UNIVERSITY OF CALCUTTA

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Ref.No : CUS/ 112 /18
Dated the 12th March, 2018

To
The Principals/T.I.C.
of all the Undergraduate Colleges
offering B.Sc. (General) in Electronics
affiliated to the University of Calcutta

Sir/Madam,

The undersigned is to inform you that the proposed **revised semester wise draft Syllabus for Electronics (General)** Courses of Studies under **CBCS has been uploaded in the Calcutta University website (www.caluniv.ac.in).**

The said syllabus has been prepared by the **U.G. Board of Studies in Electronics, C.U.**

You are requested kindly to go through it and send your feedback within 29th March, 2018.

In this regard you may send your observation/ suggestion to the **Department of U.G. Councils, C.U**. or through email (u.g.councilsc.u@gmail.com), and you also may contact **Prof. Anupam Karmakar,** Department of Electronics, C.U. through e-mail **(akelc@caluniv.ac.in / akarmakar@gmail.com).**

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Yours faithfully,

12/03/18

Secretary

UNIVERSITY OF CALCUTTA

DRAFT

CBCS SYLLABUS

F
O
R

THREE-YEAR B.Sc.
GENERAL
DEGREE COURSE OF STUDIES

ELECTRONICS

2018

Draft

CBCS Syllabus

for

Electronics (UG-General)

Course Structure
Details of Course under B.Sc. (General)

Course	*Credits Theory+Practical	Theory+Tutorial
I. Core Course		
Core Course Theory (12 Papers) 4 courses from each of the 3 disciplines of choice	**12×4 = 48**	**12×5 = 60**
Core Course Practical/Tutorial* (12 Papers) 4 courses from each of the 3 disciplines of choice	**12×2 = 24**	**12×1 = 12**
II. Elective Course		
Discipline Specific Elective Theory (6 Papers) 2 courses from each of the 3 disciplines of choice	**6×4 = 24**	**6×5 = 30**
Discipline Specific Elective Practical/Tutorial* (6 Papers) 2 courses from each of the 3 disciplines of choice	**6×2 = 12**	**6×1 = 6**
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory Courses (AECC) (2 Papers of 2 credits each)	**2×2 = 4**	**2×2 = 4**
2. Skill Enhancement Courses (SEC) (4 Papers of 2 credits each)	**4×2 = 8**	**4×2 = 8**
Total Credit	**120**	**120**

*** Wherever there is a practical there will be no tutorial and vice-versa.**

Scheme for Choice Based Credit System in B.Sc. (General) Electronics

Year	Semester	Core Course (DSCC) (12)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective (DSE) (6)
1st Year	I	DSCC-1A: Network Analysis and Analog Electronics DSCC- 2A DSCC-3A	AECC-1 English Communication		
	II	DSCC-1B: Linear and Digital Integrated Circuits DSCC-2B DSCC-3B	AECC-2 Environmental Science		
2nd Year	III	DSCC-1C: Communication Systems DSCC-2C DSCC-3C		SEC-1	
	IV	DSCC-1D: Microprocessor and Microcontroller Systems DSCC-2D DSCC-3D		SEC-2	
3rd Year	V			SEC-3	DSE-1A DSE-2A DSE-3A
	VI			SEC-4	DSE-1B DSE-2B DSE-3B

SEMERTER WISE SCHEDULE FOR B.Sc. (GENERAL) ELECTRONICS					
Year	**Semester**	**Course Opted**	**Code**	**Course Name**	**Credits**
1st Year	I	Ability Enhancement Compulsory Course-1	AECC-1	English Communication	2
		Core Course-1 Theory	ELSCCGT-1A	Network Analysis and Analog Electronics	4
		Core Course-1 Practical	ELSCCGP-1A	Network Analysis and Analog Electronics Lab	2
		Core Course-2 Theory	Other Discipline-2	DSCC-2A	4/5
		Core Course-2 Practical/Tutorial	Other Discipline-2	DSCC-2A Lab/Tutorial	2/1
		Core Course-3 Theory	Other Discipline-3	DSCC-3A	4/5
		Core Course-3 Practical/Tutorial	Other Discipline-3	DSCC-3A Lab/Tutorial	2/1
	II	Ability Enhancement Compulsory Course-2	AECC-2	Environmental Science	2
		Core Course-4 Theory	ELSCCGT-2A	Linear and Digital Integrated Circuits	4
		Core Course-4 Practical	ELSCCGP-2A	Linear and Digital Integrated Circuits Lab	2
		Core Course-5 Theory	Other Discipline-2	DSCC-2B	4/5
		Core Course-5 Practical/Tutorial	Other Discipline-2	DSCC-2B Lab/Tutorial	2/1
		Core Course -6 Theory	Other Discipline-3	DSCC-3B	4/5
		Core Course -6 Practical/Tutorial	Other Discipline-3	DSCC-3B Lab/Tutorial	2/1
2nd Year	III	Core Course-7 Theory	ELSCCGT-3A	Communication Systems	4
		Core Course-7 Practical	ELSCCGP-3A	Communication Systems Lab	2
		Core Course-8 Theory	Other Discipline-2	DSCC-2C	4/5
		Core Course-8 Practical/Tutorial	Other Discipline-2	DSCC-2C Lab/Tutorial	2/1
		Core Course-9 Theory	Other Discipline-3	DSCC-3C	4/5
		Core Course-9 Practical/Tutorial	Other Discipline-3	DSCC-3C Lab/Tutorial	2/1
		Skill Enhancement Course-1	ELSSECG-#	SEC-1	2
	IV	Core Course-10 Theory	ELSCCGT-4A	Microprocessor and Microcontroller Systems	4
		Core Course-10 Practical	ELSCCGP-4A	Microprocessor and Microcontroller Systems Lab	2
		Core Course-11 Theory	Other Discipline-2	DSCC-2D	4/5
		Core Course-11 Practical/Tutorial	Other Discipline-2	DSCC-2D Lab/Tutorial	2/1
		Core Course-12 Theory	Other Discipline-3	DSCC-3D	4/5
		Core Course-12 Practical/Tutorial	Other Discipline-3	DSCC-3D Lab/Tutorial	2/1
		Skill Enhancement Course-2	ELSSECG-#	SEC-2	2
3rd Year	V	Skill Enhancement Course-3	ELSSECG-#	SEC-3	2
		Discipline Specific Elective-1 Theory	ELSDSEGT-#	DSE-1A	4
		Discipline Specific Elective-1 Practical	ELSDSEHP-#	DSE-1A Lab	2
		Discipline Specific Elective -2 Theory	Other Discipline-2	DSE-2A	4/5
		Discipline Specific Elective-2 Practical/Tutorial	Other Discipline-2	DSE-2A Lab/Tutorial	2/1
		Discipline Specific Elective -3 Theory	Other Discipline-3	DSE-3A	4/5
		Discipline Specific Elective-3 Practical/Tutorial	Other Discipline-3	DSE-3A Lab/Tutorial	2/1
	VI	Skill Enhancement Course-4	ELSSECG-#	SEC-4	2
		Discipline Specific Elective-4 Theory	ELSDSEGT-#	DSE-1B	4
		Discipline Specific Elective-4 Practical	ELSDSEGP-#	DSE-1B Lab/Tutorial	2
		Discipline Specific Elective -5 Theory	Other Discipline-2	DSE-2B	4/5
		Discipline Specific Elective-5 Practical/Tutorial	Other Discipline-2	DSE-2B Lab/Tutorial	2/1
		Discipline Specific Elective -3 Theory	Other Discipline-3	DSE-3B	4/5
		Discipline Specific Elective-3 Practical/Tutorial	Other Discipline-3	DSE-3B Lab/Tutorial	2/1
				Total Credits	**120**

Core Course (CC): (Credits: 6 each) – CC 1-4

1. ELSDSCCG-1A: Network Analysis and Analog Electronics
2. ELSDSCCG-2A: Linear and Digital Integrated Circuits
3. ELSDSCCG-3A: Communication Systems
4. ELSDSCCG-4A: Microprocessor and Microcontroller Systems

Discipline Specific Elective (Credit: 06 each) (DSE 1A, DSE 2A): Choose 2

1. ELSDSEG-1A: Semiconductor Devices Fabrication
2. ELSDSEG-2A: Electronic Instrumentation
3. ELSDSEG-3A: Basic VLSI Design
4. ELSDSEG-4A: Digital Signal Processing
5. ELSDSEG-5A: Photonic Devices and Power Electronics
6. ELSDSEG-6A: Transmission Lines, Antenna and Radio Wave Propagation

Ability Enhancement Compulsory Course (AECC) (Credits: 2 each) – AECC 1-2

1. AECC-1: English Communication
2. AECC-2: Environmental Science

Skill Enhancement Course (SEC) (Credits: 2 each) – SEC 1-4
(4 papers to be selected)

1. ELSSECG-1: Physics Workshop Skill
2. ELSSECG-2: Computational Physics Skills
3. ELSSECG-3: Electrical Circuits and Network Skills
4. ELSSECG-4: Renewable Energy and Energy Harvesting
5. ELSSECG-5: Technical Drawing
6. ELSSECG-6: Applied Optics
7. ELSSECG-7: Weather Forecasting

Core Course Syllabus

ELSDSCCGT-1A: Network Analysis and Analog Electronics
[Credits: 04; Lecture Hours: 56]

Circuit Analysis: Concept of Voltage and Current Sources, Kirchhoff's Current Law, Kirchhoff's Voltage Law, 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, y and z Parameters and Their Conversions. **[10 Lectures]**

unction Diode and Its Applications: PN Junction Diode (Ideal and Practical), Constructions, Formation of Depletion Layer, Diode Equation and I-V Characteristics, Idea of Static and Dynamic Resistance, DC Load Line Analysis, Quiescent (Q) Point, Zener Diode, Reverse Saturation Current, Zener and Avalanche Breakdown, Qualitative Idea of Schottky Diode, Rectifiers - Half Wave Rectifier, Full Wave Rectifiers (Center Tapped and Bridge), Circuit Diagrams, Working and Waveforms, Ripple Factor and Efficiency, Filter, Shunt Capacitor Filter, Its Role in Power Supply, Output Waveform and Working, Regulation, Line and Load Regulations, Zener Diode as Voltage Regulator, Expressions for Load and Line Regulation. **[12 Lectures]**

Bipolar Junction Transistor: Construction, Principle and Working of NPN Transistor, Terminology, CE, CB and CC Configurations and Characteristics, Regions of Operation (Active, Cut-off and Saturation), Current Gains α and β, Relations between α and β, Leakage Currents. **[5 Lectures]**

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 Lectures]**

BJT Amplifiers: Small Signal Analysis of Single Stage CE Amplifier, r_e-Model and h-Parameter Equivalent Circuit, Frequency Response, Input and Output Impedance, Current and Voltage Gains, Class A, B and C Amplifiers. **[5 Lectures]**

Cascaded Amplifiers: Two Stage RC Coupled Amplifier and Its Frequency Response. **[2 Lectures]**

Feedback Amplifiers: Concept of Feedback, Negative and Positive Feedback, Advantages of Negative Feedback (Qualitative only). **[2 Lectures]**

Sinusoidal Oscillators: Barkhausen Criterion for Sustained Oscillations, Phase Shift, Colpitt's and Hartley Oscillators, Determination of Frequency and Condition of Oscillation. **[5 Lectures]**

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 Lectures]**

ELSDSCCGP-1A: Network Analysis and Analog Electronics Lab
[Credits: 02]

1. To familiarize with basic electronic components (R, C, L, diodes, transistors), Digital Multimeter, Function Generator and Oscilloscope.
2. Measurement of Amplitude, Frequency and Phase difference using Oscilloscope.
3. Verification of (a) Thevenin's theorem and (b) Norton's theorem.
4. Verification of (a) Superposition theorem and (b) Maximum Power Transfer theorem.
5. Study of the I-V Characteristics of (a) p-n junction Diode and (b) Zener diode.
6. Study of (a) Half wave 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_i, r_o, β.
9. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
10. Study of Fixed Bias and Voltage divider bias configuration for CE transistor.
11. Design of a Single Stage CE amplifier of given gain and study its frequency response.
12. Study of the I-V Characteristics of JFET.
13. Study of the I-V Characteristics of MOSFET.
14. Study of the I-V Characteristics of UJT and design of relaxation oscillator.
15. Study of the RC Phase Shift Oscillator.
16. Study of the Colpitt's Oscillator.
17. Study of the Hartley Oscillator.

ELSDSCCGT-2: 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 Lectures]**

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

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

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 Lectures]**

Boolean Algebra and Logic Gates: Positive and Negative Logic, Basic Postulates and Fundamental Theorems of Boolean Algebra, De Morgan's Theorems, Logic Symbol and Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Universal Gates, Standard Representation of Logic Functions (SOP and POS), Karnaugh Map Minimization (up to 4 Variables), Characteristics of Logic Families, Fan-in and Fan-out, Power Dissipation and Noise Immunity, Propagation Delay, Comparison of TTL and CMOS Families. **[9 Lectures]**

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 Lectures]**

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 Lectures]**

Shift Registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (up to 4 Bits). **[2 Lectures]**

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

D-A and A-D Conversion: 4-Bit Binary Weighted and R-2R D-A Converter, Circuit and Working, Accuracy and Resolution, A-D Conversion Characteristics, Successive Approximation ADC. (Mention of relevant ICs for all). **[3 Lectures]**

ELSDSCCGP-2: Linear and Digital Integrated Circuits Lab
[Credits: 02]

Section-A: Op-Amp Circuits (Hardware)

1. To design an inverting and non-inverting amplifiers using Op-amp (741, 351) for dc voltage of given gain.
2. (a) To design inverting amplifier using Op-amp (741,351) and study its frequency response.
   (b) To design non-inverting amplifier using Op-amp (741,351) and study frequency response.
3. (a) To add two dc voltages using Op-amp in inverting and non-inverting mode.
   (b) To study zero-crossing detector and comparator.
4. To design precision differential amplifier of given I/O specification using Op-amp.
5. To investigate use of op-amp as Integrator.
6. To investigate use of op-amp as Differentiator.
7. To design Wien bridge oscillator for given frequency using an op-amp.
8. To design a circuit to simulate the solution of simultaneous equation and 1st/2nd order differential equation.
9. To design Butterworth active Low Pass Filter (1st order) and study Frequency Response.
10. To design Butterworth active High Pass Filter (1st order) and study Frequency Response.
11. To design digital to analog converter (DAC) of given specifications.
12. To design Astable Multivibrator of given specification using IC 555 Timer.
13. To design Monostable Multivibrator of given specification using IC 555 Timer.

Section-B: Digital Circuits (Hardware)

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert Boolean expression into logic circuit and design it using logic gate ICs. .
3. To design Half Adder and Full Adder.
4. To design Half Subtractor and Full Subtractor.
5. To design 4 bit binary adder and adder-subtractor using Full adder IC.
6. To design a seven segment decoder driver.
7. To design 4×1 Multiplexer using gates.
8. To build Flip-Flop (RS, Clocked RS, D and JK) circuits using NAND gates.
9. To build JK Master-slave flip-flop using Flip-Flop ICs.
10. To design Counter using D/T/JK Flip-Flop ICs and study 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 1storder active low pass and high pass filters of given cutoff frequency.
6. Design a Wein's Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates.
8. Design 4-bit asynchronous counter using Flip-Flop ICs.
9. Design the CE amplifier of a given gain and its frequency response.

ELSDSCCGT-3: Communication Systems
[Credits: 04; Lecture Hours: 56]

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

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

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

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

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

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

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

ELSDSCCGP-3: Communication Systems Lab
[Credits: 02]

1. To design an Amplitude Modulator using Transistor.
2. To study envelope detector for demodulation of AM signal.
3. To study FM Generator and Detector circuit.
4. To study AM Transmitter and Receiver.
5. To study FM Transmitter and Receiver.
6. To study Time Division Multiplexing (TDM).
7. To study Pulse Amplitude Modulation (PAM).
8. To study Pulse Width Modulation (PWM).
9. To study Pulse Position Modulation (PPM).
10. To study ASK, PSK and FSK modulators.

ELSDSCCGT-4: Microprocessor and Microcontroller Systems
[Credits: 04; Lecture Hours: 56]

Introduction to Microprocessor: Introduction, Applications, Basic Block Diagram, Speed, Word Size, Memory Capacity, Classification of Microprocessors (mention different microprocessors being used). **[2 Lectures]**

8085 Microprocessor: Main Features, Architecture- Block diagram, CPU, ALU, Registers, Flags, Stack Pointer, Program Counter, Data and Address Buses, Control Signals, Pin-Out Diagram and Pin Description. **[8 Lectures]**

8085 Instruction and Programming: Operation Code, Operand and Mnemonics, Instruction Classification, Addressing Modes, Instruction Format, Instructions Set- Data Transfer, Arithmetic, Increment, Decrement, Logical, Branch and Machine Control Instructions, Assembly Language Programming Examples, Stack Operations, Subroutines and Delay Loops Call and Return Operations, Use of Counters, Timing and Control Circuitry, Timing Diagram, Instruction Cycle, Machine Cycle, T (Timing)-States, Time Delay. **[8 Lectures]**

Interrupts: Structure, Hardware and Software Interrupts, Vectored and Non-Vectored Interrupts Latency Time and Response Time. **[2 Lectures]**

Interfacing: Basic Interfacing Concepts, Memory Mapped I/O and I/O Mapped I/O and Isolated I/O Structure, Partial/Full Memory Decoding, Interfacing of Programmable Peripheral Interface (PPI) Chip (8255), Address Allocation Technique and Decoding, Interfacing of I/O Devices (LEDs and Toggle-Switches as Examples). **[4 Lectures]**

Introduction to Microcontroller: Introduction, Types, Basic Block Diagram, Comparison of Microcontroller with Microprocessors, Comparison of 8 Bit, 16 Bit and 32 Bit Microcontrollers. **[2 Lectures]**

8051 Microcontroller: Architecture- Internal Block diagram, Key Features, Pin Diagram, Memory Organization, Internal RAM Memory, Internal ROM, General Purpose Data Memory, Special Purpose/Function Registers, External Memory, Program Counter and ROM Memory Map, Data Types and Directives, Flag Bits and Program Status Word (PSW) Register, Jump, Loop and Call Instructions. **[10 Lectures]**

8051 I/O Port Programming: Introduction of I/O Port Programming, Pin-Out Diagram of 8051 Microcontroller, I/O Port Pins Description and their Functions, I/O Port Programming in 8051 (using assembly language), I/O Programming: Bit manipulation. **[4 Lectures]**

8051 Programming: 8051 Addressing Modes and Accessing Memory Locations using Various Addressing Modes, Assembly Language Instructions using Addressing Mode, Arithmetic and Logic Instructions, 8051 Programming in C- for Time Delay and I/O Operations and Manipulation, for Arithmetic and Logic operations, for ASCII and BCD Conversions, 8051 Assembly Language Programming Examples. **[10 Lectures]**

Introduction to Embedded System: Embedded Systems and General Purpose Computer Systems, Architecture of Embedded System, Classifications, Applications and Purpose of Embedded Systems. **[6 Lectures]**

ELSDSCCGP-4: Microprocessor and Microcontroller Systems Lab
[Credits: 02]

Section-A: Programs using 8085 Microprocessor:

1. Transfer of block of data.
2. Addition and subtraction of numbers using direct addressing mode.
3. Addition and subtraction of numbers using indirect addressing mode.
4. Multiplication by repeated addition.
5. Division by repeated subtraction.
6. Handling of 16-bit Numbers.
7. Search a given number in a given list.
8. Generate Fibonacci series.
9. Sorting of numbers in ascending/descending order.
10. To find square root of an integer.
11. Use of CALL and RETURN Instruction.
12. To study interfacing of IC 8255.
13. Other programs (e.g. Parity Check, using interrupts, etc.).
14. Program to verify truth table of logic gates.

Section-B: Experiments using 8051 microcontroller:

1. To find that the given numbers is 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 clock wise or counter clockwise direction.
14. Application of embedded systems: Temperature measurement and display on LCD.

Department Specific Elective (DSE) Syllabus

ELSDSEGT-1: Semiconductor Devices Fabrication
[Credits: 04; Lecture Hours: 56]

Introduction: Review of Energy bands in materials, Metal, Semiconductor and Insulator, Doping in Semiconductors, Defects- Point, Line, Schottky and Frenkel, Single Crystal, Polycrystalline and Amorphous Materials, Czochralski Technique for Silicon Single Crystal Growth. **[5 Lectures]**

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 Lectures]**

Thermal Oxidation Process: Dry and Wet, Passivation, Metallization, Diffusion of Dopants, Diffusion Profiles, Ion implantation. **[5 Lectures]**

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 Lectures]**

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 Lectures]**

VLSI Processing: Introduction of Semiconductor Process Technology, Clean Room Classification, Line Width, Photolithography- Resolution and Process, Positive and Negative Shadow Masks, Photoresist, Step Coverage, Developer, Electron Beam Lithography, Idea of Nano-Imprint Lithography, Etching- Wet Etching, Dry Etching (RIE and DRIE), Basic Fabrication Process of R, C, P-N Junction Diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS Technology, Wafer Bonding, Wafer Cutting, Wire Bonding and Packaging Issues (Qualitative Idea). **[12 Lectures]**

Micro Electro-Mechanical System (MEMS): Introduction to MEMS, Materials Selection for MEMS Devices, Selection of Etchants, Surface and Bulk Micromachining, Sacrificial Subtractive Processes, Additive Processes, Cantilever, Membranes. General Idea MEMS Based Pressure, Force, and Capacitance Transducers.
[6 Lectures]

ELSDSEGP-1: Semiconductor Devices Lab
[Credits: 02]

1. Fabrication 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. Create vacuum in a small tube (preferably of different volumes) using a mechanical rotary pump and measure pressure using vacuum gauges.
5. Deposition of metal thin films/contacts on ceramic/thin using thermal evaporation and study I-V characteristics.
6. Selective etching of different metallic thin films using suitable etchants of different concentrations.
7. Wet chemical etching of Si for MEMS applications using different concentration of etchant.
8. Calibrate semiconductor type temperature sensor (AD590, LM 35 and LM 75).
9. Quantum efficiency of CCDs.
10. To measure the resistivity of a semiconductor (Ge) crystal with temperature (up to 150^{o}C) by four-probe method.
11. To fabricate a ceramic and study its capacitance using LCR meter.
12. To fabricate a thin film capacitor using dielectric thin films and metal contacts and study its capacitance using LCR meter.
13. Study the linearity characteristics of
    (a) Pressure using capacitive transducer,
    (b) Distance using ultrasonic transducer.

ELSDSEGT-2: 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 Lectures]**

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

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

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

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

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 Lectures]**

Bio-Medical Instrumentation: Bio-Amplifiers, Bio-Potentials, Bio-Electricity, Necessity for Special Types of Amplifiers for Biological Signal Amplifications, Different Types of Bio-Op-Amps, Electrodes for ECG, EEG and EMG, Block Diagram of ECG and EEG Systems, Brief Analysis of Graphs. **[9 Lectures]**

ELSDSEGP-2: Instrumentation Lab
[Credits: 02]

1. Design of multi range ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
3. Measurement of Capacitance by De Sauty's bridge.
4. To determine the Characteristics of resistance transducer- Strain Gauge (Measurement of Strain using half and full bridge).
5. Measurement of temperature by Thermocouples.
6. To determine the characteristics of LVDT.
7. To determine the Characteristics of Thermistors and RTD.
8. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
9. Characterization of bio potential amplifier for ECG signals.
10. Study on ECG simulator.
11. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator.
12. Study of pulse rate monitor with alarm system.
13. Measurement of respiration rate using thermistor/other electrodes.
14. Test the different Arduino Boards, Open-Source and Arduino Shields.
15. Install Arduino IDE and its development tool.
16. Develop a program to Blink LED for 1second.
17. Develop a program to interface Input Switches and output LEDs with development board (Arduino).
18. Interface 7 segment display with development board (Arduino).
19. Interface LM35 temperature sensor with Arduino and monitor temperature on serial monitor.
20. Interface DC motor using L293D Motor Driver.

ELSDSEGT-3: Basic VLSI Design
[Credits: 04; Lecture Hours: 56]

Integrated Circuit Fabrication: Monolithic Integrated Circuit Technology, Planar Processes, Bipolar Transistor Fabrication, Fabrication of FET, CMOS Technology, Monolithic Diodes, Integrated Circuit Resistors, Capacitor and Packaging, Characteristics of IC Components, Microelectronic Circuit Layout. **[12 Lectures]**

CMOS Fabrication: P and N Well Processes, Twin Tub Process, Thermal Aspects, Bi-CMOS Technology, and Production of E-Beam Masks. **[7 Lectures]**

MOS and BIMOS Circuit Design Processes: MOS Layers, Stick Diagram, Design Rule and Layouts, Brief Introduction of Layout Diagrams. **[11 Lectures]**

Basic Circuit Concepts: Sheet Resistance, Area Capacitance of Layers, Standard Unit of Capacitance, Delay Unit, Inverter Delays, Driving Large Capacitive Loads, Propagation Delays, Wiring Capacitance, Choice of Layers. **[11 Lectures]**

MOS Inverter: Inverter Principle, Basic CMOS Inverter, Transfer Characteristics, Logic Threshold, Noise Margins, Propagation Delay and Power Consumption. **[8 Lectures]**

Scaling of MOS Circuits: Scaling Models and Scaling Factors, Scaling Factors for Device Parameters, Limitations of Scaling. **[7 Lectures]**

ELSDSEGP-3: Basic VLSI Design Lab
[Credits: 02]

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 dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
4. To design and plot the characteristics of a 4×1 digital multiplexer using pass transistor logic.
5. To design and plot the characteristics of a positive and negative latch based on multiplexers.

ELSDSEGT-4: Digital Signal Processing
[Credits: 04; Lecture Hours: 56]

Discrete-Time Signals and Systems: Classification of Signals, Transformations of Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties, Impulse Response, Convolution Sum, Graphical Method, Analytical Method, Properties of Convolution, Commutative, Associative, Distributive, Shift, Sum Property, System Response to Periodic Inputs, Relationship Between LTI System Properties and Impulse Response, Causality, Stability, Invertibility, Unit Step Response. **[9 Lectures]**

Discrete-Time Fourier Transform: Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties, Linearity, Time Shifting, Frequency Shifting, Differentiation in Time Domain, Differentiation in Frequency Domain, Convolution Property.
z-Transform: Bilateral (Two-Sided) z-Transform, Inverse z-Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-Plane, Region-of-Convergence (ROC), Properties of ROC, Properties, Time Reversal, Differentiation in z Domain, Power Series Expansion Method (or Long Division Method), Analysis and Characterization of LTI Systems, Transfer Function and Difference Equation System, Solving Difference Equations. **[14 Lectures]**

Filter Concepts: Phase Delay and Group Delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters, All Pass Filters, Averaging Filters, Notch Filters. **[5 Lectures]**

Discrete Fourier Transform: Frequency Domain Sampling (Sampling of DTFT), Discrete Fourier Transform (DFT) and its Inverse, DFT as Linear Transformation, Properties, Periodicity, Linearity, Circular Time Shifting, Circular Frequency Shifting, Circular Time Reversal, Multiplication Property, Parseval's Relation, Linear Convolution using DFT (Linear Convolution using Circular Convolution), Circular Convolution as Linear Convolution with Aliasing. **[9 Lectures]**

Fast Fourier Transform: Direct Computation of DFT, Symmetry and Periodicity Properties of Twiddle Factor (WN), Radix-2 FFT Algorithms, Decimation-In-Time (DIT) FFT Algorithm, Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT using FFT Algorithms. **[5 Lectures]**

Realization of Digital Filters: Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter Structures, Direct-Form, Cascade-Form, Basic Structures for IIR Systems, Direct-Form I.

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters, FIR and IIR Filters, Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method, Rectangular, Triangular, Kaiser Window, FIR Digital Differentiators.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Backward Difference Algorithm, Impulse Invariance Method. **[14 Lectures]**

ELSDSEGP-4: Digital Signal Processing Lab
[Credits: 02]

Introduction to Numerical computation software Scilab be introduced in the laboratory.

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence $r(n)$, (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \le n \le 50$.
2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for N =5

$$x(n) = rect\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 & -N \le n \le N \\ 0 & otherwise \end{cases}$$

3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$

(a) Determine $H\left(e^{jw}\right)$.

(b) Calculate and plot the steady state response $y_{ss}(n)$ to $x(n) = \cos(0.5\pi n)u(n)$.

4. Given a casual system

$$y(n) = 0.9y(n-1) + x(n)$$

(a) Find (z) and sketch its pole-zero plot.

(b) Plot the frequency response $\left|H\left(e^{jw}\right)\right|$ and $\angle H\left(e^{jw}\right)$.

5. Design a digital filter to eliminate the lower frequency sinusoid of $x(t) = \sin 7t + \sin 200t$. The sampling frequency is f_s = 500 Hz. Plot its pole zero diagram, magnitude response, input and output of the filter.
6. Let (n) be a 4-point sequence:

$$x(n) = \underset{\uparrow}{\{1,1,1,1\}} = \begin{cases} 1 & 0 \le n \le 3 \\ 0 & otherwise \end{cases}$$

Compute the DTFT $X\left(e^{jw}\right)$ and plot its magnitude.

(a) Compute and plot the 4 point DFT of $x(n)$.
(b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros).
(c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros).

7. Let $x(n)$ and $h(n)$ be the two 4-point sequences,

$$x(n) = \underset{\uparrow}{\{1,2,2,1\}}$$

$$h(n) = \underset{\uparrow}{\{1,-1,-1,1\}}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.
9. Design an FIR filter to meet the following specifications:
   Passband edge F_p = 2 kHz,
   Stopband edge F_s = 5 kHz,
   Passband attenuation A_p = 2 dB,
   Stopband attenuation A_s = 42 dB,
   Sampling frequency F_s = 20 kHz.

10. The frequency response of a linear phase digital differentiator is given by

$$H\left(e^{jw}\right) = jwe^{-j\tau w} \qquad |w| \le \pi$$

Using a Hamming window of length M = 21, design a digital FIR differentiator.
Plot the amplitude response.

ELSDSEGT-5: Photonic Devices and Power Electronics
[Credits: 04; Lecture Hours: 56]

Optoelectronic Devices: Classification of Photonic Devices, Interaction of Radiation and Matter, Radiative Transition and Optical Absorption, Light Emitting Diodes- Construction, Materials and Operation, Semiconductor Laser- Condition for Amplification, Laser Cavity, Heterostructure and Quantum Well Devices, Charge Carrier and Photon Confinement, Line Shape Function, Threshold Current, Laser Diode. **[11 Lectures]**

Photodetectors: Photoconductor, Photodiodes (p-i-n, Avalanche) and Photo Transistors, Quantum Efficiency and Responsivity, Photomultiplier Tube. **[5 Lectures]**

Solar Cell: Construction, Working and Characteristics. **[2 Lectures]**

LCD Displays: Types of Liquid Crystals, Principle of Liquid Crystal Displays, Applications, Advantages over LED Displays. **[4 Lectures]**

Introduction to Fiber Optics: Evolution of Fiber Optic System, Element of Optical Fiber Transmission Link, Optical Fiber Modes and Configurations, Mode Theory of Circular Wave Guides, Overview of Modes-Key Modal Concepts, Linearly Polarized Modes, Single Mode Fibers and Graded Index Fiber Structure.
[12 Lectures]

Power Electronics Devices: Need for Semiconductor Power Devices, Power MOSFET (Qualitative), Introduction to Family of Thyristors, Silicon Controlled Rectifier (SCR)- Structure, I-V Characteristics, Turn-On and Turn-Off Characteristics, Ratings, Gate-Triggering Circuits, Diac and Triac- Basic Structure, Working and I-V Characteristics, Application of Diac as Triggering Device for Triac. **[9 Lectures]**

Insulated Gate Bipolar Transistors (IGBT): Basic Structure, I-V Characteristics, Switching Characteristics, Device Limitations and Safe Operating Area (SOA). **[2 Lectures]**

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

ELSDSEGP-5: Photonic Devices and Power Electronics Lab
[Credits: 02]

1. To determine wavelength of sodium light using Michelson's Interferometer.
2. Diffraction experiments using a laser.
3. Study of Electro-optic Effect.
4. To determine characteristics of (a) LEDs, (b) Photo voltaic cell and (c) Photo diode.
5. To study the Characteristics of LDR and Photodiode with (i) Variable Illumination intensity and (ii) Linear Displacement of source.
6. To measure the numerical aperture of an optical fiber.
7. Output and transfer characteristics of a power MOSFET.
8. Study of I-V characteristics of SCR.
9. SCR as half wave and full wave rectifiers with R and RL loads.
10. AC voltage controller using TRIAC with UJT triggering.
11. Study of I-V characteristics of DIAC.
12. Study of I-V characteristics of TRIAC.

ELSDSEGT-6: Transmission Lines, Antenna and Radio Wave Propagation
[Credits: 04; Lecture Hours: 56]

Electromagnetic Waves and Radiation: Wave Spectrum and its Applications, Electromagnetic Fields and Maxwell's Equations, Wave Polarization, Phase and Group Velocities, Plane Wave and Uniform Plane Wave, Propagation of EM Waves in Good Conductor, Good Dielectric, Lossy and Lossless Dielectric, Pointing Vector and Power Flow of Uniform Plane Wave, Concept of Retarded Vector Potential. **[8 Lectures]**

Transmission Lines: Typical Transmission Lines, Co-axial and Two Wire Lines, Transmission Line Parameters, Transmission Line Equations and Solutions, Characteristic Impedance, Propagation Constant, Lossless and Distortionless Lines and Condition, Short Circuited, Open Circuited and Matched Lines, Reflection Coefficient, Standing Waves, VSWR, Transmission Line as Circuit Elements. **[10 Lectures]**

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 Lectures]**

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 Lectures]**

Antenna as Transmitter/Receiver: Radiation from Elementary Dipole (Hertzian Dipole), Radiation, Induction and Electrostatic Fields, Radiation Field of Half Wave Dipole, and their Radiation Resistance. **[6 Lectures]**

Types of Antennas (Qualitative Study Only): Monopole, Dipole, Folded Dipole, Loop, Helical, Rhombic, Yagi-Uda, Log Periodic, Horn, Parabolic Reflector, Antenna Array. **[8 Lectures]**

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, Critical Frequency, Maximum Usable Frequency (MUF), Skips Distance, Virtual Height, Lowest Usable Frequency (LUF), Critical Angle, optimum Working Frequency (OWF), Duct Propagation. **[9 Lectures]**

ELSDSEGP-6: Transmission Lines, Antenna and Microwave Devices Lab
[Credits: 02]

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

1. Program to determine the instantaneous field of plane wave.
2. Program to find the phase constant, phase velocity, electric field intensity and intrinsic ratio.
3. Program to determine the total voltage as function of time and position in lossless transmission line.
4. Program to find the characteristic impedance, phase constant and phase velocity.
5. Program to find the power dissipated in lossless transmission line.
6. Program to find the input impedance of transmission line terminated with pure capacitive impedance.
7. Program to determine the operating range of frequency for TE_{10} mode of air filled rectangular waveguide.
8. Program to determine the phase and group velocities for TE_{10} mode of air filled rectangular waveguide. from Dispersion diagram [$\omega-\beta$ Plot].
9. Program to determine Radiation Pattern, Gain, Directivity, Beamwidth of Folded Dipole antenna.
10. Program to determine Radiation Pattern, Gain, Directivity, Beamwidth of 3-element, 5-element and 7-element Yagi-Uda antenna and their comparative study.
11. Program to determine diameter of parabolic reflector.
12. Program to find out minimum distance between primary and secondary antenna.

Skill Enhancement Course (SEC) Syllabus

ELSSECG-1: Physics Workshop Skill
[Credits: 02; Lecture Hours: 28]

Introduction: Measuring Units, Conversion to SI and CGS, Familiarization with Meter Scale, Vernier Calliper, Screw Gauge and their Utility, Measure Dimension of Solid Block, Volume of Cylindrical Beaker/Glass, Diameter of a Thin Wire, Thickness of Metal Sheet, etc. Use of Sextant to Measure Height of Buildings, Mountains, etc. **[4 Lectures]**

Mechanical Skill: Concept of Workshop Practice, Overview of Manufacturing Methods, Casting, Foundry, Machining, Forming and Welding, Types of Welding Joints and Welding Defects, Common Materials used for Manufacturing like Steel, Copper, Iron, Metal Sheets, Composites and Alloy, Wood, Concept of Machine Processing, Introduction to Common Machine Tools like Lathe, Shaper, Drilling, Milling and Surface Machines, Cutting Tools, Lubricating Oils, Cutting of Metal Sheet using Blade, Smoothening of Cutting Edge of Sheet using File, Drilling of Holes of Different Diameter in Metal Sheet and Wooden Block, Use of Bench Vice and Tools for Fitting, Make Funnel using Metal Sheet. **[9 Lectures]**

Electrical and Electronic Skill: Use of Multimeter, Soldering of Electrical Circuits having Discrete Components (R, L, C, Diode) and ICs on PCB, Operation of Oscilloscope, Making Regulated Power Supply, Timer Circuit, Electronic Switch using Transistor and Relay. **[9 Lectures]**

Introduction to Prime Movers: Mechanism, Gear System, Wheel, Fixing of Gears with Motor Axel, Lever Mechanism, Lifting of Heavy Weight using Lever, Braking Systems, Pulleys, Working Principle of Power Generation Systems, Demonstration of Pulley Experiment. **[6 Lectures]**

ELSSECG-2: Computational Physics
[Credits: 02; Lecture Hours: 28]

Introduction: Importance of Computers in Physics, Paradigm for Solving Physics Problems for Solution, Usage of Linux as Editor.

Algorithms and Flowcharts: Algorithm- Definition, Properties and Development, Flowchart- Concept of Flowchart, Symbols, Guidelines, Types. Examples- Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of Two Matrices, Sum and Product of Finite Series, Calculation of sin(x) as a series, Algorithm for Plotting (1) Lissajous Figures and (2) Trajectory of a Projectile Thrown at an Angle with the Horizontal. **[4 Lectures]**

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

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

Programming:

1. Exercises on syntax on usage of FORTRAN.
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1. **[6 Lectures]**

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

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

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

Hands on Exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices.
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization. **[8 Lectures]**

ELSSECG-3: 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 Lectures]**

Electrical Circuits: Basic Electric Circuit Elements and their Combination, Rules to Analyze DC Sourced Electrical Circuits, Current and Voltage Drop Across DC Circuit Elements, Single-Phase and Three-Phase Alternating Current Sources, Rules to Analyze AC Sourced Electrical Circuits, Real, Imaginary and Complex Power Components of AC Source, Power Factor, Saving Energy and Money. **[4 Lectures]**

Electrical Drawing and Symbols: Drawing Symbols, Blueprints, Reading Schematics, Ladder Diagrams, Electrical Schematics, Power Circuits, Control Circuits, Reading of Circuit Schematics, Tracking the Connections of Elements and Identify Current Flow and Voltage Drop. **[4 Lectures]**

Generators and Transformers: DC Power Sources, AC/DC Generators, Inductance, Capacitance, and Impedance, Operation of Transformers. **[3 Lectures]**

Electric Motors: Single-Phase, Three-Phase and DC Motors, Basic Design, Interfacing DC or AC Sources to Control Heaters and Motors, Speed and Power of AC Motor. **[4 Lectures]**

Solid State Devices: Resistors, Inductors and Capacitors, Diode and Rectifiers, Components in Series or in Shunt, Response of Inductors and Capacitors with DC or AC Sources. **[3 Lectures]**

Electrical Protection: Relays, Fuses and Disconnect Switches, Circuit Breakers, Overload Devices, Ground-Fault Protection, Grounding and Isolating, Phase Reversal, Surge Protection, Relay Protection Device. **[3 Lectures]**

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

ELSSECG-4: Renewable Energy and Energy Harvesting
[Credits: 02; Lecture Hours: 28]

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

Solar Energy: Solar Energy, Its Importance, Storage of Solar Energy, Solar Pond, Non-Convective Solar Pond, Applications of Solar Pond and Solar Energy, Solar Water Heater, Flat Plate Collector, Solar Distillation, Solar Cooker, Solar Green Houses, Solar Cell, Absorption Air Conditioning, Need and Characteristics of Photovoltaic (PV) Systems, PV Models and Equivalent Circuits, and Sun Tracking Systems. **[5 Lectures]**

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

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Biomass. **[4 Lectures]**

Geothermal Energy: Geothermal Resources, Geothermal Technologies. **[2 Lectures]**

Hydro Energy: Hydropower Resources, Hydropower Technologies, Eenvironmental Impact of Hydro Power Sources. **[2 Lectures]**

Piezoelectric Energy Harvesting: Introduction, Physics and Characteristics of Piezoelectric Effect, Materials and Mathematical Description of Piezoelectricity, Piezoelectric Parameters and Modeling Piezoelectric Generators, Piezoelectric Energy Harvesting Applications, Human Power. **[4 Lectures]**

Electromagnetic Energy Harvesting: Linear Generators, Physics Mathematical Models, Recent Applications. **[2 Lectures]**

Carbon Captured Technologies, Cell, Batteries, Power Consumption. **[2 Lectures]**

Environmental Issues and Renewable Sources of Energy, Sustainability. **[1 Lecture]**

Demonstrations and Experiments
1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

ELSSECG-5: Technical Drawing
[Credits: 02; Lecture Hours: 28]

Introduction: Drafting Instruments and their Uses, Lettering- Construction and Uses of Various Scales, Dimensioning as per I.S.I. 696-1972, Engineering Curves- Parabola, Hyperbola, Ellipse, Cycloids, Involute, Spiral, Helix and Loci of Points of Simple Moving Mechanism, 2D Geometrical Construction, Representation of 3D Objects, Principles of Projections. **[4 Lectures]**

Projections: Straight Lines, Planes and Solids, Development of Surfaces of Right and Oblique Solids, Section of Solids. **[6 Lectures]**

Object Projections: Orthographic Projection, Interpenetration and Intersection of Solids, Isometric and Oblique Parallel Projection of Solids. **[4 Lectures]**

CAD Drawing: Introduction to CAD and Auto CAD, Precision Drawing and Drawing Aids, Geometric Shapes, Demonstrating CAD- Specific Skills (Graphical User Interface, Create, Retrieve, Edit, and Use Symbol Libraries, Use Inquiry Commands to Extract Drawing Data), Control Entity Properties, Demonstrating Basic Skills to Produce 2-D and 3-D Drawings, 3-D Modeling with Auto CAD (Surfaces and Solids), 3-D Modeling with Sketch Up, Annotating in Auto CAD with Text and Hatching, Layers, Templates and Design Center, Advanced Plotting (Layouts, Viewports), Office Standards, Dimensioning, Internet and Collaboration, Blocks, Drafting Symbols, Attributes, Extracting Data, Basic Printing, Editing Tools, Plot/Print Drawing to Appropriate Scale. **[14 Lectures]**

ELSSECG-6: Applied Optics
[Credits: 02; Lecture Hours: 28]

Sources and Detectors: Lasers, Spontaneous and Stimulated Emissions, Theory of Laser Action, Einstein's Coefficients, Light Amplification, Characterization of Laser Beam, He-Ne Laser, Semiconductor Lasers.

Experiments on Lasers:

1. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
2. To find the width of the wire or width of the slit using diffraction pattern obtained by a He Ne or solid state laser.
3. To find the polarization angle of laser light using polarizer and analyzer.
4. Thermal expansion of quartz using laser.

Experiments on Semiconductor Sources and Detectors:

1. V-I characteristics of LED.
2. Study the characteristics of solid state laser.
3. Study the characteristics of LDR.
4. Photovoltaic Cell.
5. Characteristics of IR sensor. **[8 Lectures]**

Fourier Optics: Concept of Spatial Frequency Filtering, Fourier Transforming Property of Thin Lens.

Experiments on Fourier Optics:

A. Fourier Optic and Image Processing

1. Optical image addition/subtraction.
2. Optical image differentiation.
3. Fourier optical filtering.
4. Construction of an optical 4f system.

B. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done. **[6 Lectures]**

Holography: Basic Principle and Theory, Coherence, Resolution, Types of Holograms, White Light Reflection Hologram, Application of Holography in Microscopy, Interferometry, and Character Recognition.

Experiments on Holography and Interferometry:

1. Recording and reconstructing holograms.
2. Constructing a Michelson interferometer or a Fabry Perot interferometer.
3. Measuring the refractive index of air.
4. Constructing a Sagnac interferometer.
5. Constructing a Mach-Zehnder interferometer.
6. White light Hologram. **[6 Lectures]**

Photonics (Fibre Optics): Optical Fibres and their Properties, Principal of Light Propagation through a Fibre, Numerical Aperture, Attenuation in Optical Fibre and Attenuation Limit, Single Mode and Multimode Fibres, Fibre Optic Sensors, Fibre Bragg Grating.

Experiments on Photonics: Fibre Optics

1. To measure the numerical aperture of an optical fibre.
2. To study the variation of the bending loss in a multimode fibre.
3. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern.
4. To measure the near field intensity profile of a fibre and study its refractive index profile.
5. To determine the power loss at a splice between two multimode fibre. **[8 Lectures]**

ELSSECG-7: Weather Forecasting
[Credits: 02; Lecture Hours: 28]

Introduction to Atmosphere: Elementary Idea of Atmosphere, Physical Structure and Composition, Compositional Layering of Atmosphere, Variation of Pressure and Temperature with Height, Air Temperature, Requirements to Measure Air Temperature, Temperature Sensors, Types, Atmospheric Pressure, and its Measurement, Cyclones, Anticyclones, and its characteristics. **[8 Lectures]**

Measuring the Weather: Wind, Forces Acting to Produce Wind, Wind Speed Direction, Units, and its Direction, Measuring Wind Speed and Direction, Humidity, Clouds and Rainfall, Radiation, Absorption, Emission and Scattering in Atmosphere, Radiation Laws. **[4 Lectures]**

Weather Systems: Global Wind Systems, Air Masses and Fronts, Classifications, Jet Streams, Local Thunderstorms, Tropical Cyclones, Classification, Tornadoes, Hurricanes. **[3 Lectures]**

Climate and Climate Change: Climate, its Classification, Causes of Climate Change, Global Warming and its Outcomes, Air Pollution, Aerosols, Ozone Depletion, Acid Rain, Environmental Issues Related to Climate. **[6 Lectures]**

Basics of Weather Forecasting: Weather Forecasting, Analysis and its Historical Background, Need of Measuring Weather, Types of Weather Forecasting, Weather Forecasting Methods, Criteria of Choosing Weather Station, Basics of Choosing Site and Exposure, Satellites Observations in Weather Forecasting, Weather Maps, Uncertainty and Predictability, Probability Forecasts. **[7 Lectures]**

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
   (a) To calculate the sunniest time of the year.
   (b) To study the variation of rainfall amount and intensity by wind direction.
   (c) To observe the sunniest/driest day of the week.
   (d) To examine the maximum and minimum temperature throughout the year.
   (e) To evaluate the relative humidity of the day.
   (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/warning (both aviation and non aviation).