:
Introduction to the Law of Torts and the basics to protect oneself and the company, Law affecting the Workplace, Employers Responsibilities / Duties, Hiring Practices, Introduction to Intellectual Property Law. **[03 Hrs]**

Unit 3:
Professional Code of Conduct for Engineers. Relationship between Law and Ethics. **[01 Hrs]**

Unit 4
Self Awareness:
Understanding oneself and others; Johari Window- Concept, explanation, implementation. **[02 Hrs]**

Unit 5
Needs & Self:
Needs and its importance; Understanding harmony and its relevance in actualization at personal and professional levels. **[02 Hrs]**

Unit 6
Ethics and values:
Professional ethics and their importance for students; Understanding the importance of values & their application in everyday life. **[02 Hrs]**

References:

- Business Law- By Saroj Kumar
- Law of Contract- By Avtar Singh
- Business Law- By G K Kapoor
- Business & Commercial Laws – By Sen & Mitra
- Business Law for Engineers- by Calvin Frank Allen
- Hilgard, E. R.; Atkinson, R. C. & Atkinson, R.L. (1975). Introduction to Psychology. 6th edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Govindarajan, M; Natarajan, G. M. & Senthilkumar, V.S. (2013). Professional Ethics & Human Values. Prentice Hall: New Delhi
- Gogate, S. B. (2011). Human Values & Professional Ethics. Vikas Publishing: New Delhi.
- Govindarajan, M; Natarajan, G. M. & Senthilkumar, V.S. (2013). Professional Ethics & Human Values. Prentice Hall: New Delhi
- Jayshree Suresh, Raghavan B.S.(2016). Human Values & Professional Ethics: S Chand & Company. Pvt. Ltd: New Delhi.

(HSMC) Innovation and Creativity

Teaching Scheme:
Lectures: 1 hr/week

Examination Scheme:
"To be declared by the Instructor"

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

- Understand the creativity and innovation terminologies
- Explore personal and organizational roadblocks in participating in the creative process
- Apply practical tips to discover the innovative /creative potential within the human being.
- Study frameworks, strategies, techniques for conceiving ideas.
- Develop new ways of thinking and Learn the entire innovation cycle.
- Understand different ways to protect innovation, basics on Patents and process
- Apply techniques learnt in the course to articulate, refine and pitch a new product or service project

Content:
Introduction to concepts of creativity / invention / innovation and their importance in present knowledge world. Components of the creative process, Analogy/ model to represent the creative process.

Understanding persons' Creative potential. Blockages in practicing creative process – Mindset and belief systems. Myths and misconceptions about creativity.

Practical Tips to discover and apply one's creative potential, remove blockages, deal with external factors. Importance of synergistically working in a team. Harnessing creativity from nature.

Idea conception, Idea Brainstorming sessions, Idea Evaluation, Protection/Patent review, Principles of innovation, Review of systematic strategies and methods for innovation, Innovation case study, Review of Idea/Prototype /Product and Market Plan.

Applications Exercise / Assignment: at the end of the course, the student will create teams, presents their innovative ideas, and applies their learning in practice.

Reference Books:

- Paul B. Paulus, Bernard A. Nijstad, "The Oxford Handbook of Group Creativity and Innovation", Oxford University Press, 2019.
- Jeff Dyer, Hal Gregersen, Clayton M. Christensen, "The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators", Harvard Business Review Press, 2011.
- Paddy Miller, Thomas Wedell - Wedellsborg, "Innovation as Usual: How to Help Your People Bring Great Ideas to Life", Harvard Business Review Press, 2013.

( ) Foundation of Physics

(For students directly admitted to Second Year B. Tech.)

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

At the end of this course students will be able to,

- Understand classical and wave mechanics to implement for the problems.
- Understand the laws of thermodynamics to implement in various thermodynamic systems and processes.
- Understand the basic principles of Electromagnetism and formulate it to solve the engineering problems.
- Aware of limits of classical physics and will be able to use it in the appropriate field in order to solve the problems.

Unit 1

Oscillations, Waves & Light:

SHM, characteristics of SHM, Waves, Travelling waves and its equation**,** Types of waves, Principle of Superposition, Stationary waves**,** Light as an EM Wave, graphical representation of EM wave, Interference of light due to thin film (uniform thickness), Antireflection coating, Total Internal reflection, Introduction to Optical fiber and its design. **[07 Hrs]**

Unit 2

Atomic Nucleus and Nuclear energy:

Atomic Nucleus, Nuclear force, Static properties of nucleus, Mass defect and Binding energy, Law of radioactive decay, Half-life, Applications of radioactivity, Nuclear reactions, Q-value of nuclear reaction, Nuclear fission, chain reaction and Nuclear energy. **[07 Hrs]**

Unit 3

Electrostatics:

Coulomb's law in vector form ,the electric field, Continuous charge distribution (Line, Surface& Volume)**,** Divergence of E, application of Gauss's law (simple 2 D problems)**,** The curl of E (Faraday's Law), the concept of electric potential V, Potential due to continuous charge distribution. **[07 Hrs]**

Unit 4

Magneto statics:

Steady state current (line current, Surface current and volume current), current densities, Magnetic field due to steady current (Biot-Savart's law), divergence and curl of B, Statement of Ampere's Law (with simple examples). **[07 Hrs]**

Unit 5

Elements of Thermodynamics:

Concept of Temperature, Terminology in Thermodynamics, Thermodynamic work, Caparison for Heat and Work, First Law and its applications, Heat engine and Thermal efficiency, Second law, Entropy, Disorder of system, Third law and Principle of Unattainability, Absolute Zero (Nernst's Theorem).

[07 Hrs]

Unit 6

Modern physics:

Drawbacks of Classical Mechanics, Plank's quantum hypothesis, Dual nature of matter, De-Broglie's hypothesis, light as a particle(Compton's experiment), De-Broglie's wavelength, Heisenberg's uncertainty principle(position and momentum), Wave function, its properties, conditions and its physical significance, Free particle solution of wave function. **[07 Hrs]**

References:

- Engineering Physics, Avadhanulu and Kshirsagar.
- Fundamental of Physics, Halliday-Resnick (Sixth edition)
- Optics, Brij Lal (S. Chand publication)
- Classical Electrodynamics, David Griffith (Pearson India limited)
- H .C. Verma & Halliday-Resnick (Sixth edition), B. B. Laud
- Modern Physics, S. Chand Publication.
- Concepts of Modern Physics, Arthur Beiser, Tata McGraw – Hill Edition.

(EE) Circuit Simulation Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Continuous evaluation: 50 Marks
End Semester (Oral): 50 Marks

Course Outcomes:

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

- Use MATLAB, Scilab, Powersim, and ATP/EMTP for circuit development and analysis.
- Compute parameters of a given two port network.
- Simulate DC motor equivalent circuit.
- Simulate linear integrated circuits.
- Simulate the different electronic devices.
- Develop logic circuits for controlling different processes.

List of Experiments:

1. Verification of Superposition Theorem, Thevenin's Theorem, and Norton's Theorem with voltage and current controlled sources using PSIM software: verify analytical results with simulation results.
2. To analyze the responses of RL, RC, and RLC circuit for step, impulse, and ramp input using PSIM software.
3. Fourier analysis of step, ramp, sinusoidal, triangular, saw-tooth, and square waveforms using MATLAB/Scilab and comparison with the computed results.
4. Computation and model verification of two-port network using ATP/EMTP: transmission parameters, hybrid parameters, and inverse hybrid.
5. Verification and analysis of maximum power transfer theorem, reciprocity theorem, Tellegen's theorem, and compensation theorem using PSIM software.
6. DC motors simulation using MATLAB: Verification of the characteristics.
7. Verification of different applications of operational amplifiers using PSIM software.
8. Verification of characteristics of different electronic devices using PSIM: UJT, Diode, BJT, FET, SCR and development of simple power circuit using MATLAB software..
9. Verification of NAND and NOR as universal gates and development of washing machine control logic using universal gates using MATLAB software.

(IFC-1) Smart Materials

(For students directly admitted to Second Year B. Tech.)

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Objectives:

- To introduce students to the concept of "Smart" materials and systems.
- To inculcate knowledge of various smart materials, their fabrication and their multidisciplinary applications.

Course Outcomes

At the end of this course students will be able to,

- Distinguish between smart and non-smart materials.
- Select and design appropriate smart materials for a given application.
- Quantify the behaviour of smart materials in term of their mechanics.
- Calculate the energy requirements for production and operation of smart materials and systems.

Unit 1:

Concept of Smart Materials: Retrospective review, main notion, energy aspects of external influence, systematization and methods of smart materials description: methods of materials taxonomy, smart material model, classification of smart materials and engineering systems. **[05 Hrs]**

Unit 2:

Materials for electrical engineering and electronics: conductors, semiconductors, dielectrics, magnetic materials, optically active materials, materials for thermoelectric devices, smart battery materials, radio wave absorbing materials, sealing materials, heat-insulating and sound absorbing materials. **[05 Hrs]**

Unit 3:

Structural materials: self-healing materials, heat and cold resistant materials, radiation resistant materials, corrosion-resistant materials and anti-corrosive coatings, lubricants, frictional materials, materials for operation at abnormal temperatures. **[05 Hrs]**

Unit 4:

Materials for biological and biomedical systems: materials for implants, targeted drug delivery and tissue growth, antimicrobial materials, filters for water cleaning, biodegradable packages, active and bio-selective packages. **[05 Hrs]**

Unit 5:

Mechanics of smart materials: Object and subject of smart materials mechanics, structural and functional analysis smart materials in terms of mechanics, the materials with negative characteristics as source of smart effects in structures: Auxetics, statements and solutions of some smart materials based mechanics problems – e.g. self-healing of cracks, self-reinforcing of multimodular materials, porous

materials-auxetic materials reversible transformations, self-assembling porous materials etc. **[07 Hrs]**

Unit 6:

Smart materials and energy problem: Global energy problem, energy consumption for production of materials, technical and economical efficiency of smart materials and technical systems. **[03 Hrs]**

Text Books:

- Smart Materials Taxonomy by Victor Goldade, Serge Shil'ko, Alexander Neverov, CRC Press, 1st Edition, 2016
- Smart Electronic Materials by Jasprit Singh, Cambridge University Press, 1st Edition, 2005
- Smart Materials Systems and MEMS: Design and Development methodologies by Vijay K. Varadan, K.J. Vinoy, S. Gopalkrishnan, John Wiley and Sons, 1st Edition, 2006

Reference Books:

- Encyclopedia of Smart Materials (Volume 1 and 2) by Mel Schwartz, John Wiley and Sons, 1st Edition, 2002
- Smart Materials Edited by Mel Schwartz, CRC Press, 1st Edition, 2009
- Design, Fabrication Properties and Applications of Smart and Advanced Materials, Edited by Xu Hou, CRC Press, 1st Edition, 2016
- Smart Materials: Integrated Design, Engineering Approaches and Potential Applications, Edited by Anca Filimon, Apple Academic Press and CRC Press, 1st Edition, 2019

(EE) Solid State Devices and Linear Circuits

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:
At the end of this course students will be able to,

- Analyze simple lumped electric circuit models for diodes and transistors.
- Calculate the frequency response of circuits containing BJT, Op-Amp etc.
- Apply operational amplifier models in circuits employing feedback.
- Create electronics circuit using Timer IC and voltage regulators.

Unit 1
Semiconductor Devices and their applications:
Semiconductors, P-N junction diode and its applications - clippers, clampers, multipliers, Types of diodes - Zener diode, LED, BJT- CB, CE, CC configurations, biasing, FET biasing, MOSFET biasing, NMOS, PMOS, CMOS. **[08 Hrs]**

Unit 2
Signal and Power Amplifiers:
Transistor as a switch, DC analysis of CB, CC, CE and FET amplifiers. Low and high frequency response of transistor and FET amplifier. **[06 Hrs]**

Unit 3
Operational Amplifiers:
The ideal Op-Amp, equivalent circuit of Op-Amp, ideal voltage transfer curve, open loop Op-Amp configurations, Op-Amp parameters, block diagram representation of feedback configurations, frequency response, high frequency Op-Amp. **[04 Hrs]**

Unit 4
Active Filters and Oscillators:
Active filters: low pass filter, high pass filter, band-pass filters, band reject filters, all pass filters, comparators and oscillators. **[08 Hrs]**

Unit 5
Generalized Linear Applications:
DC and AC amplifiers, instrumentation amplifier, logarithmic amplifier, voltage current converter, current to voltage converter, the integrator, the differentiator. **[08 Hrs]**

Unit 6

Specialized IC Applications:

The 555 Timer as monostable, astable multivibrator, phase locked loops operating principles, 565 PLL applications, voltage regulators- fixed, adjustable, switching, special, analog switch and analog multiplier. **[08 Hrs]**

Text Books:

- A. S. Sedra and K. C. Smith, "Microelectronic Circuits", 7th edition, Oxford Publication, 2017.
- Millman, Halkias and SatyabrataJit, "Electronic Devices and Circuits", 4th edition, McGraw Hill Education (India) Private Limited, 2015.
- Robert L. Boylestad and Louis Nashelsky, "Electronic devices and circuit theory", 11th edition, Prentice Hall India Ltd, 2015.
- Ramakant A. Gayakwad, "Op-Amps and linear integrated Circuits" 4th edition, Pearson Education, 2015.

Reference Books:

- Thomas L. Floyed, "Electronic Devices", 10th edition, Pearson Education, 2018.
- James M. Fiore, "Op Amps and Linear Integrated Circuits-Concepts and Applications", 3rd edition, Cengage Learning, 2018.
- David A. Bell, "Electronic Devices and Circuits", 5th edition, Oxford University Press, 2008.

e Learning Resources:

- Prof. A. N. Chandorkar, IIT Bombay online lecture series on Analog Electronics http://nptel.ac.in/courses/117101106/
- Prof. S. Karmalkar, IIT Madras, online lecture series on Solid State Devices http://nptel.ac.in/courses/117106091/
- Prof. S. C. Datta Roy, IIT Delhi, online lecture series on Analog Electronic Circuits http://nptel.ac.in/courses/108102095/

(EE) Electrical Circuit Analysis

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:
At the end of this course students will be able to,

- Analyze steady state and transient behaviour of the circuit
- Compute Fourier series/spectra from different types of waveforms
- Analyze two port electrical network problems
- Solve electrical network excited by sinusoidal input
- Analyze network using graph theory

Unit 1
Network Topology:
Concept of graph, tree and co-tree, tie set and cut set matrices and Kirchhoff's laws to network analysis, choice between loop and nodal analysis, concept of super loop and super mesh, dot convention for coupled circuits, concept of duality and dual networks. **[04 Hrs]**

Unit 2
Analysis of Transients in the circuit:
Initial and final conditions in network elements, forced and free response, time constants steady state and transient state response. Classical solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits. **[08 Hrs]**

Unit 3
Application of the Laplace Transformation:
Review of Laplace transform, inverse Laplace transform, analysis of electrical circuits with and without initial conditions using Laplace transform for all standard input cases. Shifted and singularity functions, Laplace transform of various periodic and non-periodic waveforms. **[08 Hrs]**

Unit 4
Network Functions for one port and two port:
Calculations of network functions for ladder and general network, poles and zeros, restrictions on pole and zero locations for driving point and transfer functions, time domain behaviour from pole and zero plot, stability of active network.
Two Port Network: Terminal pairs, relationship of two port variables, Z, Y, transmission parameters and hybrid parameters, interconnections of two port networks. **[08 Hrs]**

Unit 5

Sinusoidal steady state analysis of single phase and three phase circuits:

Power transfer and insertion loss of two port network, effective or RMS values, average power and complex power, problems in optimizing power transfer in electrical network. Balanced and unbalanced load in three phase circuits. Introduction to harmonics in the electric circuits. **[06 Hrs]**

Unit 6

Fourier series and Signal Spectra:

Fourier series, evaluations of Fourier coefficients, waveform symmetries as related to Fourier coefficients. **[04 Hrs]**

Text Books:

- Alexander and Sadiku, "Electric Circuits", 5th edition, 2012.
- M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 3rd edition
- D. Roy Chaudhary, "Network and Systems", New Age International Publications, 2nd edition.

Reference Book:

- William H. Hayt, Jack E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill international , 5th edition corrections), Jaico Publishing, 1998.

e Learning Resource:

- NPTEL Video lectures BY Ankush Sharma IIT Kanpur and by Dr. S. C. Datta Roy IIT Delhi

(EE) Measurements and Communication Systems

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

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

- Identify and calibrate various basic measurement systems, use the shunts and multipliers.
- Compute the resistance, inductance and capacitance using bridges.
- Analyze the functioning and use of electronic meters in electronic networks.
- Identify and select different electronic and electrical transducers for measurement of various electrical and non electrical quantities.
- Analyse different components of communication systems
- Understand the concepts of network and internetworking protocols.

Unit 1

Review of Electromechanical Instruments:

Definitions, units, dimensions, accuracy, resolution, classification, precision and calibration of instruments. Measurement of power in balanced and unbalanced electrical systems, Measurement of resistance, inductance and capacitance using different bridges, Megger, Earth tester. **[07 Hrs]**

Unit 2

Instrument Transformers and Special Measuring Instruments:

Instrument transformers- CT and PT/CVT, design considerations and testing, errors. Special measuring instruments: dynamometer type single and three-phase power factor meter, frequency meters, synchroscopes, tri-vector meter, Maximum demand meter, flux meter. Overview of transducers, measurement of nonelectrical quantities such as, pressure, flow, temperature, solar irradiance, wind speed, blood sugar, distance, etc. **[07 hrs]**

Unit 3

Fundamentals of Digital Measurements:

Need, comparison of analog and digital measurement, representation of digital signal, analog to digital converter (ADC), sampling theorem, quantization of signal and quantization error, accuracy of digital measurement. **[05 hrs]**

Unit 4

Digital Measurements:

Hall Effect instruments, digital voltmeter, multimeter, wattmeter and energy meter, Digital Storage Oscilloscope, Harmonic and Distortion analyzer, Spectrum and Wave analyzer, Power analyzer, Smart Energy meter, PMU, DAQ systems, PC based measurement techniques. **[06 hrs]**

Unit 5

Analog and Digital Communication Systems:

Basics of analog communication systems, introduction to modulation and de-modulation, transmitters and receivers.

Basics of digital communication system, coding techniques, frequency and time domain multiplexing, power line carrier communication systems. **[07 Hrs]**

Unit 6

Data Communication:

Types, topologies, building blocks, multiple access schemes, LAN, WAN, MAN, overview of wireless networks, overview of network models: ISO-OSI reference model and TCP/IP, reliable packet transmission, routing and internet protocol, introduction to various mobile communication techniques (1G-5G), Bluetooth, ZigBee, GPS. **[08 Hrs]**

Text Books:

- A. K. Sawhney, "A course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Sons, 1995.
- Helfrick and Cooper, "Modern Electronic Instrumentation and Measurement Techniques" Pearson, 2007.
- M. U. Reissland, "Ellectrical Measurements", Wiely Eastern Ltd., New Delhi, 1992.
- Simon Haykin, Michael Moher, "Communication Systems", 5th edition, Wiley, 2009.
- Andrew Tanenbum, "Computer Networks", 5th edition, Pearson, 2013.
- B.P. Lathi, Zhi Ding, "Modern Digital and Analog Communication", Oxford Univerisity Press, 2018.

Reference Books:

- M. A. Baldwin, "Fundamentals of Electrical Measurements, Publication - Lyall Book Depot, Ludhiyana.
- V. Popov, "Electrical Measurements, Publication - Mir, Moscow.
- Jones B.E., "Instrumentation Measurement and Feedback", Publication-Tata McGraw Hill, New Delhi, Edition 1978.
- William Stallings, "Data and computer communications", 10th edition, Prentice Hall, 2017.
- B. A. Forouzan, "Data Communications and Networking", 5th edition, Tata McGraw Hill, , 2013.

e Learning Resources:

- e notes: elearning.vtu.ac.in/, nptel.iitg.ernet.in/
- Prof. Goutam Das, IIT Kharagpur, online lecture series on Analog Communication, https://nptel.ac.in/courses/117105143/
- Prof. Abhishek Dixit, IIT Delhi, online lecture series on Principles of Digital Communication, https://nptel.ac.in/courses/108102120/
- Prof. A. Pal, IIT Kharagpur, online lecture series on Data communication, https://nptel.ac.in/courses/106105082/#

(EE) Solid State Devices and Linear Circuits Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Continuous evaluation: 50 Marks
End-Sem evaluation: 50 Marks

Course Outcomes:

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

- Analyze and evaluate a wide variety of analog circuits.
- Build circuits and take measurements of circuit variables using tools such as oscilloscopes,
- Multimeters, and signal generators.
- Use software packages like Proteus, Multisim, PSpice etc.
- Apply the knowledge for design and construction of circuits.

List of Experiments:

The laboratory course can have any 10 experiments from following list. At least 2 experiments should involve simulation using Proteus or appropriate software.

1. To design, assemble and test the wave shaping circuits using diode - clipping and clamping circuits.
2. To design, assemble and test the voltage multiplier circuits and to analyze its regulation and frequency characteristics.
3. To determine the performance characteristics of BJT using DC biasing analysis of CE, CB and CC Configuration.
4. To determine the frequency Response of a BJT/FET single stage and multistage amplifier and to study the effect of coupling and bypass capacitor on the frequency.
5. To obtain the drain and transfer characteristics of JFET.
6. To design and test dependent voltage and current sources using an Op-Amp and to determine their frequency response.
7. Analysis and applications of active circuits using Op-Amp: (i) Comparator (ii) Zero Crossing Detector, (iii) Integrator, (iv) Logarithmic amplifier, (v) Differentiator.
8. To design, assemble and test the active filters and oscillators using Op-Amp and determine their frequency stability: (i) Low pass, (ii) High pass, (iii) Band pass, (iv) Band reject, (v) All pass, (vi) Phase Shift oscillator, (vi) Wein Bridge Oscillator.
9. To design, assemble and test the Multivibrators using Op-Amp: (i) Schmitt Trigger, (ii) Monostable Multivibrator, (iii) Bistable Multivibrator, (iv) Astable Multivibrator.
10. To operate Timer IC 555/556 as (i) Schmitt Trigger, (ii) Monostable Multivibrator, (iii) Bistable Multivibrator, (iv) Sequence Timer.
11. To design, assemble and test the voltage regulators using voltage regulator IC's 78xx and 79xx, LM 317 etc.
12. To determine the lock range, free running range and capture range of PLL.
13. To design and test the given electronic application using hardware and software.
14. To perform the analysis and fault diagnosis of given electronic circuit hardware and software.

(EE) Measurements and Communication Systems Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Continuous evaluation: 50 Marks
End-Sem evaluation: 50 Marks

Course Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

- Explain and physically identify the parts like moving coil, control system, damping systems, pointer, shunts, multipliers etc. of different types of deflection systems.
- Handle cathode ray oscilloscope independently and use it effectively for measurement of various patterns, waveforms.
- Measure power in three phase circuits using analog wattmeters and also by using digital power analyzers.
- Demonstrate working of Various Biomedical Instruments.
- Recognize various transducers and use them in the measurement of various electrical and non-electrical quantities.

List of Experiments:

The laboratory course can have any 10 experiments from the following list.

1. Study of Moving iron, PMMC and Dynamometer type instruments (construction, moving systems).
2. Measurement of power in three phase balanced and unbalanced circuits by conventional two watt meter method and by power analyzer.
3. Comparative study of temperature measurement using RTD and thermocouple.
4. Study of strain gauge and measurement of force using it.
5. Measurement of light intensity using Lux-meter and to realize the light intensity distribution with change in distance.
6. Study of construction of LVDT and measurement of displacement, force and pressure by using it.
7. Calibration of Single phase energy meter (Analog and Digital) for energy measurement.
8. Measurement of R, L and C Using Different Bridges and confirmation with analytical calculations.
9. Speed measurement using photoelectric pickup, magnetic pickup and stroboscope.
10. Demonstration of Biomedical Instruments: Electrocardiogram (ECG), Sphygmomanometer (Blood Pressure measurement).
11. Amplitude modulation of baseband signal, modulation index measurements.
12. Frequency modulation of baseband signal.
13. Study of pulse coded modulation system.
14. Study of delta modulation, adaptive delta modulation techniques.
15. Pulse Width Modulation of low frequency signal.
16. Study of shift keying techniques.

(EE) Numerical Methods and Computer Programming Laboratory

Teaching Scheme:
Lecture: 1 hrs/week
Practical: 2 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
Continuous evaluation: 50 Marks
End-Sem evaluation: 50 Marks

Course outcomes:
At the end of this course students will demonstrate the ability to

- Understand various aspects of MATAB/Scilab and their utility as tool in coding various numerical methods.
- Application of various numerical methods for analysis of Electrical Engineering problems.
- Develop C, C++ and MATLAB/Python programs for numerical methods.

Unit 1
Introduction
Mathematical modeling in engineering problem solving, approximations and different types of errors, Taylor series, introduction to MATLAB programming, introduction to Scilab. **[06 Hrs]**

Unit 2
Roots of Equations:
Roots of algebraic and transcendental equations: Bracketing methods – bisection method, false position, Open methods – Newton Raphson, application: Analysis of electrical circuits using above methods. **[04 Hrs]**

Unit 3
Linear Simultaneous Algebraic Equations:
Cramer's rule, Gauss elimination – pit falls and remedies, Gauss-Seidal, Gauss-Jordan method, Newton Raphson method. Introduction to eigen value and eigen vectors and iterative method to estimate the m application: solving resistive networks. **[04 Hrs]**

Unit 4
Curve Fitting:
Interpolation - Newton's polynomial, Lagrange polynomial **[02 Hrs]**

Unit 5
Numerical Integration and Differentiation:
Integration: Newton-Cotes formulae - Trapezoidal rule, Simpson's Rule, application: calculation of RMS values. **[04 Hrs]**

Unit 6
Ordinary Differential Equations:
Euler's method, Modified Euler's method, Runge-kutta methods. **[04Hrs]**

Text Books:

- Steven Chapra, Raymond P. Canale, ”Numerical Methods for Engineers”, McGrawHill International Student Edn
- Santosh K. Gupta, ”Numerical Methods for Engineers”, Wiley Eastern.
- S. S. Sastry, “Numerical Methods”, Prentice Hall of India, New Delhi (3rd edition)
- Rudra Pratap, “MATLAB Programming” Tata McGraw Hill, NewDelhi.

Term work:

- It shall comprise of minimum 12 programs in MATLAB for solving problems demonstrating use of various numerical methods learned in above 6 units.

Semester IV [Structure for Regular Students]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Vector Calculus and Partial Differential Equations	2	1	0	3
2	BSC		Biology for Engineers	3	0	0	3
3	SBC		Micro Project	0	0	2	1
4	IFC - 2		Sensors and Automation	1	0	2	2
5	PCC		Electric Machinery I	3	0	0	3
6	PCC		Digital Electronics	3	0	0	3
7	PCC		Electromagnetic Fields	3	0	0	3
8	LC		Electric Machinery I Laboratory	0	0	2	1
9	LC		Digital Electronics Laboratory	0	0	2	1
10	LC		Data Structure and Computer Programming Laboratory	0	1	2	2
Total				15	2	10	22
Total Academic Engagement and Credits				**27**			**22**

Semester IV [Structure for students directly admitted to Second Year B. Tech.]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Multivariate Calculus and Differential Equations	4	1	0	5
2	BSC		Biology for Engineers	3	0	0	3
3	SBC		Micro Project	0	0	2	1
4	IFC - 2		Sensors and Automation	1	0	2	2
5	PCC		Electric Machinery I	3	0	0	3
6	PCC		Digital Electronics	3	0	0	3
7	PCC		Electromagnetic Fields	3	0	0	3
8	LC		Electric Machinery I Laboratory	0	0	2	1
9	LC		Digital Electronics Laboratory	0	0	2	1
10	LC		Data Structure and Computer Programming Laboratory	0	1	2	2
Total				17	2	10	24
Total Academic Engagement and Credits				**29**			**24**

(MA) Vector Calculus and Partial Differential Equations

Teaching Scheme:
Lectures: 2 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Objectives : Basic necessity for the foundation of Engineering and Technology being mathematics, the main aim is, to teach mathematical methodologies and models, develop mathematical skills and enhance thinking power of students.

Course Outcomes:
Students will be able to,

- Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type - define, identify, state, match, list, name etc.)
- Understand basic concepts. (To measure this outcome, questions may be of the type - explain, describe, illustrate, evaluate, give examples, compute etc.)
- Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
- Give reasoning. (To measure this outcome, questions may be of the type-true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
- Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

Unit 1:
Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates, substitutions in multiple integrals, Applications to Area, Volume, Moments and Center of Mass. **[10 Hrs]**

Unit 2:
Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss, arc length parameterization, applications. [**07 Hrs]**

Unit 3:
Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes. [**09 Hrs]**

Text Books:

- Maurice D. Weir, Joel Hass, Frank R. Giordano, "Thomas' Calculus", 14th edition, Pearson Education.
- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley eastern Ltd.

Reference Books:

- C. R. Wylie, “Advanced Engineering Mathematics”, McGraw Hill Publications, New Delhi.
- Wendell Fleming, “Functions of several variables”, Springer-Verlag, NewYork.
- Fritz John, “Partial Differential Equations”, 4th edition, Springer.
- Peter V. O’Neil, “Advanced Engineering Mathematics”, 7th edition, Thomson. Brooks/ Cole, Singapore.
- Michael D. Greenberg, “Advanced Engineering Mathematics”, 2nd edition, Pearson Education
- Chandrika Prasad and Reena Garg, "Advanced Engineering Mathematics", Khanna Publishing Company Private Limited, New Delhi.

Note:

All the course outcomes 1 to 3 will be judged by 75% of the questions and outcomes 4 and 5 will be judged by 25 % of questions.

(MA) Multivariate Calculus and Differential Equations

(For Students Directly admitted to SY B. Tech. after the Diploma)

Teaching Scheme:
Lectures: 4 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Objectives:

Basic necessity for the foundation of Engineering and Technology being mathematics, the main aim is, to teach mathematical methodologies and models, develop mathematical skills and enhance thinking power of students.

Course Outcomes:

Students will be able to:

- Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type - define, identify, state, match, list, name etc.)
- Understand basic concepts. (To measure this outcome, questions may be of the type - explain, describe, illustrate, evaluate, give examples, compute etc.)
- Analyze the problem and apply the appropriate concept.(To measure this outcome, questions will be based on applications of core concepts.)
- Give reasoning. To measure this outcome, questions may be of the type - true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
- Apply core concepts to new situations. (To measure this outcome, questions will be based on self-study topics and also comprehension of unseen passages.)

Unit 1:

Review of first order differential equations, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters). **[09 Hrs]**

Unit 2:

Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform. **[07 Hrs]**

Unit 3:

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points. **[07 Hrs]**

Unit 4:

Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates **[12 Hrs]**

Unit 5:

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss. **[10Hrs]**

Unit 6:

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, one dimensional heat equation. **[07 Hrs]**

Text Books:

- Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas' Calculus (12th edition) Pearson Education.
- Erwin Kreyszig, Advanced Engineering Mathematics (10th edition), Wiley eastern Ltd.

Reference Books:

- K. D Joshi, "Calculus for Scientists and Engineers", CRC Press.
- Sudhir Ghorpade and Balmohan Limaye, "A Course in Multivariate Calculus and Analysis", Springer Science and Business Media.
- George Simmons, "Differential Equations with Applications and Historical notes", Tata McGraw Hill publishing company Ltd, New Delhi.
- Wendell Fleming, "Functions of several variables", Springer - Verlag, New York.
- Fritz John, "Partial Differential Equations", 4th edition, Springer.
- C. R. Wylie, "Advanced Engineering Mathematics", McGraw Hill Publications, New Delhi
- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Thomson.Brooks / Cole, Singapore.
- Michael D. Greenberg, "Advanced Engineering Mathematics", 2nd edition, Pearson education.
- Chandrika Prasad and Reena Garg, "Advanced Engineering Mathematics", Khanna Publishing Company Private Limited, New Delhi.

Note:

All the course outcomes 1 to 3 will be judged by 75% of the questions and outcomes 4 and 5 will be judged by 25 % of questions.

( ) Biology for Engineers

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:
Students will be able to,

- Understand basic biological principles and organizational structure of living systems at molecular level.
- Comprehend basic biological principles and organizational structure of living systems at cellular level.
- Know Energy transformations and information processing in biological systems.
- Appreciate biological process with engineering perspective.
- Impart knowledge about the common corridors of biology and engineering and biologically inspired technologies.

Unit 1:
Biomolecules and Biopolymers: Structure and Function
Organic and inorganic molecules; Unique Properties of water, Vitamins and Minerals, Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA). **[06 Hrs]**

Unit 2:
Levels of Organization of Life: Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane
Levels of organization: cells, tissues, organs, systems & organism. **[06 Hrs]**

Unit 3:
Energy Transformations in Chloroplast: Photosynthesis (photochemical & biochemical phase) and ATP generation, Aerobic and anaerobic systems.
Energy Transformations in Mitochondria: Cellular respiration (glycolysis and Kreb cycle) and ATP generation.
Bioenergetics: Thermodynamic principles applied to biology, negative entropy changes in biological systems, Free Energy, Chemical Equilibrium. **[06 Hrs]**

Unit 4:
Expression and Transmission of Genetic Information: DNA replication, Enzyme driven process of DNA cloning, Protein synthesis- Transcription & translation.
Techniques for optimization:
At molecular level: Recombinant DNA Technology, DNA hybridization, PCR, DNA microarray.
[06 Hrs]

Unit 5:

Transport Phenomena in Biological Systems: Membrane channels and ion channels; Fluid flow and mass transfer (nutrients & ions); In plants: Xylem and Phloem; In animals: Blood and Lymph Transport of gases: Oxygen and Carbon dioxide

Heat Transport - Body temperature regulation.

Communication: Cell junctions, Cell-cell communications – cell signaling, Hormones, Pheromones and cell behaviour

Defense mechanisms:

In plants: Herbivory, secondary metabolites,

In animals: Innate and Adaptive immune systems **[06 Hrs]**

Unit 6:

Engineering perspectives of Biological Sciences:

Biology and engineering crosstalk – At cell level: Hybridoma technology, At tissue level: Plant Tissue Culture, Animal Tissue Culture; Tissue Engineering: Principles, methods and applications Introduction to Biomimetics and Biomimicry, nanobiotechnology **[06 Hrs]**

References:

- Lodish H, Berk A, Zipursky SL, et al. (2000) Molecular Cell Biology. W. H. Freeman.
- Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). Lehninger principles of biochemistry. New York: Worth Publishers.
- Rao CNR, et.al. Chemistry of Nanomaterials: Synthesis, Properties and Applications.
- Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
- Palsson B.O. and Bhatia S.N. (2009) Tissue Engineering. Pearson.
- Yoseph Bar-Cohen (2005). Biomimetics- Biologically Inspired Technologies
- Joseph D. Bronzino, John Enderle, Susan M. Blanchard (1999) Introduction to Biomedical Engineering.
- Routledge Taylor and Francis group (2012). Introduction to Bio-medical Engineering technologies

Table 1.1: For Teachers: Additional topics to be discussed with students in accordance with relevant biological topics (in branch-wise manner)

Disease/ Disorder	Physiology	Diagnosis	Therapeutics		Medical procedure
			Biomaterials	Instrumentation	
Cardiovascular disease	Heart – electrical stimulation and mechanical pumping	ECG, Angiography	Stents for angioplasty	Heart lung machines	Angioplasty, By-pass surgery
Bone/skull injuries	Biomechanics of musculo-skeletal system	Medical imaging technologies Arthroscopy	Prosthetics	Arthroscope Biomechanics Prosthetics	Joint replacement Total hip Replacement reh abilitation engg
Kidney disorders	Functioning of Kidney	Medical imaging technologies	Filtration membranes	Dialyser	Dialysis

(EE) Micro Project

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term work: 50 Marks
Practical/oral: 50 Marks

Course Outcomes:
At the end of this course, the students should be able to,

- Identify and formulate the project problem.
- Use the software tools for design and simulation.
- Design and fabricate various electrical/electronic elements, components and circuits.
- Test, validate and present the project models.
- Develop the ability to work in a team, appreciate concern for environment and society with interdisciplinary aspects

Course content:
Student may develop solution for a real life concept/ problem as a micro project. Students are required to learn and understand the user requirements. The paper design, simulation and fabrication will be part of the work. They may design, fabrication and use of various circuit elements and components (like transformer, motors, sensors, power supply, processor module, interfacing module, display and signal conditioning module etc.) as per the standards and practices. Students may also work on embedded software and programming.

(IFC -2) Sensors and Automation

Teaching Scheme:
Lectures: 1 hr/week
Practical: 2 hrs/week

Examination Scheme:
T1 and T2: 20 marks each
End-Sem Exam: 60 marks

Course Outcomes:
At the end of this course, the students should be able to,

- Interpret the characteristics of the transducers/sensors.
- Select transducers/sensors for specific applications.
- Understanding of working principle of Programmable Logic Controller (PLC) and Distributed Control Systems (DCS).
- Understanding the concept of Industrial Automation.

Unit 1
Basics of Sensors:
Concepts and terminology of transducer, sensor, sensor classifications and characteristics (Static and dynamic), Working principle, characterization and applications of: strain gauges, LVDT, capacitive, RTD, thermocouple, thermistor, Solid-State, pressure, optical, chemical sensors, integration of sensors for IOT and Industry 4.0 applications. **[07 Hrs]**

Unit 2
Industrial Automation:
Industrial Automation: concept, automation components, necessity and working principle, block schematic of Programmable Logic Controller (PLC). Input & Output modules (AI, DI, AO, DO), Introduction to Ladder Programming, introduction to Distributed Control Systems (DCS). Industrial automation leads to Industrial IOT and Industry 4.0. **[07 Hrs]**

List of Practical:

1. Case study /Characterization of RTD/semiconductor Temp IC.
2. Characterization of level sensors.
3. Characterization of strain gauge/ Displacement measurement using LVDT/ Encoders.
4. Characterization of PH, Conductivity, color sensor.
5. Introduction to PLC programming languages (ladder programming).
6. Ladder Programming for relay, coil, On/OFF, Sequencing of motors.
7. Ladder Programming with Timers/Counters.
8. Ladder Programming for Pick and Place type of robotics application.

Text Books:

- B. C. Nakra and K. K. Choudhari, “Instrumentation Measurements and Analysis”, by Tata McGraw Hill Education, 2nd ed., 2004.
- C.D. Johnson, “Process Control Instrumentation Technology”, by Pearson Education Limited , 8th ed., 2014.

(EE) Electric Machinery I

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:
At the end of this course, the students should be able to,

- Identify transformer, dc machine and three phase and single phase induction motors.
- Select a suitable transformer, dc machine, induction machine as per application.
- Evaluate and analyze the steady state parameters, operating characteristics and performance of transformers, dc machine and induction machine
- Analyze starting, speed control methods of dc and induction machines
- Analyze and apply the energy conversion principles to rotating machines.
- Select a suitable VRM, stepper motor, PMDC motor

Unit 1
Single Phase and Three Phase Transformer:
Review of transformer, phasor diagrams, efficiency, voltage regulation, parallel operation, per unit impedance, excitation, switching transients, auto transformers, variable frequency transformer, voltage & current transformers, welding transformers, pulse transformer, three phase transformers, standard, special transformer connections, Phase conversion, Parallel operation, three winding transformers, on load tap changing of transformers, modern trends in transformers, type and routine tests. **[08 Hrs]**

Unit 2
Electromechanical Energy Conversion Principles:
Energy in a magnetic systems, field energy and mechanical force, energy in singly and multiply excited magnetic systems, determination of magnetic force and torque from energy and co-energy, Forces and torques in magnetic field systems, dynamic equations of electromechanical systems and analytical techniques. **[07 Hrs]**

Unit 3
DC Machines :
Review, generator operation, armature and field systems, types, emf equation, armature windings, characteristics and applications, armature reaction – demagnetizing and cross magnetizing mmfs, commutation process, bad commutation and remedies.
Dc motor operation, significance of back emf, torque equation, types, characteristics and selection criterions, starting, speed control, losses and efficiency, condition for maximum efficiency, braking, applications, type and routine tests. **[08 Hrs]**

Unit 4
Three Phase Induction Machine (Asynchronous Machines):
Introduction, construction , types, flux and MMF waveforms, circuit model, no load and on load operation, phasor diagram, power factor, power output, OC and SC test, torque developed, starting

methods, deep cage bars, speed control, cogging and crawling, circle diagram, maximum torque and power estimation, efficiency, breaking, testing and applications, machine dynamics, modeling, Induction generator principle. **[07 Hrs]**

Unit 5

Fractional Kilowatt Machines:

Fractional kilowatt motors, basics of single phase motors, construction, types, double revolving theory, circuit model, phasor diagram, determination of parameters, losses and efficiency, applications, two phase induction motor. **[06 Hrs]**

Unit 6

Special Machines:

Constructional details of reluctance machine, variable-reluctance machines, basic VRM analysis, practical VRM analysis, stepper motors and their analysis, permanent magnet dc motors, high efficiency motors. **[04 Hrs]**

Text Books:

- D. P. Kothari and I. J. Nagrath, "Electric Machines", Tata Mc Graw Hill Publication, 4th edition 2010, Reprint 2012.
- E. Fitzgerald, C. Kingsley, S. D. Umans, "Electrical Machinery", Tata Mc Graw Hill, 6th edition, 2002.
- P. S. Bimbhra: Electrical Machinery – Khanna Publishers, 7th edition, 2011.

Reference Books:

- Nasser Syed, "Electrical Machines and Transformers", A New York, Macmillon 1984.
- Langsdorf A. S., "Principles of DC Machines", 6th Edition, McGraw Hill Book Company 1959.
- P. C. Sen., "Principles of Electric Machines and Power Electronics", 2nd edition, John Wiley and Sons Inc., 1997.
- M. G. Say, "Alternating Current Machines", 5th edition, Low price edition, ELBS, Reprinted 1994
- Bhag S. Guru and Huseyin R. Hiziroglu, "Electric Machinery and Transformers", 3rd Indian edition, Oxford University Press, Reprint 2014.
- B. L Thareja, A. K. Thareja,, " A text book of Electrical Technology, Vol. II, AC and DC Machines" S. Chand Publication, Multicolour edition, Reprint 2004

e Learning resource:

- https://nptel.ac.in/courses/108105017; NPTEL: Electrical Engineering, Electrical Machines –I and Electrical Machines -II.

(EE) Digital Electronics

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course outcomes

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

- Understand various number systems.
- Use K-Map for minimizing the Boolean expressions.
- Construct Combinational and Sequential logic circuits.
- Analyze various ADC/DAC for conversion of signals from analog to digital and vice-versa.
- Classify different types of memories.
- Understand fundamentals of microprocessors.

Unit 1

Fundamentals of Digital Systems and Logic Families:

Digital signals, digital circuits, number systems-binary, signed binary, octal, hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, Boolean algebra, gates, characteristics of digital ICs, digital logic families - TTL, CMOS logic, interfacing CMOS and TTL, Tri-state logic. **[07 Hrs]**

Unit 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. **[07 Hrs]**

Unit 3

Sequential Circuits and Systems:

1-bit memory, the circuit properties of bi-stable latch, the clocked SR flip flop, J-K-T and D-types flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, Asynchronous counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters, Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, state minimization, state assignment. **[08 Hrs]**

Unit 4

A/D and D/A Converters:

Digital to analog converters: weighted resistor/convertor, R-2R Ladder D/A converter, specifications, 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, dual slope

A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters. **[07 Hrs]**

Unit 5

Semiconductor Memories and Programmable Logic Devices (PLD's):

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), FLASH memory, Programmable logic array, Programmable array logic, Field Programmable Gate Array (FPGA), HDL Programming. **[08 Hrs]**

Unit 6

Fundamentals of Microprocessor:

Fundamentals of Microprocessor- Microprocessor architecture, concepts of control bus, address bus, data bus, ALU, registers, program counter, flags, interrupts, timing and control unit, addressing modes, I/O devices, instruction decoding, M/C cycle, instruction cycle tec., Microprocessor based system-basic operation. (Processor unspecific generalized approach). **[05 Hrs]**

Text Books:

- R. P. Jain, "Modern Digital Electronics", 4th edition, Tata McGraw Hill, 2009.
- M. Morris Mano, "Digital logic and Computer design", 1st edition, Pearson Prentice Hall, 2016.
- Anand Kumar, "Fundamentals of Digital Circuits", Prentice-Hall India, 4th edition, 2016.
- Ronald J Tocci, Neal Widmer, Greg Moss,"Digital systems principles and applications" 11th edition, Pearson Education, 2010.

Reference Books:

- Herbert Taub, Donald Schilling, "Digital Integrated Electronics", 1st edition, Tata McGraw Hill, 2017.
- Donald Leech, Albert Malvino, Goutam Saha," Digital Principles and Applications", 8th edition, McGraw Hill Education, 2014.

e Learning Resources:

- Prof. Goutam Saha, IIT Kharagpur, online lecture series on Digital Electronic Circuits
- https://nptel.ac.in/courses/108/105/108105132/
- Prof. S. Srinivasan, IIT Madras, online lecture series on Digital Circuits and Systems
- https://nptel.ac.in/courses/117/106/117106086/

(EE) Electromagnetic Fields

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course outcomes

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

- Analyse and calculate the capacitance, force and energy in Electrostatic devices.
- Solve and analyse the problems related to magnetic field.
- Compute and analyze performance and behavior of electromechanical devices such as motors, generators and transformers.
- Apply Maxwell's field equations to analyze and improve the performance of electromechanical devices and to develop space-related thinking ability.
- Analyze and apply the process of energy conversion and energy transfer of electromechanical devices.

Unit 1

Vector Analysis:

A) Vector Algebra:

Review, scalars and vectors, unit vector, vector addition and subtraction, position and distance vectors, vector multiplication, dot product, cross product, triple product, components of a vector.

B) Coordinate System and Transformation:

Review, Cartesian coordinates, circular cylindrical coordinates, spherical coordinates, constant coordinate surfaces.

C) Vector Calculus:

Introduction, differential length, area and volume, line, surface and volume integrals, Del operator, gradient of a scalar, divergence of a vector and divergence theorem, curl of a vector and Stokes's theorem, Laplacian of a scalar, classification of vector fields. **[08 Hrs]**

Unit 2

Electrostatic Fields:

Introduction, Coulomb's law and field intensity, electric field due to continuous charge distributions, a line charge, surface charge, volume charge, electric flux density, Gauss's law-Maxwell's law, applications of Gauss's law, point charge, infinite line charge, infinite surface charge, uniformly charged sphere, electrical potential, relationship between E and V - Maxwell's equation, an electric dipole and flux lines, energy density in electrostatic fields. **[08 Hrs]**

Unit 3

Electric Field in Material Space and Electrostatic Boundary Value Problem:

Introduction, properties of materials, convection and conduction currents, conductors, polarization in dielectrics, dielectric constant and strength, Poisson's and Laplace's equations, uniqueness theorem, general procedures for solving Poisson's and Laplace's equation, resistance and capacitance, parallel plate, coaxial and spherical capacitors. **[07 Hrs]**

Unit 4

Magnetostatic fields:

Introduction, Biot-Savart's law, Ampere's circuit law-Maxwell's equation, applications of Ampere's law, infinite line current, infinite sheet current, infinitely long coaxial transmission line, leakage flux, magnetic flux density-Maxwell's equations, Maxwell's equation for static fields, magnetic scalar and vector potentials, derivation of Biot-Savart's law and Ampere's law, forces due to magnetic fields, magnetic torque and moment, a magnetic dipole, magnetization in materials, classification of materials, magnetic boundary conditions, inductors and inductances, magnetic energy, magnetic circuits, force on magnetic materials. **[08 Hrs]**

Unit 5

Maxwell's equations:

Introduction, Faraday's law, transformer and motional, electromotive forces, stationary loop in time varying B field (transformer emf), moving loop in static B field (motional emf), moving loop in time varying field, displacement current, Maxwell's equations in final forms, time varying potentials, time harmonic fields. **[08 Hrs]**

Text Books:

- Matthew N. O. Sadiku, "Elements of Electromagnetics", Oxford University publication, 6th edition, 2014.
- A.Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2nd edition, 2009.
- A.Pramanik, "Electromagnetism – Problems with solution", Prentice Hall of India, Pvt. Ltd., 2nd edition, 2012.

Reference Books:

- G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1st edition, 1954.
- W. J. Duffin, "Electricity and Magnetism",McGraw Hill Publication, 3rd edition(Rev),1980.
- W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Inc. US,1968.
- E. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 3rd edition, 1966.
- B. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley, Educational Publishers Inc, International Edition, 1971.
- William Hayt, "Engineering Electromagnetics", Tata McGraw Hill Education Pvt. Ltd., 7th edition, 2012.

e Learning Resoures:

- https://nptel.ac.in/courses/117103065/

(EE) Electric Machinery I Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Continuous evaluation: 50 Marks
End-Sem evaluation: 50 Marks

Course Outcomes:

At the end of laboratory course the students will be able to,

- Differentiate between various types of transformers, dc machines and induction motors and appreciate constructional details.
- Select a suitable motor as per the application.
- Determine transformer, dc machine and induction machine parameters by testing.
- Practically estimate losses in transformers, dc machine and induction motors.
- Practically obtain efficiency curves of transformers, dc machines and induction motors by direct /indirect load tests.
- Control speed of various dc motor and induction motors.

List of Experiments:

From following list minimum 8 experiments are to be performed by the student;

1. To perform open circuit (OC) and short circuit (SC) test on single phase transformer to estimate its core loss, copper loss and equivalent circuit parameters.
2. To perform direct load test on single phase and three phase transformer to obtain its % efficiency and % voltage regulation at various loading conditions.
3. Parallel operation of two single-phase transformers to study their load sharing under various operating conditions.
4. To perform open delta (V-V) connection of identical two single-phase transformers to obtain three phase transformation.
5. Verification of Scott-connection of two single-phase transformers to obtain 2 phase to 3 phase transformation.
6. Verification and analysis of no load current waveform of single phase transformer.
7. Separation of transformer core loss into eddy current loss and hysteresis loss.
8. Determination of magnetization, external and internal characteristics of a DC shunt generator.
9. Determination of efficiency of a dc shunt or compound generator at various loading conditions.
10. Speed control of a separately dc Shunt motor by- (i) armature voltage control and (ii) Field
11. current control method.
12. Direct load test on separately excited dc shunt motor to obtain it's on load Efficiency.
13. Estimation of efficiency of a dc shunt or compound machine by performing Swinburne's test.
14. To perform load test on three phase squirrel cage induction motor to estimate losses and Efficiency.
15. Perform no load and blocked rotor test on three phase squirrel cage induction motor to estimate it's equivalent circuit parameters and efficiency, losses and various torques.
16. To perform no load and blocked rotor test on single phase induction motor to estimate its circuit parameters and various torques.
17. To control speed of three phase slip ring induction motor by varying the rotor resistance.

(EE) Digital Electronics Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Continuous evaluation: 50 Marks
End-Sem evaluation: 50 Marks

Course Outcomes:

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

- Analyze the functionality of logic gates.
- Realize Boolean expressions.
- Build arithmetic circuits.
- Construct combinational and sequential circuits.
- Understand the operation of various ADC/DAC.

List of Experiments:

The laboratory course can have any 10 experiments from the following list.

1. Verify the truth tables of Logic Gates.
2. Verification of Boolean laws and D Morgan's theorem.
3. Verification of MUX and DEMUX.
4. Realization of combinational circuits (Decoders/Encoders/Code Converters).
5. Design of arithmetic circuits: Half adder, Full adder, subtractor and BCD adder/ subtractor.
6. Design of Flip Flops: S-R, J-K, D type and master slave with truth tables.
7. Realization of Flip Flops using Logic Gates.
8. Design of counters using IC's: Up down, Decade, Synchronous, Binary, BCD counter.
9. Design of counters using flip flops.
10. Design of Ring counter, Johnson counter etc.
11. Function realization using data selector IC's.
12. Study of D/A and A/D converters (Any one of each class): R-2R ladder, weighted resistor method, successive approximation, voltage to frequency conversion.
13. Design of decoder driver to drive 7 segment LED display.
14. Interfacing of CMOS TTL logic families.
15. To design and test the given electronic application.
16. To perform the analysis and fault diagnosis of given electronic circuit.

(EE) Data Structure and Computer Programming Laboratory

Teaching Scheme:
Tutorial: 1 hr/week
Practical: 2 hrs/week

Examination Scheme:
Continuous evaluation: 50 Marks
End-Sem evaluation: 50 Marks

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

- Formulate and apply object-oriented programming, as a modern tool to solve given problems.
- Understand basic data structures (such as an array based list, linked list, stack, queue).
- Understand and analyze algorithms.

Unit 1
Introduction to Data Structures:
Overview, abstract data types, types of data structures, introduction to algorithm, analysis of an algorithm, big- Oh notation.
Introduction to Objects and Classes:
Specifying the class, data types, constructors, destructors, overloaded constructors, objects as function arguments, member functions, memory allocation objects.
Inheritance:
Derived class and base class, derived class constructors, class hierarchies, public and private inheritance, levels of inheritance, multiple inheritance. **[03 hrs]**

Unit 2
Pointers, Virtual Functions:
Addresses and pointers, pointers and arrays, pointers and functions, pointers and strings, memory managements, pointers to objects, pointers to derived classes, pointers to pointers. Virtual functions, friend functions, static functions, assignment and copy-initialization, this pointer. **[02 hrs]**

Unit 3
Stacks:
Definition, push and pop operation, application of stack, recursion.
Queues:
Definition, add and delete operations, circular queue, application of queue. **[02 hrs]**

Unit 4
Linked Lists:
Definition, insert and delete operations, circular linked list, doubly linked list, traversing the doubly linked list, insert and delete operations on doubly linked list. **[02 hrs]**

Unit 5
Searching and Sorting algorithms:
Search: Sequential Search, Binary Search.
Sort: List and Table Sort, Heap Sort, Merge Sort, Quick Sort, Insertion Sort. **[02 Hrs]**

Unit 6

Graphs and Shortest Path Algorithms:

Introduction to Graphs, Depth First Search (DFS), Breadth First Search (BFS), Prim's Algorithm for finding Minimum Spanning Tree (MST), Kruskal's Algorithm for finding MST, Dijkstra's Algorithm for Single Source Shortest Paths. **[03 Hrs]**

Text Books:

- Bjarne Stroustrup, "The C++ Programming Language", 4th edition, Addison-Wesley Professional, 2013.
- T. Cormen, C. Leiserson, R. Rivest, C. Stein, "Introduction to Algorithms", 3rd edition, Prentice-Hall India, 2010.
- S. Sahni, "Data Structures: Algorithms and Applications in C++", 2nd edition, Universities Press,2017.
- E. Balguruswamy, "Object Oriented Programming with C++", 7th edition, Tata McGraw Hill Publication, 2017.

Reference Books:

- A. Berman, "Data Structures via C++", Oxford Publication, 2012.
- Robert Lafore, "Object Oriented Programming in C++", 4th edition, Pearson Education, 2008.
- Aaron M, Tenenbaum, Yedidyah Langsam, M.J. Augenstein, "Data structures using C and C++", 2nd edition, Pearson Education, 2015.

e Learning Resources:

- Prof. Shankar Balachandran, IIT Madras, online lecture series on Programming, Data Structures and Algorithms https://nptel.ac.in/courses/106/106/106106133/
- Prof. Naveen Garg, IIT Delhi, online lecture series on Data Structures and Algorithms https://nptel.ac.in/courses/117/106/117106086/

Term work:

- The term work should consist of any 10 experiments based on various concepts covered in the theory.