<u>CBCS Syllabus: 4-Semester M.Sc. in Electronics</u>

(Effective from 2019 Entry Batch)

West Bengal State University

Barasat, Kolkata 700 126

Grand Total Marks: 1200 (92 Credits)

Semester	Type of course	Credit	Marks	Total
I	Analog Circuits and Systems Solid State Electronic Devices & Materials Mathematical Methods in Electronics Lab 1: Analog Circuits Lab 2: Characterization of Devices & Materials AECC	4 4 4 4 4 2	50 50 50 50 50 50	Marks : 300 Credits : 22
II	Digital Circuits and Logic Design Network Analysis and Synthesis Signal and Linear Control System Computational Skill for Electronics Lab 3: Digital Circuits SEC : Internet of Things	4 4 4 4 4 2	50 50 50 50 50 50	Marks : 300 Credits : 22
III	Electromagnetic Field and Radiation Electronic Communication Systems Digital Signal Processing DSE 1/2:Optoelectronics/ Microprocessor Fundamentals Lab 4: Electronic, Fiber Optic and Microwave Communication GEC : Quantum Computing	4 4 4 4 4 4	50 50 50 50 50 50	Marks : 300 Credits : 24
IV	Instrumentation VLSI and Power Electronics DSE 3/4: Advanced Microprocessor/ Microcontroller Lab 5: Microprocessor and Microcontroller Project	4 4 4 4 8	50 50 50 50 100	Marks : 300 Credits : 24

Semester I

	Paper title	Paper Code	Full Marks	Credit
CORE	Analog Circuits and Systems	ELTPCOR01T	50	4
	Mathematical Method in Electronics	ELTPCOR02T	50	4
	Solid State Electronic Devices and Materials	ELTPCOR03T	50	4
	Lab1: Analog Circuits	ELTPCOR04P	50	4
	Lab 2: Characterization of Devices and Materials	ELTPCOR05P	50	4
AECC	Microelectronic Reliability	ELTPAEC01M	50	2

Semester II

	Paper title	Paper Code	Full Marks	Credit
CORE	Digital Circuits and Logic Design	ELTPCOR06T	50	4
	Network Analysis and Synthesis	ELTPCOR07T	50	4
	Signal and Linear Control System	ELTPCOR08T	50	4
	Computational Skill for Electronics	ELTPCOR09T	50	4
	Lab 3: Digital Circuits	ELTPCOR10P	50	4
SEC	Internet of Things	ELTPSEC01M	50	2

Semester III

	Paper title	Paper Code	Full Marks	Credit	
CORE	Electromagnetic Field and Radiation	ELTPCOR11T	50	4	
	Electronic Communication Systems	ELTPCOR12T	50	4	
	Digital Signal Processing	ELTPCOR13T	50	4	
	Lab 4: Electronic, Fiber optic and Microwave Communication	ELTPCOR14P	50	4	
DSE 1	Optoelectronics	ELTPDSE01T	50	4	One out of ELTPDSE01T& ELTPDSE02T
DSE2	Microprocessor Fundamentals	ELTPDSE02T	50	4	
GEC	Quantum Computing	ELTPGEC01T	50	4	

Semester IV

	Paper title	Paper Code	Full Marks	Credit	
CORE	Instrumentation	ELTPCOR15T	50	4	
	VLSI and Power Electronics	ELTPCOR16T	50	4	
	Lab 5: Microprocessor and Microcontroller	ELTPCOR17P	50	4	
DSE 3	Advanced Microprocessor	ELTPDSE03T	50	4	One out of ELTPDSE03T& ELTPDSE04T
DSE4	Microcontroller	ELTPDSE04T	50	4	
	Project	ELTPCOR01M	100	4+4	

Semester – I

Semester – I: ELTPCOR01T:Analog Circuits and Systems

Course Outcome:

Students after successfully completion of the course will be able to:

- Impart knowledge on analog circuits
- Impart knowledge on circuit operation and functionality
- Impart knowledge on analog circuit to solve real-life problems
- Impart knowledge in making electronic systems

1. **Transistor:** Biasing of Bipolar junction transistors and FETs.
2. **Amplifiers:** Single stage and multistage amplifiers, Feedback in amplifiers.
3. **Op-Amp:** Ideal and practical Op-Amp characteristics, Op-Amp characterization, Frequency response and dominant-pole compensation, Characteristics of inverting and non-inverting circuits of Op-Amp.
4. **Op-Amp applications:**System Poles and Zeros, Active filters, Butterworth filters, Chebychev filters, Sallen-Key Configuration, State variable analysis and state variable filter, Integrator, Differentiator, Solution of 2^{nd} order differential equation, Schmitt trigger, Log/Antilog amplifiers, Active clippers, Active clampers, Comparators (window comparator, conversion of Sine-wave to Square-wave), Active peak detector, Absolute value circuit, Howland current source.
5. **Oscillators**: Positive feedback, Conditions of sustained oscillation, Stability, Noise, Function generators (sin, triangular sawtooth, VCO), Multivibrators.
6. **Conversion:** Frequency to voltage converter, Voltage to frequency converter.
7. **PLL:** Block diagram of PLL, Theory of PLL, and PLL construction using IC 565.

Recommended Books:

1. Integrated Electronics, Millman, Halkias, **McGrawHill**
2. Electronic Principles, A. Malvino, D. J. Bates, **Tata McGrawHill**
3. Electronic Circuits, Donald A Neamen, **Tata McGrawHill**

Semester – I: **ELTPCOR02T: Mathematical Methods in Electronics**

Course Outcome:

Students after successfully completion of the course will be able to:

- Analyze real world scenarios to recognize when vectors, matrices, or linear systems are to be used for modeling

- Analyze linear algebra concepts that are encountered in the real world, understand Complex variable
- Acquire knowledge about derivative and partial derivative
- Acquire knowledge about Laplace transform and Fourier series, Fourier Transform

1. **Linear Algebra**: Matrix Algebra, Eigen values and eigen vectors, Rank, Solution of linear equations existence and uniqueness.
2. **Transform Theory**: Laplace transform: Time domain response of circuits, Convolution integral and its application to circuits, Fourier Analysis: Steady state response, Fourier transform: Frequency domain transform.
3. **Differential equations**: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method, some applications in electronics.
4. **Calculus**: Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems, Methods of numerical differentiation and integration, Interpolation and extrapolation,Taylor series.
5. **Complex variables**: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, Residue theorem.
6. **Probability and Statistics**: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Recommended Books:

1. Higher Engineering Mathematics, B. S. Grewal, **KhannaPublication**
2. Mathematical Physics, B. D. Gupta,**Vikas**

Semester – I: **ELTPCOR03T:Solid State Electronic Devices & Materials**

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand the physics that influences the presence of charge carriers in a semiconductor
- Describe the factors that influence the flow of charge in semiconductors
- Describe the operation of semiconductor devices
- Calculate voltage and current changes in semiconductor devices
- Understand the nature of semiconducting materials

1. **Introduction to Semiconductor -** Energy bands in solids, Concept of effective mass, Mass-action law, Direct and indirect band-gap semiconductors, Degenerate and non-degenerate semiconductors, Density of states, Fermi levels, Carrier concentration at equilibrium, Conductivity, Resistivity and mobility, Effect of temperature and doping on mobility.
2. **Carrier transport**: Diffusion and drift processes, Einstein relation, Effect of recombination, Poisson and the continuity equation, Steady state carrier injection.
3. **PN junction-** Diode equation and diode equivalent circuit, Junction capacitance, Breakdown in diodes, Zener diode, Tunnel diode, Metal semiconductor junction– Ohmic and Schottky contacts.
4. Characteristics and equivalent circuits of **JFET** and **MOSFET**, **MOS** Capacitor, High Electron Mobility Transistor **(HEMT).**
5. **Low dimensional semiconductor devices** – Quantum wells, Quantum wires, Quantum dots.
6. **Solar cells** – I-V characteristics fill factor and efficiency, LED, LCD and flexible display devices.
7. **Emerging materials for future Devices**: Graphene, Carbon Nano tubes (CNT), Zinc Oxide (ZnO), Silicon Carbide (SiC) etc.

Recommended Books:

1. Solid State Electronic Devices, Ben G. Streetman and Sanjay Kumar Banerjee, **PHI Learning Pvt. Ltd.**
2. Physics of Semiconductor Devices, S. M. Sze, **Wiley.**
3. Semiconductor Physics and Devices, Islam, **Oxford.**
4. Physics of Semiconductor Devices, Shur, **PHI.**
5. The Physics of Low- dimensional Semiconductors An Introduction, John N. Davies, **Cambridge University Press**

Semester – I: ELTPCOR04P: Lab 1: Analog Circuits

Course Outcome:

Students after successfully completion of the course will be able to:

- Impart knowledge on analog circuits
- Impart knowledge on circuit operation and functionality
- Impart knowledge on analog circuit to solve real-life problems
- Impart knowledge in making electronic systems

The following or similar experiments will be offered under this Practical Paper.

1. Experimentation of Op-Amp characteristics measurements (R_{in}, R_{out}, Gain-Bandwidth product, CMRR and SlewRate).
2. Experimentation of Shallen-Key (Butterworth):LPF.

3. Experimentation of Shallen-Key (Butterworth):HPF.
4. Experimentation of Voltage to Frequency converter.
5. Experimentation of Frequency to Voltage converter.
6. Experimentation on Howland Current Source.
7. Experimentation of on Square and Triangular wave generation using Op-Amp.
8. Experimentation of PLL (IC565).
9. Experimentation of double stage RC coupled amplifier.
10. Experimentation of Regulated power supply (78XX or79XX).
11. Experimentation of Regulated power supply(317).
12. Experimentation of Diac characteristics.
13. Experimentation on Triac characteristics.

Semester – I: ELTPCOR05P: Lab 2: Characterization of Devices & Materials

Course Outcome:

Students after successfully completion of the course will be able to:

- Impart knowledge on Solar Cell
- Impart knowledge on Photoconductor
- Impart knowledge on pn junction

1. Solar Cell: V-I characteristics under illumination and dark condition; measurements of various parameters.
2. Experiment to find resistivity of a material
3. Experiment to find Dielectric permittivity of a material
4. Experiment to find ac conductivity of a material
5. Experiment to find the tangent loss of a material
6. Photoconductor: Experiment with photo conductor; measurement of gain and response time.
7. To measure capacitance of a pn junction
8. To measure bandgap energy of a pn junction

Semester – I: ELTPAEC01M Microelectronic Reliability

Course Outcome:

Students after successfully completion of the course will be able to:

- Impart knowledge about the History of Electromigration
- Impart knowledge regarding material reliability
- Impart knowledge on Dielectric Breakdown

1. **Concept of Reliability**: System and Models Definition of reliability – reliability Vs quality-reliability function-MTTF – hazard rate function- bathtub curve – derivation of the reliability function-constant failure rate model – time dependent failure models. Weibull distribution – normal distribution – the lognormal distribution. Introduction to Markov models, Markov analysis – Partially degraded and fully degraded models, Applications of Markov model, Numerical problems.
2. **Introduction to Microelectronic Reliability:** Material Reliability, Bulk Material, Reliability and Interface Reliability, Device Specific Reliability, Numerical problems.
3. **Electromigration Introduction**: History of Electromigration, Electromigration theory and modeling and their evolution, Electromigration degradation in submicron Cu interconnects, Numerical problems.
4. **Theory of Gate Dielectric Breakdown**: Introduction to Dielectric Breakdown, Time Dependent Dielectric Breakdown, Application of Anode Hole Injection Theory, Statistics of Oxide Breakdown, Numerical problems.
5. **Negative Bias Temperature Instability (NBTI):** MOSFET-based Logic Transistor-Negative bias Temperature Instability, Hot Carrier Injection, Semiconductor Flash Memory, Empirical observations regarding NBTI.

Recommended Books:

1. Charles E. Ebling, "An introduction to Reliability and Maintainability Engineering", Tata McGraw-Hill, 2000.
2. Patrick D T O'connor, "Practical Reliability Engineering", John-Wiley and Sons inc, 2002.
3. Electromigration in ULSI interconnects, C.M. Tan, A. Roy, Materials Science and Engineering R 58 (2007) 1–75.
4. Microstructure measurement techniques for studying electromigration in ULSI interconnects, Critical Reviews in Solid State and Materials Sciences, 41(3), 159–191, 2016.
5. Srinath I.S, Engineering Design and Reliability, ISTE, 1999.

Semester – II

Semester – II: ELTPCOR06T Digital Circuits and Logic Design

Course Outcome:

Students after successfully completion of the course will be able to:

- Acquire the basic knowledge of digital logic levels and understand digital electronics circuits
- Convert different type of codes and number systems which are used in digital communication and computer systems
- Impart knowledge on design of Digital Circuits

1. **Introduction:** Number System and Computers codes, Basic logic gates and their properties, Boolean switching algebra, Minimization of functions using Boolean identities and Karnaugh map, Logic Families, Implementation of Switching function using basic logic gates, Multiplexer, Demultiplexer, Decoder, Encoder, Priority Encoder, Comparator, Arithmetic Logic Circuits (ALU): Adder, Subtractor, Multiplier, Divider,Latches and Flipflops, Counters: Asynchronous, Synchronous, Hybrid, Ring and Johnson Counter, Registers & Shirt Registers, Design and analysis of fundamental mode state machines: State Variable, Table and State diagram.
2. **Memories**: RAM, ROM, PROM, EPROM, EEROM, SRAM, DRAM.
3. **Programmable Logic Devices (PLD):** Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field-Programmable Gate Array (FPGA), Complex Programmable Logic Device (CPLD).
4. **Data Converters:** Sample and Hold circuit, DAC: Weighted Resistor & R-2R Ladder Network, ADC: Counter type, Successive approximation type, Flash Type etc.
5. Analysis and Design of digital circuits using Hardware Description Language (HDL).

Recommended Books:

1. Digital Circuits (Vol.1 and Vol.2), D. Raychaudhuri, **Platinum Publishing**
2. Fundamental of Digital Circuits, Aanad Kumar,**PHI**
3. Digital Design, M. Morris Mano,**PHI**

Semester – II: ELTPCOR07T: Network Analysis andSynthesis

Course Outcome:

Students after successfully completion of the course will be able to:

- Apply the fundamental concepts in solving and analyzing different Electrical networks
- Select appropriate and relevant technique for solving the Electrical network in different conditions
- Apply mathematics in analyzing and synthesizing the networks in time and frequency domain
- Estimate the performance of a particular network from its analysis

1. **Basic Concepts**: Circuit Elements: active, passive; Energy and power of circuit elements, Response of passive circuit elements for different waveforms; Resonance: series, parallel, Q-factor, Bandwidth, Magnification factor.
2. **Network topology:** Series and parallel, Wye and delta, Simple filter, Bridge. Network graphs: Node, Mesh, Loop, Tree, co-tree, Links; Matrices associated with graphs: incidence, Fundamental cut set and Fundamental circuit matrices.
3. **Kirchhoff's laws in circuit theory, Network solution methods:** Nodal and mesh analysis; Wye and Delta transformation, Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits.
4. **Network Theorems**: Special network configurations; Superposition; Reciprocity; Generalised maximum power transfer theorems; Generalised Thevenin's, Norton's, Millman's and Tellegen's theorems; Applications.
5. **Two-Port Networks:** Equivalent circuits, Two-port parameters (Impedance, admittance, transmission and hybrid parameters), Topological descriptions of different commonly used networks, π to T and T to π conversions, Reduction of complicated network, Symmetrical network; Matrix forms of input-output relations; Cascade, Parallel and series connection of two ports; Iterative and image impedances; Characteristic impedance, Driving point impedance and transfer impedances, Propagation function; Balanced and unbalanced networks; Bartlett' s bisection theorem and its applications; Nonreciprocal and terminated two-ports, Gyrator; Negative Impedance Converter.
6. **Filter circuits:** L filter, π filter, Methods of development of different filters like high pass, Low pass, Band pass and band stop filter circuits.
7. **Transient Response of Circuits:** Laplace transformation; Transform of linear combinations and damped functions; Shifting, Differentiation, Integral, Initial and final value theorems; Applications; RL, RC, RLC and multimesh circuits; Characteristic equation; Impulse response and transfer function; Convolution integral; s-domain circuit analysis; Time domain response from pole-zero plots; Fourier analysis for periodic signals; Fourier transform; Energy calculation in frequency domain.

Recommended Books:

1. Electric Circuits, Nahvi, Edminister, **McGrawHill**
2. Circuit Theory (Analysis and Synthesis), A. Chakrobarti, **DhanpatRai**
3. Electric Circuit Theory, D. Chattopadhaya, P. C. Rakshit, **S.Chand**

Semester – II: ELTPCOR08T: Signal and Linear Control System

Course Outcome:

Students after successfully completion of the course will be able to:

- Demonstrate an understanding of the fundamentals of (feedback) control systems
- Determine and use models of physical systems in forms suitable for use in the analysis and design ofcontrol systems
- Express and solve system equations in state-variable form (state variable models)
- Determine the time and frequency-domain responses of first and second-order systems to step andsinusoidal (and to some extent, ramp) inputs.
- Determine the (absolute) stability of a closed-loop control system
- Apply root-locus technique to analyze and design control systems
- Communicate design results in written reports

1. **An introduction to signals and systems**: Signals and systems as seen in everyday life, and in various branches of engineering and science, electrical, mechanical, hydraulic, thermal, biomedical signals and systems as examples, Extracting the common essence and requirements of signal and system analysis from these examples, Definitions and properties of Laplace transform, Continuous-time and discrete-time Fourier series, Continuous-time and discrete-time Fourier Transform, DFT and FFT, Sampling theorem.
2. **Formalizing signals:**Energy and power signals, Signal properties: periodicity, Absolute integrability, Determinism and stochastic character, Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, Some special time-limited signals; continuous and discrete time signals, Continuous and discrete amplitude signals.
3. **Formalizing systems:**System properties: linearity: additivity and homogeneity, Shift-invariance, Causality, Stability, Realizability.
4. **Z-transformation:** Definition, Mapping between s-plane and z-plane, Unit circle, Convergence and ROC, Properties of z-transform,z-transform on sequences with examples,Characteristic families of signals along with ROCs, Convolution, Correlation and multiplication using z-transform, Initial value theorem, Persevals relation, Inverse z-transform by contour integration, Power series & Partial-fraction expansions with examples.

Control Systems:

1. **Introduction to Control Systems:** Introduction to automatic control, Open loop and Closed loop control systems, Mathematical modeling of a system: Block diagrams, Block diagram reduction techniques, Signal flow graph and its construction; Mason's gain formula, Different feedback

characteristics of control system.

2. **State Variable Analysis:** State variable model and solution of state equation of LTI systems, State Transition Matrix (STM).
3. **Stability** – BIBO stability criterion, Routh-Hurwitz criterion.
4. **Time Domain Analysis**:Steady state error, Steady state and transient response of a system.
5. **Root Locus Analysis and design:** Root-locus principles; construction techniques of root-locus; properties of root-locus and root-locus design.
6. **Frequency Domain Analysis:** Frequency response of Closed Loop Systems, Frequency- Domain specifications, Bode plots, Nyquest criterion.
7. **Controllers:** Error amplifier, on-off controller, Proportional (P), Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers, Dynamic behavior of control systems, Servomechanism characteristics parameters of control systems – Accuracy, Sensitivity, Disturbances, Transient response.
8. **Introduction to Digital Control system:** PLC & Application Case Studies: Speed control of DC Motors, Temp control.

Recommended Books:

1. Signal and Systems, H. P. Hsu, **Tata McGrawHill**
2. Signal and System, Oppenheim, Willsky, Nawab,**PHI**
3. Control Systems engineering, Nagrath & Gopal, **NewAge**
4. Modern Control Engineering, Ogata**PHI/Pearson**
5. Control Systems Engineering, R. Anandanatarajan & P.Ramesh babu, **Scitech**

Semester – II: ELTPCOR09T: Computational Skill for Electronics

Course Outcome:

Students after successfully completion of the course will be able to:

- To impart the skill of programming in Python
- To impart knowledge on solving scientific numerical problems
- Since this is one of the most widely used language in academics and industry a good programming skill in python will enhance the employability of the students in different research labs, IT sector and also in the field of educational content development

Language to be used for learning the following basic principles is Python

Constants and Variables, Controls, std I/O, data structures like list, tuple, string, directory, set, user defined functions, functions with default arguments, functions with arbitrary arguments. Lamda function, list comprehension, Class, methods (with self and also with self-other), instantiation, inheritance, operator overruling, Numpy, Scipy, Matplotlib and Sympy, Solution of numerical problems.

Recommended Books:

1. Python Crash Course, Eric Matthes , No Starch
2. Python for beginners. https://stackoverflow.com/questions/18754276/python-for-beginners

Semester – II: ELTPCOR10P: Lab 3: Digital Circuits

Course Outcome:

Students after successfully completion of the course will be able to:

- Design Combinational circuits
- Design Sequential circuits

The following or similar experiments will be offered to students under this Practical paper.

A. Combinational

1. Design a multiplier circuit using the 4-16 line decoders (74154) that will multiply two bit binary number
2. Keyboard encoder design using a decoder and a multiplier.
3. Using parallel connection method of 7485 IC chips to compare two 9 bit binary numbers.
4. Design a parallel binary multiplier for the multiplication of two 4 bit numbers , using the 4 bit CLA address IC 7483 or 74283 and a number of sufficient number of NAND gates.
5. Design a four digit multiplexed LED display using a single common anode BCD to seven segment decoder drive(7447).
6. Design a logic circuit using a decoder and necessary logic gates to allow the 4 bit binary numbers that are divisible by three but less than or equal to 12 and greater than two.
7. Construct a circuit that add two BCD numbers and produces a BCD sum.

B. Sequential

8. Design a 4 bit synchronous counter which should start continue from 5 when the power is switched on to the counter and should count up to 10 , after which should count down to 5 again. This process of counting from 5 to 10 and back should continue so long as power is on. Draw and explain the logic circuit & logic diagram for this circuit.
9. Implement a logic circuit of hybrid MOD-10counter.
10. Mod 64 BCD counter using 74160ICs.
11. Design a MOD-10 counter using 74190 counters .Use both up & down counting mode. Show the

counters sequence.

12. A 4 bit up/down counter using Ex-OR gates between two consecutiveT-flip-flops.
13. 4 bit bidirectional shift register using 4 D-flip-flops & 4-2:1multiplexer.
14. Shift register Experiments
15. Ring counter experiment

Semester – II: ELTPSEC01T: Internet of Things

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand the concepts of Internet of Things
- Analyze basic protocols in wireless sensor network
- Design IoT applications in different domain and be able to analyze their performance
- Implement basic IoT applications on embedded platform

1. **Introduction to IoT:** Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.
2. **IoT&M2M:** Machine to Machine, Difference between IoT and M2M, Software define Network.
3. **Network & Communication aspects:** Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation &dissemination.
4. **Challenges inIoT:** Design challenges, Development challenges, Security challenges, other challenges.
5. **Domain specific applications of IoT:** Home automation, Industry applications, Surveillance applications, Other IoT applications.
6. **Developing IoTs:** Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.

Types of IoT Jobs

1. Professional in Sensors and Actuators
2. Embedded Programs Engineer
3. The Internetz Spine
4. Software Program Engineering
5. Safety Engineering

Career opportunities in the Internet of Things:

1. Data analytics
2. Network and Structure
3. Protection
4. Device and Hardware
5. Cell and UI development

Recommended Books:

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach"

2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

Semester – III

Semester – III: ELTPCOR11T: Electromagnetic Field and Radiation

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand Maxwells's equation in time varying field
- Understand concepts of different coordinate systems, static electric and magnetic fields and methods of solving for the quantities associated with these fields, time varying fields and displacement current, propagation of electromagnetic waves and their applications in practical problems
- Learn RF/microwave analysis methods and design techniques
- Understand an overview of Passive and active devices

1. **Electrostatics:** Vector Calculus, Electric flux density, Coulombs law, Electric scalar potential, Gauss's law and its applications, Boundary conditions, Laplace's and Poisson's equations.
2. **Magnetostatics:** Magnetic flux density, BiotSavart's law, Ampere's circuital law, Magnetic scalar and vector potential.
3. **Time-Varying Electromagnetic Fields:** Maxwell's equations for static EM fields and wave equations, Plane wave propagation in free space, Dielectric and conductors, Faraday's laws of inductions, Transformer and Motional EMFs, Pointing theorem, Reflection and refraction of waves, Concept of polarization, Interference, Coherence and diffraction.
4. **Propagation of Waves:** Wave propagation in different media, Propagation through ionosphere, Effects of earth's magnetic field on ionospheric propagation.
5. **Transmission Line:** Parameters of Transmission line and its equations, Impedance, Reflections and Voltage standing wave ratio, Impedance matching process, Smith Chart and its application.
6. **Wave Guide:** Wave propagation in rectangular and cylindrical wave guides, TE,TM,TEM modes, Wave

guide coupling, Excitation of modes, Impedance measurements.

7. **Antenna:** Basic antenna parameters-Gain, Directivity, Radiation intensity, Effective area, Retarded potential, Hartzian dipole Half-wave antenna, Antenna with parabolic reflectors, Horn antennas, Lens antennas, Wide band and special purpose antennas, Helical antennas, Log-periodic antennas, Loop antennas, Practical transmitting antennas, Behavior of receiving antennas, Micro strip Patch Antenna, Printed Dipole, Frii's free space receiver power equation.

8. **Microwave:** Introduction to microwaves and their applications; Klystron amplifiers: operation and analysis, Power and efficiency, Multi cavity klystron, Reflex klystrons: operation and analysis, Electronic admittance, Electronic tuning, Power output and efficiency, Magnetrons: operation and analysis, Travelling wave tubes: operation, gain bandwidth, Coupling and focusing methods, applications, Avalanche Diode, Gunn effect and Gunn diode oscillators, Solid state microwave amplifiers, Oscillators (IMPATT & MESFET) and mixers, Microwave components: attenuator, Phase shifter, Slotted lines, Frequency meter, Directional couplers, E-plane Tee, Magic Tee and Ferrite devices; Basic measurements of frequency, SWR, Impedance and power at microwave frequencies; Principles of microwave LOS communication, Introduction to RADAR-Block diagram, Frequencies and power used in Rader, Ranging equation.

Recommended Books:

1. Antenna Theory and Design, Elliott,**Wiley**
2. Foundation of Microwave Engineering, R.E. Collin,**Wiley**
3. Microwave Engineering, D.M. Pozar,**Wiley**

Semester – III: ELTPCOR12T: Electronic Communication Systems

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand different blocks in communication system and how noise affects communication using different parameters
- Distinguish between different amplitude modulation schemes with their advantages, disadvantages and applications
- Analyze generation and detection of FM signal and comparison between amplitude and angle modulation schemes
- Understand PCM, DPCM, ASK, FSK, PSK

1. **Random Signals and Noise:** Probability, Random variables, Probability density function, Autocorrelation, Power spectral density.

2. **Analog Communication Systems:** Amplitude and angle modulation and demodulation systems, Spectral analysis of these operations, Super heterodyne receivers; Elements of hardware, Realizations of analog communication systems; TDM, FDM, signal-to-noise ratio (SNR) calculations for amplitude modulation (AM, QAM) and frequency modulation (FM) for low noise conditions, PAM, PPM, PWM, Fundamentals of information theory and channel capacity theorem.
3. **Digital Communication Systems:** Pulse code modulation (PCM), Differential pulse code modulation (DPCM), Delta modulation, Adaptive Delta Modulation, Digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), Matched filter receivers, Bandwidth consideration and probability of error calculations for these schemes, Basics of TDMA, FDMA and CDMA and GSM.

Recommended Books:

1. Principles of Communication Systems, Taub, Schilling, Saha, **Tata McGrawHill**
2. Communication Systems, Simon Haykin,**Wiley**
3. Modern Digital and Analog Communication Systems, Lathi**, Oxford**
4. Digital Communications, Ch. K. Rekha, **Scitech**

Semester – III: ELTPCOR13T: Digital Signal Processing

Course Outcome:

Students after successfully completion of the course will be able to:

- Interpret, represent and process discrete/digital signals and systems
- Determine the discrete Fourier transform of discrete-time signals
- Design & analyze DSP systems like FIR and IIR Filter

1. **Discrete-Time Signals:** Concept of discrete-time signal, Basic idea of sampling and reconstruction of signal, Sampling Theorem sequences –Periodic,Eenergy, Power, Unit-sample, Unit-step, Unit-ramp, Real &complex exponentials, Arithmetic operations on sequences.
2. **Discrete Fourier Transform:** Brief recapitulation of Fourier Series, Concept and relations for DFT/IDFT, Twiddle factors and their properties, Computational burden on direct DFT, DFT / IDFT as linear transformations, DFT/IDFT matrices, Computation of DFT/IDFT by matrix method, Multiplication of DFTs, Circular convolutions, Computation of circular convolution by graphical, DFT/IDFT and matrix methods, Linear filtering using DFT, Aliasing error, Filtering of long data sequences – Overlap-Add & Overlap Save methods with examples and exercises.
3. **Fast Fourier Transform:** Radix-2 algorithm, Decimation –in time and decimation-in-frequency

algorithms, Signal flow graphs, Butterflies, Computation in one place, Bit reversal, Examples and exercises.

4. **Filter Design:** Basic concepts behind IIR and FIR filters, Butterworth IIR analog filter, Impulse Invariant and Bilinear transforms, Design of IIR digital filter, Design of linear phase FIR filter with rectangular window.
5. **Digital Signal Processor:** Elementary idea about the architecture and important instruction sets of TMS320C 5416/6713 processor (any one), Writing of small programs in Assembly Language.

Recommended Books:

1. Digital Signal Processing – Principles, Algorithms and Applications, J.G. Proakis, D.G.Manolakis, **Pearson Education/PHI**
2. DigitalSignalProcessorsArchitectures,ImplementationsandApplications,S.M.Kuo,W.Gan, **Pearson Education**

Semester – III: ELTPDSE01T: Optoelectronics

Course Outcome:

Students after successfully completion of the course will be able to:

- Acquire fundamental understanding of the basic physics behind optoelectronic devices
- Develop basic understanding of light emitting diodes
- Develop detailed knowledge of laser operating principles and structures
- Acquire in depth understanding of photodetectors
- Describe basic laws and phenomena that define behaviour of optoelectronic systems
- Use optical fibre equipment, and data transfer using optical fiber

1. **Introduction to Fiber Optic Communication**: Importance, Generation of fiber optic communication.
2. **Optical Fiber:** Classification of optical fibers, Light propagation in optical fiber, Optical fiber as cylindrical waveguide, Modes, Characteristics parameters, Fiber Losses, Dispersion, Fiber losses, Fiber splicing, Noise control in optical fibers.
3. **Optical Sources:** LED characteristics, Characteristics of LED-based transmitter, Spontaneous emission, Stimulated emission, Einstein's co-efficients, Light amplification, Lasing condition, Population inversion, Line broadening mechanisms, Rate equations, Three and four level systems, Variation of laser power around threshold, Optical resonators, Quality factor, Stability of resonators, Mode selection, Mode locking, q-switching, Semiconductor Diode LASER, Amonioum laser, Ruby laser, He-Ne Laser, Application of lasers.
4. **Photodetectors:** p-n photodiode, Characteristics of optical receivers, PIN photodiode, Phototransistors

5. **Devices:** Optocouplers, Fiber Optic Switches, Repeaters, Amplifiers.
6. **Fiber Optic Communication System:** Coupling to and from the fiber, Modulation, Multiplexing and coding, Repeaters, Bandwidth and Rise-time budgets.
7. **Measurements:** Numerical aperture of optical fiber, Fiber attenuation, Bending losses, Bandwidth measurement.

Recommended Books:

1. Optical Fibers and Fiber Optic Communication Systems, Subir K. Sarkar, **S.Chand**
2. Fiber-Optic Communication Systems, Govind P. Agrawal,**Wiley**
3. An Introduction to Fiber Optics, A Ghatak and K. Thyagarajan, **Cambridge University Press**

Semester – III: ELTPDSE02T: Microprocessor Fundamentals

Course Outcome:

Students who successfully complete the course will be able to:

- Describe the general architecture of a microcomputer system and architecture & organization of 8085 and understand the difference between 8085 and advanced microprocessor
- Understand and realize the Interfacing of memory & various I/O devices with 8085 microprocessor
- Understand and classify the instruction set of 8085 microprocessor and distinguish the use of different instructions and apply it in assembly language programming
- Understand the architecture and operation of Programmable Interface Devices and realize the programming & interfacing of it with 8085 microprocessor

1. **Introduction:** Microprocessor architecture and its operations, Memory, Input and Output Devices.
2. **Memory Interfacing:** The 8085 MPU, Memory interfacing, Interfacing the 8155 Memory Segment.
3. **Interfacing I/O Devices:** Basic interfacing concepts, Interfacing output displays, Interfacing Input devices, Memory – Mapped I/O
4. **Counters and Time delays:**Counters and Time delays, Illustrative Program.
5. **Stack and Subroutines:** Stack, Subroutine, Restart, Conditional call and Return instructions.
6. **Interrupts:** 8085 Interrupts, 8085 Vectored interrupts.
7. **Interfacing Data Converters:** Digital to Analog (D/A) Converters, Analog to Digital (A/D) Converters.
8. **Serial I/O and Data Communication:** Baic concepts in Serial I/O, SOD and SID, Hardware Controlled serial I/O using Programmable Chips.

Recommended Books:

1. Microprocessor Architecture, Gaonkar, **PRI**
2. Microprocessor Architecture, Programming & Application, R. Gaonkar, **Wiley**
3. Microprocessors and Microcontrollers, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, **Oxford University Press**

Semester – III: ELTPCOR14P: Lab 4: Electronic, Fiber Optic and Microwave Communication

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand the operation of Electronic Communication trainer kit
- Understand the operation of Optical Communication trainer kit
- Understand the experiments on Microwave Communication

The following or similar experiments will be offered to the students under this Practical paper.

A. ElectronicCommunication

1. Amplitude Modulation/Demodulation using Trainer Kit.
2. Frequency Modulation/Demodulation using Trainer Kit
3. ASK Modulation/Demodulation using Trainer Kit
4. PSK Modulation/Demodulation using Trainer Kit
5. PWM Modulation/Demodulation using Trainer Kit
6. PAM Modulation/Demodulation using Trainer Kit.
7. PCM Modulation using Trainer Kit
8. FSK Modulation/Demodulation using Trainer Kit

B. OpticalCommunication

9. Experiments on Analog Optical Communication using Trainer Kit
10. Experiments on Digital Optical Communication using Trainer Kit
11. Experiments with laser: Acquaintance of laser safety criteria, alignment of laser, setting up of a beam expander, power distribution of the beam, spot size, coherence length, divergence angle etc.

C. Microwave Communication

Microwave measurements: Power, Frequency, Wavelength, Impedance, Attenuation etc.

Semester – III: ELTPGEC01T: Quantum Computing

Course Outcome:

Students after successfully completion of the course will be able to:

- Develop concept on quantum logic and qubit
- Develop concept on quantum gate and its operation and designing quantum circuits
- Develop concept on quantum algorithm and its application in quantum computing
- Develop concept on quantum noise, quantum error correction and detection, and quantum error correcting codes
- Develop concept on quantum teleportation and its application in quantum information processing.
- Develop concept on quantum communication
- Develop concept on quantum cryptography

Introduction to quantum computing: Quantum logic,Qubits (single qubits and multiple qubits), Bloch sphere representation of qubit, Quantum circuits.

Background Mathematics and Quantum Physics: Linear algebra, Hilbert space, Probabilities and measurements, Entanglement, Density operators and correlation, Basics of quantum mechanics; Measurements in bases other than computational basis.

Quantum Circuits: Single qubit gates, Multiple qubit gates, Design of quantum circuits.

Quantum Algorithms: Classical computation on quantum computers; Relationship between quantum and classical complexity classes;Quantum Fourier transform, Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization algorithm, Grover search algorithm.

Physical realization of Quantum Computer: Condition for quantum computation, Harmonic oscillator quantum computer; Realization of qubits: Optical photon, Trapped ions, Nuclear magnetic resonance, Superconducting materials etc.

Noise and error correction: Graph states and codes, Quantum error correction, Fault-tolerant computation.

Entropy and information : Basic properties of entropy, Shannon entropy, Von Neumann entropy, Strong subadditivity.

Quantum Information and Cryptography: Comparison between classical and quantum information theory; Bell states,Quantum teleportation,Quantum cryptography, No cloning theorem.

Semester – IV: ELTPCOR15T: Instrumentation

Course outcome:

Students after successfully completion of the course will be able to:

- Impart knowledge on electronic measurement system
- Impart knowledge on the methods of measuring different physical quantities
- Impart knowledge on measuring instruments

1. **Measuring Equipment** – Measurement of R, L and C, Bridge and Potentiometers, voltage, current, power, energy, frequency/time, phase, Digital Multimeters, CRO, Digital Storage Oscilloscope, Spectrum Analyzer.
2. **Transducers** – Resistance, Inductance, Capacitance, Piezoelectric, Thermoelectric, Hall Effect, Photoelectric, Measurement of displacement, velocity, acceleration, force, strain, temperature.
3. **Biomedical Instruments** – ECG, EEG, Blood Pressure Measurements, MEMS and its applications Sensors for IoT applications.

Recommended Books:

1. Instrumentation and Control Systems, Katta Narayan Reddy & Palakodeti Sri Rama Krishnudu, **Scitech Publication**
2. Modern Electronic Instrumentation & Measurement Technique, Helfrick & Cooper, **PHI**
3. Fundamentals of Industrial Instrumentation, Alok Barua,**Wiley**
4. Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney, **DhanpatRai**

Semester – IV: ELTPCOR16T: VLSI and PowerElectronics

Course Outcome:

Students after successfully completion of the course will be able to:

- Acquire a clear idea about fabrication process of CMOS technology
- Know various logic methods and their limitations as well as the circuit design using VLSI Technology
- Know the principle of operation, design and synthesis of different power conversion circuits and their applications

A. VLSI:

1. **Introduction:** Era of integrated circuits, Introduction to ICtechnology.

2. **Passive device fabrication:** Fundamentals of passive devicefabrication.
3. **VLSI Fabrication:** Introduction, Crystal growth, Wafer preparation, Oxidation, Diffusion, Ion implantation, Lithography, Epitaxy, Etching, Polysilicon and dielectric film deposition (isolation), Metallization, Yield andReliability.
4. **MOS Operation and Fabrication:** Structure and characteristics of E-MOSFET and D-MOSFET, Operation of MOS transistor, Modeling of MOS (MOS transistor circuit model and Small-Signal equivalent model of MOSFET), Layout design rules, Brief of NMOS and CMOS fabrication, BiCMOS inverter and brief of BiCMOS fabrication.

B. PowerElectronics

1. **Characteristics of solid state power devices:** Diac, Triac, SCR, UJT, Thyristors, Heat sinks for power devices.
2. **Regulated power supply:** Supply characteristics (Load & line regulation, output resistance, efficiency etc.), Shut regulators, Series regulators, Monolithic linear regulators (applications of 78XX, 89XX, 723).
3. **Circuits:** Full-wave rectification by SCR, Triggering, Converters, Choppers, Inverters, AC regulators, speed control of a.c. and d.c. motors, GTO switch.
4. **Control:** Stepper motor, Synchronous motor, Three-phase controlled rectifier, Switch mode power supply, uninterrupted power supply.

Recommended Books:

A: VLSI

1. Principles of VLSI and CMOS Integrated Circuits, R. Jain, A. Rai, **S.Chand**
2. Fundamentals of Semiconductor Fabrication, G.S. May, S.M. Sze,**Wiley**
3. CMOS VLSI Design: A Circuit & Systems Perspective, Neil H.E. Waste, K. Haase, D. Harris, A. Banerjee, **Pearson Education**

B: Power Electronics

1. Electronic Devices and Circuits, A. K. Maini and V. Agrawal,**Wiley**
2. Electronic Principles, A. Malvino, D. J. Bates **Tata McGrawHill**

Semester – IV: ELTPDSE03T: Advanced Microprocessor

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand basic architecture of 16 bit and 32 bit microprocessors

- Understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design
- Understand techniques for faster execution of instructions and improve speed of operation and performance of microprocessors
- Understand RISC and CISC based microprocessors

1. **Architecture of 8086/8088 microprocessors:** 8086-pin Configuration, Bus Interface Unit, Execution Unit, Memory organization.
2. **Instruction Set:** Addressing modes, software model, instruction sets, classification of instructions, Instruction Templates.
3. **Interfacing:** Basic concept in interfacing, Memory interfacing, I/O interfacing, Interfacing of support chips, Interfacing of ADC, DAC , Keyboards, Displays etc.
4. **Interrrupts of 8086:** Classification of Interrupts,Classification and response of Interrupts of 8086.

Recommended Books:

1. Microprocessor Architecture, Programming & Application, R. Gaonkar,**Wiley**
2. Microprocessors and Microcontrollers, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, **Oxford UniversityPress**
3. 8086/8088 Family, The Design, Programming and Interfacing, Uffenbeck,**PHI**

Semester – IV: ELTPDSE04T: Microcontroller

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand about the concepts and basic architecture of 8051
- Write assembly language program in 8051 for various embedded system applications
- Understand interfacing of different peripheral devices to 8051

1. **Introduction to Microcontroller:** 8051 microcontroller, 8051 pin description connection, I/O ports memory & memory organization.
2. **Instructions Set of Microcontroller 8051:** Addressing modes & instruction set.
3. **Programming and Interfacing of 8051:** Introduction, general programming example, Timer/Counter programming Examples, Interfacing example.
4. **Industrial applications of Microcontroller:** Traffic Control, Stepper motor,Scrolling.

Recommended Books:

1. Microprocessors and Microcontrollers, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, **Oxford UniversityPress**
2. Microcontroller & Microprocessor, Krishnakant,**PHI**
3. The 8051 Microcontroller, Kenneth Ayala, **CengageLearning**

Semester – IV: ELTPCOR17P: Lab 5: Microprocessor and Microcontroller

Course Outcome:

Students after successfully completion of the course will be able to:

- Understand the operation of typical microprocessor trainer kit
- Solve different problems by developing different programs
- Develop the quality of assessing and analyzing the obtained data

The following or similar experiments will be offered to the students under this Practical paper.

B. Microprocessor

1. Write an ALP to move data block starting at location ‘X’ to location ‘Y’ without overlap.
2. Write an ALP to move data block starting at location ‘X’ to location ‘Y’ with overlap.
3. Write an ALP to arrange 08-Bytes of data in descending order.
4. Write an APL to arrange 8-bytes of data in ascending order. The data is stored in memory location of which the starting address is 9050H.
5. Write an APL to convert BCD number to binary number.
6. Write an ALP to convert binary number to BCD number.
7. Write an ALP to add two BCD numbers.
8. Write an ALP to implement a counter '00-99' (UP COUNTER) in BCD.
9. Write an ALP to implement a counter 'FF-00' (UDOWN COUNTER) in HEX.
10. Write an APL to implement ‘throw a dice’ using interrupt.
11. Write an APL to implement a real time clock.
12. Write an APL to implement multiplication by shift and add method.
13. Write an APL to find the product of two unsigned binary numbers stored at location ‘X’ and ‘X+1’ using successive addition and store the result.
14. Write an APL to find the smallest of ‘N’ 1-byte numbers. Value of N is stored in location ‘X’ and numbers from ‘X+1’. Display the number in data field and its address field.
15. Write an APL for HEX to ASCII character conversion.
16. Write an APL for ASCII to HEX conversion.
17. Generation and displaying of Triangular Wave in CRO by interfacing 8085-Trainer-Kit (use DAC at

Port 3 of the trainer kit, connect 'Out2' of DAC toCRO).

C. Microcontroller

18. A set of 100 bytes of data is available in memory in the form of signed numbers. Write a program to find the sum of all positive numbers. Use 8051Trainer-Kit.
19. Solve the following expression using 8051Trainer-Kit:

$$F = \frac{C*9}{5} + 32$$

20. Write an ALP for HEX to ASCII Character conversion using 8051Trainer-Kit.
21. Write an ALP for ASCII to HEX conversion using 8051Trainer-Kit.
22. Interfacing a 'Keyboard' with the 8051 Microcontroller Trainer Kit. Write ALP to test the'Keyboard'

Semester – IV: ELTPCOR01M: Project

1. **Topic:** Many Project topics will be given to the students at the beginning of 3rd semester and or at the beginning of 4th semester.
2. **Presentation:** Each student needs to present seminar on their allocated Project topic. Additional time will be allocated for question answer session to each student.