# Semester

# V

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| **Name of the Program**: B.Tech. in ECE | **Year**: III Year | **Semester**: V |
| **Course Name:** Microwave Theory and Techniques | **Course Code**: ECUL501 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **TRANSMISSION LINE:** Equations of Voltage and Current, Propagation constant and characteristic impedance, reflection coefficient and VSWR, Smith Chart, Impedance Matching.<br>**REVIEW OF ELECTROMAGNETICS**: Maxwell's Equations, Wave Equation, Poynting Vector, Introduction to uniform plane waves and its propagation, Boundary Conditions, Wave Polarization.<br>**INTRODUCTION TO MICROWAVES:** Overview of Microwaves, Microwave Frequency bands, Applications of Microwaves | 10 |
| 3 | **MICROWAVE TRANSMISSION LINES:** Waveguides- Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Attenuation in waveguide, Circular Waveguides<br>Planar Transmission Lines-Strip lines, Microstrip line, Parallel coupled strip lines and Slot lines, Coplanar Lines | 8 |
| 4 | **MICROWAVE NETWORK ANALYSIS:** Scattering matrix, Parameters of reciprocal and Loss less networks, Scattering matrices of typical two-port, three-port and four-port networks, ABCD Matrix, Conversion between S matrix and ABCD matrix | 6 |
| 5 | **MICROWAVE COMPONENTS:** Passive and Active Microwave Devices-Microwave passive components: Directional Coupler, Power Divider, Magic Tee Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky diodes, PIN diodes<br>Microwave Tubes: Klystron, TWT, Magnetron.<br>Microwave Filters. | 12 |
| 6 | **MICROWAVE MEASUREMENTS:** Detection of microwaves, Microwave power measurement, Impedance measurement, Measurement of reflection loss (VSWR), and transmission loss in components. Network Analyzer, Spectrum Analyzer.<br>**MICROWAVE SYSTEMS**: Modern Trends in Microwaves Engineering, Effect of Microwaves on human body, Monolithic Microwave ICs, Microwave Imaging | 8 |
| Total | | **45** |

**Text Books:**

1. Das and S. Das, Microwave Engineering, Tata McGraw-Hill, 4th edition, 2020
2. D. M. Pozar, Microwave Engineering, John Wiley & Sons, 4th edition, 2011
3. S.Y.Liao, Microwave devices and circuits, Prentice Hall, 3rd Edition, 2003
4. R. K. Shevgaonkar, Eletromagnetic Waves, Tata McGraw Hill, 1st edition 2017.

**Reference Books:**

1. B. Bhat and S. K. Koul, Stripline-like Transmission Lines for Microwave Integrated Circuits, New Age International Pvt Ltd Publishers, 1st ed, 2007
2. T. C. Edwards, Foundations for Microstrip Circuit Design, John Wiley & Sons, 4th edition ,2016
3. Robert E. Collin, Foundations for microwave engineering, Wiley Publication, 2nd edition, 2007

**Prerequisite:**

1. Mathematical vector analysis
2. Knowledge of two port circuit parameters and matrix analysis
3. Working of various semiconductor devices

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| **Name of the Program:** B. Tech. in ECE | **Year:** III | **Semester:** V |
| **Course Name:** Control System | **Course Code:** ECUL502 | **Credit:** 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **Control System Concepts and Classification:** Open loop, closed loop system, Industrial Control examples, Impulse response and transfer function, block-diagram model and signal flow graphs. | 8 |
| 3 | **Mathematical Models of Systems:** Electrical and Mechanical Transfer Function, Control hardware and their models: Potentiometers, LVDT, Servomotors (DC & AC), Tacho-generators, Hydraulic actuator, Pneumatic actuating valve | 6 |
| 4 | **Time domain analysis:** Transient response and steady state Response, Measures of performance of the standard first order and second order system, steady state errors and error constants, Modes of feedback control: proportional, integral and derivative, PID, Stability – Concept and definition, Poles, Zeros, Order and Type of systems, R-H criteria, Root locus analysis. | 12 |
| 5 | **Frequency domain response:** Performance specifications in the frequency domain: Phase margin and gain margin, Bode plot, Polar plot and Nyquist plot, Stability analysis in frequency domain, Compensation of control systems: Phase-Lead compensation, Phase-Lag compensation, Lead - Lag compensation | 12 |
| 6 | **State variable Analysis:** Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability. | 6 |
| | Total | **45** |

**Text Books:**

1. I. J. Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 6th Edition, 2017.
2. B.S. Manke ; Linear Control Systems with MATLAB Applications, 12th Edition,2016.

**Reference Books:**

1. Ogata, K., "Modern Control Engineering", Pearson Education, 5th Edition, 2009,
2. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, New Jersey, USA 8th Edition, 2020,
3. Benjamin. C. Kuo, "Automatic Control Systems", Prentice Hall of India, 10th Edition, 2017.
4. Gopal, M., "Modern Control System Theory", New Age International Publishers, 3rd Edition, 2015.
5. A.K. Jairath, "Problems and solutions of control systems with essential theory" CBS Publishers, 7th Edition, 2021
6. S.K. Bhattacharya, "Control System Engineering", Pearson, 3rd Edition, 2013

**Prerequisite:**

1. Basic knowledge of Signal System

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| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: V |
| **Course Name:** Digital Signal Processing | **Course Code**: ECUL503 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **Discrete time signals:** Discrete time signal or sequences, Basic Operations on Discrete-time signals, Basic System Properties. DTFT, Sampling and reconstruction of signals, Z-Transforms, Convolution Property, Analysis of LTI system. | 7 |
| 3 | **DFT:** Discrete Fourier Transform (DFT), Inverse DFT, Properties of the DFT.<br>Fast Fourier Transform (FFT), Decimation-in-Time and Decimation-in-Frequency FFT Algorithms | 8 |
| 4 | **Infinite Impulse Response (IIR) Filters:** IIR Filter Design by Impulse Invariant Method. IIR Filer Design by Bilinear Transformation. Butterworth Filters. Chebyshev Filters. Elliptical Filters. Frequency Transformation. Realization of IIR Filter-Direct Form -I, Direct Form-II, Cascade Form, Parallel Form | 10 |
| 5 | **Finite Impulse Response (FIR) Filters:** Linear Phase filter – windowing techniques – Rectangular, Hamming, Hanning, Blackman, Bartlett, and Keiser. Realization of FIR Filters.: Direct form, Cascade Form | 10 |
| 6 | **Effect of Finite Register Length. Quantization, Multirate Digital Signal Processing:** Sampling rate converters Decimator, Interpolator Poly phase decomposition. Parametric and non-parametric spectral estimation. Applications of DSP | 9 |
| | Total | **45** |

**Text Books**

1. V. Oppenheim & R.W. Schafer, Discrete-Time Signal Processing, 3rd Edition, Pearson, 2010
2. J.G. Proakis & D.G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 5th Edition, Pearson, 2021.

**Reference Books**

1. A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, *Signals and Systems*, 2nd Edition, Pearson Education, 2015.
2. Sanjit K. Mitra, *Digital Signal Processing: A Computer-Based Approach*, 5th Edition, McGraw Hill Education, 2021.
3. Emmanuel C. Ifeachor and Barrie W. Jervis, *Digital Signal Processing: A Practical Approach*, 2nd Edition, Pearson Education, 2002.

**Prerequisite:**

1. Basic idea of linear algebra and complex numbers
2. Calculus: Differentiation, Integration

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| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: V |
| **Course Name:** Power Electronics | **Course Code**: ECUL504 | **Credit**: 2 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (30) + TW & SL(30) = 60 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **Semiconductor Power Devices:** Introduction, Basic characteristics & working of Power Diodes, DIAC, TRIAC, MOSFETs, IGBT, GTO, Power Transistor and SCR- Principle of operation, V-I Characteristics, Turn-on mechanism and its applications, | 7 |
| 3 | **Phase Controlled Rectifiers:** Basic concept, Working Principles of Single-phase Half wave bridge rectifier, Single phase Full bridge rectifier and Three phase bridge rectifiers | 5 |
| 4 | **Inverters:** Voltage Source Inverters, Three Phase Voltage Source Inverters, PWM Control of Voltage Source Inverter and applications, PWM Inverter types (half and full bridge) and comparison of their performance, Current Source Inverters | 5 |
| 5 | **Industrial Power Supplies:** Operating Principle of choppers, Step-up, Step down and reversible choppers. Control techniques for choppers – TRC and CLC, Cyclo converters<br>Switch Mode Power Supply: Buck converters, Boost converters and Buck-boost converters, Uninterruptible Power Supply | 7 |
| 6 | **Motor Control:** Introduction to speed control of DC motors using phase-controlled converters and choppers, Basic idea of speed control of three phase induction motors using voltage and frequency control methods.<br>Industrial Applications and Future Scope of Power Electronics | 5 |
| | Total | **30** |

**Text Books:**

1. Power electronics: converters, applications, and design, Ned Mohan, Tore M. Undeland, John Wiley &Sons., 3rd edition, 2003
2. Power Electronics, P. S. Bimbhra, Khanna Publishers, 7th edition, 2022
3. Power Electronics, M.D. Singh, K B Khanchandani, TATA McGraw Hill, 2nd edition, 2017
4. Power Electronics: Converters, Applications and Designs, Mohan, Robbins, Wiley, 3rd edition, 2022

**Reference books:**

1. Power Electronics: Circuits, Devices, and Applications, Rashid, Pearson, 4th edition, 2017
2. Power Electronics- Devices, Converters and Applications, Vedam Subramanyam , New Age Publications, 2nd edition, 2018
3. Modern Power Electronics & AC Drives, B. K. Bose, Pearson Education, 1st edition, 2015
4. Elements of Power Electronics, Krein, Oxford, 2nd edition, 2017

**Prerequisite:**

1. Basics of Electronic Devices and Circuits
2. Basics of Network theory

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| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: V |
| **Course Name:** Information Theory and Coding | **Course Code**: ECUL511 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **Introduction:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **Information Theory:** Concept of information, Uncertainty, and Entropy, Properties of entropy and its significance, Joint information, Conditional information, and Mutual Information, Information rate and redundancy | 8 |
| 3 | **Source Coding:** Source coding theorem, Prefix codes and Kraft inequality, Shannon–Fano coding, Huffman coding and efficiency, Arithmetic coding, Run-length and dictionary coding (Lempel–Ziv) | 8 |
| 4 | **Channel Capacity and Coding Theorem:** Discrete memoryless channel (DMC), Channel transition probabilities and mutual information, Channel capacity theorem, Binary symmetric channel, binary erasure channel, Continuous channels and Gaussian channel capacity, Shannon's limit and implications | 8 |
| 5 | **Error Control Coding — Linear Block Codes** Linear Block codes, Repetition Codes, Syndrome Decoding, Hamming Codes, Cyclic Codes, BCH Codes, Burst-error correction codes | 8 |
| 6 | **Convolutional and Advanced Codes:** Convolutional codes: structure, generator matrix, State diagrams, trellis, and Viterbi decoding, Introduction to Turbo codes and LDPC codes, Reed–Solomon codes and applications, Performance comparison of coding schemes, Applications in modern communication systems (5G, optical links) | 12 |
| | Total | **45** |

**Text Books:**

1. Ranjan Bose, *Information Theory, Coding and Cryptography*, 3rd Edition, McGraw Hill Education, 2016
2. Simon Haykin, *Communication Systems*, 5th Edition, Wiley, 2014.
3. John G. Proakis and Masoud Salehi, *Digital Communications*, 5th Edition, McGraw Hill, 2008.

**Reference Books:**

1. B. P. Lathi, *Modern Digital and Analog Communication Systems*, 4th Edition, Oxford University Press, 2010.T M Gover, J M Thomos, "Elements of Information Theory", Wiley, 1999.
2. Lin S. and Costello D. J., *Error Control Coding: Fundamentals and Applications*, 2nd Edition, Pearson, 2004.

**Prerequisite:**

1. Digital Modulation
2. Probability and Statistics
3. Linear Algebra

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| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: V |
| **Course Name:** Embedded System | **Course Code**: ECUL512 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **ESP32 FUNDAMENTALS:** ESP32 overview, ESP32 board and its variants, Comparison of ESP32 with other IoT enabled development boards, ESP32 programming basics, ESP32 peripherals, input/output, PWM, UART,I2c,SPI communication with ESP32, interfacing cameras and displays with ESP32, Network based protocols with ESP32: Wi-Fi, BLE and LoRaWAN | 9 |
| 3 | **STM32 FUNDAMENTALS:** STM32 microcontroller, GPIO programming and interfacing with LED, seven segment, LCD and keyboard. UART serial port programming, Timers and counters, ADC, DAC, sensor interfacing and signal conditioning, SPI and I2C, relay, DC and stepper motor interfacing. | 9 |
| 4 | **EMBEDDED SYSTEM:** Definition, History of Embedded Systems, Classification, Major Application Areas, Characteristics and Quality Attributes of Embedded Systems, Embedded Cores, Embedded Memories, Memory Shadowing, Onboard and External Communication Interfaces, Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer | 9 |
| 5 | **COMPONENT INTERFACING & NETWORKS:** Memory Interfacing, I/O Device Interfacing, Interrupt Controllers, Networks for Embedded systems- USB, PCI,PCI Express, UART, SPI, I2C, CAN, Wireless Applications - Bluetooth, Zigbee, Wi-Fi., 6LoWPAN, | 9 |
| 6 | **RTOS BASED EMBEDDED SYSTEM DESIGN:** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization, Device Drivers, How to Choose an RTOS. | 8 |
| | Total | 45 |

**Text Books:**

1. Asim Zulfiqar, Hands-on ESP32 with Arduino IDE, Packt Publishing Ltd., 2024.
2. Muhammad Ali Mazidi, Shujen Chen, Eshragh Ghaemi, STM32 Arm Programming for Embedded Systems: Using C Language with STM32 Nucleo, Microdigitaled, 2018.
3. Raj Kamal, Embedded Systems, McGraw Hill, 4th edition, 2023
4. Computers as Components : Principles of Embedded Computing System Design, 5th edition, Marilyn Wolf, Morgan Kaufmann Pub, 2022

**Reference Books:**

1. Ariel Lutenberg, Pablo Gomez, Eric Pernia, A Beginner's Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers, Arm Education Media, 2022.
2. Daniele Lacamera, Embedded Systems Architecture: Design and write software for embedded devices to build safe and connected systems, 2nd Edition, 2023

**Prerequisite:**

1. Digital systen design
2. Microprocessors and microcontroller Basics
3. C/C++ programming language

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| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: V |
| **Course Name:** Computer Architecture & Organization | **Course Code**: ECUL513 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite | 1 |
| 2 | **Basics of computer Architecture & organization:** Architecture and functional units of computer system, Basic operational concepts, Von-Neumann Architecture, Register & Bus Structures, Register Transfer Language, Types of instructions, Instruction Codes, machine-instructions and programs, Assembly language & Types of Assembler, Stacks, Ques & Subroutines | 8 |
| 3 | **CPU control unit design:** General register organization, Stack organization, Instruction format, Addressing Modes, Instruction sets: Data transfer & manipulation instruction, Program control, RISC & CISC architectures<br>**Micro-programmed Control:** Hardwired and micro-programmed design approaches, Address Sequencing, Micro-Program examples, Micro-instructions, Design of Control Unit. | 9 |
| 4 | **Data representation & Computer Arithmetic Circuit**: Information representation: signed number, fixed and floating point representations, Computer arithmetic –addition and subtraction of Signed numbers, multiplication & Division Algorithms, IEEE 754 floating point formats, Floating point addition/subtraction & Multiplication algorithm, Decimal Arithmetic Unit, ALU design | 9 |
| 5 | **Memory organizations**: Memory Hierarchy, Device characteristics, Memory Classification, Semiconductor Memories, RAM & ROM, Auxiliary Memory, Associative Memories, Concept of Cache Memory & their mapping techniques, Virtual memory, Page table & page replacement, Memory Management | 9 |
| 6 | **I/O Organization, Pipelining & Parallel Processing:** System organization, Input - Output systems, Standard I/O Interface Concept, Modes of Data Transfer, Priority Interrupt, IOP processor Interrupt, DMA, Basics of Pipelining, Concept of parallel processing, Forms of parallel processing | 9 |
| | Total | **45** |

**Text Books:**

1. M. Moris Mano, Computer System Architecture, 3rd edition, Pearson/PHI, India,(2006).
2. John P. Hayes, Computer Architecture and Organization, 3rd edition, Tata McGrawHill (1998).

**Reference Books:**

1. William Stallings (2010), Computer Organization and Architecture- designing for performance, 8th edition, Prentice Hall
2. Anrew S. Tanenbaum (2006), Structured Computer Organization, 5th edition, Pearson, Education Inc,
3. Carl Hamacher, Zvonks Vranesic, SafeaZaky (2002), Computer Organization, 5th edition, McGraw Hill, New Delhi, India.

**Prerequisite:**

1. Digital System Design
2. Microprocessor & Microcontroller

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: V |
| **Course Name:** OOPs/JAVA Programming lab | **Course Code**: ECUP521 | **Credit**: 1 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 2 Hrs. | **Teaching Scheme:** 30 hrs. per semester | |

| Module No. | Contents |
|---|---|
| **1** | Write a java program to find the Fibonacci series using recursive and non-recursive functions. |
| **2** | Write a java program to multiply two given matrices. |
| **3** | Write a java program to find prime numbers between 1 to n |
| **4** | Write a java program that checks whether a given string is palindrome or not |
| **5** | Write a java program to display the employee details using Scanner class |
| **6** | Write a Java program that implements a multi-thread application that has three threads |
| **7** | Write a java program to illustrate the concept of Single level and multilevel inheritance |
| **8** | Write a Java program that prints all real solutions to the quadratic equation ax2+bx+c=0. Read in a, b, c and use the quadratic formula |
| **9** | Write a java program to illustrate the concept of class with method overloading. |
| **10** | A) Write a java program for handling Mouse events and Key events<br>B) Write a java program for handling Key events |
| **11** | A) Write a java program to display File class properties<br>B) Write a java program to represent Array List class<br>C)Write a Java program loads phone no, name from a text file using hash table |
| **12** | Write a Java Program to demonstrate the following String Handlings.<br>A) String Length & Concatenation.<br>B) Character Extraction.<br>C) String Comparison |

**Text Books:**


1. Herbert Schildt. Java. The complete reference, TMH. 9thEdition.
2. H. M. Dietel and P. J. Dietel, Java How to Program 6th Edition, Pearson Education/PHI


**Reference Books:**


1. Y. Daniel Liang, Introduction to Java programming, Pearson Education, 6thEdition.
2. Cay Horstmann, Big Java, 2ndedition, Wiley Student Edition, Wiley India Private Limited


**Prerequisite:**

**1.** Basics of Programming Language

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: V |
| **Course Name:** Microwave Lab | **Course Code**: ECUP522 | **Credit**: 1 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 2 Hrs. | **Teaching Scheme:** 30 hrs. per semester | |

| Module No. | Contents |
|---|---|
| **1** | Study Microwave test bench and take readings from various microwave components and instruments like frequency meter, attenuator, detector and VSWR meter. |
| **2** | Measurement of guide wavelength and frequency using an X-band slotted line setup. |
| **3** | Measurement of low and high VSWR using an X-band slotted line setup. |
| **4** | Measurement of SWR, shift in minimum standing wave with unknown load and calculation of unknown load impedance using Smith chart. |
| **5** | Draw the V-I characteristics of a Gunn diode and determine the output power and frequency as a function of voltage. |
| **6** | Measure the power division and isolation characteristics of a micro-strip 3dB power divider. |
| **7** | Measure the power division and isolation characteristics of a hybrid ring (equivalent of waveguide Magic-Tee) in micro-strip. |
| **8** | Measure the characteristics of micro-strip 3dB branch line coupler, as a function of frequency |
| **9** | Measure the microwave input, direct, coupled and isolated powers of a micro-strip directional coupler at the center frequency using a power meter. From the measurements calculate the coupling, isolation and directivity of the coupler. |
| **10** | Measurement of resonance characteristics of a micro-strip ring resonator using power meter and determination of the substrate dielectric constant. |
| **11** | Measure the characteristics of low-pass and band-pass micro-strip filters. |

**Text Books:**

**1.** Das and S. Das, Microwave Engineering, Tata McGraw-Hill, 4th edition, 2020
**2.** D. M. Pozar, *Microwave Engineering*, John Wiley & Sons, 4th edition, 2011
**3.** S.Y.Liao, Microwave devices and circuits, Prentice Hall, 3rd Edition, 2003

**Reference Books:**

1. B. Bhat and S. K. Koul, Stripline-like Transmission Lines for Microwave Integrated Circuits, New Age International Pvt Ltd Publishers, 1st ed, 2007
2. T. C. Edwards, Foundations for Microstrip Circuit Design, John Wiley & Sons, 4th edition, 2016
3. Robert E. Collin, Foundations for microwave engineering, Wiley Publication, 2nd edition, 2007

**Prerequisite:**

1. Microwave basics and EM wave propagation
2. Working of various Microwave components and devices

# Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: V |
| **Course Name:** Digital Signal Processing Lab | **Course Code**: ECUP523 | **Credit**: 1 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 2 Hrs. | **Teaching Scheme:** 30 hrs. per semester | |

| Module No. | Contents |
|---|---|
| **1** | Introduction: Objective, scope and outcome of the course |
| **2** | Generate basic signals such as unit impulse, unit step, ramp, for periodic /non periodic (continuous time/discrete time) signal. |
| **3** | Implement a two stage Decimator and Interpolator. |
| **4** | Compute Linear Convolution of two finite length sequences |
| **5** | Implement z-transform and inverse z-transform. |
| **6** | Compute Circular Convolution of discrete sequences |
| **7** | Compute DFT/IDFT of a discrete time signal. |
| **8** | Compute N-point FFT algorithm. |
| **9** | Design FIR filter (LP/HP) using windowing (rectangular, Kaiser) techniques. |
| **10** | Design IIR Butterworth Filter (LP/HP) |
| **11** | Compute parallel and cascade realisation of digital filter structures. |
| **12** | Analyze the power spectrum of a discrete-time signal using window-based techniques and to study the effect of different window functions (Hamming, Hanning, and Rectangular) on the spectral estimation performance. |

**Text Books**


1. Oppenheim, A.V., & Schafer, R.W. *Discrete-Time Signal Processing* 3rd Edition, Pearson, 2010
2. Proakis, J.G., & Manolakis, D.G. *Digital Signal Processing: Principles, Algorithms, and Applications* 4th Edition, Pearson, 2014
3. Schilling, R.J., & Harris, S.L. *Digital Signal Processing Using MATLAB* 3rd Edition, Cengage Learning, 2017


**Reference Books**


1. Oppenheim, A.V., Willsky, A.S., & Young, I.T. Signals and Systems 2nd Edition, Prentice Hall, 1997
2. Mitra, S.K. Digital Signal Processing: A Computer-Based Approach 4th Edition, McGraw-Hill, 2011
3. Ifeachor, E.C., & Jervis, B.W. Digital Signal Processing: A Practical Approach 2nd Edition, Pearson, 2002


**Prerequisite:**

1. Basic idea of linear algebra and complex numbers
2. Calculus: Differentiation, Integration

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| **Name of the Program**: B.Tech. in ECE | **Year**: III Year | **Semester**: V |
| **Course Name:** Power Electronics Lab | **Course Code**: ECUP524 | **Credit**: 1 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 2 Hrs | **Teaching Scheme:** 30 hrs. per semester | |

| S. No. | Experiments |
|---|---|
| 1 | Plot the characteristics of SCR and observe the terminal configuration, Measure the breakdown voltage, latching and holding current. |
| 2 | To implement triggering circuits for SCR. i.e. R triggering, R-C triggering and UJT triggering circuit and observe the output waveforms |
| 3 | Plot V-I characteristics of DIAC and find the breakdown voltage |
| 4 | To implement AC voltage regulators using TRIAC, anti-parallel thyristors and TRIAC & DIAC and observe the output waveforms |
| 5 | To design single-phase full controlled bridge rectifier using Proteus software and analyze its simulated output |
| 6 | To implement single-phase cyclo converter and observe the output waveforms |
| 7 | To design buck, boost and buck-boost regulators using Proteus software and analyze its simulated output |
| 8 | To control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic. |
| 9 | To control speed of a single-phase induction motor using single phase AC voltage regulator and plot the speed control characteristics |
| 10 | To control speed of dc motor using single-phase dual-converter and observe the output waveforms |
| 11 | To realize motor control – open loop & closed loop and observe the variation of speed with load current |
| 12 | To implement Half-wave Controlled Rectifier using R - load and determine the power absorbed by the resistance and the power factor. |

**Text Books:**

1. Power electronics: converters, applications, and design, Ned Mohan, Tore M. Undeland, John Wiley &Sons., 3rd edition, 2003
2. Power Electronics, P. S. Bimbhra, Khanna Publishers, 7th edition, 2022
3. Power Electronics, M.D. Singh, K B Khanchandani, TATA McGraw Hill, 2nd edition, 2017
4. Power Electronics: Converters, Applications and Designs, Mohan, Robbins, Wiley, 3rd edition, 2022

**Reference Books:**

1. Power Electronics: Circuits, Devices, and Applications, Rashid, Pearson, 4th edition, 2017
2. Power Electronics- Devices, Converters and Applications, Vedam Subramanyam , New Age Publications, 2nd edition, 2018
3. Modern Power Electronics & AC Drives, B. K. Bose, Pearson Education, 1st edition, 2015
4. Elements of Power Electronics, Krein, Oxford, 2nd edition, 2017

**Prerequisite:**

1. Basics of Electronic Devices and Circuits
2. Basics of Network theory

# Semester

# VI

# Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

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| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: VI |
| **Course Name:** CMOS VLSI Design | **Course Code**: ECUL601 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| **1** | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | 1 |
| **2** | **Introduction to MOS Technology**: Basics of MOSFET Transistors, MOS device design equations: drain current-voltage, threshold voltage, trans-conductance, MOS fabrication techniques, NMOS Inverter and, CMOS Inverter, pull up to pull down ratio, Scaling factors for device parameters. | 10 |
| **3** | **Static CMOS logic design:** CMOS gate circuits, Pass Transistor/Transmission gate, Gate Sizing, CMOS combinational & sequential circuit design, Static Timing Analysis (STA), Stick Diagram & Euler's Path, Layout Design rules, Layout for NAND, NOR and Logic circuits, Power Dissipation & Propagation delay in CMOS circuits. | 10 |
| **4** | **Dynamic CMOS logic design:** Pre-charge & evaluation logic, Clocked CMOS (C2MOS) logic, DOMINO CMOS logic, NORA CMOS logic, charge sharing, Zipper & NP Zipper logic Dynamic Circuits | 9 |
| **5** | **Memory Devices:** Introduction to Memory Circuits, Static Vs Dynamic RAM, Read and Write Operation of 1T, 3T DRAM Cell and 6T SRAM Cell with Timing Analysis. | 5 |
| **6** | **Physical Design:** ASIC/FPGA based system Design, introduction to HDL, Basics of Verilog and its use in synthesis, Verilog Operators, modeling styles in Verilog, Blocking & Non-blocking statements, Verilog programing for logic gates, flip flops, shift registers and FSM. | 10 |
| | Total | **45** |

**Text Books:**

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", 4th edition, McGraw Hill India, 2014
2. Neil H. E. Weste and David. Harris Ayan Banerjee, "CMOS VLSI Design", 4th edition, Pearson Education, 2022.
3. J. Bhasker, "A Verilog HDL Primer", 3rd edition, Allentown, PA : Star Galaxy Pub., 2018

Reference Books:

1. J. M. Rabaey, A. Chandrakasan, and B. Nikolic, "Digital Integrated circuits: A design perspective", 2nd Edition, Pearson Education India, 2016.
2. Kamran Eshraghian, Douglas A. Pucknell, and Sholeh Eshraghian, "Essentials of VLSI Circuits and Systems", 1st edition, PHI, EEE, 2009.
3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd Edition, Prentice Hall PTR, 2003.
4. M Morris R. Mano, Michael D. Ciletti, "Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog", 6th edition, Pearson Education, 2018.

**Prerequisite:**

1. Semiconductor Devices
2. Digital Logic Circuits

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: VI |
| **Course Name:** Fiber Optic Communication | **Course Code**: ECUL602 | **Credit**: 2 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs. | **Teaching Scheme:** CI (30) + TW & SL(30) = 60 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | 1 |
| 2 | **Overview of Optical Fiber Communication:** Ray theory, General System Architecture, General characteristic parameters related to fiber communication, Single mode fibers & Multi-mode fibers, cutoff wave length, Mode Field diameter & its significance, Optical fiber materials. | 7 |
| 3 | **Transmission characteristics of Fiber Optics: Attenuation**- Absorption loss, scattering loss, bending loss, **Dispersion**- Intra & inter Modal dispersion, Material & Wave-guide dispersion, Special fibers-Dispersion shifted, Dispersion flattened, Dispersion compensating fibers (DCF), Various range windows for minimum attenuation and minimum dispersion.<br>**Fiber couplers and connectors:** Fiber alignment and Joint Losses, Fiber splices, fiber connectors and couplers.<br>Optical fiber fault distance Measurements by OTDR | 8 |
| 4 | **Optical Sources and Detectors:** Introduction LED's & LASER diodes, photo detectors, photo detector noise, Response time. | 6 |
| 5 | **Optical Amplifiers and Networks:** Optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA, Raman amplifier, optical Networks: SONET, SDH.<br>**Optical Components:** WDM & DWDM concept, WDM operation & Principle. Mach-Zehender Interferometer, electro-optic switches, Multiple Isolation and circulators, Link power Budget | 8 |
| | Total | **30** |

**Text Books**

1. John M. Senior, Optical Fiber Communications: Principles and Practice, 5th Edition, Pearson Education, 2017.
2. R.P Khare, Fiber Optics and Optoelectronics, Oxford University, 4th edition, 2016.
3. Gerd Kaiser, Optical Fiber Communication (SIE) | 5th Edition, McGraw Hill Education, 2017.

**Reference Books**

1. Djafar K. Mynbaev, Lowell L. Scheiner " Fiber -Optic Communications Technology" Pearson Education, 5th edition, 2012..
2. Ajoy Ghatak, K.Thyagarajan, "An Introduction to Fiber Optics",1st Edition,Cambridge University Press, 1998.
3. Ajoy Ghatak ," Optics" 2nd edition, Paperback McGraw-Hill Education, 2020 .

**Prerequisite:**

1. Communication Systems

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|---|---|---|
| **Name of the Program:** B. Tech. in ECE | **Year:** III Year | **Semester:** VI |
| **Course Name:** Antenna and Wave Propagation | **Course Code:**ECUL603 | **Credit:** 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs. | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **Introduction:** Objective, Scope, Outcome of the Course and prerequisite | 1 |
| 2 | **Introduction to Antenna:** Antenna parameters – Radiation Density, Radiation Intensity, Gain, Directivity, Radiation Resistance, Band width, Beam width, Input Impedance, Effective Height, Effective aperture, Network theorems applied to the antenna, Self and mutual impedance of the antenna. | 9 |
| 3 | **Wire Antennas:** Radiation from current element, Short dipole, Quarter wave Monopole and Half Wave Dipole, Loop antenna, helical antenna,<br>**Broadband Antennas:** Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas | 8 |
| 4 | **Micro strip Antennas**: Basic characteristics of micro strip antennas, feeding methods, methods of analysis, designing of rectangular and circular patch antennas<br>**Antenna Arrays:** Antenna arrays of point sources, two-element array, End fire and Broadside arrays, Principle of Pattern multiplication, Uniform linear arrays of N-elements. | 10 |
| 5 | **Aperture Antennas:** Radiation from rectangular apertures, Horn antenna, Reflector antenna, Babinet's principles and complimentary antennas, Slot antennas, Travelling wave antenna, Image antenna.<br>Basic Concepts of Smart Antennas-Concept and benefits of smart antennas, fixed weight beamforming basics, Adaptive beam forming | 9 |
| 6 | **Propagation of radio wave:** Modes of propagation , Structure of atmosphere, Ground wave propagation , Tropospheric propagation , Duct propagation, Flat earth and Curved earth concept, bending of radio waves, Sky wave propagation – Virtual height, Critical frequency, Maximum usable frequency – Skip distance | 8 |
| Total | | **45** |

**Text Books:**

1.Antennas & Wave propagation- J.D. Kraus, 5th edition, Tata McGraw Hill,2017.
2.Robert S. Elliott, "Antenna Theory and Design", John Wiley and Sons, Revised Edition, 2007.
3.Yadava.R. L, "Antennas and Wave Propagation", PHI, 2011.
4.Sisir K Das, "Antennas and Wave Propagation", Tata McGraw Hill,2015.
5.Navneet Gupta, "Antennas & Wave propagation", Sun India Publications,2008

**Reference Books:**

1. Antenna Theory - C.A. Balanis, John Wiley & Sons, 4th Ed., 2021.
2. Antenna Wave Propagation-K D Prasad, New Delhi: Satya Prakash Tech India Publications, New Delhi, Revised Edition 2021.
3. Raju.G.S. N, "Antennas and wave propagation", 1st Edition Pearson Education, 2012

**Prerequisite:**

1. Electromagnetic Fields and waves.
2. Higher Engineering Mathematics

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: VI |
| **Course Name:** Computer Network | **Course Code**: ECUL611 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs. | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | 1 |
| 2 | **Introduction to Computer Network:** Computer networks: Internet, network edge and core, Circuit & Packet switching, Modes of Data communication, Types of Connection and Network Topologies, LAN, MAN, WAN,OSI Model, Layers in OSI Model & their functions, TCP/IP protocol Suite, Queuing Theory | 8 |
| 3 | **Application Layer:** Principles of network application Layer, The Web and HTTP, File transfer Protocol, SMTP & POP, Domain Name System(DNS), Peer-to-Peer Applications, Socket programming with TCP & UDP | 8 |
| 4 | **Transport Layer:** Services of transport layer**,** Process-to-Process Delivery, Connectionless transport - User Datagram Protocol (UDP), Connection oriented transport – Transmission Control Protocol (TCP), Congestion Control-Principles, TCP congestion control, Congestion avoidance mechanisms, Quality of service | 9 |
| 5 | **Network Layer:** Virtual circuit and Datagram networks, Router, Internet Protocol (IP)-IPv4 & IPv6 Addressing, Internet Control Message Protocol (ICMP), Routing algorithms, Broadcast and Multicast routing, Network Security | 9 |
| 6 | **Data Link & Physical layer:** Services provided by Data Link Layer, Error detection & correction techniques, Data Link Control – Framing, Flow & error control, Multiple access control protocols – CSMA, CSMA/CD, CSMA/CA, IEEE 802 standards of Wired/Ethernet LAN & Wireless LAN, Network devices | 10 |
| | Total | 45 |

**Text Books:**

1. "Data Communication and Networking", Behrouz A Forouzan, Tata McGraw Hill (TMH), 4th edition, 2007.
2. "Computer Networking (A top-down approach)", Kurose Ross, Pearson, 6th edition, 2013.

**Reference Books:**

1. "Data and Computer Communications", William Stallings, Pearson, 10th edition, 2014

**Prerequisite:**

1. Digital System Design
2. Microprocessor & Microcontroller
3. Computer Architecture & Organization

# Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: VI |
| **Course Name:** Quantum Computing | **Course Code**: ECUL612 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | **1** |
| 2 | **FOUNDATIONS OF QUANTUM THEORY:** Qubits, Quantum States, State vectors & density matrices, Observables, Measurement, Hilbert Space, Unitary Transformations, Schrodinger Equation and Unitary Evolution, No Cloning Theorem, Qubits vs Classical Bits: Spin Half Systems, Photon Polarizations, Trapped Atoms and Ions, Artificial Atoms Using Circuits, Semiconducting Quantum Dots. | **9** |
| 3 | **QUANTUM GATES:** Classical vs quantum gates, Unitary matrices, Single and Multi-Qubit Gates and their matrix representations, Rotation gates, tensor product, Bell states, Quantum Correlations: Entanglement, teleportation, Bell State Measurement (BSM), Decoherence & photon loss, Super-dense coding. | **8** |
| 4 | **QUANTUM ALGORITHMS:** Early Quantum Algorithms: Deutsch Algorithm, Deutsch–Jozsa Algorithm, Bernstein-Vazirani Algorithm, Database Search: Grover's Search, Amplitude amplification, Quantum Fourier Transform (QFT), Order finding and Phase estimation, Shor's factoring algorithm, Discrete logarithm problem. | **9** |
| 5 | **QUANTUM KEY DISTRIBUTION AND CRYPTOGRAPHY:** Introduction to quantum cryptography, BB84 protocol (prepare & measure), E91 entanglement-based QKD, B92 protocol, Measurement-device-independent QKD, Eavesdropping strategies: Intercept-resend attack, Beam-splitting attack, Security proofs: Error rates & key generation rate, overview of practical QKD systems. | **9** |
| 6 | **QUANTUM NETWORKS:** Quantum Internet Protocol Stack, Quantum Network Components, Entanglement Distribution Mechanisms, Repeater chain analysis, Real-World Quantum Networks case studies: China's Micius Quantum Satellite, DARPA Quantum Network (USA), ID Quantique, Quantum Key Distribution in Indian Networks. | **9** |
| | Total | **45** |

**Text Books:**

1. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
2. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press,Cambridge, 2020
3. Quantum Computing & Techniques, Dr. R. Chopra, Khanna Publishing House (2025)
4. Introduction to Quantum Computing: From a lay person to a programmer in 30 steps, Hui Yung Wong, 1st edition, Springer-Nature Switzerland AG (2022)

**Reference Books:**

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. A Pathak, Elements of Quantum Computation & Quantum Communication, Boca Raton, CRC Press (2015)
3. Quantum computing explained, David McMahon, Wiley (2008)
4. Architectures and Cryptographic Universes (The Mechanics of Quantum Computing), A. B. Bhattacharya, Khanna Publishing House (2025).

**Prerequisites:**

1. Linear Algebra Fundamentals
2. Probability & Basic Physics

# Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: VI |
| **Course Name:** Internet of Things (IoT) | **Course Code**: ECUL613 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | 1 |
| 2 | **Introduction to IoT:** Definition and characteristics of IoT, Physical and logical design of IoT, IoT enabling Technologies- wireless sensor networks, cloud computing, big data analytics, embedded systems, IoT levels and deployment templates. | 7 |
| 3 | **M2M to IoT:** Introduction of M2M and its architecture, Difference and similarities between IOT and M2M, Introduction to SDN (Software defined networks), network function virtualization | 7 |
| 4 | **IoT Architecture and Protocol:** Reference Model and architecture, Design principles of connected devices and web connectivity-Gateway, SOAP, REST, HTTP RESTful and WebSockets, Challenges in IoT- Design challenges, Development challenges, Privacy and Security challenges | 10 |
| 5 | **IoT Hardware and Software:** Basics of Energy Transformation: Transducers, Sensors and Actuators, types of Errors in Sensors and Transducers, Analog vs Digital Sensors, Humidity sensors, Ultrasonic sensor, Temperature Sensor, Introduction to Arduino, Raspberry Pi and ESP module, Introduction to different IoT development platforms and IoT programming basics. | 10 |
| 6 | **Case study of IoT Applications:** Domain specific IoTs- Home automation, smart cities, environment, Energy, Retail, Logistics and Agriculture | 10 |
| | Total | **45** |

**Text Books:**

1. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
2. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education
3. S. Misra, A. Mukherjee, and A. Roy, 2020. *Introduction to IoT*. Cambridge University Press.

**Reference Books:**

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press,2014.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on- Approach)", 1st Edition, VPT, 2014
3. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
4. Hanes et al "IoT Fundamentals", Cisco Press

**Prerequisite:**

1. Basic electronics and circuitry:
2. Basic programming skills

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: VI |
| **Course Name:** Nano Electronics | **Course Code**: ECUL614 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| **1** | **INTRODUCTION:** Objective, Scope, outcome of the course and prerequisite | **1** |
| **2** | Introduction to particles and waves, Wave-particle duality, Top-Down/Bottom-Up approaches, Crystal growth, Nanolithography, Degeneracy. Electron energy bands, Brillouin Zones | **8** |
| **3** | Electrons in low-dimensional structure: quantum wells, quantum wires, quantum dots, Nanostructures, Schrodinger equation, Density of States. Particle in a box Concepts | **10** |
| **4** | Shrink-down approaches: Introduction, The Nanoscale MOSFET, limits to scaling, Fin-FETs, Vertical MOSFETs, Tunnel FETs, | **10** |
| **5** | Characterization of nanostructures - XRD, XPS, AFM, SEM, TEM and Raman Spectroscopy | **7** |
| **6** | Carbon Nanotubes, Nano Cuboids, Graphene: Fabrication, Structure, Properties and Applications. | **9** |
| | Total | **45** |

**Text Books:**

1. Stephen D. Sentaria, Microsystem Design, Kluwer Academic Press, 2005
2. Marc Madou, Fundamentals of micro fabrication & Nanofabrication, CRC Press, 2011.
3. T. Fukada&W.Mens, Micro Mechanical system Principle & Technology, Elsevier, 1998

**Reference Books:**

1. Introduction to Nanotechnology by Charles P. Poole Jr. and Frank J. Owens.
2. WR Fahrner, Nano Technology and Nano Electronics – Materials, devices and measurement Techniques, Springer, 2004.
3. Nanoelectronics: Nanowires, Molecular Electronics, and Nanodevices by Krzysztof Iniewski.
4. Nanoelectronic Device Applications Handbook edited by James E. Morris.

**Prerequisite:**

1. Solid-state physics, and electromagnetism.
2. Semiconductor devices and solid state electronics
3. Linear algebra, and calculus.

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: VI |
| **Course Name:** MEMS & NEMS | **Course Code**: ECUL615 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| **1** | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | 1 |
| **2** | **INTRODUCTION TO MEMS:** Basics of micro/nano mechanics, MEMS and microsystems overview, miniaturization concepts, micro-sensors and micro-actuators, micro-accelerometers, micro-fluidics, MEMS materials, thin films, basic MEMS fabrication (lithography, etching, deposition), electrostatic actuation, packaging basics. | 10 |
| **3** | **INTRODUCTION TO NEMS :** Evolution from MEMS to NEMS, MEMS vs NEMS, NEMS architecture, nano-fabrication basics, nanoscale effects, quantum tunneling and transport, wave and bandgap concepts, surface plasmon effects, NEMS applications in nano-electronics and nano-photonics. | 9 |
| **4** | **MEMS & NEMS DEVICES:** Pressure, capacitive and inertial sensors, optical MEMS, electrostatic/thermal/piezoelectric actuators, stiction and tribology, thermal effects, hermetic and vacuum packaging, reliability, MEMS scanners and micromirrors, digital micromirror devices, basics of RF-MEMS and RF/NEMS switches. | 8 |
| **5** | **NANOTECHNOLOGY-ENABLED SENSORS:** Organic/inorganic nanomaterial-based sensors, nanostructured thin-film gas sensors, deposition and substrate effects, post-treatments, 1D nanosensors (nanowires/nanotubes), nano-mechanical resonators, electrostatic nano-actuators, nanograin bulk and thin-film materials, optical and photonic nanosensors. | 9 |
| **6** | **CASE STUDIES & MODELLING**: Capacitive accelerometer case study, piezoelectric pressure sensor case study, basic analytical modelling concepts, equivalent mechanical–electrical representation, performance analysis, reliability considerations, applications in consumer electronics, automotive, aerospace, biomedical and smart devices. | 8 |
| | | **Total: 45** |

**Text Books:**

1. Vinayak Pachkawade & Koushik Guha (Eds.), Micro- and Nano-Systems in 21st-Century, Springer, 2025.
2. Zhuoqing Yang (Ed.), Advanced MEMS/NEMS Fabrication and Sensors, Springer, 2022.
3. Sunipa Roy & C. K. Sarkar, MEMS and Nanotechnology for Gas Sensors, CRC Press, 2016.

**Reference Books:**

1. S. E. Lyshevski, Nano- & Micro-Electromechanical Systems, CRC Press (Latest Ed.).
2. Qing-An Huang (Ed.), Micro Electro Mechanical Systems, Springer, 2018.
3. Marc J. Madou, From MEMS to Bio-MEMS and Bio-NEMS, CRC Press, 2011.

**Prerequisite:**

1. Engineering Physics – elasticity, stress–strain, material behavior, waves.
2. Basic Electronics / Semiconductor Fundamentals – diodes, MOS basics, doping, carrier transport.
3. Materials Science Fundamentals – crystal structure, thin films, microstructure.
4. Mechanics of Solids – force, deformation, bending, torsion (basic understanding).

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|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: VI |
| **Course Name:** IC Technology | **Course Code**: ECUL616 | **Credit**: 3 |
| **Max Marks:** 100 | **CIE:** 40 | **SEE:** 60 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester | |

| Module No. | Contents | Classroom Instruction (CI) Hours |
|---|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite | 1 |
| 2 | **Crystal growth and wafer preparation:** Semiconductor Substrate—Crystal structure and crystal defects, Electronic Grade Silicon, Crystal growth techniques- Czochralski Growth, Float Zone Growth, Wafer Preparation- Silicon Shaping, Etching and Polishing, Chemical cleaning | 8 |
| 3 | **Oxidation, Diffusion and Ion Implantation:**<br>**Oxidation**: Oxidation Growth mechanism and Kinetics, Deal-Grove Model of oxidation, Linear and Parabolic Rate co-efficient, Dry and wet Oxidation techniques and system.<br>**Diffusion**: Diffusion mechanisms, Fick's One Dimension Diffusion Equations, Analytic Solution of Fick's Law, Diffusion in $SiO_2$.<br>**Ion Implantation**: Range theory, stopping mechanism, channeling, Ion Implantation process, Annealing. | 10 |
| 4 | **Thin Film Deposition Techniques:**<br>**Chemical Vapor Deposition**: CVD for deposition of dielectric Polysilicon Thick Layer – a simple CVD system, Chemical equilibrium and the law of mass action, Introduction to atmospheric CVD of dielectric, Low pressure CVD of dielectric and semiconductor, sputtering<br>**Epitaxial Layer Growth:** Vapor Phase Epitaxy, Defects in Epitaxial growth, Metal Organic Chemical Vapor Deposition, Molecular beam epitaxy. | 10 |
| 5 | **Pattern Transfer & Etching:** Introduction to photo/optical lithography, photo resists, Contact/ proximity printers, Projection printers, Mask generation, Dry & Wet etching, Plasma etching, Reaction ion etching (RIE). | 8 |
| 6 | **VLSI Process Integration:** Junction and Oxide Isolation, LOCOS methods, Trench Isolation, Silicon-On-Insulator(SOI), Metallization, Planarization, Fundamental consideration for IC Processing, Bipolar IC Technology, NMOS IC Technology, CMOS IC Technology. | 8 |
| | | Total: 45 |

**Text Books:**

1. S. M. Sze, "VLSI Technology", 2nd edition., 2017, McGraw Hill.
2. James D. Plummer, Michael D. Deal, "Silicon VLSI Technology", 1st edition, 2009, Pearson.

**Reference Books:**

1. Gouranga Bose, "IC Technology", 1st edition, 2013, McGraw Hill.
2. Gary S. May & S. M. Sze, "Fundamentals of Semiconductor Fabrication", 1st ed., 2007, Wiley.
3. S.K Gandhi, "VLSI Fabrication Principles", 2nd edition, 1983, John Wiley Inc., New York.
4. Peter Van Zant, "Microchip Fabrication: A Practical Guide to Semiconductor Processing", 6th ed., 2014, McGraw-Hill Professional.
5. Deepak Garg, "Integrated Circuit Technology", 1st ed., 2024, S.K. Kataria & Sons.

**Prerequisite:**

1. Knowledge of basic Electronic Devices
2. Basic knowledge of ICs

# Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

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|---|---|---|
| **Name of the Program**: B. Tech. In ECE | **Year**: III | **Semester**: VI |
| **Course Name:** Optical Communication & Quantum Computing Lab | **Course Code**: ECUP621 | **Credit**: 1 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** 30 hrs. per semester | |

| Exp No. | Contents |
|---|---|
| 1 | **Introduction:** Objective, Scope, Outcome of the Course and prerequisite. |
| | PART A |
| 2 | Setting up Fiber Optic Analog and digital Link |
| 3 | Measurement of Numerical Aperture propagation loss and bending loss in optical fiber |
| 4 | Measurement of Optical Power using Optical Power Meter |
| 5 | Measurement of Fiber Attenuation Coefficient (dB/km) using OTDR and identify the fault event. |
| 6 | Study and measure characteristics of fiber optic LED's and Laser diode. |
| | PART B |
| 7 | Prepare and measure quantum states $\|0\rangle, \|1\rangle$ and superposition states using Hadamard gate. |
| 8 | Construct a single-qubit state by measuring in X, Y, Z bases and computing Bloch coordinates. |
| 9 | Prepare two different single-qubit states, apply SWAP, and verify states are exchanged. |
| 10 | Demonstrate that the Controlled-NOT gate can be decomposed into a sequence of simpler gates by implementing the identity CNOT=(I⊗H) CZ (I⊗H) and to verify the equivalence of both circuits by comparing their unitary matrices using quantum simulation tools. |
| 11 | Apply Rz($\pi$/4) (or Rx) seven times to $\|0\rangle$, plot the resulting single-qubit states on the Bloch equator/unit circle to observe cumulative rotation. |
| 12 | Build a parameterized circuit RY($\theta$) on one qubit, measure expectation value of Z to see how it varies with $\theta$ ($\langle Z \rangle = \cos\theta$). |

**Text Books:**

1. Optical Fiber Communication: Principles and Practice – John M. Senior, Pearson Education, Singapore (3rd Edition, 2009)
2. Optical Fiber Communication: Principles and Practice – John M. Senior, Pearson Education, Singapore (3rd Edition, 2009)
3. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
4. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press,Cambridge, 2020

**Reference Books:**

1. Fiber-Optic Communication Systems – Govind P. Agrawal, Wiley, Hoboken (4th Edition, 2010)
2. Fiber Optic Communications – Joseph C. Palais, Pearson Education, Boston (6th Edition, 2015)
3. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
4. A Pathak, Elements of Quantum Computation & Quantum Communication, Boca Raton, CRC Press (2015)

**Prerequisites:**

1. Linear Algebra Fundamentals
2. Probability & Basic Physics

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|---|---|---|
| **Name of the Program**: B.Tech. in ECE | **Year:** III | **Semester:** VI |
| **Course Name:** Antenna and RF Lab | **Course Code:** ECUP622 | **Credit:** 2 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** 60 hrs. per semester | |

| Exp. No. | Contents |
|---|---|
| 1 | **INTRODUCTION:** Objective, scope, outcome of the course and prerequisite |
| 2 | Simulate a WR90 rectangular waveguide and analyse the field patterns of first three modes inside it. |
| 3 | Design and simulate a microstrip transmission line at 2.4 GHz frequency. |
| 4 | Design and simulate the following microwave devices at 2.4 GHz frequency and analyse their S parameters, VSWR and Current distribution:<br>I. 3-dB branch line coupler<br>II. Wilkinson power divider<br>III. Low Pass Filter |
| 5 | Measure the radiation pattern, HPBW, FNBW and Directivity of a dipole antenna. |
| 6 | Measure the radiation pattern, Gain, HPBW of a horn antenna. |
| 6 | Design and Fabricate a planar transmission line & measure its S parameters and compare with simulated results. |
| 7 | Design and Fabricate a microwave device. Measure its S parameters and compare with simulated results. |
| 8 | Design and fabricate a microstrip patch antenna and measure its necessary parameters using VNA. |

| | | |
|---|---|---|
| **Name of the Program**: B. Tech. in ECE | **Year**: III | **Semester**: VI |
| **Course Name:** VLSI Design lab | **Course Code**: ECUP623 | **Credit**: 1.5 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** 45 hrs. per semester | |

| Exp. No. | Contents |
|---|---|
| | **PART-A**<br>Write the Verilog program, simulate, synthesize and implement the following digital logic circuits: |
| **1** | Logic gates using all architectural modeling styles |
| **2** | 8:3 priority encoder using behavioral modeling. |
| **3** | 2:4 decoder realization using data flow modeling. |
| **4** | 8:1 multiplexer using structural modeling. |
| **5** | 4 – bit Ripple carry adder using full adder (structural modeling) |
| **6** | S/R, D and J/K flip flop using behavioral modeling. |
| **7** | 4-bit Binary counter using behavioral modeling. |
| **8** | 4-bit Universal Shift Register using structural modeling. |
| | **PART-B**<br>Design & Simulate the schematic of following VLSI Circuits using suitable VLSI EDA Tool |
| **1** | DC Characteristics of MOS Transistor |
| **2** | Perform transient analysis & O/P Characteristics of CMOS Inverter |
| **3** | Perform transient analysis of CMOS NAND & NOR gates |
| **4** | Perform transient analysis of CMOS Half Adder |
| **5** | Perform transient analysis of Y = (A + BC)D |
| **6** | Perform transient analysis of CMOS SR Latch |

Text Books:

1. Ming-Bo Lin, —Introduction to VLSI Systems: A Logic, Circuit, and System Perspective‖ Indian Edition, CRC Press, 2011.
2. Sung-Mo Kang, and Yusuf Leblebici, —CMOS Digital Integrated Circuits‖, 3 rd Edition McGraw-Hill Education, 2002.
3. Y. Taur and T. H. Ning, —Fundamentals of modern VLSI Devices‖, Cambridge Univ. Press, 1998.

Reference Books:

1. Samir Palnitkar, —Verilog HDL: A Guide to Digital Design and Synthesis‖, Second Edition, Prentice Hall PTR, 2003
2. Michael, D. Ciletti, —Advanced Digital Design with the Veriolg HDL, PHI Learning Private Limited, 2012.
3. Michael, D. Ciletti, —Advanced Digital Design with the Veriolg HDL, PHI Learning Private Limited, 2012.

**Prerequisite:**

1. Electronic devices
2. Digital Electronics
3. VHDL

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| **Name of the Program**: B. Tech. in ECE | **Year**: III Year | **Semester**: VI |
| **Course Name:** Internet of Things (IoT) Lab | **Course Code**: ECUP624 | **Credit**: 1.5 |
| **Max Marks:** 100 | **CIE:** 60 | **SEE:** 40 |
| **End Term Exam Time:** 3 Hrs | **Teaching Scheme:** 45 hrs. per semester | |

| Module No. | Contents |
|---|---|
| **1** | Familiarization with Arduino/Raspberry Pi/ESP32 and perform necessary software installations. Also install MySQL database on Raspberry Pi. |
| **2** | Interface an IR sensor with Arduino and write a program to turn ON LED at sensor detection. |
| **3** | Interface a DHT11 sensor with Arduino and write a program to print temperature and humidity readings on serial monitor and OLED. |
| **4** | Interfacing a DHT11 sensor with Raspberry Pi and upload temperature and humidity values to the cloud. |
| **5** | Interface a LED with Arduino and turn it ON/OFF when '1'/'0' is received from smart phone using Bluetooth/wifi. |
| **6** | Design an edge-enabled Air-Quality Monitoring system with Periodic Cloud Upload. |
| **7** | Interface an ultrasonic sensor ESP32 and alert users via mobile alert. |
| **8** | Interface a current sensor with Raspberry Pi and upload consumption data to cloud. |
| **9** | Create a small web server on ESP32 to display real-time sensor data and control connected devices. |

**Reference Books:**

**1.** Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on- Approach)", 1st Edition, VPT, 2014, University Press.
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi.
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

**Prerequisite:**

1. Basic knowledge of Arduino, Raspberry Pi and ESP module
2. knowledge of sensor transducer actuator interfacing
3. wireless communication protocol network
4. Basic programming skills.