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

<table>
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<tr>
<th>SL. No.</th>
<th>Subject</th>
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The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

(Dr. Santanu Paul)
Deputy Registrar
UNIVERSITY OF CALCUTTA

SYLLABUS

FOR

THREE-YEAR
SIX SEMESTER

B.Sc. DEGREE
HONOURS & GENERAL
COURSE OF STUDIES

UNDER CBCS

ELECTRONICS

2018
Syllabus

for

Electronics (UG-Honours)

Under CBCS
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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-2: Group-B (Choose any 1 Paper)
DSE-2-B: Semiconductor Fabrication and Characterization (ELT-A-DSE-5-B-1-TH/P)
DSE-2-B: 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: Basic VLSI Design (ELT-A-DSE-6-A-1-TH/P)

DSE-4: Group-B (Choose any 1 Paper)
DSE-4-B: Biomedical Instrumentation (ELT-A-DSE-6-B-1-TH/P)
DSE-4-B: 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)

Semester-4 Options (Choose 1 Paper from Group-B)
SEC-2: Group-B (Choose any 1 Paper)
SEC-2-B: Internet and Java Programming (ELT-A-SEC-4-B-1-TH)
SEC-2-B: 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 Holhours 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-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**

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**Core Course (CC) - 1 Theory**

**ELT-A-CC-1-01-TH: Basic Circuit Theory and Network Analysis**

[Credits: 4; Lecture Hours: 56]


**Circuit Analysis**: Kirchhoff’s Current Law (KCL), Kirchhoff’s Voltage Law (KVL), Node Analysis, Mesh Analysis, Linear Circuits, Principle of Duality, Star-Delta Conversion. **[14]**

**DC transient Analysis**: Transient Response of Series RL, RC and RLC Circuits under DC Excitation. **[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. **[16]**

**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 Kirchhoff’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.
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 Edminster, 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]


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

Scilab/MATLAB/Any Other Mathematical Simulation Software
1. Solution of First Order Differential Equations.
5. Divergence of a given Series.
Reference Books:
• Kreyszig, Advanced Engineering Mathematics, Wiley.
• Spiegel, Lipschutz, Schiller and Spellman, Schaum’s Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill.
• Pal and Bhunia, Engineering Mathematics, Oxford.

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

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

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* Project

Core Course (CC) - 3 Theory
[Credits: 04; Lecture Hours: 56]


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, Planck’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]


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, Dielecric 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.


**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 °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.
- Pillai, Solid State Physics, New Age.

**Core Course (CC) - 4 Theory**

**ELT-A-CC-2-04-TH: C Programming and Data Structures**

[Credits: 04; Lecture Hours: 56]


**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.


**Introduction to C++**: Object Oriented Programming, Characteristics of an Object Oriented Language.  

**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.

**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).
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.
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.
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.
20. Create a Binary Tree to Perform Tree Traversals (Preorder, Postorder, Inorder) using the Concept of Recursion.
22. Implement Insertion Sort, Merge Sort, Bubble Sort, Selection Sort.

Reference Books:
- Kanetkar, Let Us C, BPB.
- Kanetkar, Understanding Pointers in C, BPB.
- Sahani and Horowitz, Data Structures, Galgotia.
- Tenenbaum, Langsam and Augenstein, Data Structures using C, Pearson.
- Forouzan, C Programming and Data Structures, Cengage.
- Ghosh, All of C, PHI.
- Samanta, Classic Data Structures, PHI.

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]
COURSE NAME WITH CODE

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<td>CC-8</td>
<td>ELT-A-CC-3-07-TI: Electromagnetics</td>
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Core Course (CC) - 5 Theory

ELT-A-CC-3-05-TI: Semiconductor Devices
[Credits: 04; Lecture Hours: 56]


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


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]


Core Course (CC) - 5 Practical

ELT-A-CC-3-05-P: Semiconductor Devices Lab
[Credits: 02; Lecture Hours: 56]

2. Study of the I-V Characteristics of the Common Emitter Configuration of BJT and obtain \( r_c, r_e, \beta \).
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain \( r_c, r_e, \alpha \).
4. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET/MOSFET.

Reference Books:
- Sze, Semiconductor Devices: Physics and Technology, Wiley.
- Dennis Le Croissette, Transistors, Pearson.
- Pierret, Semiconductor Device Fundamentals, Pearson.
- Neamen and Biswas, Semiconductor Physics and Devices, Tata McGraw Hill.
- Dutta, Semiconductor Devices and Circuits, Oxford.
- 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]
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]

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

Hardware and Circuit Simulation Software
4. Study of Clipping and Clamping Circuits.
5. Study of Fixed Bias, Voltage Divider Bias and Collector-to-Base Bias Feedback Configuration for Transistors.
7. Study of the Colpitt’s Oscillator.
8. Study of the Phase Shift Oscillator.
Reference Books:
- Boylestad 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.
- 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]


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.
7. Programs and Contour Plots to Illustrate Method of Images.
Reference Books:
- Sadiku, Elements of Electromagnetics, Oxford.
- Rao and Narayannappa, Engineering Electromagnetics, Cengage.
- Cheng, Field and Wave Electromagnetics, Pearson.
- Edminster, Electromagnetics, Schaum’s Outline Series, Tata McGraw Hill.
- 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)
[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.


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.

PCB Technology: Trends, Environmental Concerns in PCB Industry.

Reference Books:
- Bosshart, Printed Circuit Boards: Design and Technology, Tata McGraw Hill.

Skill Enhancement Course (SEC) - 1
SEC-1: Group-A (SEC-A) Option-2 (SEC-1-A-2)
[Credits: 02; Lecture Hours: 28]

Introduction: Introduction to PSpice Software, File Types, Netlist Commands.


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.

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]
### 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, Constant 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**

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.
10. Study of IC 555 as Astable Multivibrator.
11. Study of IC 555 as Monostable Multivibrator.
Reference Books:
- Coughlin and Driscoll, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Malvina, Electronic Principals, Tata McGraw-Hill.
- Kishore, Operational Amplifiers and Linear Integrated Circuits, Pearson.
- Bel, Operational Amplifiers and Linear ICs, Oxford.

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.


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:


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.
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.

**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.
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:**
- Floyd, Digital Fundamentals, Pearson.
- Bhasker, A VHDL Primer, Pearson.
- Pedroni, Circuit Design and Simulation with VHDL, PHI.
- Pedroni, Circuit Design and Simulation with VHDL, PHI.
- Bhasker, A VHDL Primer, Pearson.
- Salivahanan and Kumar, Digital Circuits and Design, Vikas.
- 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]**


**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]**

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  
3. Time Shifting and Time Scaling of Signals.  
5. Solution of Difference Equations.  
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.  
• 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]

[6]

Exception Handling: Exception Types, Uncought and Calling, Nested Try Statements, Java Thread Model, and Thread, Runnable, Thread Priorities, Synchronization, Deadlock.  
[8]

[12]

Reference Books:  
• Hahn, The Internet Complete Reference, 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]

[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, Monte Carlo 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]

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### THIRD YEAR : FIFTH SEMESTER

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**Total**: 400 [24]

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**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.


**Connectors and Probes**: Low Capacitance Probes, High Voltage Probes, Current Probes, Identifying Electronic Connectors, Audio and Video, RF/Coaxial, USB etc. [14]


**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).

Signal Generators: Audio Oscillator, Pulse Generator, Function Generators.

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).

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.
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.

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.
- 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.
- 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 Registers, 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.

**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 Features of CPU, Interrupts, Addressing Modes, Instruction Set.

**Interfacing to PIC16F887:** Interfacing of LED, Switches, Solid State Relay, Seven Segment Display, 16x2 LCD Display, 16x2 LCD Display, 4x4 Matrix Keyboard, Digital to Analog Converter, Stepper Motor and DC Motor, Corresponding Interfacing Programs using C Language.

**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.
3. Interfacing of LCD (2x16).
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.
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 (4x4).
13. Serial Communication between Microcontroller and PC.

**Reference Books:**
- Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram.
- 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.
- Microchip PIC16F87X datasheet.
Discipline Specific Electives (DSE) - 1
DSE-1: Group-A (DSE-A) Option-1 (DSE-1-A-1) Theory
[Credits: 04; Lecture Hours: 56]

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 Differentiation: Finite Difference Method and Applications to Electrostatic Boundary Value Problems.

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
[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.
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.
• Thangaraj, Computer-Oriented Numerical Methods, PHI.

DSE-1: Group-A (DSE-A) Option-2 (DSE-1-A-2) Theory
[Credits: 04; Lecture Hours: 56]

**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
[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.
10. Study of P, PI and PID Controller.

**Reference Books:**
- Nagrath and Gopal, Control System Engineering, New Age.
- Ogata, Modern Control Engineering, Pearson.
- Golnaragh 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.
- 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]


**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]

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.


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.
5. Process Integration Simulation.
6. Fabrication of Thin Film using Spin Coating System.
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.
- Weste and Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Pearson.

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]


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.

Power Inverters: Need for Commutating Circuits and their Various Types, DC Link Inverters, Parallel Capacitor Commutated Inverters 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.
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.
- Hari Babu, Power Electronics, Scitech.
- Asghar, Power Electronics, PHI.
- Moothi, Power Electronics, Oxford.

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**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]

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
2. Study of Amplitude Demodulation.
4. Study of Frequency Demodulation.
5. Study of Pulse Amplitude Modulation.
7. Study of Pulse Position Modulation.
10. Study of Phase Shift Keying.

Reference Books:
- Roddy and Coolen, Electronic Communications, Pearson.
- Blake, Electronic Communication Systems, Cengage.
- Kundu, Analog and Digital Communications, 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.

**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. [12]


**Photodetectors:** Bolometer, Photomultiplier Tube, Charge Coupled Device, Photo Transistors and Photodiodes (p-i-n, Avalanche), Quantum Efficiency and Responsivity. [8]

**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.
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.
- 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]

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.
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
• Weste and Eshraghian, Principles of CMOS VLSI Design: A System Perspective, Addison Wesley.
• Pucknell and Eshraghian, Basic VLSI Design, PHI.
• Das, VLSI Design, Oxford.

DSE-3: Group-A (DSE-A) Option-2 (DSE-3-A-2) Theory
[Credits: 04; Lecture Hours: 56]


Network Synthesis: Concept and Properties of Pole-Zero, Synthesis of Two Terminal Reactive Networks, Foster’s Reactance Theorem, Network Realization of Reactance Function, Canonical Networks, Continued Fraction Networks (Cauer Networks), Synthesis of Two Terminal R-C and R-L Networks, Positive Real Functions, Numericals. [12]


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].

Reference Books:
• Oppenheim and Schafer, Discrete Time Signal Processing, Pearson.
• Salivahanan, Digital Signal Processing, Tata McGraw Hill.
• 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]


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.

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]

2. Study on ECG Simulator.
4. Study of Pulse Rate Monitor with Alarm System.
5. Determination Pulmonary Function using Spirometer (using Mechanical System).
7. Study of Respiration Rate Monitor/Apnea Monitor.
8. Study on Ultrasound Transducers Based on Medical System.

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]

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. [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.
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 Rectangular 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.

**Reference Books**:
- Sadiku, Principles of Electromagnetics, Oxford.
- Hayt and Buck, Engineering Electromagnetics, Tata McGraw Hill.
- Yadava, Antenna and Wave Propagation, PHI.
- 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.
Syllabus

for

Electronics (UG-General)

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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-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)

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

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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]


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]


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. [2]

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.
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 Rectifier and (b) Full Wave Rectifier (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 \( r_o \), \( r_i \), \( \beta \).
9. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain \( r_i \), \( r_o \), \( \beta \).
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.

Reference Books:
- Nahvi and Edminster, Electric Circuits, Schaum’s Outline Series, Tata McGraw Hill.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Sadiku, Musa and Alexander, Applied Circuit Analysis, Tata McGraw-Hill.
- Bell, 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.
- Boylestad and Nashelsky, Electronic Devices and Circuits, Schaum’s Outline Series, Tata McGraw-Hill.
- Millman and Halkias, Introduction to Analog and Digital Circuits, Tata McGraw Hill.
- Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
- Bell, Electric Circuits, Oxford.
- Bohm, Electrical Circuits, Oxford.
- Boylestad, Essentials of Circuit Analysis, Pearson.
- Schilling and Belove, 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.

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Core Course (CC) - 1B Theory / Generic Elective - 2 Theory
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]


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]


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]


Counters (4 bits): Ripple, Ring, Synchronous, Asynchronous, Decade and Modulo-N Counters, State Table and State Diagram, Excitation Table and Excitation Equation. [3]


Core Course (CC) - 1B Practical / Generic Elective - 2 Practical
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.
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.

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.
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 Edminster, 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.
• Bell, 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.
• Boylestad and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
• Bell, Electric Circuits, Oxford.
• Schilling and Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill.
• Sedra, Smith and Chandorkar, Microelectronic Circuits, Oxford.
• 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 Rice, Electronic Devices and Circuits, Pearson.

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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]


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.

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.

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.

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.

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.
5. To Study Pulse Width Modulation (PWM).
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

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**COURSE NAME WITH CODE**

### 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).  
**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.  
**Interrupts:** Structure, Hardware and Software Interrupts, Vectored and Non-Vectored Interrupts, Latency Time and Response Time.  
**Interface:** 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).  
**Introduction to Microcontroller:** Introduction, Types, Basic Block Diagram, Comparison of Microcontroller with Microprocessors, Comparison of 8 Bit, 16 Bit and 32 Bit Microcontrollers.  
**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.  
**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 Port Programming: Bit Manipulation.  
**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.  

### 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.
5. Division by Repeated Subtraction.
6. Handling of 16-Bit Numbers.
7. Search a given Number in a given List.
8. Generate Fibonacci Series.
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 Equal 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.

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.
• Barrett, Embedded Systems: Design and Applications, Pearson Education.
• Valvano, Embedded Microcomputer System: Real Time Interfacing, Cengage Learning.
### Third Year: Fifth Semester

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**TOTAL: 400 20**

**Discipline Specific Elective (DSE) - 1A**

**DSE-1A: Group-A Option-1 (DSE-1A-1) Theory**


[Credits: 04; Lecture Hours: 56]


**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]


**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°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.

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]


Photodetectors: Photoconductor, Photodiodes (p-i-n, Avalanche) and Photo Transistors, Quantum Efficiency and Responsivity, Photomultiplier Tube.


LCD Displays: Types of Liquid Crystals, Principle of Liquid Crystal Displays, Applications, Advantages over LED Displays.


Insulated Gate Bipolar Transistors (IGBT): Basic Structure, I-V Characteristics, Switching Characteristics, Device Limitations and Safe Operating Area (SOA).

Applications of SCR: Phase Controlled Rectification, AC Voltage Control using SCR and Triac, Power Inverters, Need for Commutating Circuits and their Various Types, DC Link Inverters, Parallel Capacitor Commutated Inverters, Series Inverters, Limitations and its Improved Versions, Bridge Inverters.

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]

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:
• 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.
• Moorthy, Power Electronics, Oxford.
• Varmah and Abraham, Power Electronics, Cengage.

### THIRD YEAR : SIXTH SEMESTER

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<td>Theory: 4/5; Practical/Tutorial: 2/1</td>
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**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]


**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 Air 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]

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.
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.
8. Study on ECG Simulator.
10. Study of Pulse Rate Monitor with Alarm System.
11. Measurement of Respiration Rate using Thermistor/Other Electrodes.
14. Develop a Program to Blink LED for 1second.
15. Develop a Program to Interface Input Switches and Output LEDs with Development Board (Arduino).

Reference Books:

- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Bell, Electronic Instrumentation and Measurements, Oxford.
- 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.
- McRoberts, Beginning Arduino (Technology in Action), Apress.
- Evans, Beginning Arduino Programming (Technology in Action), Apress.
- Timmis, Practical Arduino Engineering (Technology in Action), Apress
- Oxer and Blenkins, 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]


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]  
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-IB-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.  
20. Program to Find the Characteristic Impedance, Phase Constant and Phase Velocity.  
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 Determine 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 Narayannappa, 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  
[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. 

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.

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 (Unconditional GOTO, Computed GOTO, Assigned GOTO), 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.

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.

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.
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.

Reference Books:
- Sastry, Introductory Methods of Numerical Analysis, PHI.
- Rajaraman, Computer Programming in FORTRAN 77, PHI.
- Janert, Gnuplot in Action: Understanding Data with Graphs, Manning.
- Atkinson and Han, Elementary Numerical Analysis, Wiley.
[Credits: 02; Lecture Hours: 28]


Wind Energy Harvesting: Fundamentals of Wind Energy, Wind Turbines and Different Electrical Machines in Wind Turbines, Power Electronic Interfaces, and Grid Interconnection Topologies. [3]


Demonstrations and Experiments:
1. Demonstration of Training Modules on Solar Energy, Wind Energy, etc.

Reference Books:
- Khan, Non-Convention Energy Sources, Tata McGraw Hill.
- Kothari, Singal and Ranjan, Renewable Energy Sources and Emerging Technologies, PHI.
- Balfour, Shaw and Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

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]


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.

**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.


**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.

**Reference Books**:
- Smith and Alley, Electrical Circuits: An Introduction, Cambridge.
- 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]


**Projections**: Straight Lines, Planes and Solids, Development of Surfaces of Right and Oblique Solids, Section of Solids.

**Object Projections**: Orthographic Projection, Interpenetration and Intersection of Solids, Isometric and Oblique Parallel Projection of Solids.

**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.

**Reference Books**:
- Parthasarathy and Murali, Engineering Drawing, Oxford.
- Yogesh, Nagaraja and Nandan, Computer Aided Electrical Drawing, PHI.
- Gladfelter, AutoCAD 2014 and AutoCAD LT 2014, Wiley.
- Schreyer, Architectural Design with Sketch Up, Wiley.