DEPARTMENT OF PHYSICS

DIBRUGARH UNIVERSITY

Syllabus for

B.Sc. Honours in Electronic Science

Approved by the Board of Studies in Electronics

held on April 11, 2018

Course Structure (Electronics-Major)

Details of courses under B.Sc. (Honours)

Course	*Credits	
	Theory + Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14x4 = 56	14x5 =70
Core course Practical/ Tutorial* (14 Papers)	14x2 = 28	14x1 =14
II. Elective Course (8 Papers)		
A.1. Discipline Specific Elective (4 Papers)	4x4 = 16	4x5 = 20
A.2. Discipline Specific Elective Practical/ Tutorial* (4 Papers)	4x2 = 8	4x1 = 4
B.1. Generic Elective/ Interdisciplinary (4 Papers)	4x4 = 16	4x5 = 20
B.2. Generic Elective Practical/ Tutorial* (4 Papers)	4x2 = 8	4x1 = 4

- **Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Course		
1.Ability Enhancement Compulsory Courses (AECC) (2 papers of 2 Credit each) Environmental Science/ English/ MIL communication	3x2 = 6	3x2 = 6
2. Skill Enhancement Courses (SEC) (Minimum 2) (2 papers of 2 Credits each)	2x2 = 4	2x2 = 4
Total credit	142	142

Marks Distribution: End Semester: 80%; In Semester: 20%**

*** Wherever there is a practical there will be no tutorial and vice-versa**
**** As per Dibrugarh University regulation**
At least 75% of the experiments listed in the syllabi are required to be performed by each student

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN BSc Honours in Electronics

Semester	Core Course (14)	Ability Enhancement Compulsory Course (AECC) (3)	Skill Enhancement Course (SEC) (2)	Elective: Discipline Specific (DSE) (4)	Elective: Generic (GE) (4)
I	Basic Circuit Theory and Network Analysis	AECC-1 Communicative English			GE-1
	Mathematics Foundation for Electronics	AECC-2 MIL/Communicative Hindi/Alternative English			
II	Semiconductor Devices	AECC-3 Environmental Science			GE-2
	Applied Physics				
III	Electronic Circuits		SEC-1		GE-3
	Digital Electronics and Verilog/VHDL				
	C-Programming and Data Structures				
IV	Operational Amplifiers and Applications		SEC-2		GE-4
	Signals and Systems				
	Electronic Instrumentation				
V	Microprocessors and Microcontrollers			DSE-1	
	Electromagnetics			DSE-2	
VI	Communication Electronics			DSE-3	
	Photonics			DSE-4	

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course- I	Communicative English	2
	Ability Enhancement Compulsory Course-II	MIL/Communicative Hindi/Alternative English	2
	Core Course-I	Basic Circuit Theory and Network Analysis	4
	Core Course-I Practical/Tutorial	Basic Circuit Theory and Network Analysis Lab	2
	Core course-II	Mathematics Foundation for Electronics	4
	Core Course-II Practical/Tutorial	Mathematics Foundation for Electronics Lab	2
	Generic Elective -1	GE-1	4/5
	Generic Elective -1 Practical/Tutorial		2/1
II	Ability Enhancement Compulsory Course- III	Environmental Science	2
	Core course-III	Semiconductor Devices	4
	Core Course-III Practical/Tutorial	Semiconductor Devices Lab	2
	Core course-IV	Applied Physics	4
	Core Course-IV Practical/Tutorial	Applied Physics Lab	2
	Generic Elective -2	GE-2	4/5
	Generic Elective -2 Practical/Tutorial		2/1
III	Core course-V	Electronic Circuits	4
	Core Course-V Practical/Tutorial	Electronic Circuits Lab	2
	Core course-VI	Digital Electronics and Verilog/VHDL	4
	Core Course-VI Practical/Tutorial	Digital Electronics and Verilog/VHDL Lab	2
	Core course-VII	C Programming and Data Structures	4
	Core Course-VII Practical/Tutorial	C Programming and Data Structures Lab	2
	Skill Enhancement Course -1/Ability Enhancement Elective Course-1	SEC-1	2
	Generic Elective -3	GE-3	4/5
	Generic Elective -3 Practical/Tutorial		2/1
IV	Core course-VIII	Operational Amplifiers and Applications	4
	Course-VIII Practical/Tutorial	Operational Amplifiers and Applications Lab	2
	Core course-IX	Signals and Systems	4
	Course-IX Practical/Tutorial	Signals and Systems Lab	2
	Core course-X	Electronic Instrumentation	4
	Course- X Practical/Tutorial	Electronic Instrumentation Lab	2
	Skill Enhancement Course -2/Ability Enhancement Elective Course-2	SEC-2	2
	Generic Elective -4	GE-4	4/5
	Generic Elective -4 Practical/Tutorial		2/1
V	Core course-XI	Microprocessors and Microcontrollers	4
	Core Course-XI Practical/Tutorial	Microprocessors and Microcontrollers Lab	2
	Core course-XII	Electromagnetics	4
	Core Course-XII Practical/Tutorial	Electromagnetics Lab	2
	Discipline Specific Elective -1	DSE-1	4/5
	Discipline Specific Elective -1 Practical/Tutorial	DSE-1 Lab	2/1

	Discipline Specific Elective -2	DSE-2	**4/5**
	Discipline Specific Elective- 2 Practical/Tutorial	DSE-2 Lab	**2/1**
VI	Core course-XIII	Communication Electronics	**4**
	Core Course-XIII Practical/Tutorial	Communication Electronics Lab	**2**
	Core course-XIV	Photonics	**4**
	Core Course-XIV Practical/Tutorial	Photonics Lab	**2**
	Discipline Specific Elective -3	DSE-3	**4/5**
	Discipline Specific Elective -3 Practical/Tutorial	DSE-3 Lab	**2/1**
	Discipline Specific Elective-4	DSE-4	**4/5**
	Discipline Specific Elective -4 Practical/Tutorial	DSE-4 Lab	**2/1**
Total Credits			**142**

CORE COURSE(C): (Credit: 06 each) (1 period/week for tutorials or 4 periods/week for practical)

1. Basic Circuit Theory and Network Analysis
2. Mathematics Foundation for Electronics
3. Semiconductor Devices
4. Applied Physics
5. Electronic Circuits
6. Digital Electronics and Verilog/VHDL
7. C Programming and Data Structures
8. Operational Amplifiers and Applications
9. Signals and Systems
10. Electronic Instrumentation
11. Microprocessors and Microcontrollers
12. Electromagnetics
13. Communication Electronics
14. Photonics

Discipline Specific Electives (DSE): (Credit: 06 each) (4 papers to be selected) - DSE 1-4

1. Power Electronics DSE-1
2. Modern Communication Systems DSE-2
3. Nanoelectronics DSE-3
4. Transmission Lines, Antenna and Wave Propagation DSE-3
5. Dissertation DSE-4

Skill Enhancement Course (SEC) (02 papers) (Credit: 02 each) - SEC1 to SEC2

1. Design and Fabrication of Printed Circuit Boards (4)- SEC-1
2. Robotics (4)- SEC-2

Other Discipline - GE 1 to GE 4

1. Mathematics
2. Computer Science

3. Physics
4. Biomedical Science
5. Chemistry
6. Commerce
7. Any other relevant subject to be decided upon by the BOS in Electronics from time to time

Generic Elective Papers (GE) for other Departments/Disciplines: (Credit: 06 each)

1.	Electronic Circuits and PCB Designing	GE-1
2.	Digital System Design	GE-2
3.	Instrumentation	GE-3
4.	Communication Systems	GE-4

Important:

1. The size of the practical group for practical papers is recommended to be 12-15 students.

Semester I

Course Code: ELECTRONICS-C-1
Course Title: BASIC CIRCUIT THEORY AND NETWORK ANALYSIS
Nature of the Course: CORE
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the basic circuit concepts and devices like resistors, capacitors and inductors.
2. Perform AC and DC circuit analysis.
3. Work with different theorems of network analysis.

ELECTRONICS-C-1: BASIC CIRCUIT THEORY AND NETWORK ANALYSIS (THEORY)
60 Lectures, 60 Marks

Unit- 1 **(14 Lectures, 14 Marks)**
Basic Circuit Concepts:
Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Colour coding of resistors, resistors in series and parallel.
Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel, Testing of resistance and inductance using multimeter.
Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, Construction and application, capacitors in series and parallel, factors governing the value of capacitors, testing of capacitors using multimeter.

Unit- 2 **(14 Lectures, 14 Marks)**
Circuit Analysis:
Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.
DC Transient Analysis:
RC Circuit- Charging and discharging with initial charge, RL Circuit with InitialCurrent, Time Constant, RL and RC Circuits with Sources, DC Response of Series RLC Circuits.

Unit-3 **(16 Lectures, 16 Marks)**

AC Circuit Analysis:

Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC Circuits.

Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit-4 **(16 Lectures, 16 Marks)**

Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. AC circuit analysis using Network theorems.

Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters.

Recommended readings:

- S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004)
- Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill.(2005)
- Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004)
- W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill(2005)
- Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)

ELECTRONICS-C-1: BASIC CIRCUIT THEORY AND NETWORK ANALYSIS (LAB) (HARDWARE AND CIRCUIT SIMULATION SOFTWARE)

60 Lectures, 20 Marks

1. Familiarization with
    - a) Resistance in series, parallel and series – Parallel.
    - b) Capacitors & Inductors in series & Parallel.
    - c) Multimeter – Checking of components.
    - d) Voltage sources in series, parallel and series – Parallel
    - e) Voltage and Current dividers

2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's Theorem.
6. Verification of Superposition Theorem.
7. Verification of the Maximum Power Transfer Theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.

10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10
Final (End Semester):	**80**
Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected Learner Outcomes: This course will enable the students to

1. Acquire the foundation knowledge about voltage, current and passive devices.
2. Analyse AC and DC circuits using available techniques.
3. Analyse different types of networks using the standard network theorem.

Course code: **ELECTRONICS-C-2**
Course title: MATHEMATICS FOUNDATION FOR ELECTRONICS
Nature of the course: CORE
Total Credit assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Objective of the course: At the completion of this course, a student will be able to

1. Acquire the mathematical skills and learn the techniques that are necessary to embark on the field of electronics.
2. Identify, formulate and solve complex problems in mathematics.
3. Gain the mathematical foundation, including differentiation and integration, multi-variable calculus, linear algebra, differential equations, complex variables, probability and statistics etc. which will help in the study of the broad subject electronics in a much convenient way
4. Apply this knowledge towards modelling and solution of problems in electronics with the help of advanced mathematics that this course provides.

ELECTRONICS-C-2: MATHEMATICS FOUNDATION FOR ELECTRONICS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(16 Lectures, 16 Marks)**
Ordinary Differential Equations:

First Order Ordinary Differential Equations**,** Basic Concepts, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential equations, Second Order Homogeneous and Non-Homogeneous Differential Equations**.**

Series solution of differential equations and special functions: Power series method, Legendre olynomials, Frobenius Method, Bessel's equations and Bessel's functions of first and second kind. Error functions and gamma function**.**

Unit-2 **(14 Lectures, 14 Marks)**

Matrices:

Introduction to Matrices, System of Linear Algebraic Equations, Gaussian Elimination Method, Gauss -Seidel Method, LU decomposition, Solution of Linear System by LU decomposition. Eigen Values and Eigen Vectors, Linear Transformation, Properties of Eigen Values and Eigen Vectors, Cayley-Hamilton Theorem, Diagonalization, Powers of a Matrix. Real and Complex Matrices, Symmetric, Skew Symmetric, Orthogonal Quadratic Form, Hermitian, Skew Hermitian, Unitary Matrices**.**

Unit-3 **(14 Lectures, 14 Marks)**

Sequences and series:

Sequences, Limit of a sequence, Convergence, Divergence and Oscillation of asequence, Infinite series, Necessary condition for Convergence, Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series, Leibnitz's Theorem, Absolute Convergence and Conditional Convergence, Power Series**.**

Unit-4 **(16 Lectures, 16 Marks)**

Complex Variables and Functions:

Complex Variable, Complex Function, Continuity, Differentiability, Analyticity. Cauchy-Riemann (C- R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Function, Trigonometric Functions, Hyperbolic Functions. Line Integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivative of Analytic Functions. Sequences, Series and Power Series, Taylor's Series, Laurent Series, Zeroes and Poles.Residue integration method, Residue integration of real Integrals.

Recommended readings:

- E. Kreyszig, advanced engineering mathematics, Wiley India (2008)
- Murray Spiegel, Seymour Lipschutz, John Schiller, Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill (2007)
- R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007)
- C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
- B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2007)

ELECTRONICS-C-2: MATHEMATICS FOUNDATION FOR ELECTRONICS (LAB)
(Scilab/MATLAB/ Any Other Mathematical Simulation Software)

60 Lectures, 20 Marks

1. Solution of First Order Differential Equations
2. Solution of Second Order homogeneous Differential Equations
3. Solution of Second Order non-homogeneous Differential Equations
4. Convergence of a given series.
5. Divergence of a given series.
6. Solution of linear system of equations using Gauss Elimination method.
7. Solution of linear system of equations using Gauss – Seidel method.
8. Solution of linear system of equations using L-U decomposition method.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10
Final (End Semester):	**80**
Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected Learner Outcomes: This course will enable the students to

1. Apply concepts to do mathematical modelling and analysis of numerical methods.
2. Develop their knowledge and skills for electronics, through a specialist pathway.
3. Perform independent research to help define the frontiers of knowledge in electronics or related interdisciplinary areas.

Semester II

Course code: ELECTRONICS-C-3
Course title: SEMICONDUCTOR DEVICES
Nature of the course: CORE
Total Credit assigned: 06
Distribution of credit: Theory -04, Practical-02

Course Objective: At the completion of this course, a student will be able to

1. Learn the fundamental physics of the semiconductor materials and devices.
2. Identify and characterize the semiconductor devices.
3. Apply the semiconductor devices in various circuits.

ELECTRONICS-C-3: SEMICONDUCTOR DEVICES (THEORY)

60 Lectures, 60 Marks

Unit 1 **(12 Lectures, 12 Marks)**

Semiconductor Basics:

Introduction to Semiconductor Materials, Crystal Structure, Planes and Miller Indices, Energy Band in Solids, Concept of Effective Mass, Density of States, Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors, Derivation of Fermi Level for Intrinsic & Extrinsic Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations.

Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation And Recombination Processes, Continuity Equation.

Unit 2 **(15 Lectures, 15 Marks)**

P-N Junction Diode:

Formation of Depletion Layer, Space Charge at a Junction, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction. Concept of Linearly Graded Junction, Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism.

Tunnel diode, varactor diode, solar cell: circuit symbol, characteristics, applications.

Unit 3 **(15 Lectures, 15 Marks)**

Bipolar Junction Transistors (BJT):

PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Base Transport Factor, Current Gain, Energy Band Diagram of Transistor in Thermal Equilibrium, Quantitative Analysis of Static Characteristics (Minority Carrier Distribution and Terminal Currents), Base-Width Modulation, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations. Metal Semiconductor Junctions: Ohmic and Rectifying Contacts.

Unit 4 **(18 Lectures, 18 Marks)**

Field Effect Transistors:

JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS).

Power Devices:

UJT, Basic construction and working, Equivalent circuit, intrinsic Standoff Ratio, Characteristics and relaxation oscillator-expression. SCR, Construction, Working and Characteristics, Triac, Diac, IGBT, MESFET, Circuit symbols, Basic constructional features, Operation and Applications.

Recommended readings:

- S. M. Sze, Semiconductor Devices: Physics and Technology, 2ndEdition, Wiley India edition (2002).

- Ben G Streetman and S. Banerjee, Solid State Electronic Devices, Pearson Education (2006)
- Dennis Le Croissette, Transistors, Pearson Education (1989)
- Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons (2001)
- Kanaan Kano, Semiconductor Devices, Pearson Education (2004)
- Robert F. Pierret, Semiconductor Device Fundamentals, Pearson Education (2006)

ELECTRONICS-C-3: SEMICONDUCTOR DEVICES (LAB) (HARDWARE AND CIRCUIT SIMULATION SOFTWARE)
60 Lectures, 20 Marks

1. Study of the I-V Characteristics of Diode – Ordinary and Zener Diode.
2. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β.
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
4. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i, r_o.
5. Study of the I-V Characteristics of the UJT.
6. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET.
8. Study of the I-V Characteristics of MOSFET.
9. Study of Characteristics of Solar Cell
10. Study of Hall Effect.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10
Final (End Semester):	**80**
Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Understand the basic principles and working of the semiconductor materials and devices.
2. Characterize the device.
3. Apply the knowledge of semiconductor devices in real life application.

Course code: ELECTRONICS-C- IV
Course title: APPLIED PHYSICS
Nature of the course: CORE
Total Credit assigned: 06

Distribution of credit: Theory -04, Practical-02

Course Objective: At the completion of this course, a student will be able to

1. Learn about the development of modern physics and the theoretical formation of quantum mechanics.
2. Learn about the applications of quantum mechanics in solving physical problems.
3. Learn about the physics of material science by studying mechanical properties, thermal properties, elastic and magnetic properties of materials.

ELECTRONICS-C IV: APPLIED PHYSICS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(20 Lectures, 20 Marks)**
Quantum Physics:
Inadequacies of Classical physics. Compton's effect, Photo-electric Effect, Wave-particle duality, de Broglie waves. Basic postulates and formalism of quantum mechanics: probabilistic interpretation of waves, conditions for physical acceptability of wave functions. Schrodinger wave equation for a free particle and in a force field (1 dimension), Boundary and continuity conditions. Operators in Quantum Mechanics, Conservation of probability, Time-dependent form, Linearity and superposition, Operators, Time-independent one dimensional Schrodinger wave equation, Stationary states, Eigen-values and Eigen functions. Particle in a one-dimensional box, Extension to a three dimensional box, Potential barrier problems, phenomenon of tunneling. Kronig Penney Model and development of band structure. Spherically symmetric potentials, the Hydrogen-like atom problem.

Unit-2 **(10 Lectures, 10 Marks)**
Mechanical Properties of Materials:
Elastic and Plastic Deformations, Hooke's Law, Elastic Moduli, Brittle and Ductile Materials, Tensile Strength, Theoretical and Critical Shear Stress of Crystals. Strengthening Mechanisms, Hardness, Creep, Fatigue, Fracture.

Unit-3 **(15 Lectures, 15 Marks)**
Thermal Properties:
Brief Introduction to Laws of Thermodynamics, Concept of Entropy, Concept of Phonons, Heat Capacity, Debye's Law, Lattice Specific Heat, Electronic Specific Heat, Specific Heat Capacity for Si and GaAs, Thermal Conductivity, Thermoelectricity, Seebeck Effect, Thomson Effect, Peltier Effect.

Unit-4 **(15 Lectures, 15 marks)**
Electric and Magnetic Properties:
Conductivity of metals, Ohm's Law, relaxation time, collision time and mean free path, electron scattering and resistivity of metals, heat developed in current carrying conductor, Superconductivity.

Classification of Magnetic Materials, Origin of Magnetic moment, Origin of dia, para, ferro and anti-ferro magnetism and their comparison, Ferrimagnetic materials, Saturation Magnetisation and Curie temperature, Magnetic domains, Concepts of Giant Magnetic Resistance (GMR), Magnetic recording.

Recommended readings:

- S. Vijaya and G. Rangarajan, Material Science, Tata Mcgraw Hill (2003)
- W. E. Callister, Material Science and Engineering: An Introduction, Wiley India (2006)
- Beiser, Concepts of Modern Physics , McGraw-Hill Book Company (1987)
- Ghatak& S. Lokanathan, Quantum Mechanics: Theory and Applications, Macmillan India (2004).

ELECTRONICS-C IV: APPLIED PHYSICS (LAB)
60 Lectures, 20 Marks

1. To determine Young's modulus of a wire by optical lever method.
2. To determine the modulus of rigidity of a wire by Maxwell's needle.
3. To determine the elastic constants of a wire by Searle's method.
4. To measure the resistivity of a Ge crystal with temperature by four –probe method from room temperature to 200 ^{0}C).
5. To determine the value of Boltzmann Constant by studying forward characteristics of diode.
6. To determine the value of Planck's constant by using LEDs of at least 4 different wavelengths.
7. To determine e/m of electron by Bar Magnet or by Magnetic Focusing.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10
Final (End Semester):	**80**
Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Apply quantum mechanics to solve physical systems in different areas of science.
2. Know about the physical behaviour of materials.
3. Learn how the scientific behaviours of materials can be used for human applications.

Semester III

Course Code: ELECTRONICS-C-V
Course Title: ELECTRONICS CIRCUITS
Nature of the Course: CORE
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the various uses and applications of diodes and bipolar junction transistors.
2. Utilise the necessary skill needed to analyse electronic circuits.
3. Comprehend the designing and study of different types of amplifiers.

ELECTRONICS-C-V: ELECTRONICS CIRCUITS (THEORY)
60 Lectures, 60 Marks

Unit- 1 **(14 Lectures, 14 Marks)**
Diode Circuits:
Ideal diode, piecewise linear equivalent circuit, dc load line analysis, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, comparison. Filters: types, circuit diagram and explanation of shunt capacitor filter with waveforms.
Zener diode regulator circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit- 2 **(14 Lectures, 14 Marks)**
Bipolar Junction Transistor:
Review of CE, CB Characteristics and regions of operation. Hybrid parameters. Transistor biasing, DC load line, operating point, thermal runaway, stability and stability factor, Fixed bias without and with RE, collector to base bias, voltage divider bias and emitter bias (+VCC and –VEE bias), circuit diagrams and their working.
Transistor as a switch, circuit and working**,** Darlington pair and its applications.
BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration, Quantitative study of the frequency response of a CE amplifier, Effect on gain and bandwidth for Cascaded CE amplifiers (RC coupled).

Unit- 3 **(12 Lectures, 12 Marks)**
Feedback Amplifiers:
Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances . Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Hartley oscillator.

Unit- 4 **(20 Lectures, 20 Marks)**

MOSFET Circuits:

Review of Depletion and Enhancement MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis, CMOS circuits.

Power Amplifiers:

Difference between voltage and power amplifier, classification of power amplifiers, Class A, Class B, Class C and their comparisons. Operation of a Class A single ended power amplifier. Operation of Transformer coupled Class A power amplifier, overall efficiency. Circuit operation of complementary symmetry Class B push pull power amplifier, crossover distortion, heat sinks.

Single tuned amplifiers:

Circuit diagram, Working and Frequency Response for each, Limitations of single tuned amplifier, Applications of tuned amplifiers in communication circuits

Recommended readings:

- Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI
- Electronic devices, David A Bell, Reston Publishing Company
- D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
- Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)
- J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
- J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010)
- J. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991)
- Allen Mottershed, Electronic Devices and Circuits, Goodyear Publishing Corporation.

ELECTRONICS-C-V: ELECTRONICS CIRCUITS (LAB) (Hardware and Circuit Simulation)

60 Lectures, 20 Marks

1. Study of the half wave rectifier and Full wave rectifier.
2. Study of power supply using C filter and Zener diode.
3. Designing and testing of 5V/9 V DC regulated power supply and find its load-regulation
4. Study of clipping and clamping circuits .
5. Study of Fixed Bias, Voltage divider and Collector-to-Base bias Feedback configuration for transistors.
6. Designing of a Single Stage CE amplifier.
7. Study of Class A, B and C Power Amplifier.
8. Study of the Colpitt's Oscillator.
9. Study of the Hartley's Oscillator.
10. Study of the Phase Shift Oscillator
11. Study of the frequency response of Common Source FET amplifier.

Mode of Assessment/ Assessment Tools (%)

Internal: 20

Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10

Final (End Semester): 80

Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected learner Outcomes: This course will enable the students to

1. Acquire the basic knowledge about the use and application of diode and transistor circuits.
2. Design and analyse circuits containing diodes and transistors.
3. Learn the designing of transistor amplifiers and identify various types of amplifiers.
4. Develop the knowledge about oscillators and FETs

Course Code: ELECTRONICS C-VI
Course Title: DIGITAL ELECTRONICS AND VERILOG/VHDL
Nature of the Course: CORE
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practical - 02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the binary and other number systems and Boolean algebra.
2. Comprehend the digital principles and devices like logic gates.
3. Understand the hardware programming language like Verilog/VHDL.

ELECTRONICS C-VI: **DIGITAL ELECTRONICS AND VERILOG/VHDL**
60 Lectures, 60 Marks

Unit-1 **(12 Lectures, 12 Marks)**

Number System and Codes:

Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, Octal and Hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code.

Logic Gates and Boolean algebra:

Introduction to Boolean Algebra and Boolean operators, Truth Tables of OR, AND, NOT, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates.

Digital Logic families:

Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison.

Unit-2 **(12 Lectures, 12 Marks)**

Combinational Logic Analysis and Design:

Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor

Unit-3 **(18 Lectures, 18 Marks)**

Sequential logic design:

Latches and Flip flops , S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave flip flop, Registers, Counters (synchronous and asynchronous and modulo-N), State Table, State Diagrams, counter design using excitation table and equations. , Ring counter and Johnson counter.

Programmable Logic Devices:

Basic concepts- ROM, PLA, PAL, CPLD, FPGA

Unit-4 **(18 Lectures, 18 Marks)**

Introduction to Verilog:

A Brief History of HDL, Structure of HDL Module, Comparison of VHDL, data flow style, behavioural style, structural style, mixed design style, simulating design.

Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format, Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters. Expressions, Operands, Operators, types of Expressions

Data flow Modelling and Behavioural Modeling:

Data flow Modeling: Continuous assignment, net declaration assignments, delays, net delays.

Behavioral Modeling: Procedural constructs, timing controls, block statement, procedural assignments, conditional statement, loop statement, procedural continuous assignment.

Gate level modelling–

Introduction, built in Primitive Gates, multiple input gates, Tri-state gates, pull gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Illustrative Examples (both combinational and sequential logic circuits).

OR

Introduction to VHDL:

A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches. VHDL Modules, Delays, data flow style, behavioural style, structural style, mixed design style, simulating design.

Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format. VHDL terms, describing hardware in VHDL, entity, architectures, concurrent signal assignment, event scheduling, statement concurrency, structural designs, sequential behaviour, process statements, process declarative region, process statement region, process execution, sequential statements, architecture selection, configuration statements, power of configurations.

Behavioural Modelling:
Introduction to behavioural modelling, inertial delay, transport delay , inertial delay model, transport delay model, transport vs inertial delay, simulation delta drivers, driver creation, generics, block statements, guarded blocks.
Sequential Processing:
Process statement, sensitivity list, signal assignment vs variable assignment, sequential statements, IF, CASE, LOOP, NEXT, EXIT and ASSERT statements, assertion BNF, WAIT ON signal, WAIT UNTIL expression, WAIT FOR time expression, multiple wait conditions, WAIT Time-Out, Sensitivity List vs WAIT Statement Concurrent Assignment, Passive Processes.
Data types:
Object types-signal, variable, constant, Data types– scalar types, composite types, incomplete types, File Type caveats, subtypes, Subprograms and functions.

Recommended readings:

- M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)
- Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
- W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
- R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)
- A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.
- Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

ELECTRONICS- C-VI: DIGITAL ELECTRONICS AND VERILOG/VHDL (LAB)
(Hardware and Circuit Simulation Software)
60 Lectures, 20 Marks

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.

EXPERIMENTS IN VERLOG/VHDL

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.

4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4 bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 2 bit Magnitude comparator.
10. 3 bit Ripple counter

Mode of Assessment/ Assessment Tools (%)
Internal: 20
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10
Written Test for theory and/or Viva Voce for Laboratory: 10
Final (End Semester): 80
Written Test for theory and/or Laboratory experiments: 80
(Equal weightage to be assigned to each credit)

Expected Learner Outcomes: This course will enable the students to

1. Identify the digital logic devices and their working principles.
2. Write hardware level program in Verilog and VHDL for designing digital circuits.
3. Apply the knowledge to critically asses the pros and cons of various hardware design methodologies.

Course Code: ELECTRONICS- C-VII
Course Title: C PROGRAMMING AND DATA STRUCTURES
Nature of the Course: CORE
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course objectives: At the completion of this course, a student will be able to

1. Understand high level programming language through C/C++ programming**.**
2. Learn various sequential and object oriented programming paradigm**.**

ELECTRONICS-C-VII: C PROGRAMMING AND DATA STRUCTURES (THEORY)
60 Lectures, 60 Marks

Unit- 1 **(12 Lectures, 12 Marks)**
C Programming Language:
Introduction, Importance of C, Character set, Tokens, keywords, identifier, constants, basic data types, variables: declaration & assigning values. Structure of C program Arithmetic operators, relational operators, logical operators, assignment operators, increment and

decrement operators, conditional operators, bit wise operators, expressions and evaluation of expressions, type cast operator, implicit conversions, precedence of operators. Arrays-concepts, declaration, accessing elements, storing elements, two-dimensional and multi-dimensional arrays. Input output statement and library functions (math and string related functions).

Unit-2 **(20 Lectures, 20 Marks)**

Decision making, branching & looping:

Decision making, branching and looping: if, if-else, else-if, switch statement, break, for loop, while loop and do loop. Functions: Defining functions, function arguments and passing, returning values from functions.

Structures:

Defining and declaring a structure variables, accessing structure members, initializing a structure, copying and comparing structure variables, array of structures, arrays within structures, structures within structures, structures and functions. Pointers.

Introduction to C++:

Object oriented programming, characteristics of an object-oriented language**.**

Unit-3 **(14 Lectures, 14 Marks)**

Data Structures:

Definition of stack, array implementation of stack, conversion of infix expression to prefix, postfix expressions, evaluation of postfix expression. Definition of Queue, Circular queues, Array implementation of queues. Linked List and its implementation, Link list implementation of stack and queue, Circular and doubly linked list**.**

Unit-4 **(14 Lectures, 14 Marks)**

Searching and sorting:

Insertion sort, selection sort, bubble sort, merge sort, linear Search, binary search.

Trees:

Introduction to trees, Binary search tree, Insertion and searching in a BST, pre order, post order and in order traversal (recursive)

Recommended readings:

- YashavantKanetkar, Let Us C , BPB Publications
- Programming in ANSI C, Balagurusamy, 2nd edition, TMH.
- Byron S Gottfried, Programming with C , Schaum Series
- Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, Prentice Hall
- YashavantKanetkar, Pointers in C, BPB Publications
- S. Sahni and E. Horowitz, “Data Structures”, Galgotia Publications
- Tanenbaum: “Data Structures using C”, Pearson/PHI.
- Ellis Horowitz and SartazSahani “Fundamentals of Computer Algorithms”, Computer Science Press.

ELECTRONICS-C-VII: C PROGRAMMING AND DATA STRUCTURES (LAB)
60 Lectures, 20 Marks

1. Generate the Fibonacci series up to the given limit N and also print the number of elements in the series.
2. Find minimum and maximum of N numbers.
3. Find the GCD of two integer numbers.
4. Calculate factorial of a given number.
5. Find all the roots of a quadratic equation $Ax^2 + Bx + C = 0$ for non – zero coefficients A, B and C. Else report error.
6. Calculate the value of sin (x) and cos (x) using the series. Also print sin (x) and cos (x) value using library function.
7. Generate and print prime numbers up to an integer N.
8. Sort given N numbers in ascending order.
9. Find the sum & difference of two matrices of order MxN and PxQ.
10. Find the product of two matrices of order MxN and PxQ.
11. Find the transpose of given MxN matrix.
12. Find the sum of principle and secondary diagonal elements of the given MxN matrix.
13. Calculate the subject wise and student wise totals and store them as a part of the structure.
14. Maintain an account of a customer using classes.
15. Implement linear and circular linked lists using single and double pointers.
16. Create a stack and perform Pop, Push, Traverse operations on the stack using Linear Linked list
17. Create circular linked list having information about a college and perform Insertion at front, Deletion at end.
18. Create a Linear Queue using Linked List and implement different operations such as Insert, Delete, and Display the queue elements.
19. Implement polynomial addition and subtraction using linked lists.
20. Implement sparse matrices using arrays and linked lists.
21. Create a Binary Tree to perform Tree traversals (Preorder, Postorder, Inorder) using the concept of recursion.
22. Implement binary search tree using linked lists. Compare its time complexity over that of linear search.
23. Implement Insertion sort, Merge sort, Bubble sort, Selection sort.

Mode of Assessment/ Assessment Tools (%)

Internal: 20

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): 80

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected Learner Outcomes: This course will enable the students to

1. Write C/C++ programs for various mathematical and data processing tasks
2. Apply the knowledge of high level programming language to solving various scientific and real life problems using numerical methods
3. Critically assess the applicability of numerical methods and high level language for solving human civilization problems.

Semester IV

Course Code: ELECTRONICS-C-VIII
Course Title: OPERATIONAL AMPLIFIERS AND APPLICATIONS
Nature of the Course: CORE
Total Credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the fundamentals of LSI circuit device Operational Amplifier (OP-AMP).
2. To develop analytic and synthesis skills in circuits using OP-AMPS.

ELECTRONICS-C-VIII: OPERATIONAL AMPLIFIERS AND APPLICATIONS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(18 Lectures, 18 Marks)**
Basic Operational Amplifier:
Concept of differential amplifiers (Dual input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741)
Op-Amp parameters:
Input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio

Unit-2 **(18 Lectures, 18 Marks)**
Op-Amp Circuits:
Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations, Inverting, Non-inverting, Summing and difference amplifier, Integrator, Differentiator, Voltage to current converter, Current to voltage converter.
Comparators:

Basic comparator, Level detector, Voltage limiters, Schmitt Trigger.

Signal generators:

Phase shift oscillator, Wein bridge oscillator, Square wave generator, triangle wave generator, saw tooth wave generator, and Voltage controlled oscillator(IC 566).

Unit-3 **(12 Lectures, 12 Marks)**

Multivibrators (IC 555):

Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators. Phase locked loops (PLL): Block diagram, phase detectors, IC565.

Fixed and variable IC regulators:

IC 78xx and IC 79xx -concepts only, IC LM317- output voltage equation.

Unit-4 **(12 Lectures, 12 Marks)**

Signal Conditioning circuits:

Sample and hold systems, Active filters: First order low pass and high pass butterworth filter, Second order filters, Band pass filter, Band reject filter, All pass filter, Log and antilog amplifiers.

Recommended readings:

- R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education (2003)
- R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education (2001)
- J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill,(2001)
- A.P.Malvino, Electronic Principals,6th Edition , Tata McGraw-Hill,(2003)
- K.L.Kishore,OP-AMP and Linear Integrated Circuits, Pearson(2011)

ELECTRONICS-C-VIII: OPERATIONAL AMPLIFIERS AND APPLICATION (LAB) (Hardware and Circuit Simulation Software)

60 Lectures, 20 Marks

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a First Order Low-pass filter using op-amp.
7. Designing of a First Order High-pass filter using op-amp.
8. Designing of a RC Phase Shift Oscillator using op-amp.
9. Study of IC 555 as an astable multivibrator.
10. Study of IC 555 as monostable multivibrator.
11. Designing of Fixed voltage power supply using IC regulators using 78 series and 79 series

Mode of Assessment/ Assessment Tools (%)

Internal: **20**

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): **80**

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected learner Outcomes: This course will enable the students to

1. Understand working of the OP-AMP.
2. Characterize various OP-AMP ICs and circuits.
3. Apply the knowledge to use the OP-AMP in scientific and real life applications.

Course Code: ELECTRONICS-C-IX
Course Title: SIGNALS AND SYSTEMS
Nature of the Course: CORE
Total Credits Assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the basic mathematical representation of electronic signals and systems
2. Comprehend the various mathematical tools and techniques for analyzing different types of signals and systems

ELECTRONICS-C-IX: SIGNALS AND SYSTEMS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(18 Lectures, 18 Marks)**

Signals and Systems:

Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and unit step functions, Continuous-Time and Discrete-Time Systems, Basic System Properties.

Unit-2 **(12 Lectures, 12 Marks)**

Linear Time -Invariant Systems (LTI):

Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative.LTI systems with and without memory, Invariability, Causality, Stability, Unit Step response. Differential and Difference equation formulation, Block diagram representation of first order systems.

Unit-3 **(18 Lectures, 18 Marks)**

Fourier Series Representation of Periodic Signals:

Continuous-Time periodic signals, Convergence of the Fourier series, Properties of continuous-Time Fourier series, Discrete-Time periodic signals, Properties of Discrete-Time Fourier series. Frequency-Selective filters, Simple RC highpass and lowpass filters

Fourier Transform:

Aperiodic signals, Periodic signals, Properties of Continuous-time Fourier transform, Convolution and Multiplication Properties, Properties of Fourier transform and basic Fourier transform Pairs.

Unit-4 **(12 Lectures, 12 Marks)**

Laplace Transform:

Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform for signals, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.

Recommended Readings:

- V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)
- S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)
- C. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)
- H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007)
- S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, Orchard Publications (2008)
- W. Y. Young, Signals and Systems with MATLAB, Springer (2009)
- M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2007)

ELECTRONICS-C-IX: SIGNALS AND SYSTEMS (LAB) (Scilab/MATLAB/ Other Mathematical Simulation software)

60 Lectures, 20 Marks

1. Generation of Signals: continuous time
2. Generation of Signals: discrete time
3. Time shifting and time scaling of signals.
4. Convolution of Signals
5. Solution of Difference equations.
6. Fourier series representation of continuous time signals.
7. Fourier transform of continuous time signals.
8. Laplace transform of continuous time signals.
9. Introduction to Xcos/similar function and calculation of output of systems represented by block diagrams

Mode of Assessment/ Assessment Tools (%)

Internal: **20**

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): **80**

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Identify different signal types and understand the formalism of treating signals and systems in mathematical domain.
2. Apply the mathematical tools to represent signals and analyze time domain and Frequency domain signals and systems like LTI.

Course Code: ELECTRONICS-C-X
Course Title: ELECTRONIC INSTRUMENTATION
Nature of the Course: CORE
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the various measurement instruments and the measurement techniques involved.
2. Handle different instruments like power supply, Oscilloscope etc.
3. Develop the knowledge about transducers and sensors.

ELECTRONICS-C-X: ELECTRONIC INSTRUMENTATION (THEORY)
60 Lectures, 60 Marks

Unit-1 **(15 Lectures, 15 Marks)**

Qualities of Measurement:

Specifications of instruments, their static and dynamic characteristics, Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis. Statistical analysis of data and curve fitting.

Basic Measurement Instruments:

PMMC instrument, galvanometer, DC measurement - ammeter, voltmeter, **o**hm meter, AC measurement, Digital voltmeter systems (integrating and non-integrating types), digital multimeters, digital frequency meter system (different modes and universal counter).

Connectors and Probes:

low capacitance probes, high voltage probes, current probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc

Unit-2 **(15 Lectures, 15 Marks)**

Measurement of Resistance and Impedance:
Low Resistance: Kelvin's double bridge method, Medium Resistance by Voltmeter Ammeter method, Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Maxwell's bridge, Hay's bridge, and Anderson's bridge, Measurement of Capacitance, Schering's bridge, DeSauty's bridge, Measurement of frequency, Wien's bridge.
A-D and D-A Conversion:
4 bit binary weighted resistor type D-A conversion, circuit and working. Circuitof R-2R ladder.A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs for all).

Unit-3 **(15 Lectures, 15 Marks)**
Oscilloscopes:
CRT, wave form display and electrostatic focusing, time base and sweep synchronization, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, Sampling Oscilloscope, DSO and Powerscope: Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, rise time).
Signal Generators:
Audio oscillator, Pulse Generator, Function generators**.**
Unit-4 **(15 Lectures, 15 Marks)**
Transducers and sensors:
Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge – Theory, types, temperature compensation and applications), Capacitive (Variable Area Type – Variable Air Gap type – Variable Permittivity type), Inductive (LVDT) and piezoelectric transducers.
Measurement of displacement, velocity and acceleration (translational and rotational). Measurement of pressure (manometers, diaphragm, bellows), Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

Recommended readings:

- H. S. Kalsi, Electronic Instrumentaion, TMH(2006)
- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice-Hall (2005).
- Instrumentation Measurement and analysis: Nakra B C, Chaudry K, TMH
- E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).
- Joseph J Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education (2005)
- David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall (2013).
- Oliver and Cage, “Electronic Measurements and Instrumentation”, TMH (2009).
- Alan S. Morris, “Measurement and Instrumentation Principles”, Elsevier (Buterworth Heinmann-2008).
- K Sawhney, Electrical and Electronics Measurements and Instrumentation, DhanpatRai and Sons (2007).
- S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998□

ELECTRONICS-C-X: ELECTRONIC INSTRUMENTATION (LAB)
60 Lectures, 20 Marks

1. Design of multi range ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
3. Measurement of Capacitance by de'Sautys.
4. Measure of low resistance by Kelvin's double bridge.
5. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
6. To determine the Characteristics of LVDT.
7. To determine the Characteristics of Thermistors and RTD.
8. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
9. To study the Characteristics of LDR, Photodiode, and Phototransistor:
   i. Variable Illumination.
   ii. Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor).

Mode of Assessment/ Assessment Tools (%)
Internal: 20
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10
Written Test for theory and/or Viva Voce for Laboratory: 10
Final (End Semester): 80
Written Test for theory and/or Laboratory experiments: 80
(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to
1. Use and apply various measurement instruments.
2. Measure resistance, capacitance, and temperature using available bridge methods.
3. To design circuits for systems like power supply and sample and hold circuits etc.
4. Acquire theoretical and practical knowledge about various sensors.

Semester V

Course Code: ELECTRONICS-C-XI
Course Title: MICRO PROCESSOR AND MICROCONTROLLER
Nature of the Course: CORE
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be introduced to

1. Microprocessors and microcontroller**.**
2. Assembly language programming of microprocessors and microcontroller**.**

ELECTRONICS-C-XI: MICRO PROCESSOR AND MICROCONTROLLER (THEORY)
60 Lectures, 60 Marks

Unit-1 **(16 Lectures, 16 Marks)**
Introduction to Microprocessor:
Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used)
Microprocessor 8085:
Features, Architecture -block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O.
8085 Instructions:
Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Assembly language programming examples.

Unit-2 **(12 Lectures, 12 Marks)**
Stack operations, subroutine, call and return instructions. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay.
Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts
Microcontrollers:
Introduction, Different types of microcontroller, embedded microcontrollers, processor architectures. Harvard vs. Princeton, CISC vs. RISC architectures, microcontroller memory types, microcontroller features, clocking, I/O pins, interrupts, timers, peripherals,

Unit-3 **(8 Lectures, 8 Marks)**
Introduction to 8051, 8051 family microcontroller, Core features, Architecture, pin diagram, memory organization- Program and data memory organization, I/O Ports, oscillator module, Timer modules (Timer 0, Timer 1 and Timer 2)

Unit-4 **(16 Lectures, 16 Marks)**
PIC16F887 Microcontroller:
Core features, Architecture, pin diagram, memory organization- Program and data memory organization, I/O Ports, oscillator module, Timer modules (Timer 0, Timer 1 and Timer 2), comparator module, analog-to-digital converter (ADC) module, data EEPROM, Enhanced capture/compare/PWM module , EUSART, master synchronous serial port (MSSP) module, special features of the CPU, interrupts, addressing modes, instruction set.

Unit-5 **(8 Lectures, 8 Marks)**

Interfacing with PIC16F887 and 8051 Family:

LED, Switches, Solid State Relay, Seven Segment Display, 16x2 LCD display, 4x4 Matrix Keyboard, Digital to Analog Converter, Stepper Motor and DC Motor. Interfacing program examples using C language.

Recommended readings:

- Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
- Fundamentals of Microprocessor & Microcomputer: B. Ram—Danpat Rai Publications.
- Microchip PIC16F87X datasheet
- PIC Microcontrollers, Milan Verle, , mikro Elektronika, 1st edition (2008)
- Muhammad Ali Mazidi, "Microprocessors and Microcontrollers", Pearson, 2006

ELECTRONICS-C-XI: MICRO PROCESSOR AND MICROCONTROLLER (LAB)
60 Lectures, 20 Marks

8085 Assembly language programs:

1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multi byte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16 bit number by 8 bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to find minimum and maximum among N numbers
9. Program to find the square root of an integer.
10. Program to find GCD of two numbers.
11. Program to sort numbers in ascending/descending order.
12. Program to verify the truth table of logic gates.

PIC Microcontroller Programming:

Note: Programs to be written using C programming language

1. LED blinking with a delay of 1 second.
2. Solid State Relay Interface
2. Interfacing of LCD (2X16).
3. Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/anticlockwise with speed control.
4. To test all the gates of a given IC74XX is good or bad.
5. Generate sine, square, saw tooth, triangular and staircase waveform using DAC interface.
6. Display of 4- digit decimal number using the multiplexed 7-segment display interface.

7. Analog to digital conversion using internal ADC and display the result on LCD.
8. Implementation of DC-Volt meter (0-5V) using internal ADC and LCD
9. Digital to analog conversion using PWM (pulse delay to be implemented using timers).
10. Speed control of DC motor using PWM (pulse delay to be implemented using timers).
11. Interfacing of matrix keyboard (4X4).
12. Serial communication between microcontroller and PC.

Mode of Assessment/ Assessment Tools (%)
Internal: 20
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10
Written Test for theory and/or Viva Voce for Laboratory: 10
Final (End Semester): 80
Written Test for theory and/or Laboratory experiments: 80
(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Understand architecture and programming model of microprocessors 8085 and microcontroller 8051
2. Apply the assembly language programming knowledge to build various small systems based on microprocessors 8085 and microcontroller 8051.
3. Asses the applicability of microprocessors and microcontroller for solving various real life problems

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Course Code: ELECTRONICS-C-XII
Course Title: ELECTROMAGNETICS
Nature of the Course: CORE
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the physical and mathematical principles of the behaviour of electricity and magnetism in matter.
2. Comprehend the properties of the electromagnetic wave and its interaction with matter with the help of Maxwell's equations.
3. Understand the principles and processes related to polarization, interference, and diffraction along with their applications to the development of wave-guide and optical fibres.

ELECTRONICS-C-XII: ELECTROMAGNETICS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(15 Lectures, 15 Marks)**

Vector Analysis:

Scalars and Vectors, Vector Algebra, Rectangular (Cartesian) Coordinate System, Vector Components and Unit Vector, Vector Field, Products, Cylindrical Coordinates, Spherical Coordinates, Differential Length, Area and Volume, Line Surface and Volume integrals, Del Operator, Gradient of a Scalar, Divergence and Curl of a Vector, the Laplacian.

Electrostatic Fields:

Coulomb's Law and Electric Field, Field due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation. Electric Potential, Potential due to a Charge and Charge distribution, Electric dipole. Electric Fields in Conductors, Current and Current Density, Continuity of Current, Metallic Conductor Properties and Boundary Conditions, Method of Images. Dielectric materials, Polarization, Dielectric Constant, Isotropic and Anisotropic dielectrics, Boundary conditions, Capacitance and Capacitors. Electrostatic Energy and Forces.

Unit- 2 **(15 Lectures, 15 Marks)**

Poisson's Equation and Laplace's Equation:

Derivation of Poisson's and Laplace's equation, Uniqueness
Theorem, Examples of Solution of Laplace's Equation: Cartesian, Cylindrical and Spherical Coordinates.

Magnetostatics:

Biot Savert's law and Applications, Magnetic dipole, Ampere's Circuital Law, Curl and Stoke's Theorem, Maxwell's Equation, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits. Inductances and Inductors, Magnetic Energy, Forces and Torques.

Unit-3 **(15 Lectures, 15 Marks)**

Time-Varying Fields and Maxwell's Equations:

Faraday's Law of Electromagnetic Induction, Stationary Circuit in Time-Varying Magnetic Field, Transformer and Motional EMF, Displacement Current, Maxwell's Equations in differential and integral form and Constitutive Relations. Potential Functions, Lorentz gauge and the Wave Equation for Potentials, Concept of Retarded Potentials. Electromagnetic Boundary Conditions. Time-Harmonic Electromagnetic Fields and use of Phasors

Unit-4 **(15 Lectures, 15 Marks)**

Electromagnetic Wave Propagation:

Time- Harmonic Electromagnetic Fields and use of Phasors, the Electromagnetic Spectrum, Wave Equation in a source free isotropic homogeneous media, Uniform Plane Waves in Lossless and Lossy unbounded homogeneous media, Wave Polarization, Phase and Group velocity, Flow of Electromagnetic Power and Poynting Vector. Uniform Plane wave incident on a Plane conductor boundary, concept of reflection and standing wave.

Guided Electromagnetic Wave Propagation:

Waves along Uniform Guiding Structures, TEM, TE and TM waves, Electromagnetic Wave Propagation in Parallel Plate and Rectangular Metallic Waveguides.

Recommended readings:

- Murray. R. Spiegel, Vector Analysis, Schaum series, Tata McGraw Hill (2006)
- M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
- W. H. Hayt and J. A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
- D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
- J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
- N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
- Introduction to Electrodynamics, D.J. Griffiths, Pearson Education (2012)
- Electromagnetic Wave and Radiating System, Jordan and Balmain, Prentice Hall (1979)

ELECTRONICS-C-XII: ELECTROMAGNETICS (LAB) (Using Scilab/ Any Other Similar Freeware)

60 Lectures, 20 Marks

1. Understanding and Plotting Vectors.
2. Transformation of vectors into various coordinate systems.
3. 2D and 3D Graphical plotting with change of view and rotation.
4. Representation of the Gradient of a scalar field, Divergence and Curl of Vector Fields.
5. Plots of Electric field and Electric Potential due to charge distributions.
6. Plots of Magnetic Flux Density due to current carrying wire.
7. Programs and Contour Plots to illustrate Method of Images
8. Solutions of Poisson and Laplace Equations – contour plots of charge and potential distributions
9. Introduction to Computational Electromagnetics: Simple Boundary Value Problems by Finite Difference/Finite Element Methods.

Mode of Assessment/ Assessment Tools (%)

Internal: 20

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): 80

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable to

1. Solve problems relevant to interfaces between media with defined boundary conditions.
2. Use Maxwell's equations to describe the behaviour of electromagnetic waves in vacuum as well as medium.
3. Describe states and methods of polarization and analyze the polarization state of a light source

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Semester VI

Course Code: ELECTRONICS-C-XIII
Course Title: COMMUNICATION ELECTRONICS
Nature of the Course: CORE
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the basic techniques of electronic communication like modulation.
2. Apply the knowledge to understand the current generation communication technologies.

ELECTRONICS-C-XIII: COMMUNICATION ELECTRONICS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(10 Lectures, 10 Marks)**
Electronic communication:
Block diagram of an electronic communication system, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals. Concept of Noise, Types of Noise, Signal to noise ratio, Noise Figure, Noise Temperature, Friss formula.

Unit-2 **(20 Lectures, 20 Marks)**
Amplitude Modulation:
Amplitude Modulation, modulation index and frequency spectrum. Generation of AM, Amplitude Demodulation (diode detector), Concept of Double side band suppressed carrier, Single side band suppressed carrier, other forms of AM (Pilot Carrier Modulation, Vestigial Side Band modulation, Independent Side Band Modulation). Block diagram of AM Transmitter and Receiver
Angle modulation:
Frequency and Phase modulation, modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM (direct and indirect methods), FM detector (PLL).Block diagram of FM Transmitter and Receiver Comparison between AM, FM and PM.

Unit -3 **(15 Lectures, 15 Marks)**
Pulse Analog Modulation:
Channel capacity, Sampling theorem, PAM, PDM, PPM modulation and detection techniques, Multiplexing, TDM and FDM.
Pulse Code Modulation:

Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration.

Unit -4 **(15 Lectures, 15 Marks)**

Digital Carrier Modulation Techniques:

Block diagram of digital transmission and reception, Information capacity, Bit Rate, Baud Rate and M-ary coding. Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK)

Recommended readings:

- Electronic communication systems- Kennedy, 3rd edition, McGraw international publications
- Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
- Communication Systems, S. Haykin, Wiley India (2006)
- Advanced electronic communications systems – Tomasi, 6th edition, PHI.
- Communication Systems, S. Haykin, Wiley India (2006)

ELECTRONICS-C-XIII: COMMUNICATION ELECTRONICS (LAB) (Hardware and Circuit Simulation Software)

60 Lectures, 20 Marks

1. Study of Amplitude Modulation
2. Study of Amplitude Demodulation
3. Study of Frequency Modulation
4. Study of Frequency Demodulation
5. Study of Pulse Amplitude Modulation
6. AM Transmitter/Receiver
7. FM Transmitter/Receiver
8. Study of TDM, FDM
9. Study of Pulse Width Modulation
10. Study of Pulse Position Modulation
11. Study of Pulse Code Modulation
12. Study of Amplitude Shift Keying
13. Study of Phase Shift Keying,
14. Study of Frequency Shift Keying.

Mode of Assessment/ Assessment Tools (%)

Internal: 20

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): 80

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Identify the basic techniques of communication like carrier modulation/demodulation.
2. Analyze the modulations schemes and their applicability.
3. Analyze present generation systems.

Course Code: ELECTRONICS-C-XIV
Course Title: PHOTONICS
Nature of the Course: CORE
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the fundamental of optics and optical devices.
2. Identify and apply optical principles in various applications.

ELECTRONICS-C-XIV: PHOTONICS (THEORY)
60 Lectures, 60 Marks

Unit-1 **(20 Lectures, 20 Marks)**
Light as an Electromagnetic Wave:
Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law. Interaction of electromagnetic waves with dielectrics: origin of refractive index, dispersion.
Interference:
Superposition of waves of same frequency, Concept of coherence, Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings; Michelson interferometer. Holography.
Diffraction:
Huygen Fresnel Principle, Diffraction Integral, Fresnel and Fraunhoffer approximations. Fraunhoffer Diffraction by a single slit, rectangular aperture, double slit, Resolving power of microscopes and telescopes; Diffraction grating: Resolving power and Dispersive power

Unit-2 **(10 Lectures, 10 Marks)**
Polarization:
Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law;Double refraction by crystals, Interference of polarized light, Wave propagation in uniaxial media. Half wave and quarter wave plates. Faraday rotation and electro-optic effect.

Unit-3 **(15 Lectures, 15 Marks)**
Light Emitting Diodes:
Construction, materials and operation.

Lasers:
Interaction of radiation and matter, Einstein coefficients, Condition for amplification, laser cavity, threshold for laser oscillation, line shape function. Examples of common lasers. The semiconductor injection laser diode.
Photodetectors:
Bolometer, Photomultiplier tube, Charge Coupled Device. Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.
LCD Displays:
Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

Unit-4 **(15 Lectures, 15 Marks)**
Guided Waves and the Optical Fiber:
TE and TM modes in symmetric slab waveguides, effective index, field distributions, Dispersion relation and Group Velocity. Step index optical fiber, total internal reflection, concept of linearly polarized waves in the step index circular dielectric waveguides, single mode and multimode fibers, attenuation and dispersion in optical fiber.

Recommended readings:

- Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
- E. Hecht, Optics, Pearson Education Ltd. (2002)
- J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
- S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)
- Ghatak A.K. and Thyagarajan K., "Introduction to fiber optics," Cambridge Univ. Press. (1998)

ELECTRONICS-C-XIV: PHOTONICS (LAB)
60 Lectures, 20 Marks

1. To verify the law of Malus for plane polarized light.
2. To determine wavelength of sodium light using Michelson's Interferometer.
3. To determine wavelength of sodium light using Newton's Rings.
4. To determine the resolving power and Dispersive power of Diffraction Grating.
5. Diffraction experiments using a laser.
6. Study of Faraday rotation.
7. Study of Electro-optic Effect.
8. To determine the specific rotation of scan sugar using polarimeter.
9. To determine characteristics of LEDs and Photo- detector.
10. To measure the numerical aperture of an optical fiber.

Mode of Assessment/ Assessment Tools (%)
Internal: **20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): 80

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Identify various optical devices and principles
2. Characterize the optical devices
3. Apply the knowledge to use optical devices in scientific and real life applications
4. Critically analyze the advantage/disadvantages of optical systems and its applicability.
5.

DISCIPLINE SPECIFIC ELECTIVES (DSE)

Course code: **ELECTRONICS-DSE -I**
Course title: POWER ELECTRONICS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course objectives: After completing the course, a student will be able to

1. Understand the various devices used in power electronics and develop the knowledge to deal with these devices.
2. Realize and work with circuits like, inverter and chopper along with the knowledge of elctro-mechnaical machines.

ELECTRONICS DSE-I: POWER ELECTRONICS
60 Lectures, 60 Marks

Unit- 1 **(12 Lectures, 12 Marks)**

Power Devices:

Need for semiconductor power devices, Power diodes, Enhancement of reverse blocking capacity, Introduction to family of thyristors.

Silicon Controlled Rectifier (SCR):

Structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Factors affecting the characteristics/ratings of SCR, Gate-triggering circuits, Control circuits design and Protection circuits, Snubber circuit.

Unit- 2 **(14 Lectures, 14 Marks)**

Diac and Triac:

Basic structure, working and V-I characteristic of, application of a Diac as atriggering device for a Triac.

Insulated Gate Bipolar Transistors (IGBT):

Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA) etc.

Application of SCR:

SCR as a static switch, phase controlled rectification, single phase half wave, full wave and bridge rectifiers with inductive & non-inductive loads; AC voltage control using SCR and Triac as a switch.

Power MOSFETs:

Operation modes, switching characteristics, power BJT, second breakdown, saturation and quasi-saturation state.

Unit- 3 **(17 Lectures, 17 Marks)**

Power Inverters:

Need for commutating circuits and their various types, d.c. link invertors, Parallel capacitor commutated invertors with and without reactive feedback and its analysis, Series Invertor, limitations and its improved versions, bridge invertors.

Choppers:

basic chopper circuit, types of choppers(Type A-D), step-down chopper, step-up chopper, operation of d.c. chopper circuits using self commutation (A & B- type commutating circuit), cathode pulse turn-off chopper(using class D commutation), load sensitive cathode pulse turn-off chopper (Jones Chopper), Morgan's chopper.

Unit- 4 **(17 Lectures, 17 Marks)**

Electromechanical Machines:

DC Motors, Basic understanding of field and armature, Principle of operation, EMF equation, Back EMF, Factors controlling motor speed, Thyristor based speed control of dc motors, AC motor (Induction Motor only), Rotor and stator, torque & speed of induction motor, Thyristor control of ac motors (block diagrams only).

Recommended readings:

- Power Electronics, P.C. Sen, TMH
- Power Electronics & Controls, S.K. Dutta
- Power Electronics, M.D. Singh & K.B. Khanchandani, TMH
- Power Electronics Circuits, Devices and Applications, 3rd Edition, M.H. Rashid, Pearson Education
- Power Electronics, Applications and Design, Ned Mohan, Tore.
- Power Electronics, K. HariBabu, Scitech Publication.
- Power Electronics, M.S. JamilAsghar, PHI.
- A Textbook of Electrical Technology-Vol-II, B.L. Thareja, A.K. Thareja, S.Chand

ELECTRONICS-DSE–I: POWER ELECTRONICS (LAB)
60 Lectures, 20 Marks

1. Study of I-V characteristics of DIAC
2. Study of I-V characteristics of a TRIAC
3. Study of I-V characteristics of a SCR
4. SCR as a half wave and full wave rectifiers with R and RL loads
5. DC motor control using SCR.
6. DC motor control using TRIAC.
7. AC voltage controller using TRIAC with UJT triggering.
8. Study of parallel and bridge inverter.
9. Design of snubber circuit
10. VI Characteristic of MOSFET and IGBT (Both)
11. Study of chopper circuits.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10
Final (End Semester):	**80**
Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Acquire the knowledge about various types of power devices and their uses.
2. Understand the behaviour of these devices and will be able to use them wherever necessary.

Course code: **ELECTRONICS-DSE -2**
Course title: MODERN COMMUNICATION SYSTEMS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory-04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Learn about different types of new generation communication systems and technologies.
2. Familiarize with the knowledge of optical communication, cellular communication, satellite communication and LAN

ELECTRONICS-DSE 2: MODERN COMMUNICATION SYSTEMS (THEORY)

60 Lectures, 60 Marks

Unit-1 **(10 Lectures, 10 Marks)**

Advanced Digital Modulation Technique:

DPCM, DM, ADM. Binary Line Coding Technique, Multi level coding, QAM (Modulation and Demodulation)

Unit-2 **(10 Lectures, 10 Marks)**

Optical Communication:

Introduction of Optical Fiber, Types of Fiber, Guidance in Optical Fiber, Attenuation and Dispersion in Fiber, Optical Sources and Detectors, Block Diagram of optical communication system, optical power budgeting

Unit-3 **(20 Lectures, 20 Marks)**

Cellular Communication:

Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Unit-4 **(20 Lectures, 20 Marks)**

Satellite communication:

Introduction, need, satellite orbits, advantages and disadvantages of geostationary satellites. Satellite visibility, satellite system – space segment, block diagrams of satellite sub systems, up link, down link, cross link, transponders (C- Band), effect of solar eclipse, path loss, ground station, simplified block diagram of earth station. Satellite access, TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA, Satellite antenna (parabolic dish antenna), GPS-services like SPS & PPS.

Local area networks (LAN):

Primary characteristics of Ethernet-mobile IP, OSI model, wireless LAN requirements-concept of Bluetooth, Wi-Fi and WiMAX.

Recommended readings:

- W. Tomasi, Electronic Communication Systems: Fundamentals through Advanced, Pearson Education, 3rd Edition
- Martin S. Roden, Analog& Digital Communication Systems, Prentice Hall, Englewood Cliffs, 3rd Edition
- Modern digital and analog Communication systems- B. P. Lathi, 4rd Edition 2009 Oxford University press.
- ThiagarajanVishwanathan, Telecommunication Switching Systems and Networks, Prentice Hall of India.

- Theodore S. Rappaport, Wireless Communications Principles and Practice, 2^{nd} Edition, Pearson Education Asia.

ELECTRONICS-DSE 2: MODERN COMMUNICATION SYSTEMS (LAB)
60 Lectures, 20 Marks

1. Modulation of LED and detection through Photo detector.
2. Calculation of the transmission losses in an optical communication system.
3. Study of 16 QAM modulation and Detection with generation of Constellation Diagram
4. Study of DPCM and demodulation.
5. Study of DM, ADM
6. Study of architecture of Mobile phone.
7. Study of Satellite Communication System.
8. Study of Optical Fiber Communication System

Mode of Assessment/ Assessment Tools (%)
Internal: 20
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10
Written Test for theory and/or Viva Voce for Laboratory: 10
Final (End Semester): 80
Written Test for theory and/or Laboratory experiments: 80
(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Understand the various techniques and methods used in modern day communication systems.
2. Understand the technology behind different types of communication being used around us.

Course code: ELECTRONICS-DSE-3
Course title: NANOELECTRONICS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practials-02

Course Objectives: The main objective of this course is to introduce the students to

1. The world of nanoscience and nanotechnology.
2. The various preparation and characterization techniques of nanomaterials.
3. The optical and electronic transport properties of nanomaterials and their applications.

ELECTRONICS-DSE-3: NANOELECTRONICS (THEORY)
60 Lectures, 60 Marks

Unit 1 **(14 Lectures, 14 Marks)**

Introduction:
Definition of Nano-Science and Nano Technology, Applications of Nano-Technology.

Introduction to Physics of Solid State:
Size dependence of properties, bonding in atoms and giant molecular solids, Electronic conduction, Systems confined to one, two or three dimension and their effect on property

Quantum Theory for Nano Science:
Time dependent and time independent Schrodinger wave equations. Particle in a box, Potential step: Reflection and tunneling (Quantum leak). Penetration of Barrier, Electron trapped in 2D plane (Nano sheet), Quantum confinement effect in nano materials.

Quantum Wells, Wires and Dots:
Preparation of Quantum Nanostructure; Size and Dimensionality effect, Fermi gas; Potential wells; Partial confinement; Excitons; Single electron Tunneling, Infrared detectors; Quantum dot laser Superconductivity.

Unit-2 **(18 Lectures, 18 Marks)**

Growth Techniques of Nanomaterials:
Synthetic aspects: bottom up and top down approaches, Lithograpahic and Nonlithograpahic techniques, Sputtering and film deposition in glow discharge, DC sputtering technique (p-CuAlO2 deposition). Thermal evaporation technique, E-beam evaporation, Chemical Vapour deposition(CVD), Synthesis of carbon nano-fibres and multi-walled carbon nanotubes, Pulsed Laser Deposition, Molecular beam Epitaxy, Sol-Gel Technique (No chemistry required), Synthesis of nanowires/rods, Electro deposition, Chemical bath deposition, Ion beam deposition system, Vapor-Liquid –Solid (VLS) method of nanowire

Unit -3 **(18 Lectures, 18 Marks)**

Methods of Measuring Properties and Characterization techniques:

Microscopy:
Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Field Ion Microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) including energy dispersive X-ray (EDX) analysis, low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED)

Spectroscopy:
Infra-red and Raman Spectroscopy, X-ray Spectroscopy, Magnetic resonance, Optical and Vibrational Spectroscopy

Characterization and application like biopolymer tagging and light emitting semiconductor quantum dots.

Unit- 4 **(10 Lectures, 10 Marks)**

Carbon nanotubes, nano cuboids, graphene, carbon quantum dots: Fabrication, structure. electrical, mechanical, and vibrational properties and applications. Use of nano particles for biological application, drug delivery and bio-imaging, Impact of nanotechnology on the environment.

Recommended readings:

- Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
- Nanomaterials: synthesis, properties and applications, Institute of Physics, 1998.
- Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
- Electron Microscopy and analysis, 2nd ed. Taylor and Francis, 2000.
- Bio-Inspired Nanomaterials and Nanotechnology, Edited by Yong Zhou, Nova Publishers.
- Quantum dot heterostructures, Wiley, 1999.
- Modern magnetic materials: principles and applications, John Wiley & Sons, 2000.
- Nano: The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
- Nanobiotechnology, concepts, applications and perspectives, Wiley-VCH, 2004.

ELECTRONICS-DSE-3: NANOELECTRONICS (LAB)
60 Lectures, 20 Marks

1. Synthesis of at least two different sizes of Nickel Oxide/ Copper Oxide/ Zinc Oxide Nano Particles Using Sol-Gel Method
2. Polymer synthesis by suspension method / emulsion method
3. B-H loop of nanomaterials.
4. Magnetoresistance of thin films and nanocomposite, I-V characteristics and transient response.
5. Particle size determination by X-ray diffraction (XRD) and XRD analysis of the given XRD spectra
6. Determination of the particle size of the given materials using He-Ne LASER.
7. Selective area electron diffraction: Software based structural analysis based on TEM
   based experimental data from published literature. (Note: Later experiment may be performed in the lab based on availability of TEM facility).
8. Surface area and pore volume measurements of nanoparticles (a standard sample and a new sample (if available)).
9. Spectroscopic characterization of metallic, semiconducting and insulating nanoparticles.

Mode of Assessment/ Assessment Tools (%)

Internal: 20

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10

Written Test for theory and/or Viva Voce for Laboratory: 10

Final (End Semester): 80

Written Test for theory and/or Laboratory experiments: 80

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Understand the importance of nanoscience and nanotechnology in our daily lives.
2. Learn about various experimental methodologies with necessary theoretical background, which may be useful for pursuing further studies on the area of nanoscience and technology.

Course code: ELECTRONICS-DSE 4
Course title: TRANSMISSION LINES, ANTENNA AND WAVE PROPAGATION
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practical --02

Course Objectives: At the completion of this course, a student will be able to

1. Learn the basics of electromagnetic wave propagation.
2. Learn about transmission lines and waveguides.
3. Develop the knowledge of radiation of electromagnetic waves and types of antenna.

ELECTRONICS-DSE 4: TRANSMISSION LINES, ANTENNA AND WAVE PROPAGATION (THEORY)
60 Lectures, 60 Marks

Unit-1 **(15 Lectures, 15 Marks)**
Electromagnetic Wave Propagation:
Propagation in Good Conductors, Skin Effect, Reflection of uniform Plane Waves at normal incidence, Plane Wave reflection at Oblique Incidence, Wave propagation in dispersive media, concept of phase velocity and group velocity.

Unit-2 **(15 Lectures, 15 Marks)**
Transmission Lines:
Typical Transmission lines- Co-axial, Two Wire, Microstrip, Coplanarand Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines, lowloss, lossless line, Distortionless line, Input Impedance, Standing Wave Ratio ,Power. and lossy lines, Shorted Line, Open-Circuited Line, Matched Line, Smith Chart, Transmission Line Applications.

Unit-3 **(15 Lectures, 15 Marks)**
Waveguides and Waveguide Devices:
Wave propagation in waveguides, Parallel plate waveguides, TEM, TM and TE modes, Rectangular waveguides, circular waveguides, Power transmission and attenuation, Rectangular cavity resonators, directional couplers, isolator, circulator.

Unit-4 **(15 Lectures, 15 Marks)**

Radiation of electromagnetic waves:

Concept of retarded potentials, Antenna Parameters: Radiation Mechanism, Current Distribution on a Thin Wire Antenna, Radiation Pattern, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance Antenna Radiation Efficiency, Effective Length and Equivalent Areas, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation

Types of Antenna:

Hertzian dipole, Half wave dipole, Quarter-wave dipole, Yagi-Uda, microstrip, Parabolic antenna, Helical antenna, Antenna array.

Recommended readings:

- M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press (2001)
- Karl E. Longren, Sava V. Savov, Randy J. Jost., Fundamentals of Electromagnetics with MATLAB,PHI
- W. H. Hayt and J.A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
- D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
- J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
- N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
- G. S. N. Raju, Antennas and Propagation, Pearson Education (2001)

ELECTRONICS-DSE-4: TRANSMISSION LINES, ANTENNA AND WAVE PROPAGATION(LAB) (Scilab/MATLAB/Other Mathematical Simulation Software)
60 Lectures, 20 Marks

1. Program to determine the phasor of forward propagating field
2. Program to determine the instantaneous field of a plane wave
3. Program to find the Phase constant, Phase velocity, Electric Field Intensity and Intrinsic ratio
4. Program to find skin depth, loss tangent and phase velocity
5. Program to determine the total voltage as a function of time and position in a loss less transmission line
6. Program to find the characteristic impedance, the phase constant an the phase velocity
7. Program to find the output power and attenuation coefficient
8. Program to find the power dissipated in the lossless transmission line
9. Program to find the total loss in lossy lines
10. Program to find the load impedance of a slotted line
11. Program to find the input impedance for a line terminated with pure capacitive impedance.
12. Program to determine the operating range of frequency for TE10 mode of air filled rectangular waveguide.

13. Program to determine Directivity, Bandwidth, Beamwidth of an antenna.
14. Program to determine diameter of parabolic reflector.
15. Program to find out minimum distance between primary and secondary antenna.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		10
Written Test for theory and/or Viva Voce for Laboratory:		10
Final (End Semester):	**80**	
Written Test for theory and/or Laboratory experiments:		80

(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Understand the propagation of electromagnetic waves and how the electromagnetic wave can be effective transmitted through transmission lines or wave guides.
2. Comprehend the radiation of electromagnetic waves and the types of antenna
3. Use mathematical simulation software like Scilab, MATLAB etc and to use them to calculate various parameters related to electromagnetic wave propagation, transmission lines, waveguides and antenna.

SKILL ENHANCEMENT COURSE (SEC)

Course code: ELECTRONICS-SEC-1
Course title: DESIGN AND FABRICATION OF PRINTED CIRCUIT BOARDS
Nature of the course: SEC
Total credit assigned: 02

Course Objective: After the end of the course, a student will be able to

1. Understand the fundamentals of printed circuit boards and its classification.
2. Develop the knowledge about designing and fabrication of printed circuit boards.

ELECTRONICS-SEC-1: DESIGN AND FABRICATION OF PRINTED CIRCUIT BOARDS (THEORY)
(30 Lectures, 40 Marks)

Unit-I **(8 Lectures, 11 Marks)**
PCB Fundamentals:
PCB Advantages, components of PCB, Electronic components, Microprocessors and Microcontrollers, IC’s, Surface Mount Devices (SMD).

Classification of PCB - single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.

Unit-II **(8 Lectures, 11 Marks)**

Schematic & Layout Design:

Schematic diagram, General, Mechanical and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for library, Tracks, Pads, Vias, power plane, grounding.

Unit-III **(14 Lectures, 18 Marks)**

Technology OF PCB:

Design automation, Design Rule Checking; Exporting Drill and Gerber Files; Drills; Footprints and Libraries Adding and Editing Pins, copper clad laminates materials of copper clad laminates, properties of laminates (electrical & physical), types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing, Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls.Trends, Environmental concerns in PCB industry.

Recommended readings:

- Printed circuit Board – Design & Technology by Walter C. Bosshart, Tata McGraw Hill.
- Printed Circuit Board –Design, Fabrication, Assembly & Testing, R.S. Khandpur, TATA McGraw Hill Publisher

Mode of Assessment/ Assessment Tools

Internal: 10

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 5

Written Test for theory and/or Viva Voce for Laboratory: 5

Final (End Semester): 40

Written Test for theory and/or Laboratory experiments: 40

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Acquire the knowledge about the importance and necessity of printed circuit boards in electronic applications.
2. Learn the techniques and processes involved in the design and fabrication of printed circuit boards.

Course code: ELECTRONICS-SEC-2

Course title: ROBOTICS

Nature of the course: SEC

Total credit assigned: 02

Course Objective: At the completion of this course, a student will be able to

1. Learn the fundamental principles in Robotics.
2. Learn robot programming and configuring environments.
3. Understand various Robotic applications.

ELECTRONICS-SEC-2: ROBOTICS (THEORY)
(30 Lectures, 40 Marks)

Unit-I **(8 Lectures, 11 Marks)**
Programming Environments:
Integrated Development Environment (IDE) for AVR microcontrollers, free IDEs like AVR Studio, WIN AVR. Installing and configuring for Robot programming, In System Programmer (ISP), loading programmes on Robot

Unit-II **(12 Lectures, 16 Marks)**
Sensors and Actuators:
White line sensors , IR range sensor of different range, Analog IR proximity sensors , Analog directional light intensity sensors , Position encoders , Servo mounted sensor pod/ Camera Pod, Wireless colour camera , Ultrasound scanner , Gyroscope and Accelerometer , Magnetometer, GPS receiver, Battery voltage sensing, Current Sensing
DC Motors, Gearing and Efficiency, Servo Motors, Stepper motors, Motor Control and its implementations

Unit-III **(10 Lectures, 13 Marks)**
LCD interfacing with the robot (2 x 16 Characters LCD)
Other indicators:
Indicator LEDs, Buzzer
Timer / Counter operations:
PWM generation, Motor velocity control, Servo control, velocity calculation and motor position Control, event scheduling.
Communication:
Wired RS232 (serial) Communication, Wireless ZigBee Communication, USB Communication, Simplex infrared Communication (IR remote to robot)

Recommended readings:

- Saha, S.K., Introduction to Robotics, 2nd Edition, McGraw-Hill Education, New Delhi, 2014
- R.K. Mittal, I.J. Nagrath, “Robotics & Control”, Tata McGraw & Hills, 2005.

Mode of Assessment/ Assessment Tools

Internal: 10

Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	5
Written Test for theory and/or Viva Voce for Laboratory:	5

Final (End Semester): 40

Written Test for theory and/or Laboratory experiments:	40

(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Identify the and understand working principles of Robotics
2. Install and run Robot programming
3. Apply the knowledge to using Robots for real life situations

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GENERIC ELECTIVE (GE)

Course Code: ELECTRONICS-GE-1
Course Title: ELECTRONIC CIRCUITS AND PCB DESIGNING
Nature of the course: GE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practical --02

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

1. Learn various uses and applications of diodes and bipolar junction transistors.
2. Acquire the necessary skill to analyse electronic circuits.
3. Learn about designing and study of small signal amplifiers.
4. Understand the fundamentals of printed circuit boards and its classification.
5. Develop the knowledge about designing and fabrication of printed circuit boards.
6. Learn etching and soldering process.

ELECTRONICS-GE-1: ELECTRONIC CIRCUITS AND PCB DESIGNING (THEORY)
(60Lectures, 60 Marks)

Unit-1 **(10 Lectures, 10 Marks)**
Network theorems (DC analysis only):
Review of Ohms law, Kirchhoff's laws, voltage divider and current divider theorems, open and short circuits.
Thevenin's theorem, Norton's theorem and inter conversion, superposition theorem, maximum power transfer theorem.

Unit 2 **(12 Lectures, 12 Marks)**

Semiconductor Diode and its applications:

PN junction diode and characteristics ,ideal diode and diode approximations. Block diagram of a Regulated Power Supply, Rectifiers: HWR, FWR - center tapped and bridge FWRs. Circuit diagrams, working and waveforms, ripple factor &efficiency (no derivations).Filters: circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator:

circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-3 **(18 Lectures, 18 Marks)**

BJT and Small Signal amplifier:

Bipolar Junction Transistor: Construction, principle &working of NPN transistor, terminology. Configuration: CE, CB, CC. Definition of α, β and γ and their interrelations, leakage currents. Study of CE Characteristics, Hybrid parameters. Transistor biasing: need for biasing, DC load line, operating point, thermal runaway, stability and stability factor.

Voltage divider bias: circuit diagrams and their working, Q point expressions for voltage divider biasing.

Small signal CE amplifier: circuit, working, frequency response, re model for CE configuration, derivation for Av, Z in and Z out.

Unit-4 **(20 Lectures, 20 Marks)**

Types of PCB:

Single sided board, double sided, Multilayer boards, Plated through holes technology, Benefits of Surface Mount Technology (SMT), Limitation of SMT, Surface mount components: Resistors, Capacitor, Inductor, Diode and IC's.

Layout and Artwork:

Layout Planning: General rules of Layout, Resistance, Capacitance and Inductance, Conductor Spacing, Supply and Ground Conductors, Component Placing and mounting, Cooling requirement and package density, Layout check.

Basic artwork approaches, Artwork taping guidelines, General artwork rules: Artwork check and Inspection.

Laminates and Photo printing:

Properties of laminates, Types of Laminates, Manual cleaning process, Basic printing process for double sided PCB's, Photo resists, wet film resists, Coating process for wet film resists, Exposure and further process for wet film resists, Dry film resists

Etching and Soldering:

Introduction, Etching machine, Etchant system. Principles of Solder connection, Solder joints, Solder alloys, Soldering fluxes. Soldering, De soldering tools and Techniques.

Recommended readings:

- Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI
- Electronics text lab manual, Paul B. Zbar.

- Electric circuits, JoesephEdminister, Schaum series.
- Basic Electronics and Linear circuits, N.N. Bhargava, D.C. Kulshresta and D.C Gupta -TMH.
- Electronic devices, David A Bell, Reston Publishing Company/DB Tarapurwala Publ.
- Walter C.Bosshart “PCB DESIGN AND TECHNOLOGY” Tata McGraw Hill Publications, Delhi. 1983
- Clyde F.Coombs “Printed circuits Handbook” III Edition, McGraw Hill.

ELECTRONICS-GE-1: ELECTRONIC CIRCUITS AND PCB DESIGNING (LAB) (HARDWARE AND CIRCUIT SIMULATION SOFTWARE)
60 Lectures, 20 Marks

1. Verification of Thevenin’s theorem
2. Verification of Super position theorem
3. Verification of Maximum power transfer theorem.
4. Half wave Rectifier – without and with shunt capacitance filter.
5. Centre tapped full wave rectifier – without and with shunt capacitance filter.
6. Zener diode as voltage regulator – load regulation.
7. Transistor characteristics in CE mode – determination of ri, ro and β.
8. Design and study of voltage divider biasing.
9. Designing of an CE based amplifier of given gain
10. Designing of PCB using artwork, its fabrication and testing.
11. Design, fabrication and testing of a 9 V power supply with zener regulator

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		10
Written Test for theory and/or Viva Voce for Laboratory:		10
Final (End Semester):	**80**	
Written Test for theory and/or Laboratory experiments:		80

(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Acquire the basic knowledge about the use and application of diode and transistor circuits.
2. Design and analyse circuits containing diodes and transistors.
3. Learn the designing of transistor amplifiers and identify various types of amplifiers.
4. Develop the knowledge about printed circuit boards in electronic applications and will learn the techniques and processes involved in the design and fabrication of printed circuit boards.

Course Code: ELECTRONICS-GE-2
Course Title: DIGITAL SYSTEM DESIGN
Nature of the Course: GE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practical --02

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

1. Learn about the digital principles like number systems and Boolean algebra
2. Apply the digital electronic principles in circuit analysis and synthesis.

ELECTRONICS-GE-2: DIGITAL SYSTEM DESIGN (THEORY)
60 Lectures, 60 Marks

Unit-1 **(15 Lectures, 15 Marks)**
Number System and Codes:
Decimal, Binary, Hexadecimal, Octal, BCD, Conversions, Complements (1's and 2's), Signed and unsigned numbers, addition and subtraction, multiplication and subtraction, Gray Codes
Boolean algebra and Logic gates:
Boolean algebra- Positive and negative logic. Boolean laws. De Morgan's theorems, simplification of Boolean expressions-SOP and POS. Logic gates- basic logic gates-AND, OR, NOT, logic symbol and truth table. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. K-map-3 and 4 variable expressions. Characteristics of logic families: Fan In and Fan out, power dissipation and noise Immunity, propagation delay, comparison of TTL and CMOS families.

Unit-2 **(10 Lectures, 10 Marks)**
Combinational logic analysis and design:
Multiplexers and Demultiplexers, Adder (half and full) and their use as subtractor, Encoder and Decoder, Code Converter (Binary to BCD and vice versa)

Unit-3 **(15 Lectures, 15 Marks)**
Sequential logic design:
Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (ripple, synchronous and asynchronous, ring, modulus)

Unit-4 **(20 Lectures, 20 Marks)**
Introduction to Microprocessor:
Introduction, applications, basic block diagram, speed, word size, memory capacity, classification of microprocessors (mention different microprocessors being used)
Microprocessor 8085:
Features, architecture -block diagram, internal registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085.

Recommended readings:

- M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)
- Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
- W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
- R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw-Hill (1994)
- A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.
- Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

ELECTRONICS- GE-2: DIGITAL SYSTEM DESIGN (LAB) (Hardware and Circuit Simulation Software)
60 Lectures, 20 Marks

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.

VHDL

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4 bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 2 bit Magnitude comparator.
10. 3 bit Ripple counter.

Mode of Assessment/ Assessment Tools (%)
Internal: 20
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10
Written Test for theory and/or Viva Voce for Laboratory: 10
Final (End Semester): 80

Written Test for theory and/or Laboratory experiments: 80
(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Identify and understand digital electronics principles and systems.
2. Apply the knowledge to build small electronic systems using digital ICs and techniques.

Course Code: ELECTRONICS-GE-3
Course Title: INSTRUMENTATION
Nature of the course: GE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practical --02

Course objective: At the end of the course, a student will be able to

1. Learn about the various measurement instruments and the measurement techniques involved.
2. Handle different instruments like signal generators and Oscilloscope.
3. Develop the knowledge of the students about transducers of different types.
4. Learn about data acquisition systems.
5. Gain theoretical and practical knowledge about various instruments used in the field of biological sciences and medical science.

ELECTRONICS-GE-3: INSTRUMENTATION (THEORY)
(60Lectures, 60 Marks)

Unit-1 **(10 Lectures, 10 Marks)**
DC and AC indicating Instruments:
Accuracy and precision, Types of errors, PMMC galvanometer, sensitivity, Loading effect, Conversion of Galvanometer into ammeter, Voltmeter and Shunt type ohmmeter, Multimeter.

Unit-2 **(20 Lectures, 20 Marks)**
Oscilloscopes:
CRT, wave form display and electrostatic focusing, time base and sweep synchronisation, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, Sampling Oscilloscope, DSO and Powerscope: Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, rise time).
Signal Generators:
Audio oscillator, Pulse Generator, Function generators.

Unit-3 **(10 Lectures, 10 Marks)**

Transducers:

Basic requirements of transducers, Transducers for measurement of non-electrical quantities: Types and their principle of working , measurement of Linear displacement, Acceleration, Flow rate, Liquid level, strain, Force, Pressure, Temperature.

Unit-4 **(20 Lectures, 20 Marks)**

Data acquisition systems:

Block diagram, brief description of preamplifier, signal conditioner, instrumentation amplifier, waveform generator, A/D and D/A converter blocks, computer controlled test and measurement system.

Bio-medical instrumentation:

Bio-Amplifiers: Bio potentials - Bio-electricity – Necessity for special types of amplifiers for biological signal amplifications - Different types of Bio-OP-Amps. Electrodes for ECG, EEG, and EMG, block diagram of ECG and EEG systems, brief analysis of graphs.

Recommended readings:

- Electrical Measurement in Measuring Instruments. Goldwing E.W. and Widdies
- Electrical and Electronics Measurement and Instrumentation Sahwany A.K.
- Instrumentation devices and systems: Rangan, Sarma, Mani, TMH
- Instrumentation measurement and analysis: Nakra B C, Chaudry K K, TMH
- Handbook of biomedical instrumentation: Khandpur R S, TMH
- Measurement systems applications and design: Doeblin E O, McGraw Hill, 1990.
- Electron measurements and instrumentation techniques: Cooper W D and Helfric A D, PHI, 1989.
- Biomedical instrumentation and measurements: Leslie-Cromwell, Fred J Weibell, Erich A Pfieffer, PHI, 1994.
- Mechatronics – principles and applications, Godfrey C Onwubolu, Elsevier, 2006

ELECTRONICS-GE-3: INSTRUMENTATION (LAB)
60Lectures, 20 Marks

1. Design of multi range ammeter and voltmeter using galvanometer.
2. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
3. To determine the Characteristics of LVDT.
4. To determine the Characteristics of Thermistors and RTD.
5. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
6. Characterization of bio potential amplifier for ECG signals.
7. Study on ECG simulator
8. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator
9. Study of pulse rate monitor with alarm system

10. Measurement of respiration rate using thermister /other electrodes.

Mode of Assessment/ Assessment Tools (%)
Internal: 20
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 10
Written Test for theory and/or Viva Voce for Laboratory: 10
Final (End Semester): 80
Written Test for theory and/or Laboratory experiments: 80
(Equal weightage to be assigned to each credit)

Expected learner outcomes: This course will enable the students to

1. Acquire the necessary knowledge to use different measuring instruments for measurements of voltage, currents and resistances.
2. Acquire the knowledge to handle and use oscilloscope, DSO and pulse generators.
3. Equip themselves with the theoretical and practical knowledge about various types of transducers.
4. Learn about the various sections of a data acquisition system (DAQ) and the function of DAQ in general.
5. Learn about some very important instruments used in the field of biological and medical science.

Course Code: ELECTRONICS- GE-4
Course Title: COMMUNICATION SYSTEMS
Nature of the Course: GE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practical --02

Course objective: At the completion of this course, a student will be able to

1. Learn the basics of electronic communication systems and the significance of noise in communication.
2. Understand the various types of modulation schemes both theory and practical.
3. Learn about various digital modulation techniques and some associated concepts.
4. Study various types of multiple accessing techniques.
5. Understand cellular communication and satellite communications.

ELECTRONICS- GE-4: COMMUNICATION SYSTEMS (THEORY)
60Lectures, 60 Marks

Unit-1 **(16 Lectures, 16 Marks)**
Noise and Transmission lines:
Noise-Introduction, internal and external noises, signal to noise ratio and noise figure
Amplitude Modulation/demodulation techniques:

Block diagram of electronic communication system. Modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only). Limitations of AM.
Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms.
Block diagram of AM transmitter and Receiver.

Unit-2 **(12 Lectures, 12 Marks)**
Frequency Modulation/demodulation techniques:
Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator.
FM detector – principle, slope detector-circuit, principle of working and waveforms.
Block diagram of FM transmitter and Receiver. Comparison of AM and FM.

Unit- 3 **(16 Lectures, 16 Marks)**
Digital communication:
Introduction to pulse and digital communications, digital radio, sampling theorem, types-PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, MODEM– modes, classification, interfacing (RS232). TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA

Unit- 4 **(16 Lectures, 16 Marks)**
Cellular Communication:
Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.
Satellite communication:
Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

Recommended readings:

- Electronic Communication, George Kennedy, 3rd edition, TMH.
- Electronic Communication, Roddy and Coolen, 4th edition, PHI.
- Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
- Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition- Pearson education

ELECTRONICS-GE-4: COMMUNICATION SYSTEMS (LAB)
60Lectures, 20 Marks

1. Amplitude modulator and Amplitude demodulator
2. Study of FM modulator using IC8038
3. Study of VCO using IC 566
4. Study of Time Division Multiplexing and de multiplexing
5. Study of AM Transmitter/Receiver
6. Study of FM Transmitter/Receiver
7. ASK modulator and demodulator
8. Study of FSK modulation
9. Study of PWM and PPM
10. Study of PAM modulator and demodulator.

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	10
Written Test for theory and/or Viva Voce for Laboratory:	10
Final (End Semester):	**80**
Written Test for theory and/or Laboratory experiments:	80

(Equal weightage to be assigned to each credit)

Expected learner outcome: This course will enable the students to

1. Learn some of the most fundamental techniques used in communication.
2. Understand the various aspects of a communication system.
3. Recognise the different available modulation techniques along with the practical knowledge about the technology behind the schemes.
4. Equip themselves with the knowledge to understand analog and digital modulation techniques.
5. Learn about different aspects of cellular communication and satellite communication systems.