UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

UNIVERSITY OF CALCUTTA

SYLLABUS

F
O
R

THREE-YEAR
SIX SEMESTER

B.Sc. DEGREE
HONOURS & GENERAL
COURSE OF STUDIES

UNDER CBCS

ELECTRONICS

2018

Syllabus

for

Electronics (UG-Honours)

Under CBCS

SEMESTERWISE SCHEDULE FOR B.Sc. (HONOURS) ELECTRONICS					
Year	**Semester**	**Course Opted**	**Course Name**	**Credits**	**Marks**
1st Year	1st	Core Course-1 Theory	Basic Circuit Theory and Network Analysis	4	100
		Core Course-1 Practical	Basic Circuit Theory and Network Analysis Lab	2	
		Core Course-2 Theory	Mathematics Foundation for Electronics	4	100
		Core Course-2 Practical	Mathematics Foundation for Electronics Lab	2	
		Generic Elective-1 Theory	GE-1 Theory (of other Subject/Discipline)	4/5	100
		Generic Elective-1 Practical/Tutorial	GE-1 Lab/Tutorial (of other Subject/Discipline)	2/1	
		Ability Enhancement Compulsory Course-1	Communicative English/MIL	2	100
			Semester Total	**20**	**400**
	2nd	Core Course-3 Theory	Applied Physics	4	100
		Core Course-3 Practical	Applied Physics Lab	2	
		Core Course-4 Theory	C Programming and Data Structure	4	100
		Core Course-4 Practical	C Programming and Data Structure Lab	2	
		Generic Elective-2 Theory	GE-2 Theory (of other Subject/Discipline)	4/5	100
		Generic Elective-2 Practical/Tutorial	GE-2 Lab/Tutorial (of other Subject/Discipline)	2/1	
		Ability Enhancement Compulsory Course-2	Environmental Studies	2	100
			Semester Total	**20**	**400**
2nd Year	3rd	Core Course-5 Theory	Semiconductor Device	4	100
		Core Course-5 Practical	Semiconductor Device Lab	2	
		Core Course-6 Theory	Electronic Circuits	4	100
		Core Course-6 Practical	Electronic Circuits Lab	2	
		Core Course-7 Theory	Electromagnetics	4	100
		Core Course-7 Practical	Electromagnetics Lab	2	
		Skill Enhancement Course-1	SEC-1	2	100
		Generic Elective-3 Theory	GE-3 Theory (of other Subject/Discipline)	4/5	100
		Generic Elective-3 Practical/Tutorial	GE-3 Lab/Tutorial (of other Subject/Discipline)	2/1	
			Semester Total	**26**	**500**
	4th	Core Course-8 Theory	Operational Amplifiers and Applications	4	100
		Core Course-8 Practical	Operational Amplifiers and Applications Lab	2	
		Core Course-9 Theory	Digital Electronics and VHDL	4	100
		Core Course-9 Practical	Digital Electronics and VHDL Lab	2	
		Core Course-10 Theory	Signals and Systems	4	100
		Core Course-10 Practical	Signals and Systems Lab	2	
		Skill Enhancement Course-2	SEC-2	2	100
		Generic Elective-4 Theory	GE-4 Theory (of other Subject/Discipline)	4/5	100
		Generic Elective-4 Practical/Tutorial	GE-4 Lab/Tutorial (of other Subject/Discipline)	2/1	
			Semester Total	**26**	**500**
3rd Year	5th	Core Course-11 Theory	Electronic Instrumentation	4	100
		Core Course-11 Practical	Electronic Instrumentation Lab	2	
		Core Course-12 Theory	Microprocessors and Microcontrollers	4	100
		Core Course-12 Practical	Microprocessors and Microcontrollers Lab	2	
		Discipline Specific Elective-1 Theory	DSE-1 Theory	4	100
		Discipline Specific Elective-1 Practical	DSE-1 Lab	2	
		Discipline Specific Elective -2 Theory	DSE-2 Theory	4	100
		Discipline Specific Elective-2 Practical	DSE-2 Lab	2	
			Semester Total	**24**	**400**
	6th	Core Course-13 Theory	Communication Electronics	4	100
		Core Course-13 Practical	Communication Electronics Lab	2	
		Core Course-14 Theory	Photonics	4	100
		Core Course -14 Practical	Photonics lab	2	
		Discipline Specific Elective-3 Theory	DSE-3 Theory	4	100
		Discipline Specific Elective-3 Practical	DSE-3 Lab	2	
		Discipline Specific Elective-4 Theory	DSE-4 Theory	4	100
		Discipline Specific Elective-4 Practical	DSE-4 Lab	2	
			Semester Total	**24**	**400**
			Grand Total	**140**	**2600**

B.Sc. (HONOURS) ELECTRONICS

Core Course (CC): (Credits: 6 each) – CC 1-14
CC-01: Basic Circuit Theory and Network Analysis (ELT-A-CC-1-01-TH/P)
CC-02: Mathematics Foundation for Electronics (ELT-A-CC-1-02-TH/P)
CC-03: Applied Physics (ELT-A-CC-2-03-TH/P)
CC-04: C Programming and Data Structures (ELT-A-CC-2-04-TH/P)
CC-05: Semiconductor Devices (ELT-A-CC-3-05-TH/P)
CC-06: Electronic Circuits (ELT-A-CC-3-06-TH/P)
CC-07: Electromagnetics (ELT-A-CC-3-07-TH/P)
CC-08: Operational Amplifiers and Applications (ELT-A-CC-4-08-TH/P)
CC-09: Digital Electronics and VHDL (ELT-A-CC-4-09-TH/P)
CC-10: Signals and Systems (ELT-A-CC-4-10-TH/P)
CC-11: Electronic Instrumentation (ELT-A-CC-5-11-TH/P)
CC-12: Microprocessors and Microcontrollers (ELT-A-CC-5-12-TH/P)
CC-13: Communication Electronics (ELT-A-CC-6-13-TH/P)
CC-14: Photonics (ELT-A-CC-6-14-TH/P)

Discipline Specific Elective (DSE): (Credits: 6 each) – DSE 1-4

Semester-5 Options (Choose 2 Papers taking 1 each from Group-A and Group-B)

DSE-1: Group-A (Choose any 1 Paper)
DSE-1-A-1: Numerical Techniques (ELT-A-DSE-5-A-1-TH/P)
DSE-1-A-2: Control Systems (ELT-A-DSE-5-A-2-TH/P)

DSE-2: Group-B (Choose any 1 Paper)
DSE-2-B-1: Semiconductor Fabrication and Characterization (ELT-A-DSE-5-B-1-TH/P)
DSE-2-B-2: Power Electronics (ELT-A-DSE-5-B-2-TH/P)

Semester-6 Options (Choose 2 Papers taking 1 each from Group-A and Group-B)

DSE-3: Group-A (Choose any 1 Paper)
DSE-3-A-1: Basic VLSI Design (ELT-A-DSE-6-A-1-TH/P)
DSE-3-A-2: Digital Signal Processing (ELT-A-DSE-6-A-2-TH/P)

DSE-4: Group-B (Choose any 1 Paper)
DSE-4-B-1: Biomedical Instrumentation (ELT-A-DSE-6-B-1-TH/P)
DSE-4-B-2: Transmission Lines, Antenna and Microwave Devices (ELT-A-DSE-6-B-2-TH/P)

Ability Enhancement Compulsory Course (AECC): (Credits: 2 each) – AECC 1-2
AECC-1: Communicative English/MIL
AECC-2: Environmental Studies

Skill Enhancement Course (SEC): (Credits: 2 each) – SEC 1-2

Semester-3 Options (Choose 1 Paper from Group-A)
SEC-1: Group-A (Choose any 1 Paper)
SEC-1-A-1: Design and Fabrication of Printed Circuit Boards (ELT-A-SEC-3-A-1-TH)
SEC-1-A-2: Circuit Modeling using PSPICE (ELT-A-SEC-3-A-2-TH)

Semester-4 Options (Choose 1 Paper from Group-B)
SEC-2: Group-B (Choose any 1 Paper)
SEC-2-B-1: Internet and Java Programming (ELT-A-SEC-4-B-1-TH)
SEC-2-B-2: Programming with Matlab/Scilab (ELT-A-SEC-4-B-2-TH)

Generic Elective (GE): (Credits: 6 each) from other Subjects/Disciplines – GE 1-4
(Electronics Honours Students have to choose 4 GE Papers taking 2 Papers each from 2 other Subjects/Disciplines)

Generic Elective (GE): (Credits: 6 each) for other Hohours Subjects/Disciplines – GE 1-2
(Honours Students of other Subjects/Disciplines than Electronics have to choose any 2 Papers of the following Core Course (CC): (Credits: 6 each) – CC 1-4 of B.Sc. (General) Electronics as GE)
CC-1A / GE-1: Network Analysis and Analog Electronics (ELT-G-CC-1-1-TH/P) / (ELT-A-GE-1-1-TH/P)
CC-2A / GE-2: Linear and Digital Integrated Circuits (ELT-G-CC-2-2-TH/P) / (ELT-A-GE-2-2-TH/P)
CC-3A / GE-3: Communication Electronics (ELT-G-CC-3-3-TH/P) / (ELT-A-GE-3-3-TH/P)
CC-4A / GE-4: Microprocessors and Microcontrollers (ELT-G-CC-4-4-TH/P) / (ELT-A-GE-4-4-TH/P)

HONOURS SYLLABUS

FIRST YEAR : FIRST SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-1	ELT-A-CC-1-01-TH: Basic Circuit Theory and Network Analysis		50		10	10	100	4
	ELT-A-CC-1-01-P: Basic Circuit Theory and Network Analysis Lab			30				2
CC-2	ELT-A-CC-1-02-TH: Mathematics Foundation for Electronics		50		10	10	100	4
	ELT-A-CC-1-02-P: Mathematics Foundation for Electronics Lab			30				2
GE-1	Generic Elective-1 Theory	Other Subject/Discipline	50/65		10	10	100	4/5
	Generic Elective-1 Practical/Tutorial	than Electronics		30/15				2/1
AECC-1	Communicative English/MIL		80		10	10	100	2
						TOTAL	400	20

Core Course (CC) - 1 Theory
ELT-A-CC-1-01-TH: Basic Circuit Theory and Network Analysis
[Credits: 4; Lecture Hours: 56]

Basic Circuit Concepts: Classification of Circuit Elements, Resistors, Fixed and Variable Resistors, Construction and Characteristics, Color Coding of Resistors, Resistors in Series and Parallel, Testing of Resistance using Multimeter, Inductors, Fixed and Variable Inductors, Self and Mutual Inductance, Energy Stored in an Inductor, Inductance in Series and Parallel, Testing of 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, Ideal and Practical Voltage and Current Sources, Dependent Sources, Laws of Conservation of Flux Linkage and Charge. **[10]**
Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Linear Circuits, Principle of Duality, Star-Delta Conversion.
DC transient Analysis: Transient Response of Series RL, RC and RLC Circuits under DC Excitation. **[14]**
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, Sinusoidal Circuit Analysis for RL, RC, Series and Parallel RLC Circuits, Power in AC Circuits, Instantaneous Power, Average Power, Reactive Power, Power Factor.
Resonance in Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth, Passive Filters, Low Pass, High Pass, Band Pass and Band Stop Filers, Integrator and differentiator. **[16]**
Network Theorems: Superposition Theorem, Millman's Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Tellegen's Theorem, Bisection Theorem, Maximum Power Transfer Theorem, AC Circuit Analysis using Network Theorems.
Two Port Networks: Impedance (Z), Admittance (Y) and Transmission (ABCD) Parameters.
Network Graph Theory: Equivalent Graph, Incidence Matrix, Fundamental Tie-Set/Cut-Set. **[16]**

Core Course (CC) - 1 Practical
ELT-A-CC-1-01-P: Basic Circuit Theory and Network Analysis Lab
[Credits: 2; Lecture Hours: 56]

1. Familiarization with:
   (a) Resistance in Series, Parallel and Series-Parallel; (b) Capacitors and Inductors in Series and 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 and 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.

Reference Books:

- Hyat, Kemmerly and Durbin, Engineering Circuit Analysis, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Bel, Electronic Circuits, Oxford.
- Carlson, Circuits, Cengage.
- Kuo, Network Analysis and Synthesis, Wiley.
- Dorf and Svoboda, Introduction to Electric Circuits, Wiley.
- DeCarlo and Lin, Linear Circuit Analysis, Oxford.
- Sivanagaraju and Rao, Electrical Circuits Analysis, Cengage.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Ryder, Network, Lines and Fields, Pearson Education.
- Nasar, Electric Circuits, Schaum's Solved Problems Series, Tata McGraw Hill.
- Nahvi and Edminister, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill.

Core Course (CC) - 2 Theory
ELT-A-CC-1-02-TH: Mathematics Foundation for Electronics
[Credits: 4; Lecture Hours: 56]

Ordinary Differential Equation: 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 Polynomials, Frobenius Method, Bessel's Equations and Bessel's Functions of First and Second Kind, Error Functions and Gamma Function. **[14]**

Matrices: Introduction to Matrices, System of Linear Algebraic Equations, Gaussian Elimination Method, Gauss-Seidel Method, LU Decomposition, Solution of Linear System by LU Decomposition, Eigenvalues and Eigenvectors, Linear Transformation, Properties of Eigenvalues and Eigenvectors, Cayley-Hamilton Theorem, Diagonalization, Powers of a Matrix, Real and Complex Matrices, Symmetric, Skew Symmetric, Orthogonal Quadratic Form, Hermitian, Skew Hermitian, Unitary Matrices. **[10]**

Sequences and Series: Sequences, Limit of a Sequence, Convergence, Divergence and Oscillation of a Sequence, 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. **[10]**

Complex Variables and Functions: Complex Variable, Complex Function, Continuity, Differentiability, Analyticity, Cauchy-Riemann (C-R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Function, Trigonometric Function, Hyperbolic Function, 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. **[12]**

Laplace Transform: Properties of Laplace Transform, Laplace Transform of Different Signals, Inverse Laplace Transform and Applications in Circuit Analysis, Equivalent Circuit of Inductor and Capacitor in s-Domain. **[10]**

Core Course (CC) - 2 Practical
ELT-A-CC-1-02-P: Mathematics Foundation for Electronics Lab
[Credits: 02; Lecture Hours: 56]

Scilab/MATLAB/Any Other Mathematical Simulation Software

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.

Reference Books:

- Kreyszig, Advanced Engineering Mathematics, Wiley.
- Spiegel, Lipschutz, Schiller and Spellman, Schaum,s Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill.
- Ramana, Higher Engineering Mathematics, Tata McGraw Hill.
- Pal and Bhunia, Engineering Mathematics, Oxford.
- Garg and Gupta, Engineering Mathematics Volume I & II, Pearson.
- Dass and Verma, Higher Engineering Mathematics, S. Chand.
- John Bird, Engineering Mathematics, Elsevier-Newnes.

Ability Enhancement Compulsory Course (AECC) - 1
AECC-1: Communicative English/MIL
[Credits: 02]

Generic Elective (GE) - 1 (Choose 1 Paper from other Subject/Discipline)
[Credits: 06]

FIRST YEAR : SECOND SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE	MARKS					CREDITS
		Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-3	ELT-A-CC-2-3-TH: Applied Physics	50		10	10	100	4
	ELT-A-CC-2-3-P: Applied Physics Lab		30				2
CC-4	ELT-A-CC-2-4-TH: C Programming and Data Structure	50		10	10	100	4
	ELT-A-CC-2-4-P: C Programming and Data Structure Lab		30				2
GE-2	Generic Elective-2 Theory Other Subject/Discipline	50/65		10	10	100	4/5
	Generic Elective-2 Practical/Tutorial than Electronics		30/15				2/1
AECC-1	Environmental Studies	50	30*	10	10	100	2
* Project					TOTAL	400	20

Core Course (CC) - 3 Theory
ELT-A-CC-2-03-TH: Applied Physics
[Credits: 04; Lecture Hours: 56]

Physics of Crystalline Solids: Crystalline Materials, Crystal Structure in Solids, Concept of Lattice and Basis, Crystal Axes and Planes, Primitive and Unit Cells, Packing Fraction for Simple, Body-Centered and Face-Centered Cubic Lattices, Calculation of Interplaner Spacing for Cubic Lattice, Miller Indices, Concept of Reciprocal Lattice, Bragg's Equation in Direct and Reciprocal Lattice (no derivation), Bonding in Solids, Basic Ideas of Metallic Bonds, Ionic Bonds, Covalent Bonds, Vander Waal's Bonds. **[8]**

Quantum Mechanics: Inadequacies of Classical Physics (in Relevance to Electron Diffraction Experiment), Compton's Effect, Photo-Electric Effect, Blackbody Radiation, Wien's Law, Raleigh Jeans Law, Plank's Law, Introduction to Wave Particle Duality, de Broglie's Hypothesis, Heisenberg's Uncertainty Principle, Probability Density and Born Interpretation, Basic Postulates and Formalism of Quantum Mechanics, Wavefunctions, Operators in Quantum Mechanics, Eigenstates, Eigenvalues and Eigenfunctions, Schrodinger Wave Equation, Qualitative Discussion of Phenomenon of Tunnelling, Particle in a One-Dimensional Box, Extension to a Three-Dimensional Box, Potential Barrier Problems (Free Electron, Electron in an Infinite Well), Kronig-Penney Model and Development of Band Structure, E-k Diagram in Solids, Classification of Conductors, Insulators and Semiconductors. **[16]**

Mechanical Properties of Materials: Concept of Elastic and Plastic Deformations, Hooke's Law, Elastic Moduli, Brittle and Ductile Materials, Tensile Strength.

Thermal Properties: Specific Heat in Solids, Phonons, Heat Capacity, Debye's Law, Basic Concept of Thermoelectricity, Laws of Thermodynamics, Concept of Entropy, Thermodynamic Potentials, Helmholtz Free Energy, Enthalpy Function, Gibb's Free Energy, Chemical Potential, Relation of Chemical Potential with Fermi Level. **[10]**

Statistical Mechanics: Macroscopic and Microscopic States, Concept of Phase Space and Density of States, Statistical Interpretation of Entropy, Quantization of Phase Space, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein Distribution Functions and their Importance. **[10]**

Electric Properties: Metals (Conductors), Basic Concept of Free Electron Theory, 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, Concept of Superconductivity; Insulators, Dielectric Properties, Concepts of Polarization, Permittivity and Dielectric Constant; Semiconductors, Bonding in Elemental and Compound Semiconductors, Intrinsic and Extrinsic Semiconductor, Concept of Holes,

Computation of Carrier Concentrations, Fermi Level in Semiconductors, E-k Diagrams to Explain Direct and Indirect Bandgap Semiconductors.
Magnetic Properties: Classification of Magnetic Materials, Magnetic Moment, Dia, Para, Ferro and Antiferro Magnetism, Ferrimagnetic Materials, Saturation Magnetisation, Curie Temperature. **[12]**

Core Course (CC) - 3 Practical
ELT-A-CC-2-03-P: Applied Physics Lab
[Credits: 02; Lecture Hours: 56]

1. To Measure the Resistivity of a Si Crystal with Temperature by Four-Probe Method from Room Temperature to 200 ^{O}C).
2. To Determine the Value of Boltzmann Constant by Studying Forward Characteristics of Diode.
3. To Determine the Value of Planck's Constant by using LEDs of Different Wavelengths.
4. Simulation Studies:
   (a) Find Lowest Energy Eigenvalues for 1-D Schrodinger Equation.
   (b) Plotting Tunneling Probability as a Function of Barrier Width.
   (c) Plot Energy Band-Diagram corresponding to Different Potential Profile.

Reference Books:

- Callister and Balasubramaniam, Material Science and Engineering, Wiley.
- Vijaya and Rangarajan, Material Science, Tata McGraw Hill.
- Bransden, Quantum Mechanics, Pearson.
- Griffiths, Introduction to Quantum Mechanics, Pearson.
- Majumdar, Quantum Mechanics in Physics and Chemistry with Applications to Biology, PHI.
- Lokanathan and Gambhir, Statistical and Thermal Physics: An Introduction, PHI.
- Eisberg and Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley.
- Pillai, Solid State Physics, New Age.
- Kasap, Principles of Electronic Materials and Devices, Tata McGraw Hill.
- Roy, Fundamentals of Classical and Statistical Thermodynamics, Wiley.

Core Course (CC) - 4 Theory
ELT-A-CC-2-04-TH: C Programming and Data Structures
[Credits: 04; Lecture Hours: 56]

C Programming Language: Introduction, Importance of C, Character Set, Tokens, Keywords, Identifier, Constants, Basic Data Types, Variables, Declaration and 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). **[12]**
Decision Making, Branching and 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. **[16]**
Data Structures: Definition of Stack, Array Implementation of Stack, Conversion of Infix Expression to Prefix and 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. **[14]**
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, Preorder, Postorder and Inorder Traversal (Recursive). **[14]**

Core Course (CC) - 4 Practical
ELT-A-CC-2-04-P: C Programming and Data Structures Lab
[Credits: 02; Lecture Hours: 56]

The list of programs given below is indicative only. Students should do programs which make use of the different programming techniques and data structures.

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 and Difference of Two Matrices of Order M×N and P×Q.
10. Find the Product of Two Matrices of Order M×N and P×Q.
11. Find the Transpose of given M×N Matrix.
12. Find the Sum of Principle and Secondary Diagonal Elements of the given M×N Matrix.
13. Calculate the Subject wise and Student wise Totals and Store them as a Part of the Structure.
14. Implement Linear and Circular Linked Lists using Single and Double Pointers.
15. Create a Stack and Perform Pop, Push, Traverse Operations on the Stack using Linear Linked List.
16. Create Circular Linked List having Information about a College and Perform Insertion at Front, Deletion at End.
17. Create a Linear Queue using Linked List and Implement Different Operations such as Insert, Delete, and Display the Queue Elements.
18. Implement Polynomial Addition and Subtraction using Linked Lists.
19. Implement Sparse Matrices using Arrays and Linked Lists.
20. Create a Binary Tree to Perform Tree Traversals (Preorder, Postorder, Inorder) using the Concept of Recursion.
21. Implement Binary Search Tree using Linked Lists. Compare its Time Complexity over that of Linear Search.
22. Implement Insertion Sort, Merge Sort, Bubble Sort, Selection Sort.

Reference Books:

- Kanetkar, Let Us C, BPB.
- Balagurusamy, Programming in ANSI C, Tata McGraw Hill.
- Gottfried, Programming with C, Schaum's Outlines Series, Tata McGraw Hill.
- Kernighan and Ritchie, The C Programming Language, Pearson.
- Kanetkar, Understanding Pointers in C, BPB.
- Sahani and Horowitz, Data Structures, Galgotia.
- Tenenbaum, Langsam and Augenstein, Data Structures using C, Pearson.
- Horowitz and Sahani, Fundamentals of Computer Algorithms, Computer Science Press.
- Forouzan, C Programming and Data Structures, Cengage.
- Ghosh, All of C, PHI.
- Samanta, Classic Data Structures, PHI.
- Thareja, Data Structure Using C, Oxford.
- Thareja, Programming in C, Oxford.

Ability Enhancement Compulsory Course (AECC) - 2
AECC-2: Environmental Science
[Credits: 02]

Generic Elective (GE) - 2 (Choose 1 Paper from other Subject/Discipline)
[Credits: 06]

SECOND YEAR : THIRD SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-5	ELT-A-CC-3-05-TH: Semiconductor Device		50		10	10	100	4
	ELT-A-CC-3-05-P: Semiconductor Device Lab			30				2
CC-6	ELT-A-CC-3-06-TH: Electronic Circuits		50		10	10	100	4
	ELT-A-CC-3-06-P Electronic Circuits Lab			30				2
CC-7	ELT-A-CC-3-07-TH: Electromagnetics		50		10	10	100	4
	ELT-A-CC-3-07-P: Electromagnetics Lab			30				2
SEC-1	Choose any 1 Paper of the following: Group-A (SEC-A) Option-1 (SEC-1-A-1): ELT-A-SEC-3-A-1-TH: Design and Fabrication of Printed Circuit Boards Group-A (SEC-A) Option-2 (SEC-1-A-2): ELT-A-SEC-3-A-2-TH: Circuit Modeling using PSPICE		80		10	10	100	2
GE-3	Generic Elective-2 Theory	Other Subject/Discipline	50/65		10	10	100	4/5
	Generic Elective-2 Practical/Tutorial	than Electronics		30/15				2/1
						TOTAL	500	26

Core Course (CC) - 5 Theory
ELT-A-CC-3-05-TH: Semiconductor Devices
[Credits: 04; Lecture Hours: 56]

Semiconductor Basics: Introduction to Semiconductor Material, Elemental and Compound Semiconductors, Direct and Indirect Bandgap Semiconductors, Intrinsic and Extrinsic Semiconductors, Carriers in Semiconductors. Concept of Effective Mass, Density of States, Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations, Charge Neutrality Condition, Degenerate and Non-Degenerate Semiconductors.

Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes, Continuity Equation. **[13]**

Physics of Junctions: Homojunction and Heterojunction: Metal-Metal Contact, Metal-Semiconductor Contact (Both Ohmic and Schottky Junction).

Semiconductor-Semiconductor Homojunction: Formation of Depletion Layer / Space Charge Region at the Junction, Variation of Depletion Width in presence and absence of Field, Built-in Electric Field and Potential, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Junction Capacitance (Depletion and Diffusion), Junction Breakdown Mechanism, Concept of Abrupt and Linearly Graded Junctions.

PN Junction Diode: Current-Voltage Characteristics, DC and AC Equivalent Circuit (Eber's-Moll Equation and Charge Balance Equation).

Application of Junction Properties: Varactor Diode, Solar Cell, Zener Diode. **[13]**

Bipolar Junction Transistors (BJT): Basic Transistor Action, BJT as a Current Control Device, 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. **[12]**

Field Effect Transistors: Transverse Field Effect and Channel Isolation, Categories of FETs.

JFET: Construction, Channel Formation, Pinch-off and Saturation Voltage, Current-Voltage Output Characteristics.

MOSFET: MOS Capacitor, Channel Formation, Threshold Voltage (Ideal and Real), Current-Voltage Relation, Depletion and Enhancement Type MOSFET, Complimentary MOS (CMOS). **[12]**

Power Devices: UJT, Construction, Working Principle, Equivalent Circuit, Intrinsic Standoff Ratio, Characteristics, Relaxation Oscillator, Basic Working Principle and Characteristics of SCR, Diac and Triac. **[6]**

Core Course (CC) - 5 Practical
ELT-A-CC-3-05-P: Semiconductor Devices Lab
[Credits: 02; Lecture Hours: 56]

1. Study of the I-V Characteristics of PN Junction Diode and Zener Diode.
2. Study of the I-V Characteristics of the Common Emitter 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 SCR.
5. Study of the I-V Characteristics of the Diac.
6. Study of the I-V Characteristics of the Triac.

7. Study of the I-V Characteristics of JFET/MOSFET.
8. Study of Characteristics of Solar Cell.
9. Study of Hall Effect.

Reference Books:
- Sze, Semiconductor Devices: Physics and Technology, Wiley.
- Streetman and Banerjee, Solid State Electronic Devices, Pearson.
- Dennis Le Croissette, Transistors, Pearson.
- Singh, Semiconductor Devices: Basic Principles, Wiley.
- Pierret, Semiconductor Device Fundamentals, Pearson.
- Dimitrijev, Principles of Semiconductor Devices, Oxford.
- Neamen and Biswas, Semiconductor Physics and Devices, Tata McGraw Hill.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson.
- Kano, Semiconductor Devices, Pearson.

Core Course (CC) - 6 Theory
ELT-A-CC-3-06-TH: Electronic Circuits
[Credits: 04; Lecture Hours: 56]

Diode Circuits: Piece-Wise Linear Characteristics of Diode, DC Load Line Analysis, Quiescent (Q) Point, Clipping and Clamping Circuits. Rectifiers, Half-Wave Rectifier, Full-Wave Rectifier (Center Tapped and Bridge), PIV, Ripple Factor, Efficiency, Filters, Types, Circuit Diagram and Explanation of Shunt Capacitor Filter with Waveforms, Zener Diode Regulator, Circuit Diagram, Explanation for Load and Line Regulation.**[14]**
Bipolar Junction Transistor Circuits: Review of CE, CB Characteristics and Regions of Operation. Hybrid Parameters, r_e Model, Transistor Biasing, DC Load Line, Operating Point, Thermal Runaway, Stability and Stability Factor, Fixed Bias with and without Emitter Resistor, Collector to Base Bias, Voltage Divider Bias and Emitter Bias, Transistor as a Switch, Circuit and Working, Darlington Pair and its Applications, BJT Amplifier, Voltage and Power Amplifier, DC and AC Load Line Analysis, Hybrid Model of CE Configuration, Quantitative Study of Frequency Response of CE Amplifier, Effect on Gain and Bandwidth for Cascaded RC Coupled CE Amplifier. **[14]**
Feedback Amplifiers: Concept of Feedback, Negative and Positive Feedback, Types of Feedback Circuits, Advantages and Disadvantages of Negative Feedback, Voltage (Series and Shunt) and Current (Series and Shunt) Feedback Amplifiers, Effect of Negative Feedback on Gain, Input and Output Impedances, Bandwidth and Distortion, Barkhausen Criteria, Phase Shift Oscillator, Colpitts Oscillator, Hartley Oscillator, Regulated Power Supply, Series and Shunt (using BJT). **[14]**
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, Class AB and their Comparisons, Operation of Class A Single Ended Power Amplifier, Operation of Transformer Coupled Class A Power Amplifier, Efficiency, Operation of Complementary Symmetry Class B Push Pull Power Amplifier, Crossover Distortion, Heat Sinks.
Single Tuned Amplifiers: Circuit Diagram, Working and Frequency Response, Limitations of Single Tuned Amplifier, Applications of Tuned Amplifiers in Communication Circuits. **[14]**

Core Course (CC) - 6 Practical
ELT-A-CC-3-06-P: Electronic Circuits Lab
[Credits: 02; Lecture Hours: 56]

Hardware and Circuit Simulation Software
1. Study of the Half-Wave Rectifier and Full-Wave (Center-tap and Bridge) Rectifier.
2. Study of Power Supply using C Filter and Zener Diode.
3. Designing and Testing of 5V/9V DC Regulated Power Supply using Two Transistors and find its Load Regulation.
4. Study of Clipping and Clamping Circuits.
5. Study of Fixed Bias, Voltage Divider Bias and Collector-to-Base Bias Feedback Configuration for Transistors.
6. Designing of a Single Stage CE Amplifier.
7. Study of the Colpitt's Oscillator.
8. Study of the Phase Shift Oscillator
9. Study of the Frequency Response of Common Source FET Amplifier.

Reference Books:

- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Schilling and Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill.
- Neamen, Electronic Circuits: Analysis and Design, Tata McGraw Hill.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Sedra and Smith, Microelectronic Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.
- Bogart, Beasley and Rico, Electronic Devices and Circuits, Pearson.
- Jyoti Prasad Bandyopadhyay, Solid State Electronics Devices, Vikas.

Core Course (CC) - 7 Theory
ELT-A-CC-3-07-TH: Electromagnetics
[Credits: 04; Lecture Hours: 56]

Vector Analysis, Poisson's Equation and Laplace Equation: Scalars and Vectors, Unit Vector and Vector Components, Vector Field, Vector Algebra, Rectangular (Cartesian) Coordinate, Curvilinear Coordinates: Unit Vectors and Scalar Factors, Cylindrical Coordinate and Spherical Coordinate, Differential Length, Area and Volume, Line, Surface and Volume Integrals, Del Operator, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stokes's Theorem, Green's Theorem, Laplacian of a Scalar. **[8]**

Electrostatics: Coulomb's Law, Electric Field and Electric Potential due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law – Maxwell's Equation and Applications, Electric Dipole, Electric Fields in Different Materials, Current and Current Density, Polarization, Dielectric Constant, Linear and Nonlinear, Homogeneous and Inhomogeneous, Isotropic and Anisotropic Dielectrics, Boundary Conditions, Poisson's and Laplace's Equations and their Derivations and Examples of Solutions, Uniqueness Theorem, Capacitance and Capacitors, Method of Images, Electrostatic Energy and Forces, Energy Density. **[12]**

Magnetostatics: Biot Savart's Law and Applications, Magnetic Dipole, Ampere's Circuital Law – Maxwell's Equation and Applications, Magnetic Flux and Magnetic Flux Density – Maxwell's Equation, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic Materials, Magnetic Boundary Conditions, Inductors and Inductances, Mutual and Self Inductance, Magnetic Circuits, Magnetic Energy, Forces, Torque and Moment. **[11]**

Time-Varying Fields and Maxwell's Equations: Faraday's Law of Electromagnetic Induction – Maxwell's Equation, 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 Wave Equation for Potentials, Concept of Retarded Potentials, Electromagnetic Boundary Conditions. **[11]**

Electromagnetic Wave Propagation: Time-Harmonic Electromagnetic Fields, Electromagnetic Spectrum, Wave Equation in a Source Free Isotropic Homogeneous Media, Uniform Plane Waves in Lossless and Lossy Unbounded Homogeneous Media, Uniform Plane Waves in Good Dielectrics and Conductor, Skin Effect, Wave Polarization, Reflection and Transmission of Plane Waves at Normal and Oblique Incidence, Snell's Law, Fresnel's Equation, Brewster's Angle, Wave Propagation in Dispersive Media, Normal and Anomalous Dispersion, Concept of Phase and Group Velocity, Electromagnetic Power and Poynting Vector and Poynting Theorem. **[14]**

Core Course (CC) - 7 Practical
ELT-A-CC-3-07-P: Electromagnetics Lab
[Credits: 02; Lecture Hours: 56]

Scilab/Matlab/Any Other Similar Free Software

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.

Reference Books:
- Spiegel, Lipschutz and Spellman, Vector Analysis, Schaum's Outline Series, Tata McGraw Hill.
- Ida, Engineering Electromagnetics, Springer.
- Sadiku, Elements of Electromagnetics, Oxford.
- Rao and Narayanappa, Engineering Electromagnetics, Cengage.
- Hayt, Buck and Akhtar, Engineering Electromagnetics, Tata McGraw Hill.
- Cheng, Field and Wave Electromagnetics, Pearson.
- Edminster, Electromagnetics, Schaum's Outline Series, Tata McGraw Hill.
- Rao, Elements of Engineering Electromagnetics, Pearson.
- Griffiths, Introduction to Electrodynamics, Pearson.
- Jordan and Balmain, Electromagnetic Waves and Radiating Systems, Pearson.

Skill Enhancement Course (SEC) - 1
SEC-1: Group-A (SEC-A) Option-1 (SEC-1-A-1)
ELT-A-SEC-3-A-1-HT: Design and Fabrication of Printed Circuit Boards
[Credits: 02; Lecture Hours: 28]

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. **[4]**
Schematic and 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. **[10]**
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 and 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. **[12]**
PCB Technology: Trends, Environmental Concerns in PCB Industry. **[2]**

Reference Books:
- Bosshart, Printed Circuit Boards: Design and Technology, Tata McGraw Hill.
- Khandpur, Printed Circuit Board: Design, Fabrication, Assembly and Testing, Tata McGraw Hill.

Skill Enhancement Course (SEC) - 1
SEC-1: Group-A (SEC-A) Option-2 (SEC-1-A-2)
ELT-A-SEC-3-A-2-HT: Circuit Modeling using PSPICE
[Credits: 02; Lecture Hours: 28]

Introduction: Introduction to PSpice Software, File Types, Netlist Commands. **[4]**
Basic Analysis: DC, AC, Transient, Analog Behavioral Models (ABM), Equations Setup, IF Statement, Voltage/Current/Frequency Dependent Sources, Advanced Analyses, Noise, Monte-Carlo. **[10]**
Circuit Modeling: I-V Characteristic, Temperature Effects, Iterative Solution of Simple Series Circuit, Solution of Simple Series Circuit using an Equation Solver, PSpice Solution of Simple Series Circuit, PSpice I-V Characteristic, PSpice I-V Characteristic with Temperature Dependence, Thevenin Solution, Diode Models, Diode Circuits, Rectifier, Clipping, Zener Circuits, Clipping , MOSFETS , PSpice AC, DC, Transient, and Bias Point Simulations, MOSFET as Switch, Resistive Pull-up, Active Pull-up, Drive an LED, Basic NMOS Gate, Ohmic and SAT Regions, Bias with Current Source, MOSFET Small-Signal Analysis, Small-Signal Model, Common-Source Amplifier, Source-Follower, Input and Output Impedance, Bipolar Junction Transistors, PSpice AC, DC, transient, and Bias Point Simulations, BJT as Switch, Drive an LED, Drive a Relay, Biasing with Current Sources, BJT Small-Signal Analysis, Hybrid-pi Model, Common Emitter Amplifier, Emitter Follower, Input and output Impedance, Op-Amps, Analysis using Subcircuits. **[14]**

Reference Books
- Rashid, SPICE for Circuits and Electronics Using PSPICE, Pearson Education.
- Roberts and Sedra, SPICE, Oxford University Press.

Generic Elective (GE) - 3 (Choose 1 Paper from other Subject/Discipline)
[Credits: 06]

SECOND YEAR : FOURTH SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE	MARKS					CREDITS
		Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-8	Operational Amplifiers and Applications (ELT-A-CC-4-08-TH)	50		10	10	100	4
	Operational Amplifiers and Applications Lab (ELT-A-CC-4-08-P)		30				2
CC-9	Digital Electronics and VHDL (ELT-A-CC-4-09-TH)	50		10	10	100	4
	Digital Electronics and VHDL Lab (ELT-A-CC-4-09-P)		30				2
CC-10	Signals and Systems (ELT-A-CC-4-10-TH)	50		10	10	100	4
	Signals and Systems Lab (ELT-A-CC-4-10-P)		30				2
SEC-2	Choose any 1 Paper of the following: Group-B (SEC-B) Option-1 (SEC-2-B-1): ELT-A-SEC-4-B-1-TH: Internet and Java Programming Group-B (SEC-B) Option-2 (SEC-2-B-2): ELT-A-SEC-4-B-2-TH: Programming with Matlab/Scilab	80		10	10	100	2
GE-3	Generic Elective-2 Theory / Other Subject/Discipline than Electronics	50/65		10	10	100	4/5
	Generic Elective-2 Practical/Tutorial		30/15				2/1
						TOTAL	500	26

Core Course (CC) - 8 Theory
ELT-A-CC-4-08-TH: Operational Amplifiers and Applications
[Credits: 04; Lecture Hours: 56]

Basic Operational Amplifier: Concept of Differential Amplifiers (Dual Input and Balanced and Unbalanced Output), Constant Current Bias, Current Mirror, Cascaded Differential Amplifier Stages with Concept of Level Transistor, Ideal Op-Amp and its Characteristics, Block Diagram of Op-Amp (IC 741), Deviations for a Real Op-Amp from Ideal Behavior.
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. **[12]**
Op-Amp Circuits and Applications: Open and Closed Loop Configuration, Frequency Response, Inverting, Non-Inverting, Summing and Difference Amplifiers, Integrator, Differentiator, Multiplier and Divider, Voltage to Current and Current to Voltage Convertor, Instrumentation Amplifier.
Comparators: Basic Comparator, Level Detector, Voltage Limiters, Schmitt Trigger.
Signal Generators: Concept of Sinusoidal and Relaxation Type, Phase Shift Oscillator, Wien Bridge Oscillator, Square Wave Generator, Triangle Wave Generator, Saw Tooth Wave Generator, Voltage Controlled Oscillator (IC 566). **[18]**
Timers Circuits: Multivibrators (IC 555), Functional Block Diagram, Astable and Monostable Multivibrator Circuits and Applications, Phase Locked Loops (PLL), Block Diagram, Phase Detectors, IC565, Voltage Controlled Oscillator (IC 566).
Fixed and Variable IC Regulators: IC 78xx and IC 79xx (Concepts only), IC LM317, Output Voltage Equation, SMPS, Principle of DC-to-DC Conversion, Block Diagram Representation of SMPS Module. **[12]**
Signal Conditioning Circuits: Sample and Hold Systems, Active Filters, Butterworth Filter, First and Second Order Low Pass and High Pass Filters, Band Pass Filter, Band Reject Filter, All Pass Filter, Log and Antilog Amplifiers. **[14]**

Core Course (CC) - 8 Practical
ELT-A-CC-4-08-P: Operational Amplifiers and Applications Lab
[Credits: 02; Lecture Hours: 56]

Hardware and Circuit Simulation Software
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. Designing of a Wien Bridge Oscillator using Op-Amp.
10. Study of IC 555 as Astable Multivibrator.
11. Study of IC 555 as Monostable Multivibrator.
12. Designing of Fixed Voltage Power Supply using IC Regulators using 78 Series and 79 Series.

Reference Books:

- Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson.
- Coughlin and Driscoll, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Malvino, Electronic Principals, Tata McGraw-Hill.
- Kishore, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Bel, Operational Amplifiers and Linear ICs, Oxford.
- Jacob, Analog Integrated Circuits Applications, Pearson.
- Fiore, Op-Amps and Linear Integrated Circuits: Concepts and Applications, Cengage.
- Ganesh Babu, Linear Integrated Circuits and Applications, Scitech.

Core Course (CC) - 9 Theory
ELT-A-CC-4-09-TH: Digital Electronics and VHDL
[Credits: 04; Lecture Hours: 56]

Number System and Codes: Decimal, Binary, Hexadecimal and Octal Number Systems, Base Conversions and Arithmetic (Addition, Subtraction by Complement Method, Multiplication), Representation of Signed and Unsigned Numbers, Binary Coded Decimal (BCD) Code.
Logic Gates and Boolean Algebra: Basic Postulates and Fundamental Theorems of Boolean Algebra, Switching Equivalent Circuits of Basic Gates, Truth Tables and Symbolic Representation of OR, AND, NOT, NAND, NOR XOR, XNOR Gates, Universal Logic Gates, Circuit Representation using Universal Logic Gates.
Digital Logic Families: Fan-in, Fan-out, Noise Immunity, Noise Margin, Power Dissipation, Figure of Merit, Speed Power Product, TTL and CMOS Families and their Comparison. **[14]**
Combinational Logic Analysis and Design: Standard Representation of Logic Functions (SOP and POS), Karnaugh Map Minimization, Multiplexers and Demultiplexers, Encoder and Decoder, Implementation of Logic Functions with Multiplexer, Binary Adder and Subtractor, Parallel Adder/Subtractor, Comparator, Parity Checker. **[14]**
Sequential Logic Design: Latches and Flip Flops, Registers, Counters (Ripples, Ring, Johnson, Synchronous, Asynchronous and Modulo-N), State Table, State Diagrams, Counter Design using Excitation Table and Equations.
Programmable Logic Devices: Basic Concepts, ROM, PLA, PAL, CPLD, FPGA.
Memory: Memory Technology, Types of Memory, Volatile and Non-Volatile, ROM, PROM, EPROM, EEPROM, Flash Memory, SRAM, DRAM, SDRAM, Concept of Primary, Secondary and Cache Memory. **[14]**
VHDL Programming:
Introduction to VHDL: Brief History of HDL, Structure of HDL Module, Introduction to Simulation and Synthesis Tools, Test Benches. VHDL Modules, Delays, Data Flow Style, Behavioral Style, Structural Style, Mixed Design Style, Simulating Design. Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, Format, VHDL Terms, Hardware in VHDL, Entity, Architectures, Concurrent signal Assignment, Event Scheduling, Statement Concurrency, Structural Designs, Sequential Behavior, Process Statements, Process Declarative Region, Process Statement Region, Process Execution, Sequential Statements, Architecture Selection, Configuration Statements, Power of Configuration.
Behavioral Modeling: Introduction to Behavioral Modeling, Inertial Delay and Model, Transport Delay and Model, Inertial vs Transport 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. **[14]**

Core Course (CC) - 9 Practical
ELT-A-CC-4-9-P: Digital Electronics and VHDL Lab
[Credits: 02; Lecture Hours: 56]

Hardware

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 Half and Full Adder.
4. Design Half and Full Subtractor.
5. Design Seven Segment Display Driver.

6. Design 4 × 1 Multiplexer using Gates.
7. To Build Flip-Flop Circuits (RS, Clocked RS, D-type) using Elementary Gates.
8. Design Counters (Ring, Ripple, Johnson and Mod-N) using D/T/JK Flip-Flop.
9. Design Shift Register and Study Serial and Parallel Shifting of Data.

Experiments in VHDL (Circuit Simulation)

1. Write Code to Realize Basic and Derived Logic Gates.
2. Half Adder and 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 (4×1, 8×1) and Demultiplexer using Logic Gates.
6. Decoder (2×4, 3×8), Encoders and Priority Encoders.
7. Design and Simulation of 4-Bit Adder.
8. Code Converters (Binary to Gray and Vice Versa).
9. 2-bit Magnitude Comparator.
10. 3-bit Ripple Counter.

Reference Books:

- Mano and Cileti, Digital Design: With an Introduction to Verilog HDL, Pearson.
- Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw Hill.
- Flyod, Digital Fundamentals, Pearson.
- Raychaudhuri, Digital Circuits, Vol. 1&2, Platinum.
- Gothmann, Digital Electronics: An Introduction to Theory and Practice, PHI.
- Kumar, Fundamentals of Digital Circuits, PHI.
- Dueck, Digital Design, Cengage.
- Comer, Digital Logic and State Machine Design, Oxford.
- Salivahanan and Kumar, Digital Circuits and Design, Vikas.
- Fletcher, An Engineering Approach to Digital Design, Pearson.
- Wakerly, Digital Design: Principles and Practices, Pearson.
- Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson.
- Pedroni, Circuit Design and Simulation with VHDL, PHI.
- Bhasker, A VHDL Primer, Pearson.

Core Course (CC) - 10 Theory
ELT-A-CC-4-10-TH: Signals and Systems
[Credits: 04; Lecture Hours: 56]

Signals and Systems: Continuous and Discrete Time Signals, Digital Signal, Types of Signals (Deterministic and Nondeterministic, Periodic and Aperiodic, Symmetric and Antisymmetric, Energ and Power, Causal, Noncausal and Anticausal, Single and Multiple Valued Signals), Signals in Time, Spatial and Frequency Domain, Transformation of the Independent Variable, Exponential and Sinusoidal Signals, Impulse and Unit Step Functions, Continuous and Discrete Time Systems and their Classifications, Basic System Properties. **[12]**

Linear Time Invariant Systems (LTI): Discrete and Continuous Time LTI Systems, Properties of LTI Systems, Convolution, 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. **[14]**

Fourier Series: 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.

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. **[16]**

Z-Transform: Introduction to Z-Transform, Region of Convergence, Properties of Z-Transforms, Inverse Z-Transforms, Relation with Laplace and Fourier Transforms, Condition of Stability, Application of Z-Transforms. **[14]**

Core Course (CC) - 10 Practical
ELT-A-CC-4-10-P: Signals and Systems Lab
[Credits: 02; Lecture Hours: 56]

Scilab/MATLAB/Any Other Mathematical Simulation Software

1. Generation of Continuous Time Signals.
2. Generation of Discrete Time Signals.
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.

Reference Books:

- Haykin and Veen, Signals and Systems, Wiley.
- Lathi, Principles of Linear Systems and Signals, Oxford.
- Roberts and Sharma, Fundamentals of Signals and Systems, Tata McGraw Hill.
- Oppenheim, Willsky and Hamid, Signals and Systems, Pearson.
- Anand Kumar, Signals and Systems, PHI.
- Rawat, Signals and Systems, Oxford.
- Ramesh Babu and Anandanatarajan, Signals and Systems, Scitech.
- Nagoor Kani, Signals and Systems, Tata McGraw Hill.
- Iyer, Signals and Systems, Cengage.
- Hsu, Signals and Systems, Schaum's Outline Series, Tata McGraw Hill.
- Young, Signals and Systems with MATLAB, Springer.
- Karris, Signals and Systems with MATLAB Computing and Simulink Modelling, Orchard.

Skill Enhancement Course (SEC) - 2
SEC-2: Group-B (SEC-B) Option-1 (SEC-2-B-1)
ELT-A-SEC-4-B-1-TH: Internet and Java Programming
[Credits: 02; Lecture Hours: 28]

Internet: Introduction, Understanding the Internet, Internet Addressing, Hardware Requirements to Connect to the Internet. **[2]**
Data types, Arrays, Operators, Flow Control: Branching, Looping. Classes, New Operator, Dot Operator, Method Declaration and Calling, Constructors, Inheritance, Super, Method Overriding Final, Finalize, Static, Package and Import Statement, Interface and Implements. **[6]**
Exception Handling: Exception Types, Uncaught and Calling, Nested Try Statements, Java Thread Model, and Thread, Runnable, Thread Priorities, Synchronization, Deadlock. **[8]**
File Handling: Input Stream, Output Stream, and File Stream, Applets Tag, Order of Applet Initialization, Repainting, Sizing Graphics, Abstract Window Tool Kit Components. **[12]**

Reference Books:

- Hahn, The Internet Complete Reference, Tata McGraw Hill.
- Naughton, The Java hand book, Tata McGraw Hill.
- Khurana, Programming with Java, Vikas.

Skill Enhancement Course (SEC) - 2
SEC-2: Group-B (SEC-B) Option-2 (SEC-2-B-2)
ELT-A-SEC-4-B-2-TH: Programming with Matlab/Scilab
[Credits: 02; Lecture Hours: 28]

MATLAB Basics: MATLAB Environment, Basic Computer Programming, Variables and Constants, Operators and Simple Calculations, Formulas and Functions, MATLAB Toolboxes. **[4]**
Matrices and Vectors: Matrix and Linear Algebra Review, Vectors and Matrices in MATLAB, Matrix Operations and Functions in MATLAB. **[6]**

Computer Programming: Algorithms and Structures, MATLAB Scripts and Functions (m-Files), Simple Sequential Algorithms, Control Structures. **[6]**
MATLAB Programming: Reading and Writing Data, File Handling, Personalized Functions, Toolbox Structure, MATLAB Graphic Functions.
Numerical Simulations: Numerical Methods and Simulations, Random Number Generation, Montecarlo Methods. **[12]**

Reference Books:
- Hanselman and Littlefield, Mastering MATLAB, Pearson Education.
- Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, Oxford University Press.
- Bansal, MATLAB and Its Applications in Engineering, Pearson Education.
- Navas and Jayadevan, Lab Primer Through MATLAB, PHI Learning.

Generic Elective (GE) - 4 (Choose 1 Paper from other Subject/Discipline)
[Credits: 06]

THIRD YEAR : FIFTH SEMESTER							
COURSE TYPE	COURSE NAME WITH CODE	MARKS					CREDITS
		Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-11	ELT-A-CC-5-11-TH: Electronic Instrumentation	50		10	10	100	4
	ELT-A-CC-5-11-P: Electronic Instrumentation		30				2
CC-12	ELT-A-CC-5-12-TH: Microprocessors and Microcontrollers	50		10	10	100	4
	ELT-A-CC-5-12-P: Microprocessors and Microcontrollers Lab		30				2
DSE-1	Choose any 1 Paper of the following: Group-A (DSE-A) Option-1 (DSE-1-A-1): ELT-A-DSE-5-A-1-TH: Numerical Techniques ELT-A-DSE-5-A-1-P: Numerical Techniques Lab	50		10	10	100	4
	Group-A (DSE-A) Option-2 (DSE-1-A-2): ELT-A-DSE-5-A-2-TH: Control Systems ELT-A-DSE-5-A-2-P: Control Systems Lab		30				2
DSE-2	Choose any 1 Paper of the following: Group-B (DSE-B) Option-1 (DSE-2-B-1): ELT-A-DSE-5-B-1-TH: Semiconductor Fabrication and Characterization ELT-A-DSE-5-B-1-P: Semiconductor Fabrication and Characterization Lab	50		10	10	100	4/5
	Group-B (DSE-B) Option-2 (DSE-2-B-2): ELT-A-DSE-5-B-2-TH: Power Electronics ELT-A-DSE-5-B-2-P: Power Electronics Lab		30				2/1
					TOTAL	400	24

Core Course - 11 Theory
ELT-A-CC-5-11-TH: Electronic Instrumentation
[Credits: 04; Lecture Hours: 56]

Qualities of Measurement: Specifications of Instruments and 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, Ohm Meter, AC Measurement, Digital Voltmeter (Integrating and Nonintegrating Types) System, Digital Multimeter, Digital Frequency Meter System.
Connectors and Probes: Low Capacitance Probes, High Voltage Probes, Current Probes, Identifying Electronic Connectors, Audio and Video, RF/Coaxial, USB etc. **[14]**
Measurement of Resistance and Impedance: Low Resistance by Kelvin's Double Bridge Method, Medium Resistance by Voltmeter Ammeter Method and Wheatstone Bridge Method, High Resistance by Megger AC 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: Circuit and Working of 4 Bit Binary Weighted Resistor Type and R-2R Ladder Type D-A Conversion, Circuit of A-D Conversion, Characteristics, Successive Approximation ADC, (Mention of Relevant ICs for all). **[14]**
Oscilloscope: CRT, Waveform Display and Electrostatic Focusing, Time Base and Sweep Synchronization, Measurement of Voltage, Frequency and Phase by CRO, Oscilloscope Probes, Block Diagram, Working Principle, Advantages and Applications of Dual Trace Oscilloscope, Sampling Oscilloscope, Digital Storage Oscilloscope and Powerscope, CRO Specifications (Bandwidth, Sensitivity, Rise Time).

Signal Generators: Audio Oscillator, Pulse Generator, Function Generators. **[14]**
Transducers and Sensors: Classification of Transducers, Basic Requirement/Characteristics of Transducers, Active and Passive Transducers, Resistive (Potentiometer, Strain Gauge, Theory, Types, Temperature Compensation and Applications), Capacitive (Variable Area, Variable Air Gap and Permittivity Types), 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). **[14]**

Core Course - 11 Practical
ELT-A-CC-5-11-P: Electronic Instrumentation Lab
[Credits: 02; Lecture Hours: 56]

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. Design and Implementation of Instrumentation Amplifier using 741 Op-Amp.
6. To Determine the Characteristics of Resistance Transducer - Strain Gauge (Measurement of Strain using Half and Full Bridge).
7. To Determine the Characteristics of LVDT.
8. To Determine the Characteristics of Thermistors and RTD.
9. Measurement of Temperature by Thermocouples and Study of Transducers like AD590 (Two Terminal Temperature Sensor), PT-100, J- type, K-type.
10. To Study the Characteristics of LDR, Photodiode, and Phototransistor:
    (a) Variable Illumination; (b) Linear Displacement.
11. Design and Implementation of Temperature Controller.

Reference Books:

- Kalsi, Electronic Instrumentation, Tata McGraw Hill.
- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Nakra and Chaudry, Instrumentation Measurement and Analysis, Tata Mcgraw Hill.
- Doebelin, Measurement Systems: Application and Design, Tata McGraw Hill.
- Patranabis, Principles of Electronic Instrumentation, PHI.
- Carr, Elements of Electronic Instrumentation and Measurement, Pearson.
- Bell, Electronic Instrumentation and Measurements, Oxford.
- Oliver and Cage, Electronic Measurements and Instrumentation, Tata Mcgraw Hill.
- Morris, Measurement and Instrumentation Principles, Elsevier (Buterworth-Heinmann).
- Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai.
- Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata McGraw Hill.
- Ghosh, Introduction to Measurements and Instrumentation, PHI.

Core Course - 12 Theory
ELT-A-CC-5-12-TH: Microprocessors and Microcontrollers
[Credits: 04; Lecture Hours: 56]

Introduction to Microprocessors: 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, Special Purpose Resisters, Stack Pointer, Program Counter, Types of Buses, Multiplexed Address Bus 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, Partial/Full Memory Decoding, DMA.
8085 Instructions: Operation Code, Operand and Mnemonics, Instruction Set of 8085, Instruction Classification, Addressing Modes, Instruction Format, Instruction Classifications, Data Transfer Instructions, Arithmetic Instructions, Increment and Decrement Instructions, Logical Instructions, Branch Instructions and Machine Control Instructions, Assembly Language Programming Examples, 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 8085 Microprocessor, Processing of Vectored and Non-Vectored Interrupts, Latency Time and Response Time, Handling Multiple Interrupts, Interfacing with Programmable Peripheral Interface (PPI) Chip 8255, Interfacing with Analog to Digital Converter (ADC) Chip 0808. **[28]**

Introduction to Microcontrollers: Introduction, Different Types of Microcontrollers, Embedded Microcontrollers, Processor Architectures, Harvard vs. Princeton, CISC vs. RISC Architectures, Microcontroller Memory Types, Microcontroller Features, Clocking, I/O Pins, Interrupts, Timers, Peripherals.
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 (CCP) Module, EUSART, Master Synchronous Serial Port (MSSP) Module, Special Fatures of CPU, Interrupts, Addressing Modes, Instruction Set.
Interfacing to PIC16F887: Interfacing of LED, Switches, Solid State Relay, Seven Segment Display, 16x2 LCD Display, 16×2 LCD Display, 4×4 Matrix Keyboard, Digital to Analog Converter, Stepper Motor and DC Motor, Corresponding Interfacing Programs using C Language. **[28]**

Core Course - 12 Practical
ELT-A-CC-5-12-P: Microprocessors and Microcontrollers Lab
[Credits: 02; Lecture Hours: 56]

Assembly Language Programming:
1. Program to Transfer a Block of Data.
2. Program for Multibyte Addition.
3. Program for Multibyte 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:
1. LED Blinking with a Delay of 1 second.
2. Solid State Relay Interface.
3. Interfacing of LCD (2×16).
4. Interfacing of Stepper Motor and Rotating Stepper Motor by N Steps Clockwise/Anticlockwise with Speed Control.
5. To Test all the Gates of a given IC74XX is Good or Bad.
6. Generate Sine, Square, Sawtooth, Triangular and Staircase Waveform using DAC Interface.
7. Display of 4-Digit Decimal Number using the Multiplexed 7-Segment Display Interface.
8. Analog to Digital Conversion using Internal ADC and Display the Result on LCD.
9. Implementation of DC Voltmeter (0-5V) using Internal ADC and LCD.
10. Digital to Analog Conversion using PWM (Pulse Delay to be Implemented using Timers).
11. Speed Control of DC Motor using PWM (Pulse Delay to be Implemented using Timers).
12. Interfacing of Matrix Keyboard (4×4).
13. Serial Communication between Microcontroller and PC.

Reference Books:

- Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram.
- B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai.
- Mazidi, McKinlay, Mazidi and Das, Microprocessors and Microcontrollers, Pearson.
- Mathur and Panda, Microprocessors and Microcontrollers, PHI.
- Krishna Kant, Microprocessors and Microcontrollers: Architecture, Programming and System Design, PHI.
- Kumar, Saravanan, and Jeevananthan, Microprocessors and Microcontrollers, Oxford.
- Verle, PIC Microcontrollers, MikroElektronika.
- Mazidi, Naimi and Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson.
- Ayala and Gadre, The 8051 Microcontroller and Embedded Systems using Assembly and C, Cengage.
- Causey, McKinlay and Mazidi, PIC Microcontroller and Embedded Systems: Using assembly and C for PIC 18, Pearson.
- Microchip PIC16F87X datasheet.

Discipline Specific Electives (DSE) - 1
DSE-1: Group-A (DSE-A) Option-1 (DSE-1-A-1) Theory
ELT-A-DSE-5-A-1-TH: Numerical Techniques
[Credits: 04; Lecture Hours: 56]

Numerical Methods: Floating Point, Round-Off Error, Error Propagation, Stability, Programming Errors.
Solution of Transcendental and Polynomial Equations: Bisection Method, Secant and Regula Falsi Methods, Newton Raphson Method, Rate of Convergence, General Iteration Methods, Newton's Method for Systems, Method for Complex Roots, Roots of Polynomial Equations. **[16]**
Interpolation and Polynomial Approximations: Taylor Series and Calculation of Functions, Langrange Interpolation, Newton Divided Difference Interpolation (Forward and Backward Difference Formulae), Truncation Errors.
Curve Fitting: Least Square Fitting, Curve Fitting, Interpolation by Spline Functions. **[12]**
Numerical Integration: Trapezoidal Rule, Error Bounds and Estimate for the Trapezoidal Rule, Simpson's Rule, Error of Simpson's Rule.
Numerical Differentiation: Finite Difference Method and Applications to Electrostatic Boundary Value Problems.
Numerical methods for first order differential equations: Euler-Cauchy Method, Heun's Method, Classical Runge Kutta Method of Fourth Order, Methods for System and Higher Order Equations. **[16]**
Numerical Methods in Linear Algebra: Linear Systems Ax=B, Gauss Elimination, Partial Pivoting, LU Factorization, Doolittle's, Crout's and Cholesky's Methods, Matrix Inversion, Gauss-Jordon, Iterative Methods, Gauss-Seidel Iteration, Jacobian iteration.
Matrix Eigenvalue: Power Method. **[12]**

DSE-1: Group-A (DSE-A) Option-1 (DSE-1-A-1) Practical
ELT-A-DSE-5-A-1-P: Numerical Techniques Lab
[Credits: 02; Lecture Hours: 56]

C Language/Scilab/MatLab/Any Other Mathematical Simulation Software
1. Program to Implement Bisection Method.
2. Program to Implement Secant Method.
3. Program to Implement Regula Falsi Method.
4. Program to Implement Newton Raphson Method.
5. Program to Implement Trapezoidal Rule.
6. Program to Implement Simpson's Rule.
7. Program to Implement Runge Kutta Method.
8. Program to Implement Euler-Cauchy Method.
9. Program to Implement Gauss-Jordon Method.
10. Program to Implement Gauss-Seidel Iteration.
11. Program to Implement Newton Forward/Backward Interpolation.
12. Program to Implement Lagrange's Interpolation.

Reference Books:

- Kreyszig, Advanced Engineering Mathematics, Wiley.
- Dey and Gupta, Numerical Methods, Tata McGraw Hill.
- Balagurusamy, Numerical Methods, Tata McGraw Hill.
- Rajaraman, Computer Oriented Numerical Methods, PHI.
- Sastry, Introductory Methods of Numerical Analysis, PHI.
- Jain, Iyengar and Jain, Numerical Methods (Problems and Solutions), New Age.
- Grewal, Numerical Methods in Engineering and Science with Programs in C, C++ & MATLAB, Khanna.
- Thangaraj, Computer-Oriented Numerical Methods, PHI.

DSE-1: Group-A (DSE-A) Option-2 (DSE-1-A-2) Theory
ELT-A-DSE-5-A-2-TH: Control Systems
[Credits: 04; Lecture Hours: 56]

Introduction to Control Systems: Open Loop and Closed Loop Control Systems, Mathematical Modeling of Physical Systems (Electrical, Mechanical and Thermal), Derivation of Transfer Function, Block Diagram Representation and Signal Flow Graph, Reduction Technique, Mason's Gain Formula, Effect of Feedback on Control Systems. **[12]**

Time Domain Analysis: Time Domain Performance Criteria, Transient Response of First, Second and Higher Order Systems, Steady State Errors and Static Error Constants, Performance Indices.
Concept of Stability: Asymptotic Stability and Conditional Stability, Routh-Hurwitz Criterion, Relative Stability Analysis, Root Locus Plots and their Applications. **[14]**
Frequency Domain Analysis: Correlation between Time and Frequency Response, Polar and Inverse Polar Plots, Frequency Domain Specifications, Logarithmic Plots (Bode Plots), Gain and Phase Margins, Nyquist Stability Criterion, Relative Stability using Nyquist Criterion, Constant M and N Circles. **[16]**
State Space Analysis: Definitions of State, State Variables, State Space, Representation of Systems, Solution of Time Invariant, Homogeneous State Equation, State Transition Matrix and its Properties.
Controllers and Compensation Techniques: Response with P, PI and PID Controllers, Concept of Compensation, Lag, Lead and Lag-Lead Networks. **[14]**

DSE-1: Group-A (DSE-A) Option-2 (DSE-1-A-2) Practical
ELT-A-DSE-5-A-2-P: Control Systems Lab
[Credits: 02; Lecture Hours: 56]

Implementation using Hardware and Scilab/MATLAB/Any Other Circuit Simulation Software
1. To Study Characteristics of:
   (a) Synchro Transmitter Receiver; (b) Synchro as Error Detector.
2. To Study Position Control of DC Motor.
3. To Study Speed Control of DC Motor.
4. To Find Characteristics of AC Servo Motor.
5. To Study Time Response of Type 0, 1 and 2 Systems.
6. To Study Frequency Response of First and Second Order Systems.
7. To Study Time Response Characteristics of Second Order System.
8. To Study Effect of Damping Factor on Performance of Second Order System.
9. To Study Frequency Response of Lead and Lag Networks.
10. Study of P, PI and PID Controller.

Reference Books:

- Nagrath and Gopal, Control System Engineering, New Age.
- Ogata, Modern Control Engineering, Pearson.
- Golnaraghi and Kuo, Automatic Control System, Wiley.
- Nise Control System Engineering, Wiley.
- Anand Kumar, Control Systems, PHI.
- Distefano, Stubberud, Williams and Mandal, Control Systems, Schaum's Outline Series, Tata McGraw Hill.
- Wolovich, Automatic Control Systems: Basic Analysis and Design, Oxford.
- Venkatesh and Rao, Control Systems, Cengage.

Discipline Specific Electives (DSE) - 2
DSE-2: Group-B (DSE-B) Option-1 (DSE-2-B-1) Theory
ELT-A-DSE-5-B-1-TH: Semiconductor Fabrication and Characterization
[Credits: 04; Lecture Hours: 56]

Introduction of Semiconductor Process Technology (Line width - 10 nm Technology), Semiconductor Materials, Single Crystal, Polycrystalline and Amorphous, Crystal Growth Techniques, Czochralski Technique, Distribution of Dopants, Effective Segregation Coefficient, Float Zone Process, Bridgman Technique, Wafer Preparation.
Epitaxy Deposition: Epitaxial Growth by Vapor Phase Epitaxy (VPE) and Molecular Beam Epitaxy (MBE).
Characterization: Various Characterization Methods for Structural, Electrical and Optical Properties, Basic Idea of X-Ray Diffractometer (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM) and UV-VIS-NIR Spectrophotometer (Atomic Force Microscopy (AFM)). **[18]**
Oxidation: Thermal Oxidation Process, Kinetics of Growth for Thick and Thin Oxide, Dry and Wet Oxidation, Effects of High Pressure and Impurities, Impurity Redistribution during Oxidation, Masking Property of Silicon Oxide, Chemical Vapour Deposition of Silicon Oxide, Properties of Silicon Oxide, Step Coverage, P-Glass Flow.
Diffusion: Basic Diffusion Process, Diffusion Equation, Diffusion Profiles, Extrinsic Diffusion Concentration Dependent Diffusivity, Lateral Diffusion, Doping through Ion Implantation and its Comparison with Diffusion. **[14]**

Lithographic Processes: Clean Room, Optical Lithography, Exposure Tools, Masks, Photoresist, Pattern Transfer, Resolution Enhancement Techniques, Electron Beam Lithography, X-Ray Lithography and Ion Beam Lithography, Comparison between Various Lithographic Techniques.
Etching: Wet Chemical Etching, Basic Process and Examples of Etchants for Semiconductors, Insulators and Conductors, Dry Etching using Plasma Etching Technique, Lambda Rule, Scaling Rules.
Metallization: Uses of Physical Vapor Deposition and Chemical Vapor Deposition Technique for Aluminum and Copper Metallization. **[14]**
Process Integration: Passive Components, Integrated Circuit Resistor, Integrated Circuit Inductor, Integrated Circuit Capacitor, Bipolar Technology, Basic Fabrication Process, Isolation Techniques, MOSFET Technology, Basic Fabrication Process of NMOS, PMOS and CMOS Technology. **[10]**

DSE-2: Group-B (DSE-B) Option-1 (DSE-2-B-1) Practical
ELT-A-DSE-5-B-1-P: Semiconductor Fabrication and Characterization Lab
[Credits: 02; Lecture Hours: 56]

1. To Measure the Resistivity of Semiconductor Crystal with Temperature by Four-Probe Method.
2. To Determine the Type (n or p) and Mobility of Semiconductor Material using Hall-Effect.
3. Oxidation Process Simulation.
4. Diffusion Process Simulation.
5. Process Integration Simulation.
6. Fabrication of Thin Film using Spin Coating System.
7. Crystallographic Analysis and Particle Size Determination by X-Ray Diffraction (XRD) (of the given XRD Spectra). Introduction to JCPDS Card.
8. Determination of Optical Bandgap through Transmission Spectra from Published Literature.

Reference Books:
- May and Sze, Fundamentals of Semiconductor Fabrication, Wiley.
- Eckertova, Physics of Thin Films, Springer.
- Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, Wiley.
- Sze, Semiconductor Devices: Physics and Technology, Wiley.
- Bose, IC Fabrication Technology, Tata McGraw Hill.
- Plummer, Deal and Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modeling, Pearson.
- Weste and Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Pearson.
- Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford.

DSE-2: Group-B (DSE-B) Option-2 (DSE-2-B-2) Theory
ELT-A-DSE-5-B-2-TH: Power Electronics
[Credits: 04; Lecture Hours: 56]

Power Devices: Need for Semiconductor Power Devices, Power Diodes, Enhancement of Reverse Blocking Capacity, Introduction to Family of Thyristors.
Silicon Controlled Rectifier (SCR): Structure, Two Transistor Analogy, I-V Characteristics, Turn-On and Turn-Off Characteristics, Ratings, Factors affecting the Characteristics/Ratings of SCR, Gate-Triggering Circuits, dv/dt Triggering Circuits, Control Circuits Design and Protection Circuits, Snubber Circuit. **[12]**
Diac and Triac: Basic Structure, Working and V-I Characteristics, Application of Diac as Triggering Device for 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 Static Switch, Phase Controlled Rectification, Single Phase Half Wave, Full Wave and Bridge Rectifiers with Inductive and Non-Inductive Loads, AC Voltage Control using SCR and Triac as Switch.
Power MOSFETs: Operation Modes, Switching Characteristics, Power BJT, Second Breakdown, Saturation and Quasi-Saturation State. **[12]**
Power Inverters: Need for Commutating Circuits and their Various Types, DC Link Inverters, Parallel Capacitor Commutated Invertors with and without Reactive Feedback and its Analysis, Series Inverter, Limitations and its Improved Versions, Bridge Inverters.
Choppers: Basic Chopper Circuit, Types of Choppers (Type A-D), Step-Down and Step-Up Choppers, Operation of DC Chopper Circuits using Self-Commutation (A-Type and 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.

Regulators and Converters: Basics, Series, Shunt, Buck, Boost, Buck-Boost, Cuk. **[18]**
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 anS speed of Induction Motor, Thyristor Control of AC Motors(Block Diagrams only). **[14]**

DSE-2: Group-B (DSE-B) Option-2 (DSE-B-2) Practical
ELT-A-DSE-5-B-2-P: Power Electronics Lab
[Credits: 02; Lecture Hours: 56]

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. V-I Characteristic of MOSFET and IGBT (Both).
11. Study of Chopper Circuits.

Reference Books:

- Sen, Power Electronics, Tata McGraw Hill.
- Datta, Power Electronics and Controls, Reston/Prentice Hall.
- Singh and Khanchandani, Power Electronics, Tata McGraw Hill.
- Rashid, Power Electronics: Circuits, Devices and Applications, Pearson.
- Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, Wiley.
- Hari Babu, Power Electronics, Scitech.
- Asghar, Power Electronics, PHI.
- Moorthi, Power Electronics, Oxford.
- Thareja and Thareja, A Textbook of Electrical Technology, Vol. II, S. Chand.

THIRD YEAR : SIXTH SEMESTER							
COURSE TYPE	COURSE NAME WITH CODE	MARKS					CREDITS
		Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-13	Communication Electronics (ELT-A-CC-6-13-TH)	50		10	10	100	4
	Communication Electronics Lab (ELT-A-CC-6-13-TP)		30				2
CC-14	Photonics (ELT-A-CC-6-14-TH)	50		10	10	100	4
	Photonics Lab (ELT-A-CC-6-14-P)		30				2
DSE-3	Choose any 1 Paper of the following: Group-A (DSE-A) Option-1 (DSE-3-A-1): ELT-A-DSE-6-A-1-TH: Basic VLSI Design ELT-A-DSE-6-A-1-P: Basic VLSI Design Lab	50		10	10	100	4
	Group-A (DSE-A) Option-2 (DSE-3-A-2): ELT-A-DSE-6-A-2-TH: Digital Signal Processing ELT-A-DSE-6-A-2-P: Digital Signal Processing Lab		30				2
DSE-4	Choose any 1 Paper of the following: Group-B (DSE-B) Option-1 (DSE-4-B-1): ELT-A-DSE-6-B-1-TH: Biomedical Instrumentation ELT-A-DSE-6-B-1-P: Biomedical Instrumentation Lab	50		10	10	100	4/5
	Group-B (DSE-B) Option-2 (DSE-4-B-2): ELT-A-DSE-6-B-2-TH: Transmission Lines, Antenna and Microwave Devices ELT-A-DSE-6-B-2-P:Transmission Lines, Antenna and Microwave Devices Lab		30				2/1
					TOTAL	400	24

Core Course - 13 Theory
ELT-A-CC-6-13-TH: Communication Electronics
[Credits: 04; Lecture Hours: 56]

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, Friis Transmission Equation. **[14]**

Amplitude Modulation: Amplitude Modulation, Modulation Index and Frequency Spectrum, Generation of AM (Linear and Non Linear Methods), Amplitude Demodulation (Diode Detector), Concept of Double Side Band Suppressed Carrier (DSBC), Single Side Band Suppressed Carrier (SSBC) (Chopper, Balanced Modulation), Pilot Carrier Amplitude Modulation, Vestigial Side Band (VSB) Modulation, Independent Side Band Modulation, Block Diagram of AM Transmitter and Receiver (Super Heterodyne Receiver, Advantages over TRF, utility of Heterodyning, Different Stages). **[14]**

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. **[10]**

Pulse Analog Modulation: Channel Capacity, Sampling Theorem, PAM, PDM, PPM Modulation and Detection Techniques, Multiplexing, TDM and FDM. **[5]**

Pulse Code Modulation: Need for Digital Transmission, Quantizing, Uniform and Non-Uniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration. **5]**

Digital Carrier Modulation Techniques: Block Diagram of Digital Transmission and Reception, Information Capacity, Bit Rate, Baud Rate and M-Array Coding, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). **[8]**

Core Course - 13 Practical
ELT-A-CC-6-13-P: Communication Electronics Lab
[Credits: 02; Lecture Hours: 56]

Hardware and Circuit Simulation Software

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. Study of Pulse Width Modulation.
7. Study of Pulse Position Modulation.
8. Study of Pulse Code Modulation.
9. Study of Amplitude Shift Keying.
10. Study of Phase Shift Keying.
11. Study of Frequency Shift Keying.

Reference Books:

- Kennedy, Electronic Communication Systems, Tata McGraw Hill.
- Roddy and Coolen, Electronic Communications, Pearson.
- Haykin, Communication Systems, Wiley.
- Lathi and Ding, Modern Digital and Analog Communication Systems, Oxford.
- Blake, Electronic Communication Systems, Cengage.
- Frenzel, Principles of Electronic Communication Systems, Tata McGraw Hill.
- Tomasi, Advanced Electronic Communications Systems, Pearson.
- Kundu, Analog and Digital Communications, Pearson.
- Couch, Digital and Analog Communication Systems, Pearson.

Core Course - 14 Theory
ELT-A-CC-6-14-TH: Photonics
[Credits: 04; Lecture Hours: 56]

Light as Electromagnetic Wave: Plane Waves in Homogeneous Media, Concept of Spherical Waves, Reflection and Transmission at an Interface, Total Internal Reflection, Brewster's Law, Stoke's Law, Interaction of Electromagnetic Waves with Dielectrics, Origin of Refractive Index, Dispersion.

Interference: Superposition of Waves of Same Frequency, Concept of Coherence, Interference using Division of Wavefront and Division of Amplitude, Young's Double Slit, Thin Film Interference, Anti-Reflecting Films, Newton's Rings, Michelson Interferometer, Holography.

Diffraction: Huygen's Principle, Diffraction Integral, Fresnel and Fraunhoffer Approximations, Fraunhoffer Diffraction by Single Slit, Rectangular Aperture, Double Slit, Rayleigh Criterion of Limit of Resolution, Resolving Power of Microscopes and Telescopes, Diffraction Grating, Resolving Power and Dispersive Power. **[14]**

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. **[12]**
Light Emitting Diodes: Construction, Materials, Operation, Concept of Quantum Efficiency.
Lasers: Interaction of Radiation and Matter, Einstein Coefficients, Condition for Amplification, Laser Cavity, Threshold for Laser Oscillation, Line Shape Function, Examples of Common Lasers, Semiconductor Injection Laser Diode. **[8]**
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. **[10]**
Guided Waves and Optical Fiber: TE and TM Modes in Symmetric Slab Waveguides, Effective Refractive Index, Field Distributions, Dispersion Relation and Group Velocity, Step Index Optical Fiber, Total Internal Reflection, Concept of Linearly Polarized Waves in Step Index Circular Dielectric Waveguides, Single Mode and Multimode Fibers, Attenuation and Dispersion in Optical Fiber, Basic Idea of OEIC (Optoelectronic Communication System). **[12]**

Core Course - 14 Practical
ELT-A-CC-6-14-P: Photonics Lab
[Credits: 02; Lecture Hours: 56]

1. To Determine Wavelength of Sodium Light using Newton's Rings.
2. To Determine the Resolving Power and Dispersive Power of Diffraction Grating.
3. Diffraction Experiments using a Laser.
4. To Determine the Specific Rotation of Scan Sugar using Polarimeter.
5. To Determine Characteristics of LEDs and Photo-Detector.
6. To Measure the Numerical Aperture of an Optical Fiber.

Reference Books:

- Ghatak, Optics, Tata McGraw Hill.
- Hecht, Optics, Pearson.
- Wilson and Hawkes, Optoelectronics: An Introduction, Pearson.
- Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson.
- Ghatak and Thyagarajan, An Introduction to Fiber Optics, Cambridge.
- Khare, Fiber Optics and Optoelectronics, Oxford.
- Roy, Advanced Optical Fiber Communications, Scitech.

Discipline Specific Electives (DSE) - 3
DSE-3: Group-A (DSE-A) Option-1 (DSE-3-A-1) Theory
ELT-A-DSE-6-A-1-TH: Basic VLSI Design
[Credits: 04; Lecture Hours: 56]

Metal Oxide Semiconductor (MOS): Introduction to Basic Principle of MOS Transistor, Large Signal MOS Models (Long Channel) for Digital Design, MOS SPICE Model, MOS Device Layout, Transistor Layout, Inverter Layout, CMOS Digital Circuit Layout, Effects of Scaling on MOS behavior. **[16]**
MOS Inverter: Inverter Principle, Depletion and Enhancement Load Inverters, Basic CMOS Inverter, Transfer Characteristics, Logic Threshold, Noise Margins, Dynamic behavior, Propagation Delay and Power Consumption. **[14]**
Combinational MOS Logic Design: Static MOS Design, Pass Transistor Logic, Complex Logic Circuits, Sequential MOS Logic Design, Static Latches, Flip Flops and Registers, Dynamic Latches and Registers, CMOS Schmitt Trigger, Monostable Sequential Circuits, Astable Circuits, Concept of BICMOS. **[14]**
Memory Design: ROM and RAM Cells Design, Dynamic MOS Design, Dynamic Logic Families and Performances, Interconnect and Clock Distribution, Interconnect Delays, Cross Talks, Clock Distribution. **[12]**

DSE-3: Group-A (DSE-A): Option-1 (DSE-3-A-1) Practical
ELT-A-DSE-6-A-1-P: Basic VLSI Design Lab
[Credits: 02; Lecture Hours: 56]

Implementation using Hardware and/or any Circuit Simulation Software
1. To Plot the Output Characteristics and Transfer Characteristics of n-Channel and p-Channel MOSFET.
2. To Design and Plot the Static (VTC) and Dynamic Characteristics of Digital CMOS Inverter.

3. To Design and Plot the Output Characteristics of 3-Inverter Ring Oscillator.
4. To Design and Plot the Dynamic Characteristics of 2-Input NAND, NOR, XOR and XNOR Logic Gates using CMOS Technology.
5. To Design and Plot the Characteristics of a 4×1 Digital Multiplexer using Pass Transistor Logic.
6. To Design and Plot the Characteristics of a Positive and Negative Latch Based on Multiplexers.
7. To Design and Plot the Characteristics of a Master-Slave Positive and Negative Edge Triggered registers Based on Multiplexers.

Reference Books
- Kang, eblebici and Kim, CMOS Digital Integrated Circuit: Analysis and Design, Tata McGraw Hill.
- Rabey, Chandrakasan and Nikolic, Digital Integrated Circuits: A Design perspective, Pearson.
- Weste and Eshraghian, Principles of CMOS VLSI Design: A System Perspective, Addison Wesley.
- Pucknell and Eshraghian, Basic VLSI Design, PHI.
- Das, VLSI Design, Oxford.
- Martin, Digital Integrated Circuit Design, Oxford.

DSE-3: Group-A (DSE-A) Option-2 (DSE-3-A-2) Theory
ELT-A-DSE-6-A-2-TH: Digital Signal Processing
[Credits: 04; Lecture Hours: 56]

Discrete Time Systems: Discrete Sequences, Linear Coefficient Difference Equation, Representation of DTS, LSI Systems. Stability and Causality, Frequency Domain Representations and Fourier Transform of DT Sequences. **[12]**
Network Synthesis: Concept and Properties of Pole-Zero, Synthesis of Two Terminal Reactive Networks, Foster's Reactance tTeorem, Network Realization of Reactance Function, Canonic Networks, Continued Fraction Networks (Cauer Networks), Synthesis of Two Terminal R-C and R-L Networks, Positive Real Functions, Numericals. **[12]**
Discrete Fourier Transform: DFT Assumptions and Inverse DFT, Matrix Relations, Relationship with FT and its Inverse, Circular Convolution, DFT Theorems, DCT, Computation of DFT, FFT Algorithms and Processing Gain, Discrimination, Interpolation and Extrapolation, Gibbs Phenomena, FFT of Real Functions Interleaving and Resolution Improvement, Word Length Effects. **[16]**
Digital Filters: Analog Filter Review, Concept of Filters in Signal Processing, Filter Parameters, Concept of LP, HP, BP, Notch Filters, Types of Filters, Butterworth and Chebyshev, System Function for IIR and FIR Filters, Network Representation, Canonical and Decomposition Networks, IIR Filter Realization Methods and their Limitations, FIR Filter Realization Techniques, Discrete Correlation and Convolution, Properties and Limitations. **[16]**

DSE-3: Group-A (DSE-A) Option-2 (DSE-3-A-2) Practical
ELT-A-DSE-6-A-2-P: Digital Signal Processing Lab
[Credits: 02; Lecture Hours: 56]

Implementation using Scilab/MATLAB/Any Other Mathematical Simulation Software
1. Generation of Unit Sample Sequence, Unit Step, Ramp Function, Discrete Time Sequence, Real Sinusoidal Sequence.
2. Generate and Plot Sequences over an Interval.
3. Given x[n], Write Program to Find X[z].
4. Fourier Transform, Discrete Fourier Transform and Fast Fourier Transform.
5. Design of a Butterworth Analog Filter for Low Pass and High Pass.
6. Design of Digital Filters.

Reference Books:
- Oppenheim and Schafer, Discrete Time Signal Processing, Pearson.
- Salivahanan, Digital Signal Processing, Tata McGraw Hill.
- Proakis and Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson.
- Nagoor Kani, Digital Signal Processing, Tata McGraw Hill.
- Chen, Digital Signal Processing, Oxford.
- Kumar, Digital Signal Processing, PHI.
- Ramesh Babu, Di
- gital Signal Processing, Scitech.
- Singh, Digital Signal Processing Implementations, Cengage.
- Udayashankara, Modern Digital Signal Processing: Includes Signals and Systems and Digital Signal Processing with MATLAB Programs, DSP Architecture with Assembly and C Programs, PHI Learning.

Discipline Specific Electives (DSE) - 4
DES-4: Group-B (DSE-B) Option-1 (DSE-4-B-1) Theory
ELT-A-DSE-6-B-1-TH: Biomedical Instrumentation
[Credits: 04; Lecture Hours: 56]

Biomedical Signals and Physiological Transducers: Source of Biomedical Signal, Origin of Bioelectric Signals, Recording Electrodes, Electrodes for ECG, EMG and EEG, Physiological Transducers, Pressure, Temperature, Photoelectric and Ultrasound Transducers, Measurement in Respiratory System, Physiology of Respiratory System, Measurement of Breathing mechanics, Spiro meter, Respiratory Therapy Equipments, Inhalators, Ventilators, Respirators, Humidifiers, Nebulizers, Aspirators, Biomedical Recorders, ECG, EEG and EMG, MEMS Based Biosensors. **[16]**
Patient Monitoring Systems and Audiometers: Cardiac Monitor, Bedside Patient Monitor, Measurement of Heart Rate, Blood Pressure, Temperature, Respiration Rate, Arrhythmia Monitor, Methods of Monitoring Fatal Heart Rate, Monitoring Labor Activity, Audiometers, Blood Cell Counters, Oximeter, Blood Flow Meter, Cardiac Output Measurement, Blood Gas Analyzers. **[14]**
Modern Imaging Systems: Introduction, Basic Principle and Block Diagram of X-Ray Machine, X-Ray Computed Tomography (CT), Magnetic Resonance Imaging (MRI) System, Ultrasonic Imaging System, Eco-Cardiograph, Eco Encephalography, Ophthalmic Scans, Therapeutic Equipments, Cardiac Pacemakers, Cardiac Defibrillators, Hemodialysis Machine, Surgical Diathermy Machine. **[16]**
Patients Safety and Computer Applications in Biomedical Field: Electric Shock Hazards and Precautions to Minimize them, Effects of Electric Current on Human Body, Leakage Current Shocks and Precautions to Minimize them, Safety Codes for Electro Medical Equipment, Electric Safety Analyzer, Testing of Biomedical Equipment, Use of Microprocessors in Medical Instruments, Microcontrollers, PC Based Medical Instruments, Computerized Critical Care Units, Planning and Designing a Computerized Critical Care Unit.
Physiotherapy: Software Diathermy, Microwave Diathermy, Ultrasound Therapy Unit, Electrotherapy Equipments, Ventilators. **[10]**

DSE-4: Group-B (DSE-B) Option-1 (DSE-4-B-1) Practical
ELT-A-DSE-6-B-1-P: Biomedical Instrumentation Lab
[Credits: 02; Lecture Hours: 56]

1. Characterization of Bio Potential Amplifier for ECG Signals.
2. Study on ECG Simulator.
3. Measurement of Heart Sound using Electronic Stethoscope. Study on ECG Heart Rate Monitor/Simulator.
4. Study of Pulse Rate Monitor with Alarm System.
5. Determination Pulmonary Function using Spirometer (using Mechanical System).
6. Measurement of Respiration Rate using Thermistor/Other Electrodes.
7. Study of Respiration Rate Monitor/Apnea Monitor.
8. Study on Ultrasound Transducers Based on Medical System.
9. Study of Pacemaker.
10. Measurement of Pulse Rate using Photoelectric Transducer and Pulse Counting for known Period.

Reference Books:

- Carr and Brown, Introduction to Biomedical Equipment Technology, Pearson.
- Chatterjee, Biomedical Instrumentation System, Cengage.
- Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill.
- Natarajan, Biomedical Instrumentation and Measurements, PHI.
- Jacobson and Webster, Medicine and Clinical Engineering, Prentice Hall.
- Venkata Ram, Biomedical Electronics and Instrumentation, Galgotia.
- Webster, Medical Instrumentation: Application and Design, Wiley.
- Cromwell, Biomedical Instrumentation and Measurements, Pearson.

DSE-4: Group-B (DSE-B) Option-2 (DSE-4-B-2) Theory
ELT-A-DSE-6-B-2-TH: Transmission Lines, Antenna and Microwave Devices
[Credits: 04; Lecture Hours: 56]

Transmission Lines: Typical Transmission Lines, Co-Axial, Two Wire, Microstrip, Coplanar and Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave Propagation in Transmission Lines, Characteristics Impedance, Propagation Constant, Lowloss and Lossless and Distortionless Line, Input

Impedance, Reflection Coefficient, Standing Wave and Standing Wave Ratio, Power and Lossy Lines, Short-Circuited and Open-Circuited Line, Matched Line, Smith Chart, Transmission Line Applications. **[12]**

Guided Waves and Waveguides: Wave Propagation between Parallel Conducting Planes, TEM, TE and TM Modes, Rectangular Waveguides, Circular Waveguides, Power Transmission and Attenuation, Rectangular Cavity Resonators, Directional Couplers, Isolator, Circulator. **[10]**

Antenna Fundamentals and Parameters: Concept of Retarded Potentials, Antenna Radiation Mechanism, Current Distribution on a Thin Wire Antenna, Input Impedance, Radiation Resistance, Radiation Pattern (Field, Power and Phase Patterns), Radiation Power Density, Radiation Intensity, Directive Gain, Directivity, Power Gain, Antenna Efficiency, Beamwidth, Bandwidth, Beam Efficiency, Effective Height, Effective Aperture, Aperture Efficiency, Polarization, Antenna Noise Temperature and Noise Figure.

Antenna as Transmitter/Receiver: Radiation from Elementary Dipole (Hertzian Dipole), Field Regions around Antenna (Radiation, Induction and Electrostatic Fields), Radiation Field of Half Wave Dipole, and their Radiation Resistance.

Types of Antennas (Qualitative Study Only): Monopole, Dipole, Folded Dipole, Loop, Helical, Rhombic, Yagi-Uda, Log Periodic, Horn, Parabolic Reflector, Antenna Array, Microstrip Antenna. **[18]**

Propagation of Radio Waves: Different Modes of Propagation, Ground Wave, Space Wave, Radio Horizons, Sky Wave, Structure of Ionosphere, Critical Frequency, Maximum Usable Frequency (MUF), Skip Distance, Virtual Height, Duct Propagation. **[6]**

Microwave Devices (Qualitative Study Only): Microwave Domains, Two-Cavity Klystron, Reflex Klystron, Travelling Wave Tube (TWT), Magnetron, Transferred Electron Mechanism and Gunn Diode, Avalanche Transit Time Mechanism and IMPATT Diode, Tunnel Diode. **[10]**

DSE-4: Group-B (DSE-B) Option-2 (DSE-4-B-2) Practical
ELT-A-DSE-6-B-2-P: Transmission Lines, Antenna and Microwave Devices Lab
[Credits: 02; Lecture Hours: 56]

Implementation with Hardware and/or SciLab/MATLAB/Any Other Mathematical Simulation Software

1. Program to Determine the Phasor of Forward Propagating Field.
2. Program to Determine the Instantaneous Field of 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 Function of Time and Position in Loss Less Transmission Line.
6. Program to Find the Characteristic Impedance, Phase Constant and Phase Velocity.
7. Program to Find the Output Power and Attenuation Coefficient.
8. Program to Find the Power Dissipated in Lossless Transmission Line.
9. Program to Find the Total Loss in Lossy Lines.
10. Program to Find the Load Impedance of Slotted Line.
11. Program to Find the Input Impedance of Transmission Line Terminated with Pure Capacitive Impedance.
12. Program to Determine the Operating Range of Frequency for TE_{10} Mode of Air-Filled Rectangula Waveguide.
13. Program to Determine Directivity, Bandwidth, Beamwidth of Antenna.
14. Program to Determine Diameter of Parabolic Reflector.
15. Program to Find Minimum Distance between Primary and SecondAry antenna.
16. Simple Problems using Smith Chart.

Reference Books:

- Sadiku, Principles of Electromagnetics, Oxford.
- Hayt and Buck, Engineering Electromagnetics, Tata McGraw Hill.
- J. A. Edminster, Electromagnetics, Schaum's Outline Series, Tata McGraw Hill.
- Rao, Elements of Engineering, Electromagnetics, Pearson.
- Ballanis, Antenna Theory: Analysis and Design, Wiley.
- Yadava, Antenna and Wave Propagation, PHI.
- Harish and Sachidananda, Antennas and Wave Propagation, Oxford.
- Raju, Antennas and Wave Propagation, Pearson.
- Liao, Microwave Devices, Pearson.
- Das and Das, Microwave Engineering, Tata McGraw Hill.
- Raghuvanshi, Microwave Engineering, Cengage.
- Das, Microwave Engineering, Oxford.
- Lonngren, Savov and Jost, Fundamentals of Electromagnetics with MATLAB, SciTech.

Syllabus

for

Electronics (UG-General)

Under CBCS

SEMERTER WISE SCHEDULE FOR B.Sc. (GENERAL) ELECTRONICS						
Year	**Semester**	**Course Type/Opted**		**Course Name**	**Credits**	**Marks**
1st Year	1st	CC-1A	Core Course-1 Theory	Network Analysis and Analog Electronics	4	100
			Core Course-1 Practical	Network Analysis and Analog Electronics Lab	2	
		CC-2A	Core Course-2 Theory	Subject/Discipline-2 (other than Electronics)	4/5	100
			Core Course-2 Practical/Tutorial		2/1	
		CC-3A	Core Course-3 Theory	Subject/Discipline-3 (other than Electronics)	4/5	100
			Core Course-3 Practical/Tutorial		2/1	
		AECC-1	Ability Enhancement Compulsory Course-1	Communicative English/MIL	2	100
				Semester Total	**20**	**400**
	2nd	CC-1B	Core Course-4 Theory	Linear and Digital Integrated Circuits	4	100
			Core Course-4 Practical	Linear and Digital Integrated Circuits Lab	2	
		CC-2B	Core Course-5 Theory	Subject/Discipline-2 (other than Electronics)	4/5	100
			Core Course-5 Practical/Tutorial		2/1	
		CC-3B	Core Course -6 Theory	Subject/Discipline-3 (other than Electronics)	4/5	100
			Core Course -6 Practical/Tutorial		2/1	
		AECC-2	Ability Enhancement Compulsory Course-2	Environmental Studies	2	100
				Semester Total	**20**	**400**
2nd Year	3rd	CC-1C	Core Course-7 Theory	Communication Electronics	4	100
			Core Course-7 Practical	Communication Electronics Lab	2	
		CC-2C	Core Course-8 Theory	Subject/Discipline-2 (other than Electronics)	4/5	100
			Core Course-8 Practical/Tutorial		2/1	
		CC-3C	Core Course-9 Theory	Subject/Discipline-3 (other than Electronics)	4/5	100
			Core Course-9 Practical/Tutorial		2/1	
		SEC-A	Skill Enhancement Course-1		2	100
				Semester Total	**20**	**400**
	4th	CC-1D	Core Course-10 Theory	Microprocessors and Microcontrollers	4	100
			Core Course-10 Practical	Microprocessors and Microcontrollers Lab	2	
		CC-2D	Core Course-11 Theory	Subject/Discipline-2 (other than Electronics)	4/5	100
			Core Course-11 Practical/Tutorial		2/1	
		CC-3D	Core Course-12 Theory	Subject/Discipline-3 (other than Electronics)	4/5	100
			Core Course-12 Practical/Tutorial		2/1	
		SEC-B	Skill Enhancement Course-2		2	100
				Semester Total	**20**	**400**
3rd Year	5th	DSE-1A	Discipline Specific Elective-1 Theory	DSE-1A	4	100
			Discipline Specific Elective-1 Practical	DSE-1A Lab	2	
		DSE-2A	Discipline Specific Elective -2 Theory	Subject/Discipline-2 (other than Electronics)	4/5	100
			Discipline Specific Elective-2 Practical/Tutorial		2/1	
		DSE-3A	Discipline Specific Elective -3 Theory	Subject/Discipline-3 (other than Electronics)	4/5	100
			Discipline Specific Elective-3 Practical/Tutorial		2/1	
		SEC-A	Skill Enhancement Course-3		2	100
				Semester Total	**20**	**400**
	6th	DSE-1B	Discipline Specific Elective-4 Theory	DSE-1B	4	100
			Discipline Specific Elective-4 Practical	DSE-1B Lab/Tutorial	2	
		DSE-2B	Discipline Specific Elective -5 Theory	Subject/Discipline-2 (other than Electronics)	4/5	100
			Discipline Specific Elective-5 Practical/Tutorial		2/1	
		DSE-3B	Discipline Specific Elective -3 Theory	Subject/Discipline-3 (other than Electronics)	4/5	100
			Discipline Specific Elective-3 Practical/Tutorial		2/1	
		SEC-B	Skill Enhancement Course-4	SEC-4	2	100
				Semester Total	**20**	**400**
				Grand Total	**120**	**2400**

B.Sc. (GENERAL) ELECTRONICS

Core Course (CC): (Credits: 6 each) – CC 1-4 / Generic Elective (GE): (Credits: 6 each) – GE 1-4
(Honours Students of other Subjects/Disciplines than Electronics have to choose any 2 Papers of the following as GE)

CC-1A / GE-1: Network Analysis and Analog Electronics (ELT-G-CC-1-1-TH/P) / (ELT-A-GE-1-1-TH/P)
CC-2A / GE-2: Linear and Digital Integrated Circuits (ELT-G-CC-2-2-TH/P) / (ELT-A-GE-2-2-TH/P)
CC-3A / GE-3: Communication Electronics (ELT-G-CC-3-3-TH/P) / (ELT-A-GE-3-3-TH/P)
CC-4A / GE-4: Microprocessors and Microcontrollers (ELT-G-CC-4-4-TH/P) / (ELT-A-GE-4-4-TH/P)

Discipline Specific Elective (DSE): (Credit: 06 each) – DSE-1A & DSE-1B

Semester-5 Options (Choose 1 Paper from Group-A)

DSE-1A: Group-A (Choose any 1 Paper)
DSE-1A-1: Semiconductor Devices Fabrication (ELT-G-DSE-5-A-1-TH/P)
DSE-1A-2: Photonic Devices and Power Electronics (ELT-G-DSE-5-A-2-TH/P)

Semester-6 Options (Choose 1 Paper from Group-B)

DSE-1B: Group-B (Choose any 1 Paper)
DSE-1B-1: Electronic Instrumentation (ELT-G-DSE-6-B-1-TH/P)
DSE-1B-2: Transmission Lines, Antenna and Radio Wave Propagation (ELT-G-DSE-6-B-2-TH/P)

Ability Enhancement Compulsory Course (AECC): (Credits: 02 each) – AECC 1-2
AECC-1: Communicative English/MIL
AECC-2: Environmental Studies

Skill Enhancement Course (SEC): (Credits: 02 each) – SEC-A & SEC-B
(Choose 2 Papers taking 1 each from Group-A and Group-B)

Semester-3/5 Options (Choose 1 Paper from Group-A)

SEC-A: Group-A (Choose any 1 Paper)
SEC-A-1: Computational Physics Skills (ELT-G-SEC-3/5-A-1-TH)
SEC-A-2: Renewable Energy and Energy Harvesting (ELT-G-SEC-3/5-A-2-TH)

Semester-4/6 Options (Choose 1 Paper from Group-B)

SEC-B: Group-B (Choose any 1 Paper)
SEC-B-1: Electrical Circuits and Network Skills (ELT-G-SEC-4/6-B-1-TH)
SEC-B-2: Technical Drawing (ELT-G-SEC-4/6-B-2-TH)

GENERAL SYLLABUS

FIRST YEAR : FIRST SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-1A	ELT-G-CC-1-1-TH: Network Analysis and Analog Electronics		50		10	10	100	4
	ELT-G-CC-1-1-P: Network Analysis and Analog Electronics			30				2
CC-2A	Core Course-2 Theory	Subject/Discipline-2 (other than Electronics)	50/65		10	10	100	4/5
	Core Course-2 Practical/Tutorial			30/15				2/1
CC-3A	Core Course-3 Theory	Subject/Discipline-3 (other than Electronics)	50/65		10	10	100	4/5
	Core Course-3 Practical/Tutorial			30/15				2/1
AECC-1	Communicative English/MIL		80		10	10	100	2
						TOTAL	400	20

Core Course (CC) - 1A Theory / Generic Elective - 1 Theory
Course Code: ELT-G-CC-1-1-TH / ELT-A-GE-1-1-TH
Course Name: Network Analysis and Analog Electronics
[Credits: 04; Lecture Hours: 56]

Circuit Analysis: Concept of Voltage and Current Sources, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Mesh Analysis, Node Analysis, Star and Delta Networks, Star-Delta Conversion, Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Maximum Power Transfer Theorem, Two Port Networks, h, Z and Y Parameters and their Conversions. **[10]**
Junction Diode and Its Applications: PN Junction Diode (Ideal and Practical), Constructions, Formation of Depletion Layer, Diode Equation and I-V Characteristics, Idea of Static and Dynamic Resistance, DC Load Line Analysis, Quiescent (Q) Point, Zener Diode, Reverse Saturation Current, Zener and Avalanche Breakdown, Qualitative Idea of Schottky Diode, Rectifiers, Half Wave Rectifier, Full Wave Rectifiers (Center Tapped and Bridge), Circuit Diagrams, Working and Waveforms, Ripple Factor and Efficiency, Filter, Shunt Capacitor Filter, Its role in Power Supply, Output Waveform and Working, Regulation, Line and Load Regulations, Zener Diode as Voltage Regulator, Expressions for Load and Line Regulation. **12]**
Bipolar Junction Transistor: Construction, Principle and Working of NPN Transistor, Terminology, CE, CB and CC Configurations and Characteristics, Regions of Operation (Active, Cut-off and Saturation), Current Gains α and β, Relations between α and β, Leakage Currents. **[5]**
Transistor Biasing: Need for Biasing, Fixed Bias, Collector to Base Bias, Voltage Divider Bias and Emitter Bias, Circuits and Working, DC Load Line and Operating (Q) Point, Thermal Runaway, Stability and Stability Factor. **[5]**
BJT Amplifiers: Small Signal Analysis of Single Stage CE Amplifier, r_e-Model and h-Parameter Equivalent Circuit, Frequency Response, Input and Output Impedance, Current and Voltage Gains, Class A, B and C Amplifiers. **[5]**
Cascaded Amplifiers: Two Stage RC Coupled Amplifier and its Frequency Response. **[2]**
Feedback Amplifiers: Concept of Feedback, Negative and Positive Feedback, Advantages of Negative Feedback (Qualitative only). **[2]**
Sinusoidal Oscillators: Barkhausen Criterion for Sustained Oscillations, Phase Shift, Colpitt's and Hartley Oscillators, Determination of Frequency and Condition of Oscillation. **[5]**
Unipolar Devices: JFET, Construction, Working and I-V Characteristics (Output and Transfer), Pinchoff Voltage, MOSFET, MOS Capacitor, Channel Formation, Threshold Voltage (Ideal and Real), Current-Voltage Relation, Depletion and Enhancement Type MOSFET, Complementary MOS (CMOS), UJT, Basic Construction, Working, Equivalent Circuit and I-V Characteristics. **[10]**

Core Course (CC) - 1A Practical / Generic Elective - 1 Practical
Course Code: ELT-G-CC-1-1-P / ELT-A-GE-1-1-P
Course Name: Network Analysis and Analog Electronics Lab
[Credits: 02; Lecture Hours: 56]

1. To Familiarize with Basic Electronic Components (R, C, L, Diodes, Transistors), Digital Multimeter, Function Generator and Oscilloscope.
2. Measurement of Amplitude, Frequency and Phase Difference using Oscilloscope.
3. Verification of (a) Thevenin's Theorem and (b) Norton's Theorem.
4. Verification of (a) Superposition Theorem and (b) Maximum Power Transfer Theorem.
5. Study of the I-V Characteristics of (a) P-N Junction Diode and (b) Zener Diode.
6. Study of (a) Half Wave Rrectifier and (b) Full Wave Rrectifier (FWR) without and with Capacitor Filter.

7. Study of Zener Diode as Voltage Regulator and its Load Regulation.
8. Study of the I-V Characteristics of the Common Emitter Configuration of BJT and obtain r_i, r_o, β.
9. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
10. Study of Fixed Bias and Voltage Divider Bias Configuration for CE Transistor.
11. Design of a Single Stage CE amplifier of given Gain and study its Frequency Response.
12. Study of the I-V Characteristics of JFET/MOSFET.
13. Study of the RC Phase Shift Oscillator.
14. Study of the Colpitt's Oscillator.

Reference Books:

- Nasar, Electric Circuits, Schaum's Solved Problems Series, Tata McGraw Hill.
- Nahvi and Edminister, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Hyat, Kemmerly and Durbin, Engineering Circuit Analysis, Tata McGraw Hill.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Bel, Electric Circuits, Oxford.
- Carlson, Circuits, Cengage.
- Kuo, Network Analysis and Synthesis, Wiley.
- Dorf and Svoboda, Introduction to Electric Circuits, Wiley.
- DeCarlo and Lin, Linear Circuit Analysis, Oxford.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Ryder, Network, Lines and Fields, Pearson.
- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Schilling and Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill.
- Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Neamen, Electronic Circuits: Analysis and Design, Tata McGraw Hill.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.
- Bogart, Beasley and Rico, Electronic Devices and Circuits, Pearson.

FIRST YEAR : SECOND SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-1B	Linear and Digital Integrated Circuits (ELT-G-CC-2-2-TH)		50		10	10	100	4
	Linear and Digital Integrated Circuits (ELT-G-CC-2-2-P)			30				2
CC-2B	Core Course-5 Theory	Subject/Discipline-2 (other than Electronics)	50/65		10	10	100	4/5
	Core Course-5 Practical/Tutorial			30/15				2/1
CC-3B	Core Course-6 Theory	Subject/Discipline-3 (other than Electronics)	50/65		10	10	100	4/5
	Core Course-6 Practical/Tutorial			30/15				2/1
AECC-2	Environmental Studies		50	30*	10	10	100	2
* Project						TOTAL	400	20

Core Course (CC) - 1B Theory / Generic Elective - 2 Theory
Course Code: ELT-G-CC-2-2-TH / ELT-A-GE-2-2-TH
Course Name: Linear and Digital Integrated Circuits
[Credits: 04; Lecture Hours: 56]

Operational Amplifiers (Black Box Approach): Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Open and Closed Loop Configuration, Frequency Response, CMRR, PSRR, Slew Rate and Concept of Virtual Ground. **[3]**

Applications of Op-Amps: Inverting and Non-Inverting Amplifiers, Summing and Difference Amplifiers, Differentiator, Integrator, Voltage to Current and Current to Voltage Converters, Comparator and Zero-Crossing Detector, Schmitt Trigger, Wien Bridge Oscillator, Active Low Pass and High Pass Butterworth Filter (1st Order only). **[11]**

Clock and Timer (IC 555): Functional Block Diagram of IC 555, Astable and Monostable Multivibrator Circuits. **[2]**

Number System and Codes: Decimal, Binary, Octal and Hexadecimal Number Systems, Base Conversions, 1's and 2's Complements, Representation of Signed and Unsigned Numbers, BCD Code, Grey Codes, Binary, Octal and Hexadecimal Arithmetic, Addition, Subtraction by 2's Complement Method, Multiplication. **[8]**
Boolean Algebra and Logic Gates: Positive and Negative Logic, Basic Postulates and Fundamental Theorems of Boolean Algebra, De Morgan's Theorems, Logic Symbol and Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Universal Gates, Standard Representation of Logic Functions (SOP and POS), Karnaugh Map Minimization (up to 4 Variables), Characteristics of Logic Families, Fan-in and Fan-out, Power Dissipation and Noise Immunity, Propagation Delay, Comparison of TTL and CMOS Families. **[9]**
Combinational Circuits: Half and Full Adder, Half and Full Subtractor, 4-Bit Binary Adder and Subtractor, Multiplexers, Demultiplexers, Encoder, Decoder, Code Converter (Binary to BCD and Vice Versa). **[9]**
Sequential Circuits: Latches, Flip flop, SR, JK, D and T Flip Flops, Truth Table, Excitation Table and Excitation Equation, Clocked (Level and Edge Triggered) Flip Flops, Preset and Clear Operations, Race Around Conditions in JK flip flop, Master-Slave JK Flip Flop. **[6]**
Shift Registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (up to 4 Bits). **[2]**
Counters (4 bits): Ripple, Ring, Synchronous, Asynchronous, Decade and Modulo-N Counters, State Table and State Diagram, Excitation Table and Excitation Equation. **[3]**
D-A and A-D Conversion: 4-Bit Binary Weighted and R-2R D-A Converter, Circuit and Working, Accuracy and Resolution, A-D Conversion Characteristics, Successive Approximation ADC. (Mention of relevant ICs for all). **[3]**

Core Course (CC) - 1B Practical / Generic Elective - 2 Practical
Course Code: ELT-G-CC-2-2-P / ELT-A-GE-2-2-P
Course Name: Linear and Digital Integrated Circuits Lab
[Credits: 02; Lecture Hours: 56]

Section-A: Op-Amp Circuits (Hardware)
1. To Design an Inverting and Non-Inverting Amplifiers using Op-Amp (741, 351) for DC Voltage of given Gain.
2. (a) To Design Inverting Amplifier using Op-Amp (741,351) and Study its Frequency Response.
   (b) To Design Non-Inverting Amplifier using Op-Amp (741,351) and Study Frequency Response.
3. (a) To Add two DC Voltages using Op-Amp in Inverting and Non-Inverting Mode.
   (b) To Study Zero-Crossing Detector and Comparator.
4. To Design Precision Differential Amplifier of given I/O Specification using Op-Amp.
5. To Investigate use of Op-Amp as Integrator.
6. To Investigate use of Op-Amp as Differentiator.
7. To Design Wien Bridge Oscillator for given Frequency using an Op-Amp.
8. To Design a Circuit to Simulate the Solution of Simultaneous Equation and 1st/2nd Order Differential Equation.
9. To Design Butterworth Active Low Pass Filter (1st order) and study its Frequency Response.
10. To Design Butterworth Active High Pass Filter (1st order) and study its Frequency Response.
11. To Design Digital to Analog Converter (DAC) of given Specifications.
12. To Design Astable Multivibrator of given Specification using IC 555 Timer.
13. To Design Monostable Multivibrator of given Specification using IC 555 Timer.

Section-B: Digital Circuits (Hardware)
1. To Verify and design AND, OR, NOT and XOR Gates using NAND Gates.
2. To Convert Boolean Expression into Logic Circuit and Design it using Logic Gate ICs. .
3. To Design Half Adder and Full Adder.
4. To Design Half Subtractor and Full Subtractor.
5. To Design 4-Bit Binary Adder and Adder-Subtractor using Full Adder IC.
6. To Design a Seven Segment Decoder Driver.
7. To Design 4×1 Multiplexer using Gates.
8. To Build Flip-Flop (RS, Clocked RS, D and JK) Circuits using NAND Gates.
9. To Build JK Master-Slave Flip-Flop using Flip-Flop ICs.
10. To Design Counter using D/T/JK Flip-Flop ICs and study its Timing Diagram.
11. To Design Shift Register and study Serial and Parallel Shifting of Data using D/JK Flip-Flop ICs.

Section-C: SPICE/MULTISIM Simulations for Electronic Circuits and Devices
1. To Verify the Thevenin's and Norton's Theorems.

2. Design and Analyze the Series and Parallel LCR Circuits.
3. Design the Inverting and Non-Inverting Amplifier using an Op-Amp of given Gain.
4. Design and Verification of Op-Amp as Integrator and Differentiator.
5. Design the 1st Order Active Low Pass and High Pass Filters of given Cutoff Frequency.
6. Design a Wein's Bridge Oscillator of given Frequency.
7. Design Clocked SR and JK Flip Flops using NAND Gates.
8. Design 4-Bit Asynchronous Counter using Flip Flop ICs.
9. Design the CE Amplifier of a given Gain and Study its Frequency Response.

Reference Books:

- Nasar, Electric Circuits, Schaum's Solved Problems Series, Tata McGraw Hill.
- Nahvi and Edminister, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Hyat, Kemmerly and Durbin, Engineering Circuit Analysis, Tata McGraw Hill.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Bel, Electric Circuits, Oxford.
- Carlson, Circuits, Cengage.
- Kuo, Network Analysis and Synthesis, Wiley.
- Dorf and Svoboda, Introduction to Electric Circuits, Wiley.
- DeCarlo and Lin, Linear Circuit Analysis, Oxford.
- Ghosh, Network Theory: Analysis and Synthesis, PHI.
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Ryder, Network, Lines and Fields, Pearson.
- Boylestead and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
- Bell, Electronic Devices and Circuits, Oxford.
- Schilling and Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill.
- Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
- Millman and Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw Hill.
- Neamen, Electronic Circuits: Analysis and Design, Tata McGraw Hill.
- Cathey, 2000 Solved Problems in Electronics, Schaum's Outline Series, Tata McGraw Hill.
- Mottershead, Electronic Devices and Circuits: An Introduction, PHI.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- Rashid, Electronic Devices and Circuits, Cengage.
- Bogart, Beasley and Rico, Electronic Devices and Circuits, Pearson.

SECOND YEAR : THIRD SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-1C	ELT-G-CC-3-3-TH: Communication Electronics		50		10	10	100	4
	ELT-G-CC-3-3-P: Communication Electronics Lab			30				2
CC-2C	Core Course-8 Theory	Subject/Discipline-2	50/65		10	10	100	4/5
	Core Course-8 Practical/Tutorial	(other than Electronics)		30/15				2/1
CC-3C	Core Course-9 Theory	Subject/Discipline-3	50/65		10	10	100	4/5
	Core Course-9 Practical/Tutorial	(other than Electronics)		30/15				2/1
SEC-A	Choose any 1 Paper of the following: Group-A Option-1 (SEC-A-1): ELT-G-SEC-3/5-A-1-TH: Computational Physics Group-A Option-2 (SEC-A-2): ELT-G-SEC-3/5-A-2-TH: Renewable Energy and Energy Harvesting		80		10	10	100	2
						TOTAL	400	20

Core Course (CC) - 1C Theory / Generic Elective - 3 Theory
Course Code: ELT-G-CC-3-3-TH / ELT-A-GE-3-3-TH
Course Name: Communication Electronics
[Credits: 04; Lecture Hours: 56]

Electronic Communication: Introduction to Communication, Means and Modes, Need for Modulation, Block Diagram of an Electronic Communication System, Brief Idea of Frequency Allocation for Radio Communication System in India (TRAI), Electromagnetic Communication Spectrum, Band Designations and Usage, Channels and Base-Band Signals, Noise, Internal and External Noises, Signal-to-Noise (S/N) Ratio and Noise Figure. **[7]**

Amplitude Modulation: Definition, Representation, Modulation Index, Expression for Instantaneous Voltage, Power Relations, Frequency Spectrum, Concept of DSBFC, DSBSC, SSBSC Generation and Detection, Limitations of AM, Demodulation, AM Detection, Diode Detector Circuit, Principle of Working and Waveforms, Concept of VSB, Block Diagram of AM Transmitter and Receiver. **[9]**

Frequency Modulation and Phase Modulation: Definition, Representation, Modulation Index, Frequency Spectrum, Bandwidth Requirements, Frequency Deviation and Carrier swing, Equivalence between FM and PM, Generation of FM using VCO, Demodulation, FM Detector, Slope Detector Circuit, Principle of Working and Waveforms, Block Diagram of FM Transmitter and Receiver, Comparison of AM and FM, Qualitative Idea of Super Heterodyne Receiver. **[9]**

Analog Pulse Modulation: Channel Capacity, Sampling Theorem, Basic Principles of PAM, PWM and PPM, Modulation and Detection Technique for PAM only, Multiplexing, TDM and FDM. **[5]**

Digital Modulation Techniques: Need for Digital Transmission, Block Diagram of Digital Transmission and Reception, Pulse Code Modulation, Sampling, Quantization (Uniform and Non-uniform), Quantization Error, Companding, Encoding, Decoding, Regeneration, Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK), Advantages and Disadvantages of Digital Communication, Characteristics of Data Transmission Circuits, Shannon Limit for Information Capacity, Bandwidth Requirements, Data Transmission Speed (Bit Rate and Baud Rate), Noise, Cross Talk, Echo Suppressors, Distortion and Equalizer. **[9]**

Cellular Communication: Concept of Cellular Mobile Communication, Frequency Bands used in Cellular Communication, Concept of Cell Sectoring and Cell Splitting, Absolute RF Channel Numbers (ARFCN), Frequency Reuse, Roaming and Hand Off, Authentication of SIM Card of Subscribers, IMEI Number, Need for Data Encryption, Architecture (Block Diagram) of Cellular Mobile Communication Network, Concept of GSM, CDMA, TDMA and FDMA, Comparison of TDMA and FDMA Technology, Simplified Block Diagram of Cellular Phone Handset, Comparative Study of GSM and CDMA, Qualitative concepts of 2G, 3G and 4G, Qualitative idea of GPS Navigation System. **[9]**

Satellite Communication– Introduction, Need, Geosynchronous Satellite Orbits, Geostationary Satellite, Advantages of Geostationary Satellites, Satellite Visibility, Transponders (C-Band), Friis Transmission Equation, Path Loss, Ground Station, Simplified Block Diagram of Earth Station, Uplink and Downlink. **[8]**

Core Course (CC) - 1C Practical / Generic Elective - 3 Practical
Course Code: ELT-G-CC-3-3-P / ELT-A-GE-3-3-P
Course Name: Communication Electronics Lab
[Credits: 02; Lecture Hours: 56]

1. To Design an Amplitude Modulator using Transistor.
2. To Study Envelope Detector for Demodulation of AM Signal.
3. To Study FM Generator and Detector Circuit.
4. To Study Pulse Amplitude Modulation (PAM).
5. To Study Pulse Width Modulation (PWM).
6. To Study Pulse Position Modulation (PPM).
7. To Study ASK, PSK and FSK Modulators.

Reference Books:

- Roddy and Coolen, Electronic Communications, Pearson.
- Tomasi, Advanced Electronic Communications Systems, Pearson.
- Lathi and Ding, Modern Digital and Analog Communication Systems, Oxford.
- Kennedy, Electronic Communication Systems, Tata McGraw Hill.
- Frenzel, Principles of Electronic communication Systems, Tata McGraw Hill.
- Haykin, Communication Systems, Wiley.
- Blake, Electronic Communication Systems, Cengage.
- Kundu, Analog and Digital Communications, Pearson.
- Couch, Digital and Analog Communication Systems, Pearson.

SECOND YEAR : FOURTH SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
CC-1D	ELT-G-CC-3-3-TH: Microprocessors and Microcontrollers		50		10	10	100	4
	ELT-G-CC-3-3-P: Microprocessors and Microcontrollers Lab			30				2
CC-2D	Core Course-11 Theory	Subject/Discipline-2 (other than Electronics)	50/65		10	10	100	4/5
	Core Course-11 Practical/Tutorial			30/15				2/1
CC-3D	Core Course-12 Theory	Subject/Discipline-3 (other than Electronics)	50/65		10	10	100	4/5
	Core Course-12 Practical/Tutorial			30/15				2/1
SEC-B	Choose any 1 Paper of the following: Group-B Option-1 (SEC-B-1): ELT-G-SEC-4/6-B-1-TH: Electrical Circuits and Network Skills Group-B Option-2 (SEC-B-2): ELT-G-SEC-4/6-B2-TH: Technical Drawing		80		10	10	100	2
						TOTAL	400	20

Core Course (CC) - 1D Theory / Generic Elective - 4 Theory
Course Code: ELT-G-CC-4-4-TH / ELT-A-GE-4-4-TH
Course Name: Microprocessors and Microcontrollers
[Credits: 04; Lecture Hours: 56]

Introduction to Microprocessor: Introduction, Applications, Basic Block Diagram, Speed, Word Size, Memory Capacity, Classification of Microprocessors (Mention Different Microprocessors being used). **[2]**
8085 Microprocessor: Main Features, Architecture, Block Diagram, CPU, ALU, Registers, Flags, Stack Pointer, Program Counter, Data and Address Buses, Control Signals, Pin-Out Diagram and Pin Description. **[8]**
8085 Instruction and Programming: Operation Code, Operand and Mnemonics, Instruction Classification, Addressing Modes, Instruction Format, Instructions Set, Data Transfer, Arithmetic, Increment, Decrement, Logical, Branch and Machine Control Instructions, Assembly Language Programming Examples, Stack Operations, Subroutines and Delay Loops Call and Return Operations, Use of Counters, Timing and Control Circuitry, Timing Diagram, Instruction Cycle, Machine Cycle, T (Timing)-States, Time Delay. **[8]**
Interrupts: Structure, Hardware and Software Interrupts, Vectored and Non-Vectored Interrupts, Latency Time and Response Time. **[2]**
Interfacing: Basic Interfacing Concepts, Memory Mapped I/O and I/O Mapped I/O and Isolated I/O Structure, Partial/Full Memory Decoding, Interfacing of Programmable Peripheral Interface (PPI) Chip (8255), Address Allocation Technique and Decoding, Interfacing of I/O Devices (LEDs and Toggle-Switches as Examples). **[4]**
Introduction to Microcontroller: Introduction, Types, Basic Block Diagram, Comparison of Microcontroller with Microprocessors, Comparison of 8 Bit, 16 Bit and 32 Bit Microcontrollers. **[2]**
8051 Microcontroller: Architecture, Internal Block Diagram, Key Features, Pin Diagram, Memory Organization, Internal RAM, Internal ROM, General Purpose Data Memory, Special Purpose/Function Registers, External Memory, Program Counter and ROM Memory Map, Data Types and Directives, Flag Bits and Program Status Word (PSW) Register, Jump, Loop and Call Instructions. **[10]**
8051 I/O Port Programming: Introduction of I/O Port Programming, Pin-Out Diagram of 8051 Microcontroller, I/O Port Pins Description and their Functions, I/O Port Programming in 8051 (using Assembly Language), I/O Programming: Bit Manipulation. **[4]**
8051 Programming: 8051 Addressing Modes and Accessing Memory Locations using Various Addressing Modes, Assembly Language Instructions using Addressing Mode, Arithmetic and Logic Instructions, 8051 Programming in C for Time Delay and I/O Operations and Manipulation, for Arithmetic and Logic operations, for ASCII and BCD Conversions, 8051 Assembly Language Programming Examples. **[10]**
Introduction to Embedded System: Embedded Systems and General Purpose Computer Systems, Architecture of Embedded System, Classifications, Applications and Purpose of Embedded Systems. **[6]**

Core Course (CC) - 1D Practical / Generic Elective - 4 Practical
Course Code: ELT-G-CC-4-4-P / ELT-A-GE-1-1-P
Course Name: Microprocessors and Microcontrollers Lab
[Credits: 02; Lecture Hours: 56]

Section-A: Programs using 8085 Microprocessor:
1. Transfer of Block of Data.
2. Addition and Subtraction of Numbers using Direct Addressing Mode.
3. Addition and Subtraction of Numbers using Indirect Addressing Mode.
4. Multiplication by Repeated Addition.
5. Division by Repeated Subtraction.

6. Handling of 16-Bit Numbers.
7. Search a given Number in a given List.
8. Generate Fibonacci Series.
9. Sorting of numbers in Ascending/Descending Order.
10. To Find Square Root of an Integer.
11. Use of CALL and RETURN Instruction.
12. To Study Interfacing of IC 8255.
13. Other Programs (e.g. Parity Check, using Interrupts, etc.).
14. Program to Verify Truth Table of Logic Gates.

Section-B: Experiments using 8051 Microcontroller:

1. To Find that the given Numbers are Prime or not.
2. To Find the Factorial of a Number.
3. To Find (a) Largest of N Numbers and (b) Smallest of N numbers.
4. To Find Whether the given Data is Palindrome.
5. To Arrange the Numbers in Ascending/Descending Order.
6. Write a Program to Make the Two Numbers Eequal by Increasing the Smallest Number and Decreasing the Largest Number.
7. Use one of the Four Ports of 8051 for O/P Interfaced to Eight LED's. Simulate Binary Counter (8 Bit) on LED's .
8. Program to Glow the First Four LEDs then next Four using TIMER Application.
9. Program to Rotate the Contents of the Accumulator First Right and then Left.
10. Program to Run a Countdown from 9-0 in the Seven Segment LED Display.
11. To Interface Seven Segment LED Display with 8051 Microcontroller and Display 'HELP' in the Seven Segment LED Display.
12. To Toggle '1234' as '1324' in the Seven Segment LED Display.
13. Interface Stepper Motor with 8051 and Write a Program to Move the Motor through a given Angle in Clockwise or Counter Clockwise Direction.
14. Application of Embedded Systems: Temperature Measurement and Display on LCD.

Reference Books:

- Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram.
- B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai.
- Krishna Kant, Microprocessors and Microcontrollers: Architecture, Programming and System Design, PHI.
- Mathur and Panda, Microprocessors and Microcontrollers, PHI.
- Shah, 8051 Microcontrollers: MCS 51 Family and its Variants, Oxford.
- Ayala and Gadre, The 8051 Microcontroller and Embedded System using Assembly and C, Cengage.
- Raj Kamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw Hill.
- Mazidi, Mazidi and McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson.
- Barrett, Embedded Systems: Design and Applications, Pearson Education.
- Valvano, Embedded Microcomputer System: Real Time Interfacing, Cengage Learning.

THIRD YEAR : FIFTH SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
DSE-1A	Choose any 1 Paper of the following: Group-A Option-1 (DSE-1A-1): ELT-G-DSE-5-A-1-TH: Semiconductor Devices Fabrication		50		10	10	100	4
	ELT-G-DSE-5-A-1-P: Semiconductor Devices Fabrication Lab Group-A Option-2 (DSE-1A-2): ELT-G-DSE-5-A-2-TH: Photonic Devices and Power Electronics ELT-G-DSE-5-A-2-P: Photonic Devices and Power Electronics Lab			30				2
DSE-2A	Discipline Specific Elective -2 Theory	Subject/Discipline-2 (other than Electronics)	50/65		10	10	100	4/5
	Discipline Specific Elective-2 Practical/Tutorial			30/15				2/1
DSE-3A	Discipline Specific Elective-3 Theory	Subject/Discipline-3 (other than Electronics)	50/65		10	10	100	4/5
	Discipline Specific Elective-3 Practical/Tutorial			30/15				2/1
SEC-A	Choose any 1 Paper of the following (if not opted in Semester-3): Group-A Option-1 (SEC-A-1): ELT-G-SEC-3/5-A-1-TH: Computational Physics Group-A Option-2 (SEC-A-2): ELT-G-SEC-3/5-A-2-TH: Renewable Energy and Energy Harvesting		80		10	10	100	2
						TOTAL	400	20

Discipline Specific Elective (DSE) - 1A
DSE-1A: Group-A Option-1 (DSE-1A-1) Theory
ELT-G-DSE-5-A-1-TH: Semiconductor Devices Fabrication
[Credits: 04; Lecture Hours: 56]

Introduction: Review of Energy Bands in Materials, Metal, Semiconductor and Insulator, Doping in Semiconductors, Defects, Point, Line, Schottky and Frenkel, Single Crystal, Polycrystalline and Amorphous Materials, Czochralski Technique for Silicon Single Crystal Growth. **[5]**
Thin Film Growth Techniques and Processes: Vacuum Pumps, Primary Pump (Mechanical) and Secondary Pumps (Diffusion, Turbo Molecular, Cryopump, Sputter Ion), Basic Working Principle, Throughput and Characteristics in Reference to Pump Selection, Vacuum Gauges (Pirani and Penning), Sputtering, Evaporation (Thermal, Electron Beam), Pulse Laser Deposition (PLD), Chemical Vapor Deposition (CVD), Epitaxial Growth, Deposition by Molecular Beam Epitaxy (MBE). **14]**
Thermal Oxidation Process: Dry and Wet, Passivation, Metallization, Diffusion of Dopants, Diffusion Profiles, Ion Implantation. **[5]**
Semiconductor Devices: Review of P-N Junction Diode, Metal-Semiconductor Junction, Metal-Oxide-Semiconductor (MOS) Capacitor and Its C-V Characteristics, MOSFET (Enhancement and Depletion Mode) and its High Frequency Limit, Microwave Devices, Tunnel Diode. **[5]**
Memory Devices: Volatile Memory, Static and Dynamic Random Access Memory (RAM), Complementary Metal Oxide Semiconductor (CMOS) and NMOS, Non-Volatile, NMOS (MOST, FAMOS), Ferroelectric Memories, Optical Memories, Magnetic Memories, Charge Coupled Devices (CCD). **[9]**
VLSI Processing: Introduction of Semiconductor Process Technology, Clean Room Classification, Line Width, Photolithography, Resolution and Process, Positive and Negative Shadow Masks, Photoresist, Step Coverage, Developer, Electron Beam Lithography, Idea of Nano-Imprint Lithography, Etching, Wet Etching, Dry Etching (RIE and DRIE), Basic Fabrication Process of R, C, P-N Junction Diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS Technology, Wafer Bonding, Wafer Cutting, Wire Bonding and Packaging Issues (Qualitative idea). **[12]**
Micro Electro-Mechanical System (MEMS): Introduction to MEMS, Materials Selection for MEMS Devices, Selection of Etchants, Surface and Bulk Micromachining, Sacrificial Subtractive Processes, Additive Processes, Cantilever, Membranes. General Idea MEMS Based Pressure, Force, and Capacitance Transducers. **[6]**

DSE-1A: Group-A Option-1 (DSE-A-1) Practical
ELT-G-DSE-5-A-1-P: Semiconductor Devices Fabrication Lab
[Credits: 02; Lecture Hours: 56]

1. Fabrication/Simulation of Alloy p-n Junction Diode and Study its I-V Characteristics.
2. Study the Output and Transfer Characteristics of MOSFET.
3. To Design and Plot the Static and Dynamic Characteristics of Digital CMOS Inverter.
4. Deposition of Metal Dot on Ceramic/Thin Film and Study I-V Characteristics.
5. Selective Etching of Different Metallic Thin Films using Suitable Etchants of Different Concentrations.
6. Calibrate Semiconductor Type Temperature Sensor (AD590, LM 35 and LM 75).

7. To Measure the Resistivity of a Semiconductor (Ge) Crystal with Temperature (up to 150^{o}C) by Four-Probe Method.
8. To Fabricate a Ceramic and Study its Capacitance using LCR Meter.
9. To Fabricate a Thin Film Capacitor using Dielectric Thin Films and Metal Contacts and study its Capacitance using LCR Meter.

Reference Books:

• Sze and Ng, Physics of Semiconductor Devices, Wiley.
• Maissel and Glang, Handbook of Thin Film Technology, Tata McGraw Hill.
• May and Sze, Fundamentals of Semiconductor Fabrication, Wiley.
• Champbell, The Science and Engineering of Microelectronic Fabrication, Oxford.
• Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, Wiley.
• Plummer, Deal and Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modeling, Pearson.

DSE-1A: Group-A Option-2 (DSE-A-2) Theory
ELT-G-DSE-5-A-2-TH: Photonic Devices and Power Electronics
[Credits: 04; Lecture Hours: 56]

Optoelectronic Devices: Classification of Photonic Devices, Interaction of Radiation and Matter, Radiative Transition and Optical Absorption, Light Emitting Diodes, Construction, Materials and Operation, Semiconductor Laser, Condition for Amplification, Laser Cavity, Heterostructure and Quantum Well Devices, Charge Carrier and Photon Confinement, Line Shape Function, Threshold Current, Laser Diode. **[11]**
Photodetectors: Photoconductor, Photodiodes (p-i-n, Avalanche) and Photo Transistors, Quantum Efficiency and Responsivity, Photomultiplier Tube. **[5]**
Solar Cell: Construction, Working and Characteristics. **[2]**
LCD Displays: Types of Liquid Crystals, Principle of Liquid Crystal Displays, Applications, Advantages over LED Displays. **[4]**
Introduction to Fiber Optics: Evolution of Fiber Optic System, Element of Optical Fiber Transmission Link, Optical Fiber Modes and Configurations, Mode Theory of Circular Wave Guides, Overview of Modes-Key Modal Concepts, Linearly Polarized Modes, Single Mode Fibers and Graded Index Fiber Structure. **[12]**
Power Electronics Devices: Need for Semiconductor Power Devices, Power MOSFET (Qualitative), Introduction to Family of Thyristors, Silicon Controlled Rectifier (SCR), Structure, I-V Characteristics, Turn-On and Turn-Off Characteristics, Ratings, Gate Triggering Circuits, Diac and Triac, Basic Structure, Working and I-V Characteristics, Application of Diac as Triggering Device for Triac. **[9]**
Insulated Gate Bipolar Transistors (IGBT): Basic Structure, I-V Characteristics, Switching Characteristics, Device Limitations and Safe Operating Area (SOA). **[2]**
Applications of SCR: Phase Controlled Rectification, AC Voltage Control using SCR and Triac, Power Invertors, Need for Commutating Circuits and their Various Types, DC Link Invertors, Parallel Capacitor Commutated Invertors, Series Invertors, Limitations and its Improved Versions, Bridge Invertors. **[11]**

DSE-1A: Group-A Option-2 (DSE-A-2) Practical
ELT-G-DSE-5-A-P: Photonic Devices and Power Electronics Lab
[Credits: 02; Lecture Hours: 56]

1. Diffraction Experiments using a Laser.
2. To Determine Characteristics of (a) LEDs, (b) Photo Voltaic Cell and (c) Photo Diode.
3. To Study the Characteristics of LDR and Photodiode with (a) Variable Illumination Intensity and (b) Linear Displacement of Source.
4. To Measure the Numerical Aperture of an Optical Fiber.
5. Output and Transfer Characteristics of a Power MOSFET.
6. Study of I-V Characteristics of SCR.
7. SCR as Half Wave and Full Wave Rectifiers with R and RL Loads.
8. Study of I-V Characteristics of DIAC.
9. Study of I-V Characteristics of TRIAC.

Reference Books:

• Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson.
• Ghatak and Thyagarajan, An Introduction to Fiber Optics, Cambridge.
• Wilson and Hawkes, Optoelectronics: An Introduction, Pearson.
• Gupta, Optoelectronic Devices and Systems, PHI.

- Khare, Fiber Optics and Optoelectronics, Oxford.
- Sen, Power Electronics, Tata McGraw Hill.
- Singh and Khanchandani, Power Electronics, Tata McGraw Hill.
- Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education.
- Thareja and Thareja, A Textbook of Electrical Technology, Vo. II, S. Chand.
- Asghar, Power Electronics, PHI.
- Moorthi, Power Electronics, Oxford.
- Varmah and Abraham, Power Electronics, Cengage.

THIRD YEAR : SIXTH SEMESTER								
COURSE TYPE	COURSE NAME WITH CODE		MARKS					CREDITS
			Theory	Practical/ Tutorial	Internal Assessment	Attendance	Total	
DSE-1B	Choose any 1 Paper of the following: Group-B Option-1 (DSE-1B-1): ELT-G-DSE-6-B-1-TH: Electronic Instrumentation ELT-G-DSE-6-B-1-P: Electronic Instrumentation Lab Group-B Option-2 (DSE-1B-2): ELT-G-DSE-6-B-2-TH: Transmission Lines, Antenna and Radio Wave Propagation ELT-G-DSE-6-B-2-P: Transmission Lines, Antenna and Radio Wave Propagation Lab		50		10	10	100	4
				30				2
DSE-2B	Discipline Specific Elective -5 Theory	Subject/Discipline-2 (other than Electronics)	50/65		10	10	100	4/5
	Discipline Specific Elective-5 Practical/Tutorial			30/15				2/1
DSE-3B	Discipline Specific Elective-6 Theory	Subject/Discipline-3 (other than Electronics)	50/65		10	10	100	4/5
	Discipline Specific Elective-6 Practical/Tutorial			30/15				2/1
SEC-B	Choose any 1 Paper of the following (if not opted in Semester-4): Group-B Option-1 (SEC-B-1): ELT-G-SEC-4/6-B-1-TH: Electrical Circuits and Network Skills Group-B Option-2 (SEC-B-2): ELT-G-SEC-4/6-B-2-TH: Technical Drawing		80		10	10	100	2
						TOTAL	400	20

Discipline Specific Elective (DSE) - 1B
DSE-1B: Group-B Option-1 (DSE-1B-1) Theory
ELT-G-DSE-6-B-1-TH: Electronic Instrumentation
[Credits: 04; Lecture Hours: 56]

Measurements: Accuracy and Precision, Significant Figures, Error and Uncertainty Analysis, Sensitivity and Loading Effect, Shielding and Grounding, Electromagnetic Interference. **[4]**

Basic Measurement Instruments: PMMC Galvanometer, DC Measurement, Ammeter, Voltmeter, Ohmmeter, AC Measurement, Digital Voltmeter Systems (Integrating and Non-integrating), Digital Multimeter, Measurement of Low Resistance by Kelvin's Double Bridge Method, Medium Resistance by Voltmeter Ammeter Method and Wheatstone Bridge Method and High Resistance by Megger AC Bridges, Measurement of Self Inductance by Maxwell's Bridge, Hay's Bridge and Anderson's Bridge, Measurement of Capacitance by Schering's Bridge and De Sauty's Bridge, Measurement of Frequency by Wien's Bridge Method. **[10]**

Oscilloscope: Block Diagram, CRT, Waveform Display and Electrostatic Focusing, Time Base and Sweep Synchronisation, , Screens for CRT, Oscilloscope Probes, Measurement of Voltage, Frequency and Phase by CRO, Digital Storage Oscilloscopes- Principle and Working, Advantages and Applications, CRO Specifications (Bandwidth, Sensitivity, Rise-Time), LCD Display for Instruments. **[10]**

Signal Generators: Audio Oscillator, Pulse Generator, Function Generators. (Qualitative only) **[3]**

Transducers: Classification, Basic Requirements and Characteristics, Active and Passive Transducers, Resistive (Potentiometer and Strain Gauge, Theory, Temperature Compensation and Applications), Capacitive (Variable Area and Variable Air Gap Types), Inductive (LVDT) and Piezoelectric Transducers, Measurement of Temperature (RTD, Semiconductor IC Sensors), Light Transducers (Photo Resistors and Photovoltaic Cells). **[10]**

Data Acquisition using Arduino: Arduino, Birth, Open Source Community, Functional Block Diagram, Functions of each Pin, Arduino Development Boards- IDE, I/O Functions, Looping Techniques, Decision Making Techniques, Designing of 1st Sketch, Programming of Arduino (Arduino ISP), Serial Port Interfacing, Basic Interfacing and I/O Concept, Interfacing LED, Switch, 7seg LED. **[10]**

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. **[9]**

DSE-1B: Group-B Option-1 (DSE-1B-1) Practical
ELT-G-DSE-6-B-1-P: Electronic Instrumentation Lab
[Credits: 02; Lecture Hours: 56]

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 Temperature by Thermocouples.
4. To Determine the Characteristics of LVDT.
5. To Determine the Characteristics of Thermistors and RTD.
6. Measurement of Temperature by Thermocouples and Study of Transducers like AD590 (Two Terminal Temperature Sensor), PT-100, J- type, K-type.
7. Characterization of Bio-Potential Amplifier for ECG Signals.
8. Study on ECG Simulator.
9. Measurement of Heart Sound using Electronic Stethoscope. Study on ECG Heart Rate Monitor/Simulator.
10. Study of Pulse Rate Monitor with Alarm System.
11. Measurement of Respiration Rate using Thermistor/Other Electrodes.
12. Test the Different Arduino Boards, Open-Source and Arduino Shields.
13. Install Arduino IDE and its Development Tool.
14. Develop a Program to Blink LED for 1second.
15. Develop a Program to Interface Input Switches and Output LEDs with Development Board (Arduino).
16. Interface 7 Segment Display with Development Board (Arduino).
17. Interface LM35 Temperature Sensor with Arduino and Monitor Temperature on Serial Monitor.

Reference Books:

- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Doebelin, Measurement Systems: Application and Design, Tata McGraw Hill.
- Bell, Electronic Instrumentation and Measurements, Oxford.
- Morris, Measurement and Instrumentation Principles, Elsevier (Butterworth Heinmann).
- Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill.
- Patranabis, Principles of Electronic Instrumentation, PHI.
- Ghosh, Introduction to Measurements and Instrumentation, PHI.
- Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai.
- Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, Pearson.
- Chatterjee, Biomedical Instrumentation Systems, Cengage.
- Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill.
- Natarajan, Biomedical Instrumentation and Measurements, PHI.
- Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry, Wiley.
- McRobetrs, Beginning Arduino (Technology in Action), Apress.
- Evans, Beginning Arduino Programming (Technology in Action), Apress.
- Timmis, Practical Arduino Engineering (Technology in Action), Apress
- Oxer and Blemings, Practical Arduino: Cool Projects for Open Source Hardware (Technology in Action), Apress.

DSE-1B: Group-B Option-2 (DSE-1B-2) Theory
ELT-G-DSE-6-B-2-TH: Transmission Lines, Antenna and Radio Wave Propagation
[Credits: 04; Lecture Hours: 56]

Electromagnetic Waves and Radiation: Wave Spectrum and its Applications, Electromagnetic Fields and Maxwell's Equations, Wave Polarization, Phase and Group Velocities, Plane Wave and Uniform Plane Wave, Propagation of EM Waves in Good Conductor, Good Dielectric, Lossy and Lossless Dielectric, Pointing Vector and Power Flow of Uniform Plane Wave, Concept of Retarded Vector Potential. **[8]**
Transmission Lines: Typical Transmission Lines, Co-axial and Two Wire Lines, Transmission Line Parameters, Transmission Line Equations and Solutions, Characteristic Impedance, Propagation Constant, Lowloss, Lossless and Distortionless Lines and Condition, Short Circuited, Open Circuited and Matched Lines, Reflection Coefficient, Standing Waves, VSWR, Transmission Line as Circuit Elements. **[10]**
Wave Guide: Basic Concept of Waveguide, Advantages over Transmission Line, Qualitative Study of Rectangular Waveguide, TE and TM Modes, Group and Phase Velocities, Guide Wavelength, Cutoff Wavelength, Free Space Wavelength, Dominant and Degenerate Modes, Field Pattern of TE_{10} Mode in Transverse and Longitudinal Cross-Sections of Rectangular Waveguide. **[7]**

Antenna Fundamentals and Parameters: Antenna Radiation Mechanism, Types of Antenna, Field Regions around Antenna, Input Impedance, Radiation Resistance, Radiation Pattern (Field, Power and Phase Patterns), Radiation Intensity, Gain, Directivity, Power Gain, Efficiency, Beamwidth, Bandwidth, Effective Aperture and Height, Antenna Noise Temperature and Noise Figure. **[8]**
Antenna as Transmitter/Receiver: Radiation from Elementary Dipole (Hertzian Dipole), Radiation, Induction and Electrostatic Fields, Radiation Field of Half Wave Dipole, and their Radiation Resistance. **[6]**
Types of Antennas (Qualitative Study Only): Monopole, Dipole, Folded Dipole, Loop, Helical, Rhombic, Yagi-Uda, Log Periodic, Horn, Parabolic Reflector, Antenna Array. **[8]**
Propagation of Radio Waves: Different Modes of Propagation, Ground Wave and Field Strength, Space Wave and Field Strength, Line of Sight Distance and Radio Horizons, Sky Wave, Structure of Ionosphere, Ionosphere Refractive Index, Critical Frequency, Maximum Usable Frequency (MUF), Skip Distance, Virtual Height, Lowest Usable Frequency (LUF), Critical Angle, Optimum Working Frequency (OWF), Duct Propagation. **[9]**

DSE-1B: Group-B Option-2 (DSE-1B-2) Practical
Course Code: ELT-G-DSE-6-B-2-P
Course Name: Transmission Lines, Antenna and Radio Wave Propagation Lab
[Credits: 02; Lecture Hours: 56]

Implementation with Hardware and/or Scilab/MATLAB/Any Other Mathematical Simulation Software
17. Program to Determine the Instantaneous Field of Plane Wave.
18. Program to Find the Phase Constant, Phase Velocity, Electric Field Intensity and Intrinsic Ratio.
19. Program to Determine the Total Voltage as Function of Time and Position in Lossless Transmission Line.
20. Program to Find the Characteristic Impedance, Phase Constant and Phase Velocity.
21. Program to Find the Power Dissipated in Lossless Transmission Line.
22. Program to Find the Input Impedance of Transmission Line Terminated with Pure Capacitive Impedance.
23. Program to Determine the Operating Range of Frequency for TE_{10} Mode of Air-filled Rectangular Waveguide.
24. Program to Ddetermine the Phase and Group Velocities for TE_{10} Mode of Air-Filled Rectangular Waveguide from Dispersion Diagram [$\omega-\beta$ Plot].
25. Program to Determine Radiation Pattern, Gain, Directivity, Beamwidth of Folded Dipole antenna.
26. Program to Determine Radiation Pattern, Gain, Directivity, Beamwidth of 3-element, 5-Element and 7-Element Yagi-Uda Antenna and their Comparative Study.
27. Program to Determine Diameter of Parabolic Reflector.
28. Program to Find Minimum Distance between Primary and Secondary Antenna.

Reference Books:

- Sadiku, Principles of Electromagnetics, Oxford.
- Jordan and Balmain, Electro Magnetic Waves and Radiating Systems, Pearson.
- Rao, Elements of Engineering Electromagnetics, Pearson.
- Rao and Narayanappa, Engineering Electromagnetics, Cengage.
- Ballanis, Antenna Theory: Analysis and Design, Wiley.
- Yadava, Antenna and Wave Propagation, PHI.
- Harish and Sachidananda, Antennas and Wave Propagation, Oxford.
- Raju, Antennas and Propagation, Pearson.
- Hayt, Buck and Akhtar, Engineering Electromagnetics, Tata McGraw Hill.
- Cheng, Field and Wave Electromagnetics, Pearson.
- Edminster, Electromagnetics, Schaum's Outline Series, Tata McGraw Hill.
- Lonngren, Savov and Jost, Fundamentals of Electromagnetics with MATLAB, SciTech.

Skill Enhancement Course (SEC) - A
SEC-A: Group-A Option-1 (SEC-A-1)
ELT-G-SEC-3/5-A-1-TH: Computational Physics
[Credits: 02; Lecture Hours: 28]

Introduction: Importance of Computers in Physics, Paradigm for Solving Physics Problems for Solution, Usage of Linux as Editor.
Algorithms and Flowcharts: Algorithm, Definition, Properties and Development, Flowchart, Concept of Flowchart, Symbols, Guidelines, Types, Examples, Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of Two Matrices, Sum and Product of Finite Series, Calculation of sin(x) as a Series,

Algorithm for Plotting (1) Lissajous Figures and (2) Trajectory of a Projectile Thrown at an Angle with the Horizontal. **[4]**

Scientific Programming: Some Fundamental Linux Commands (Internal and External Commands), Development of FORTRAN, Basic Elements of FORTRAN, Character Set, Constants and their Types, Variables and their Types, Keywords, Variable Declaration and Concept of Instruction and Program, Operators, Arithmetic, Relational, Logical and Assignment Operators, Expressions, Arithmetic, Relational, Logical, Character and Assignment Expressions, Fortran Statements, I/O Statements (Unformatted/Formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of Writing Program and Concept of Coding, Initialization and Replacement Logic, Examples from Physics Problems. **[5]**

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder Statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO), Subscripted Variables (Arrays, Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, Open a File, Writing in a File, Reading from a File, Examples from Physics Problems.

Programming:

1. Exercises on Syntax on Usage of FORTRAN.
2. Usage of GUI Windows, Linux Commands, familiarity with DOS Commands and Working in an Editor to Write Sources Codes in FORTRAN.
3. To Print out all Natural Even/Odd Numbers between given Limits.
4. To Find Maximum, Minimum and Range of a given Set of Numbers.
5. Calculating Euler Number using exp(x) Series Evaluated at x=1. **[6]**

Scientific Word Processing: Introduction to LaTeX, TeX/LaTeX Word Processor, Preparing a Basic LaTeX File, Document Classes, Preparing an Input File for LaTeX, Compiling LaTeX File, LaTeX Tags for Creating Different Environments, Defining LaTeX Commands and Environments, Changing Type Style, Symbols from other Languages.

Equation Representation: Formulae and Equations, Figures and other Floating Bodies, Lining in Columns-Tabbing and Tabular Environment, Generating Table of Contents, Bibliography and Citation, Making an Index and Glossary, List Making Environments, Fonts, Picture Environment and Colors, Errors. **[5]**

Visualization: Introduction to Graphical Analysis and its Limitations, Introduction to Gnuplot, Importance of Visualization of Computational and Computational Data, Basic Gnuplot Commands, Simple Plots, Plotting Data from a File, Saving and Exporting, Multiple Data Sets per File, Physics with Gnuplot (Equations, Building Functions, User Defined Variables and Functions), Understanding Data with Gnuplot.

Hands on Exercises:

1. To Compile a Frequency Distribution and Evaluate Mean, Standard Deviation etc.
2. To Evaluate Sum of Finite Series and the Area under a Curve.
3. To Find the Product of Two Matrices.
4. To Find a Set of Prime Numbers and Fibonacci Series.
5. To Write Program to open a File and generate Data for Plotting using Gnuplot.
6. Plotting Trajectory of a Projectile Projected Horizontally.
7. Plotting Trajectory of a Projectile Projected making an Angle with the Horizontally.
8. Creating an Input Gnuplot File for Plotting a Data and saving the output for seeing on the Screen. Saving it as an eps File and as a pdf File.
9. To Find the Roots of a Quadratic Equation.
10. Motion of a Projectile using Simulation and Plot the Output for Visualization.
11. Numerical Solution of Equation of Motion of Simple Harmonic Oscillator and Plot the Outputs for Visualization.
12. Motion of Particle in a Central Force Field and Plot the Output for Visualization. **[8]**

Reference Books:

- Sastry, Introductory Methods of Numerical Analysis, PHI.
- Rajaraman, Computer Programming in FORTRAN 77, PHI.
- Lamport , LaTeX: A Document Preparation System, Pearson.
- Janert, Gnuplot in Action: Understanding Data with Graphs, Manning.
- Lipsdutz and Poe, Theory and Problems of Programming with FORTRAN including structured FORTRAN, Schaum's Outline Series, Tata McGraw Hill.
- Verma, Computational Physics: An Introduction, New Age.
- Atkinson and Han, Elementary Numerical Analysis, Wiley.

SEC-A: Group-A Option-2 (SEC-A-2)
ELT-G-SEC-3/5-A-2-TH: Renewable Energy and Energy Harvesting
[Credits: 02; Lecture Hours: 28]

Fossil Fuels and Alternate Sources of Energy: Fossil Fuels and Nuclear Energy, Their Limitation, Need of Renewable Energy, Non-Conventional Energy Sources, An Overview of Developments in Offshore Wind Energy, Tidal Energy, Wave Energy Systems, Ocean Thermal Energy Conversion, Solar Energy, Biomass, Biochemical Conversion, Biogas Generation, Geothermal Energy Tidal Energy, Hydroelectricity. **[3]**

Solar Energy: Solar Energy, Its Importance, Storage of Solar Energy, Solar Pond, Non-Convective Solar Pond, Applications of Solar Pond and Solar Energy, Solar Water Heater, Flat Plate Collector, Solar Distillation, Solar Cooker, Solar Green Houses, Solar Cell, Absorption Air Conditioning, Need and Characteristics of Photovoltaic (PV) Systems, PV Models and Equivalent Circuits, and Sun Tracking Systems. **[5]**
Wind Energy Harvesting: Fundamentals of Wind Energy, Wind Turbines and Different Electrical Machines in Wind Turbines, Power Electronic Interfaces, and Grid Interconnection Topologies. **[3]**
Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Biomass. **[4]**
Geothermal Energy: Geothermal Resources, Geothermal Technologies. **[2]**
Hydro Energy: Hydropower Resources, Hydropower Technologies, Environmental Impact of Hydro Power Sources. **[2]**
Piezoelectric Energy Harvesting: Introduction, Physics and Characteristics of Piezoelectric Effect, Materials and Mathematical Description of Piezoelectricity, Piezoelectric Parameters and Modeling Piezoelectric Generators, Piezoelectric Energy Harvesting Applications, Human Power. **[4]**
Electromagnetic Energy Harvesting: Linear Generators, Physics Mathematical Models, Recent Applications. **[2]**
Carbon Captured Technologies, Cell, Batteries, Power Consumption. **[2]**
Environmental Issues and Renewable Sources of Energy, Sustainability. **[1]**

Demonstrations and Experiments:
1. Demonstration of Training Modules on Solar Energy, Wind Energy, etc.
2. Conversion of Vibration to Voltage using Piezoelectric Materials.
3. Conversion of Thermal Energy into Voltage using Thermoelectric Modules.

Reference Books:

- Khan, Non-Conventional Energy Sources, Tata McGraw Hill.
- Sukhatme and Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.
- Boyle, Renewable Energy: Power for a Sustainable Future, Oxford.
- Kothari, Singal and Ranjan, Renewable Energy Sources and Emerging Technologies, PHI.
- Jayakumar, Solar Energy Resource Assessment Handbook (2009).
- Balfour, Shaw and Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

Skill Enhancement Course (SEC) - B
SEC-B: Group-B Option-1 (SEC-B-1)
ELT-G-SEC-4/6-B-1-TH: Electrical Circuits and Network Skills
[Credits: 02; Lecture Hours: 28]

Basic Electricity Principles: Voltage, Current, Resistance, and Power, Ohm's Law, Series, Parallel, and Series-Parallel Combinations, AC and DC Electricity, Familiarization with Multimeter, Voltmeter and Ammeter. **[3]**
Electrical Circuits: Basic Electric Circuit Elements and their Combination, Rules to Analyze DC Sourced Electrical Circuits, Current and Voltage Drop Across DC Circuit Elements, Single-Phase and Three-Phase Alternating Current Sources, Rules to Analyze AC Sourced Electrical Circuits, Real, Imaginary and Complex Power Components of AC Source, Power Factor, Saving Energy and Money. **[4]**
Electrical Drawing and Symbols: Drawing Symbols, Blueprints, Reading Schematics, Ladder Diagrams, Electrical Schematics, Power Circuits, Control Circuits, Reading of Circuit Schematics, Tracking the Connections of Elements and Identify Current Flow and Voltage Drop. **[4]**
Generators and Transformers: DC Power Sources, AC/DC Generators, Inductance, Capacitance, and Impedance, Operation of Transformers. **[3]**

Electric Motors: Single-Phase, Three-Phase and DC Motors, Basic Design, Interfacing DC or AC Sources to Control Heaters and Motors, Speed and Power of AC Motor. **[4]**
Solid State Devices: Resistors, Inductors and Capacitors, Diode and Rectifiers, Components in Series or in Shunt, Response of Inductors and Capacitors with DC or AC Sources. **[3]**
Electrical Protection: Relays, Fuses and Disconnect Switches, Circuit Breakers, Overload Devices, Ground-Fault Protection, Grounding and Isolating, Phase Reversal, Surge Protection, Relay Protection Device. **[3]**

Electrical Wiring: Different Types of Conductors and Cables, Basics of Wiring-Star and Delta Connection, Voltage Drop and Losses Across Cables and Conductors, Instruments to Measure Current, Voltage, Power in DC and AC Circuits, Insulation, Solid and Stranded Cable, Conduit, Cable Trays, Splices, Wirenuts, Crimps, Terminal Blocks, and Solder, Preparation of Extension Board. **[4]**

Reference Books:

- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- Thareja and Thareja, A Textbook of Electrical Technology, Vol. I & II, S. Chand.
- Say, Performance and Design of Alternating Current Machines, Pitman.

SEC-B: Group-B Option-2 (SEC-B-2)
ELT-G-SEC-4/6-B-2-TH: Technical Drawing
[Credits: 02; Lecture Hours: 28]

Introduction: Drafting Instruments and their Uses, Lettering, Construction and Uses of Various Scales, Dimensioning as per I.S.I. 696-1972, Engineering Curves, Parabola, Hyperbola, Ellipse, Cycloids, Involute, Spiral, Helix and Loci of Points of Simple Moving Mechanism, 2D Geometrical Construction, Representation of 3D Objects, Principles of Projections. **[4]**
Projections: Straight Lines, Planes and Solids, Development of Surfaces of Right and Oblique Solids, Section of Solids. **[6]**
Object Projections: Orthographic Projection, Interpenetration and Intersection of Solids, Isometric and Oblique Parallel Projection of Solids. **[4]**
CAD Drawing: Introduction to CAD and Auto CAD, Precision Drawing and Drawing Aids, Geometric Shapes, Demonstrating CAD, Specific Skills (Graphical User Interface, Create, Retrieve, Edit, and Use Symbol Libraries, Use Inquiry Commands to Extract Drawing Data), Control Entity Properties, Demonstrating Basic Skills to Produce 2-D and 3-D Drawings, 3-D Modeling with Auto CAD (Surfaces and Solids), 3-D Modeling with Sketch Up, Annotating in Auto CAD with Text and Hatching, Layers, Templates and Design Center, Advanced Plotting (Layouts, Viewports), Office Standards, Dimensioning, Internet and Collaboration, Blocks, Drafting Symbols, Attributes, Extracting Data, Basic Printing, Editing Tools, Plot/Print Drawing to Appropriate Scale. **[14]**

Reference Books:

- Parthasarathy and Murali, Engineering Drawing, Oxford.
- Yogesh, Nagaraja and Nandan, Computer Aided Electrical Drawing, PHI.
- Venugopal, and Prabhu Raja, A Text Book of Engineering Graphics, New Age.
- Gladfelter, AutoCAD 2014 and AutoCAD LT 2014, Wiley.
- Schreyer, Architectural Design with Sketch Up, Wiley.