DATA STRUCTURES USING C++ (3:0:2)

Sub. Code: EC0412	CIE: 50% Marks
Hrs /Week: 3	SEE: 50% Marks
SEE Hrs: 3 Hrs	Max. Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Learn the concepts of object oriented programming and their applications.
2. Analyze step by step and develop algorithms to solve real world problems.
3. Apply and implement advanced data structures concepts, such as: Binary trees and balanced trees, searching and sorting heaps and priority queues, linked list concepts to solve computational problems.
4. Gain the knowledge on memory management in operating systems, allocation and deallocation of memory.
5. Analyze the time and space complexity of advanced data structures and their supported operations.

PART – A

Unit 1: Objects and Classes:

A Simple Class C++ Objects as Physical Objects - C++ Objects as Data Types - Object as function argument Constructors - Copy Constructors, Returning Objects from functions - Structures and Classes - Arrays and Strings. **6 Hrs**

Unit 2: Operator Overloading:

Overloading Unary and Binary Operator - Data Type Conversion and its Pitfalls, Inheritance: Derived Class and Base Class - Derived Class Constructors, Overloading Member Functions- Class Hierarchies - Public and Private Inheritance - Levels of Inheritance - Multiple Inheritance. Pointers: Address and Pointers - Pointers and Arrays - New and Delete Operator - Pointer to Pointer. **8 Hrs**

Unit 3: Virtual Functions:

Virtual Functions- and Polymorphism - Friend Functions Static Functions - this Pointer - Streams and Files: Stream Classes - Stream Errors- Disk File I/O with Streams - File Pointers. Templates and Exception: Function Templates - Class Templates - Exceptions. **6 Hrs**

PART – B

Unit 4: Linked List:

Linked List Introduction-Implementation of Linked Lists Using Arrays-Linear Linked List-Basic, Operations on linear linked List-Searching-Reversing-Concatenating-Disposing on linear linked Lists- Doubly linked List- Basic Operations on Doubly Linked List- Circular Linked List-Basic Operations on Circular Linked List. **12 Hrs**

Unit 5: Sorting and Searching Techniques:

Sorting - Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Heap Sort, Merge Sort.
Searching- Linear Search, Binary Search. **8 Hrs**

Text Books:

1. **"Data Structures using C++", S**artajSahni, Tata McGraw Hill.
2. **"Data Structures using C and C++",** Y.Langsam, M.Augenstein and A.M.Tenenbaum Prentice Hall India.

Reference Books:

1. **" C++, The Complete Reference" ,** Herbert Schmidt, McGraw-Hill Publishing Company Limited, New Delhi, 3rd Edition, 2002
2. **"Programming with C++ - A Computer Science Tapestry",**Owen L. Astrachan, Special Indian edition 2007, Tata McGraw-Hill, Second reprint, 2008.
3. **"Object Oriented Programming in C++",** Robert Lafore, Third Edition, Galgotia Publishers, Pune, Reprint, 2006.
4. **"Expert Data Structures using C/C++",**AbhishekDayaSagar,BPB Publications, New Delhi 2004.

DATA STRUCTURES USING C++ - LABORATORY

The following programs must be implemented using C++

1. Stack ADT & Queue ADT using Linked List
2. Deque using Doubly Linked List
3. Binary Search Tree
4. Non Recursive Traversal of BST
5. Recursive Traversal of BST
6. BFS & DFS
7. Merge Sort and Heap Sort
8. B-TREE
9. AVL Tree

DIGITAL DESIGN USING VERILOG HDL (4:0:2)

Sub Code: EC0508	CIE: 50% Marks
Hours /Week: 4	SEE: 50% Marks
SEE Hrs: 3	Max. Marks: 100

Pre-requisite: Digital Electronics Circuits (EC0502)

Course Outcome:

On successful completion of the course, the students will be able to

1. Explain advanced topics in digital logic design
2. Use proven design methodologies based on standard CAD tools
3. Explain the differences and similarities in hardware and software design
4. Use modern specification methods (HDL)
5. Design combinational devices with a full set of CAD tools (skills)
6. Use modeling and verification with hardware description languages
7. Use programmable logic devices and FPGAs
8. Design state machines, data path controllers, and assorted CPUs with a full set of CAD tools
9. Describe timing analysis

PART – A

Unit 1: Introduction to Verilog:

Conventional approach to digital design.VLSI design.ASIC design flow.Role of HDL Levels of design description, Concurrency, Simulation and synthesis, Functional verification, System tasks, Programming Language Interface (PLI). Module, Simulation and synthesis tools, Test Benches. **7Hrs**

Unit 2: Language Constructs and Conventions:

Keywords, Identifiers, numbers, strings, logic values, strengths, data types, scalars and vectors, parameters, memory, operators, system tasks. **6Hrs**

Unit 3: Gate Level Modeling:

Gate primitives, Module structure, tri-state gates, Array of instances of gates, Design of flip-flops with gates, Delays, Strengths and contention resolution, net types Design of basic circuits. Modeling at data flow level, continuous assignment structures, assignment to vectors **7Hrs**

PART – B

Unit 4: Behavioral Modeling:

Operators and assignments, functional bifurcation, initial and always constructs, Assignments with delays, wait construct, Multiple always blocks, blocking and non-blocking assignments, case statement, if and if-else construct, assign- de assign construct, repeat construct, loops, disable construct, parallel blocks, force-release construct, events, functions, tasks and user defined primitives. **10Hrs**

Unit 5: Switch Level Modeling:

Basic transistor switches, CMOS switch, bidirectional gates, time delays with switch primitives. **5Hrs**

Unit 6: SystemTasks, Functions and Compiler Directives:

Parameters, path delays, module parameters, system tasks and functions,file-based tasks and functions, compiler directives. **6Hrs**

Text book:

1. **"Design through VERILOG HDL"** By T R. Padmanabhan. Published by IEEE Press and JohnWiley and Sons.2004.

ReferenceBooks:

1. **Advanced Digital Design using Verilog HDL** ByCelleti Published by PHI 2003
2. **Verilog HDL** by SamthPalnitkar Published by Pearson Education 2003

DIGITAL DESIGN USING VERILOG HDL - LABORATORY

LIST OF EXPERIMENTS

1. Simulation and implementation of combinational systems
2. Simulation and implementation of sequential systems
3. Experiments using DE2 board
4. Demonstration of an embedded processor.
5. Simulation of finite state machines
6. Simulation of ASMD systems and RTL designs

TEXT BOOK:

"Design through VERILOG HDL" By T R. Padmanabhan. Published by IEEE Press and John Wiley and Sons.2004.

COMMUNICATION NETWORKS (4:0:0)

Sub. Code: EC0414	CIE: 50% Marks
Hrs/week: 4	SEE: 50% Marks
SEE Hrs: 3	Max Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Explain Network fundamentals and terminology.
2. Explainthe principles of LAN design such as topology and configuration depending on types of users accessing the network.
3. Interpret different types of network interfaces and their uses by identifying and using basic Network components, choosing appropriate network type and media.
4. Explain network industry standards using OSI-ISO and TCP/IP models.

PART – A

Unit 1: Introduction: Network Architecture:

Layering and protocols, OSI Architecture, Internet Architecture, Performance Parameter: Bandwidth ad Latency, DelayBandwidth Products, High Speed Networks, Application Performance Needs. **8 Hrs**

Unit 2: Direct Link Networks:

Physically Connected Hosts (Nodes and Links)Encoding (NRZ, NRZI, Manchester, 4B/5B, 8B6T, Multiline Transmission, MLT-3Framing: Fixed Size and Variable Size Framing, Byte-Oriented Protocols, Bit-Oriented Protocols (HDLC), Clock-Based Framing (SONET) Reliable Transmission: Noisy and Noiseless Channels. **10Hrs**

Unit 3: Multiple Access and LAN's:

Random Access, Controlled Access, Wired LAN, WirelessLAN. Wired: Ethernet (802.3), Rings (802.5, FDDI, RPR) Wireless: Bluetooth (802.15.1), Wi- Fi (802.11), WI Max (802.16), Cell Phone Technologies **8 Hrs**

PART – B

Unit 4: Internetworking:

Global addresses : Datagram forwarding in IP, Address Translation(ARP),Host Configuration (DHCP),IPv4 Addresses and Data format,IPv6 Addresses and data format, Multicast Addresses **8 Hrs**

Unit 5:End to End Protocols:

Getting Processes to communicate UNIX, TCP, UDP **8 Hrs**

Unit 6:Applications, Traditional Applications:

Electronic Mail (SMTP, MIME, IMAP), World Wide Web (HTTP), Domain Name Serviced (DNS), Network Management (SNMP), Web Services: Multimedia Applications **10 Hrs**

Text Books:

1. **'Computer Networks',** 'Larry L. Peterson and Bruce S. Devie', Morgan Kaufmann Publications, 4th Edition, 2002.
2. **'Data Communication and Networking'**, 'Behrouz A Forouzan', Tata McGraw-Hill Publishing Company Limited, Indian Edition, 2006.

Reference Book:

'Computer Networks', 'Andrew S Tannenbaum', Prentice Hall of India Pvt. Ltd., 4th Edition.

WIRELESS COMMUNICATION (4:0:0)

Sub. Code: EC0413	CIE: 50% Marks
Hrs/week: 4	SEE: 50% Marks
SEE Hrs: 3	Max Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Explain and compare the various cellular systems.
2. Apply the concept of cell, frequency reuse and handoff in wireless communication systems.
3. Analyze interference between mobiles and base stations and its effect on the capacity of cellular systems.
4. Apply various techniques to improve the capacity and performance of wireless communication systems
5. Explainvarious components of cellular system.
6. Describe Network and System Architecture,Channel Concept and System Operations in TDMA using GSM technology and CDMA using CDMA technology.
7. Analyze the basics of radio propagation models.
8. Analyze spread spectrum and other modulation techniques in wireless communication systems
9. Apply the concept of diversity techniques in radio propagation to improve performance.

PART – A

Unit 1: Introduction and Evolution of Mobile Radio Communication:

Evolution of Mobile Radio Communication, Frequencies for radio transmission, FCC Allocation for Mobile Radio transmission, Wireless communication standards, 1G,2G,3G and 4G Cellular systems. **7Hrs**

Unit 2: Mobile Communication Concepts:

Introduction, Concept of cellular communications, Cell Fundamentals, Frequency Reuse concepts, Concept of cell cluster, Cellular layout for frequency reuse, Geometry of hexagonal cell, Frequency Reuse Ratio, Co-channel and Adjacent Channel Interference, Various mechanism for capacity increase, Cell Splitting, Sectoring, Microcell Zone Concept, Channel Assignment Strategies, Handoff Strategies. **10Hrs**

Unit 3: Common Cellular System Components:

Common Cellular Network Components, Hardware and Software Views of the Cellular Network, 3G Cellular Systems Components, Cellular Component Identification, Call Establishment. **8Hrs**

PART – B

Unit 4: GSM and TDMA Technology:

GSM System Overview, GSM Network and System Architecture, GSM Channel Concept, GSM System Operation, GSM Identities, GSM System Operations, GSM Infrastructure Communications. **8Hrs**

Unit 5: CDMA Technology:

CDMA Overview, CDMA Network and System Architecture, CDMA Basics, CDMA Channel Concept, CDMA System Operations, 3G CDMA, IS-95B, CDMA2000 and W-CDMA. **9Hrs**

Unit 6: Wireless Modulation techniques:

Characteristics of air interface, Path loss models, wireless coding techniques, Digital modulation techniques, Spread Spectrum Modulation Techniques, Ultra Wide Band radio technology, Diversity techniques. **8Hrs**

Text Books:

1. **'Wireless Cellular Communications'**, 'Sanjay Sharma', KATSON books, 2nd Edition 2007.
2. **'Introduction to Wireless Telecommunications Systems and Networks',** 'Mullet', CengageLearning, Sixth Indian reprint 2010.

Reference book:

Wireless Communications: Principles and Practice by Rappaport Theodore.Pearson Education India, 2009

EMBEDDED SYSTEMS (3:0:2)

Sub. Code: EC0417	CIE: 50% Marks
Hrs/week: 3	SEE: 50% Marks
SEE Hrs: 3	Max Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Common peripherals of an embedded target board
2. Use of serial interface and JTAG port
3. Booting sequence and memory layout
4. Function of boot loader and U-boot compilation and installation.
5. Linux kernel and its configuration, compilation
6. Root file system and Busy box.
7. Using Make and different methods of debugging
8. Flash memory and flash file systems

PART – A

Unit1: Embedded systems and Embedded Linux System:

Introduction. Embedded Linux Development. Target Hardware. Booting Linux. Development Environment. System Design. Boot Loader, Kernel, Root File System, Application, Cross-Compiler **4 Hrs**

Unit2: Configuring the Software Environment:

Target Emulation Virtual Machines Host Environment .Linux. Windows. Host Services TFTP DHCP.NFS PXE. Cabling: Serial (for Console), Network. Why Target Emulation? Emulation via QEMU Compiling QEMU. Using QEMU to Emulate a Target Using QEMU to Compile under Emulation **7 Hrs**

Unit3: Configuring the Target Board:

Booting the board , Assessing the Kernel, Understanding the RFS. Cross-Compiler The Boot Loader, Kernel-Land vs. User land., Boot Loaders, Flash Memory. Kernel Startup, The Kernel Entry Point, User land Startup, Busy Box Init Hardware Constraints, Development Languages: C, C++, Java, Non-Traditional Embedded Languages: Python, TCL. Performance and Profiling Tools. **9 Hrs**

PART – B

Unit4: Application Development:

Coding for Portability, System Differences, Tools required. Using Make, .Running the code on target. Getting Started on Application, .Types of Debugging: Remote Debugging Overview, Debugging C and C++, Building GDB, GDB Front Ends, Compiling for Debugging. **7 Hrs**

Unit5: Kernel Configuration and Development:

Kernel Project Layout, .Building the Kernel, How Kernel Configuration Works, Default Configurations, Editing .config By Hand. Building the Kernel, .Building Modules. Cleaning Up. Configuring the Boot Loader and Kernel, U-Boot ,Other Boot loaders, Execution in Place, Selecting a Root File System, .Block-Based File Systems. MTD File Systems, RAM Buffer–Based File Systems, Assembling a Root File System. Creating the Staging Area, Creating a Directory Skeleton, Libraries and Required Files. Creating Initialization Scripts, Setting Ownership and Permissions. **7 Hrs**

Unit6: Real Time Concepts and System Tuning:

Real-Time Core Concepts. The Linux Scheduler Real-Time Scheduler .Real-Time Implementation in Linux, Real-Time Programming Practices. The One Real-Time Process, Lock Memory, Avoiding the Heap, Asking for Priority Inheritance Mutexes , I/O Is Nondeterministic. Using Thread Pools. Three or Fewer Megabytes, 16–32 Megabytes, More than a Gigabyte. Reducing the Size of the Root File System, Compiling to Save Space, Reducing the Size of the Kernel, Removing Unneeded Features and Drivers, Minimizing Boot Time Reducing Kernel Boot-Up Time, Measuring Kernel Boot-Up Times, Reducing Root File System Startup Times.
8 Hrs

Note: Parts of Part A (QEMU) and Part B will have laboratory exercises using an ARM board.

TextBook:

'Professional Linux Embedded Systems', 'Gene Sally', Academic Press 2010

CMOS VLSI CIRCUITS (4:0:2)

Sub Code: EC0509	CIE: 50% Marks
Hours / Week: 4	SEE: 50% Marks
SEE Hours: 3	Max. Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Explain VLSI Design Flow and Transistor-Level CMOS Logic design.
2. Analyze static and dynamic CMOS logic gates.
3. Describe VLSI Fabrication and CMOS Physical Design.
4. Analyze Gate Function and Timing Characteristics and delay analysis.
5. Explain analog CMOS cell design.
6. Analyze interconnects and parasitic effects.

PART –A

Unit 1: An overview of VLSI:

Complexity and Design, Basic concepts, Logic Design with MOSFETs: Ideal switches and Boolean operations, MOSFETs and Switches, Basic Logic gates in CMOS, Complex logic gates in CMOS, Transmission Gate Circuits, Clocking and Data flow control. **10 Hrs**

Unit 2: Physical Structure of CMOS Integrated Circuits:

Integrated Circuit Layers, MOSFETs, CMOS Layers, Designing FET Array. **6 Hrs**

Unit 3: Elements of Physical Design:

Basic Concepts, Layout of Basic structures, Cell Concepts, FET Sizing and Unit Transistor, Physical Design of Logic Gates, Design Hierarchies. **8 Hrs**

PART – B

Unit 4: Electronic Analysis of CMOS Logic Gates:

DC Characteristics of the CMOS Inverter, Inverter Switching characteristics, Power dissipation, NAND and NOR Transients Response, Analysis of Complex Logic Gates, Gates Design for Transient Performance. **8 Hrs**

Unit 5: VLSI for Testing:

Testing combinational logic, sequential logic, scan testing ,boundary scan, built-in-self-test(only hardware testing).

CMOS Process Enhancements: Multiple threshold voltages and oxide thickness, Silicon on insulator(SOI),implication for circuit styles, High-K- Gate dielectrics, silicon on Ge bipolar transistor structure. **8 Hrs**

Unit 6:Advanced Techniques in CMOS Logic Circuits:

Mirrors Circuits, Pseudo-nMOS, Tri-State Circuits, Clocked CMOS, Dynamic CMOS Logic Circuits. Dual rail logic networks. **10 Hrs**

Text books:

1. **"Introduction to VLSI Circuits and Systems",** John P. Uyemura, John Wiley.2010.
2. **"CMOS VLSI DESIGN",** Neil H.E.Weste, David Harris, PearsonEducation.2012.

Reference book:

1. **"CMOS Digital Integrated Circuits- Analysis and Design",** Sung-Mo Kang and Yusuf Leblebici, TMH,2005.
2. **"Digital systems design using VHDL"** Charles H Roth,Thomson learning.2006.

CMOS VLSI LABORATORY

DESIGN AND VERIFY THE FOLLOWING BY SCHEMATIC SIMULATION AND LAYOUT SIMULATION

1. Inverter using FETs.
2. Two input NAND, NOR, XOR gates.
3. Realization of Boolean expressions.
4. Combinational Circuit Design of Adders, MUX and its realizations.
5. Sequential Circuit Design of flip-flops, counters and Shift registers.
6. Differential Amplifier.
7. Schmitt trigger.
8. Common Source and Common Drain Amplifier.
9. Op-amp.

Note: Effect of changes in process technology parameters such as from 1.2 microns to 35nano microns and step-wise fabrication processes (2D/3D view) for the above experiments to be studied.

Text Books:

1. **'Introduction to VLSI Circuits and System'**, 'John P Uymeura', Wiley Publications, 2nd Edition, 2001
2. **'Basics Of CMOS Cell Design: Deep-Submicron CMOS Circuit Design'**, 'Etienne Sicard, Sonia Delmas Bendhia', Tata Mcgraw Hill, 2nd Edition 2005

CONTROL SYSTEMS (4:0:0)

Sub. Code: EC0406	CIE: 50% Marks
Hrs /Week: 4	SEE: 50% Marks
SEE Hrs: 3 Hrs	Max. Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Apply the concept of mathematics to model a physical system.
2. Compare open loop and closed loop control systems.
3. Analyze the transient and steady-state behavior of dynamic systems.
4. Analyze closed loop system performance in the time and frequency domain.
5. Analyze the stability of closed loop control systems.
6. Represent a control system using state space techniques.

PART – A

Unit 1: Mathematical Models of Physical Systems:

Introduction to control systems – Historical development of control systems – open loop and closed loop control system – Definitions – Examples of control systems – Comparison of OLCs and CLCs – overview of engineering control problems.
Differential equation for physical systems – Transfer function analysis – Mechanical translation and rotational systems – Electrical systems – Electromechanical systems – Analogous Systems – F-V and F-I analogy **10Hrs**

Unit 2: Block Diagram and Signal Flow Graphs:

Block diagram representation of control system – Block diagram algebra and reduction – Examples to illustrate the above. Signal flow graph representation – SFG reduction using Mason's gain formula. **7 Hrs**

Unit 3: Time Domain Analysis of Control Systems:

Introduction – Standard test signals – Type and order of the system – Time response of first and second order systems – Time domain specifications – Overview of the Response with P, PI and PID controllers – Steady state error and error constants (both dynamic and static) **8 Hrs**

PART – B

Unit 4: Stability Analysis of Control Systems:

Introduction – Necessary conditions for stability – BIBO stability – Zero input and asymptotic stability – Methods of determining stability – Routh – Hurwitz criterion – Difficulties and remedies – Relative stability. Basic properties of root locus – Construction of root loci – Some typical root locus plots – Application of root locus **10 Hrs**

Unit 5: Frequency Domain Analysis of Control Systems:

Introduction – Frequency domain specifications – Estimation of specifications for a second order system – Polar plots – Bode plots – Gain and phase margins - Stability analysis using polar and Bode plots. **9 Hrs**

Unit 6: Stability Analysis and State Space Techniques:

Introduction – State space formulation – State variables – State space models from transfer function – State transition matrix – Solution of linear state equations. Nyquist stability criterion and its significance **8Hrs**

Text Book:

"**Control Systems engineering"** J.Nagareth and M.Gopal, New age international, 4th edition

Reference Books:

1. **"Modern control engineering"** , K.Ogata **,**–Pearson education Asia / PHI 4th edition, 2002
2. "**Automatic Control System"**, Benjamin C.Kuo, PHI, 8th edition, 2002.

LINEAR INTEGRATED CIRCUITS AND APPLICATIONS (4:0:2)

Sub. Code: EC0503	CIE: 50% Marks
Hrs /Week: 6	SEE: 50% Marks
SEE Hrs: 3 Hrs	Max. Marks: 100

Pre-requisite: Analog Electronics Circuits (EC211)

Course Outcome:

On successful completion of the course, the students will be able to

1. Analyze differential amplifiers and current sources used in linear integrated circuits.
2. Apply the concepts of loading, impedance matching, gain and frequency response in electronic circuit design and analysis.
3. Discuss the linear and non linear applications of an Op-Amp.
4. Analyze and design amplifiers and active filters.
5. Analyze and design of waveform generators using Op-Amp.
6. Analyze and design of circuits using special IC chips.

PART – A

Unit 1: Basics of Operational Amplifiers:

Brief review of Operational Amplifiers – Block diagram of an Opamp, Differential amplifiers, Frequency response of an Opamp,. Single supply Opamps-other operational amplifiers. **8 Hrs**

Unit 2: Linear applications of an Opamp:

Inverting, Non-inverting , voltage follower, Opamp parameters and their measurement summing, scaling and averaging amplifiers using Opamps, Bridge amplifiers, Analog integrators, Differentiators, Line driving amplifiers, AC coupled feedback amplifiers, voltage to current converters, current to voltage converter, Instrumentation amplifier, Current amplifiers, Charge amplifiers. **10 Hrs**

Unit 3: Op-Amp in Non-linear Applications:

Logand antilog amplifiers and their applications, Comparators, Zero crossing detector, sample and hold circuits, precision AC/DC converters, **9Hrs**

PART – B

Unit 4: p-Amp in Non-linear Applications: (Contd.)

Waveform generators, Schmitt trigger, Analog multipliers, Analog dividers, squarers and square-rooters, Active filters **7 Hrs.**

Unit 5: Additional Linear IC Circuits:

Phase locked loop, operating principles, monolithic phase locked loop. 565 PLL applications. Analog to digital and digital to analog converters. **9 Hrs**

Unit 6: Integrated circuit timers:

Operating mode of the 555 timer, Astable operation, monostable operation and other Applications of the 555,IC voltage regulators. **9 Hrs**

Text books:

"Op-Amps and linear Integrated Circuits",Ramakanth A. Gayakwad, Prentice – Hall of India, 3rd Edition, 1988.

Reference Books:

1. **"Operational Amplifiers and Linear Integrated Circuits",** Robert F. Coughlin and Fredrick F. Driscoll, Prentice – Hall of India, 4th Edition, 1987
2. **"Integrated Electronics",**Millman and Halkias, Tata McGraw Hill Publication, New Delhi, 1991 Edition..
3. **"Linear Integrated Circuits",**B Roy Chaudary and SheilJain,New Age International Pvt Limited

LINEAR INTEGRATED CIRCUITS AND APPLICATIONS LABORATORY

LIST OF EXPERIMENTS

1. Mathematical operations using Opamps (Adder, Subtractor, Integrator, differentiator), AC Amplifier
2. Generation of waveforms like sine, square and triangular using 741 ICs, from first principles.
3. Design and testing of comparator and Schmitt trigger circuits using 741.
4. Monostable and Astable multivibrators using 555 timers.
5. Study of DAC using ICs (like DAC-08) and testing for linearity, resolution and error.
6. Precision half wave and full wave rectifiers using Opamps.
7. A/D converter
8. Design of Active Filters(Low Pass and High Pass)
9. Design of Active Filters(Band Pass and Band Elimination)
10. Study of Function generator chip 8038
11. Study of Three terminal voltage regulator and Design of Current Booster for a three terminal regulator
12. PLL and its applications

- **Study means conduction of experiments with a note on design aspects**
- **All the above experiments will be first be simulated and then implemented.**

ADVANCED COMMUNICATION AND CODING THEORY (4:0:0)

Sub. Code: EC0440 **CIE: 50% Marks**

Hrs. /Week: 4 **SEE: 50% Marks**

SEE Hrs.: 3 **Max. Marks: 100**

Course Outcome:

On successful completion of the course, the students will be able to:

1. Describe and analyse various modulation schemes in digital communication system and solve problems on probability of error.
2. Analyse and solve problems on spread spectrum and advanced modulation techniques.
3. Analyse of information theory, source and channel coding techniques.
4. Describe and analyse advanced coding schemes.

Unit 1: Digital Carrier Modulation Schemes:

Introduction, Binary ASK, PSK, DPSK, FSK, and QPSK modulation schemes, Probability of error, Matched filter and its transfer function, correlator, Comparison of digital modulation schemes. **10 Hrs.**

SLE: SDR

Unit 2: Spread Spectrum Modulation

Pseudo noise sequences, notion of spread spectrum, direct sequence spread spectrum with coherent binary PSK, frequency hopped spread spectrum, applications. **8 Hrs.**

SLE: CDMA

Unit 3: Advanced Modulation Techniques

M-ary ASK and FSK, advanced QAM (16, 32), MSK, GMSK, TCM. **9 Hrs.**

SLE: 64 -QAM

Unit 4: Measure of Information, Source Coding and Channel Capacity:

Introduction, Measure of information, concept of Entropy for memory less sources, Shannon's and Shannon-Fano encoding algorithm, Huffman coding, discrete memory less Channels, Mutual information, Channel Capacity, Introduction to continuous channels and Shannon Hartley theorem. **9 Hrs.**

SLE: Source coding using modern coding techniques.

Unit 5: Error Control Coding:

Introduction, properties of optimum code, linear block codes, Convolution codes (time domain approach only), Cyclic codes. **8 Hrs.**

SLE: Channel coding using modern coding techniques.

Unit 6: Advanced Coding Techniques:

Reed Solomon Codes, Viterbi codes, Trellis code**s**, Irregular codes **8 Hrs.**

SLE: LDPC code**s.**

Text Books:

1. Simon Haykin, ***"Communication Systems",*** John Willey, 4th Edition, 2006.
2. Blahut R. E, ***"Theory and Practice of Error Control Codes"****,* Addisson Wesley, 1983.

References Books:

1. Simon Haykin, *"****An Introduction to Analog and Digital Communications****",* 2nd Edition, John Wiley, 2012.
2. Shu Lin and Danicl J. Costello Jr., ***"Error Control Coding: Fundamentals and Application"***, Prentice Hall, 2003.

ADVANCED COMMUNICATION LABORATORY (0:0:3)

Sub. Code: EC0110 **Hrs. /Week: 3**

Course Outcome:

On successful completion of the course, the students will be able to:

1. Performance analysis of various digital modulation techniques.
2. Experimentally find the performance parameters of filter circuits, Couplers, Power dividers using Microwave Striplines.
3. Performance analysis of various CODECs.
4. Design, simulate and implement various Digital Communication circuits.

LIST OF EXPERIMENTS

1. Performance analysis of Fiber Optic link.
2. Performance analysis of ASK and FSK.
3. Performance analysis of PSK and DPSK.
4. Implementation of CODECs using Hamming, cyclic and convolution codes.
5. Measurement of transmission loss and reflection loss of a 50-ohm microstrip transmission line.
6. Measurement of power division, isolation and return loss characteristics of a 3dB power divider.
7. Measurement of characteristics of a branch line and backward wave directional coupler.
8. Measurement of filter characteristics of lowpass and bandpass filter

DIGITAL SIGNAL PROCESSING (3:2:2)

Sub. Code: EC0510	CIE: 50% Marks
Hrs /Week: 5	SEE: 50% Marks
SEE Hrs: 3 Hrs	Max. Marks: 100

Pre-requisite: Signals and Systems (EC0404)

Course Outcome:

On successful completion of the course, the students will be able to

1. Representation of analog signals by their discrete time samples and apply DFT and its properties to sample and reconstruct discrete time signals.
2. Represent signals in the frequency domain with discrete tools.
3. Apply frequency transformation in the analog and digital domain to design filters.
4. Design IIR and FIR filters relative to specific performance parameters.

Unit 1: The Discrete Fourier Transform:

Frequency Domain Sampling: The Discrete Fourier Transform Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals. The Discrete Fourier Transform (DFT). The DFT as a linear Transformation. Relationship of the DFT to Other Transforms. Properties of the DFT. Periodicity, Linearity, and Symmetry Properties. Multiplication of two DFTs and Circular Convolution, Frequency analysis of signals using the DFT. **9 Hrs**

SLE: Additional DFT Properties.

Unit 2: Efficient Computation of DFT:

Fast Fourier Transform Algorithms: Efficient Computation of the DFT: FFT Algorithms, Direct Computation of the DFT. Radix-2 FFT algorithms. Decimation-in-time FFT algorithm and in-place computations, Decimation-in-frequency FFT algorithm and in-place computations, Chirp Z-Transform. **7 Hrs**

SLE: Gortezel Algorithm.

Unit 3: Frequency Transformations:

Frequency Transformations in the Analog domain. Frequency Transformations in the digital domain. **4 Hrs**

SLE: Designing problems on transformations.

Unit 4: Design of FIR Filters:

Properties of FIR digital filters, Different types of windows; Rectangular, Bartlett, Hanning, Hamming, Blackmann& Kaiser windows, Design of FIR filters using above windows. **8 Hrs**

SLE: MATLAB programming for above windows

Unit 5: Design of IIR Filters:
IIR Filter Design by Approximation of Derivatives IIR Filter Design by Impulse Invariance. IIR Filter Design by the Bilinear Transformation. The Matched—Transformation. Characteristics of Commonly Used Analog Filters. Application of above technique to the design of Butterworth & Chebyshev filters. **9 Hrs**
SLE: A comparison of IIR & FIR digital filters, MATLAB programming on filters.

Unit 6: Digital Filter Structures:
Basic IIR Filter Structures: Direct forms (I & II), cascade and parallel realizations. Signal flow graph, Transposed structure, Basic FIR filter structures- Direct form structure, frequency sampling structure, Lattice structure, Linear phase FIR structure. **5 Hrs**
SLE: FIR structures.

Text Books:
1. "**Digital Signal Processing – Principles algorithm and application",** Proakis and Manolakis, Pearson Education 4th Edition, 2007.
2. **"Discrete Time Signal Processing",** Oppenheim andSchaffer, PHI,2003

Reference Book:
"Digital Signal Processing", Sanjit K. Mitra, TMH, 2004

DIGITAL SIGNAL PROCESSING LABORATORY (0:0:2)

I) LIST OF EXPERIMENTS USING MATLAB / SCILAB / OCTAVE / WAB

1. Verification of sampling theorem.
2. Impulse response of a given system
3. Linear convolution of two given sequences.
4. Circular convolution of two given sequences
5. Solving a given difference equation.
6. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum.
7. Design and implementation of FIR filter to meet given specifications.
8. Design and implementation of IIR filter to meet given specifications.

II) LIST OF EXPERIMENTS USING DSP PROCESSOR

1. Linear convolution of two given sequences.
2. Circular convolution of two given sequences.
3. Computation of N- Point DFT of a given sequence
4. Realization of an FIR filter (any type) to meet given specifications. The input can be a signal from function generator
5. Realization of an IIR filter (any type) to meet given specifications. The input can be a signal from function generator

ANALOG & DIGITAL COMMUNICATION (4:0:0)

Sub. Code: EC0439 **CIE: 50% Marks**

Hrs. /Week: 4 **SEE: 50% Marks**

SEE Hrs.: 3 **Max. Marks: 100**

Course Outcome:

On successful completion of the course, the students will be able to:

1. Describe and analyse the working of amplitude and frequency modulated systems and analyse in time and frequency domain using Fourier and Hilbert transform.

2. Describe different types of noise and evaluate noise figure and figure of merit for various communication circuits.
3. Distinguish between Analog and Digital Communication system and analyse various sampling methods and its reconstruction.
4. Analyse and solve problems on various waveform coding and base band shaping technique.

Unit 1: Analog Modulation

Introduction to Analog communication, need for modulation, AM: Description, generation and detection, Double side band suppressed carrier modulation (DSB-SC). Costas loop, FM: Description, generation and detection methods, SSB: Description in Time domain using Hilbert transform. **10 Hrs.**

SLE: Generation of SSB wave: Phase discrimination method, Detection of SSB wave.

Unit 2: Noise & Noise in Continuous wave modulation systems:

Introduction, shot noise, thermal noise, white noise, noise equivalent bandwidth, noise figure, equivalent noise temperature, noise effect in two-port networks. noise performance in AM and FM receivers, Pre-emphasis and De-emphasis. **9 Hrs.**

SLE: Noise Reduction Techniques.

Unit 3: Sampling Process:

Introduction, basic signal processing operations in digital communication, communication channel sampling and Sampling Theorem: Ideal, natural and flat top sampling, Quadrature sampling of Band pass signal. **9 Hrs.**

SLE: Design of flattop sampling circuit.

Unit 4: TDM

Introduction, TDM for analog and digital signal, bandwidth in TDM, bit stuffing techniques, TDM demultiplexing. **7 Hrs.**

Unit 5: Waveform Coding Techniques:

PCM, Quantization, Quantization noise and SNR, robust quantization, DPCM, DM, T1 carrier system. **8 Hrs.**

SLE: ADPCM and its applications.

Unit 6: Base-Band Shaping for Data Transmission:

Discrete PAM signals, ISI, Nyquist's criterion for distortion less base-band binary transmission, correlative coding, eye pattern, base-band M-ary PAM systems, equalization. **9 Hrs.**

SLE: Adaptive equalization.

Text Books:

1. Simon Haykin, *"An Introduction to Analog and Digital Communications",* John Wiley, 2nd Edition, 2012.
2. K. Sam Shanmugam, ***"Digital and Analog Communication System"***, Wiley, 2012.

Reference Books:

1. Simon Haykin, *"**Communication Systems",*** John Willey, 4th Edition,2006.
2. Leon W. Couch, ***"Digital & Analog Communication Systems",*** Pearson, 8th Edition, 2013.

COMMUNICATION LABORATORY (0:0:3)

Sub. Code: EC0109 **Hrs. /Week: 3**

Course Outcome:

On successful completion of the course, the students will be able to:

1. Performance analysis of AM, FM, TDM and radiation pattern of antennas.
2. Simulate and experimentally verify sampling theorem.
3. Design, Simulate and Implement various Analog communication circuits.

LIST OF EXPERIMENTS

1. Test tuned amplifier, find centre frequency, bandwidth and quality factor.

2. Performance analysis of AM modulation and detection.
3. Performance analysis of FM modulation and detection.
4. Generate PAM for different modulating signals and demodulate using suitable filters.
5. Plotting of radiation pattern and calculation of 3-dB bandwidth of folded dipole, slot, helix and Microstrip antennas
6. Design and test a T, π, bridge & Lattice type Attenuators for a given characteristic resistance and attenuation factor.
7. Verification of sampling theorem using natural and flat top samples.
8. Performance analysis of TDM.

OPERATING SYSTEM (4:0:0)

Sub. Code: EC0410	CIE: 50% Mark
Hrs/week: 4	SEE: 50% Marks
SEE Hrs: 3	Max Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Explain the concept of operating systems and its types.
2. Distinguish between processes and threads.
3. Explain interrupts, synchronization, waiting, and atomic behavior.
4. Explain virtual memory, paging, and memory allocation.
5. Describe caching principles and quantitative estimation of cache behavior.
6. Analyze paging performance and page replacement.
7. Explain files and its types.
8. Describe input, output, and types of I/O devices.

PART – A

Unit 1: Introduction and Overview of Operating Systems:

Operating system, Goals of an O.S, Operation of an O.S, Resource allocation and related functions, User interface related functions, Classes of operating systems, O.S and the computer system, Batch processing system, Multi programming systems, Time sharing systems, Real time operating systems, distributed operating systems. **8 Hrs**

Unit 2: Structure of the Operating Systems:

Operation of an O.S, Structure of the supervisor, Configuring and installing of the supervisor, Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel based operating systems, and Microkernel based operating systems. **8 Hrs**

Unit 3: Process Management:

Process concept, Programmer view of processes, OS view of processes, Interacting processes, Threads, Processes in UNIX, Threads in Solaris. **8 Hrs**

PART – B

Unit 4: Memory Management:

Memory allocation to programs, Memory allocation preliminaries, Contiguous and noncontiguous allocation to programs, Memory allocation for program-controlled data, kernel memory. **8 Hrs**

Unit 5: Virtual Memory:

Virtual memory basics, Virtual memory using paging, Demand paging, Page replacement, Page replacement policies, Memory allocation to programs, Page sharing, UNIX virtual memory. **7 Hrs**

Unit 6: Scheduling:

Fundamentals of scheduling, Long-term scheduling, Medium and short term scheduling, Real time scheduling, Process scheduling in UNIX.
Message Passing: Implementing message passing, Mailboxes, Inter process communication in UNIX). **10 Hrs**

Text book:

"Operating Systems, A Concept based Approach", 'D.M. Dhamdhare', TMH, 2nd Ed.2006.

Reference books:

1. **'Operating Systems Concepts',** 'Silberschatz and Galvin', John Wiley, 5th Edition, 2001.
2. **'Operating System – Internals and Design Systems',** 'Willaim Stalling', Pearson Education, 4th Ed, 2006.

WIRELESS NETWORKS (4:0:0)

Sub. Code: EC0429	CIE: 50% Marks
Hrs/week: 4	SEE: 50% Marks
SEE Hrs: 3	Max Marks: 100

Pre-requisite: 1.Wireless Communication (EC0413)
2. Communication Networks (EC0414)

Course Outcome:

On successful completion of the course, the students will be able to

1. Explain the fundamentals of wireless networking
2. Describe and analyze various Wireless Networks like LAN, WAN, PAN and MAN& their performance analysis.
3. Describe and compare Broad Band Satellite and Microwave Systems.
4. Explain air interface technologies and emerging wireless technologies.

PART – A

Unit1: Cellular Wireless Data Networks – 2.5 and 3G Systems:

Introduction to wireless Networks, CDPD, GPRS, and EDGE Date Networks, CDMA Date Networks, Evolution of GSM and NA-TDMA to 3G, Evolution of CDMA to 3G, SMS, EMS, MMS and MIM Services **9Hrs**

Unit2: Wireless LAN's /IEEE 802.11x:

Introduction, Evolution of Wireless LANs, IEEE 802.11 Design Issue, Services, Layer 2, MAC Layer Operations, Layer 1, Higher Rate Standards, Wireless LAN Security, Competing Wireless Technologies, Typical WLAN Hardware **8Hrs**

Unit3: Wireless PANs/IEEE 802.15x:

Introduction, Wireless PAN Applications and Architecture, IEEE 802.15.1 Physical Layer Details, Bluetooth Link Controller Basics and Operational States, IEEE 802.15.1 Protocols and Host Control Interface, Evolution of IEEE 802.15 Standards. **8Hrs**

PART – B

Unit4: Broadband Wireless MAN's/IEEE 802.16x:

Introduction to WMAN/IEEE 802.16x Technologies, IEEE 802.16 Wireless MANs, MAC Layer Details, Physical Layer Details, Physical Layer Details for 2-11 GHz, Common System Operations. **8Hrs**

Unit 5: Broad Band Satellite and Microwave Systems:

Introduction, Line-of Sight Propogation, Fundamentals of Satellite Systems, Broadband Satellite Networks, Broadband Microwave and Millimeter Wave Systems. **9Hrs**

Unit 6: Emerging Wireless Technology:

Introduction, New and Emerging Air Interface Technologies, New Wireless Network Implementations, IEEE 802.20/Mobile Broadband Wireless Access, Satellite Ventures and Other Future Possibilities. **7Hrs**

Text Book:

'Introduction to Wireless Telecommunications Systems and Networks', 'Mullet', Cengage Learning, Indian Edition, 2006

Reference Book:

'**IS-95 CDMA and cdma 2000 Cellular/PCS System Implementation'**, 'Vijay K Gard', Pearson Education, Low Price Edition.

INTERNET OF THINGS (IOT) (2:0:2)

Sub. Code: EC0435	CIE: 50% Marks
Hrs/week: 2	SEE:50% Marks
SEE Hrs: 3	Max Marks: 100

Course Learning Outcomes – upon successful completion of this course, the participant will be able to:

1. Design and Implement interfaces for IoT applications.
2. Develop programming skills
3. Demonstrate knowledge and understanding of the security and ethical issues of the Internet of Things
4. Conceptually identify vulnerabilities, including recent attacks, involving the Internet of Things
5. Conceptually describe countermeasures for Internet of Things devices
6. Analyze the societal impact of IoT security events
7. Compare and contrast the threat environment based on industry and/or device type

Assessment Components and Evaluation Standards

Students will be evaluated by course participation in weekly Quiz, Tests, examinations, and Mini Projects.

Unit 1: Introduction- The definition of the Internet of Things - overview, applications, potential & challenges, and architecture. Platform for IoT devices - Device architectures, Conventional and renewable power sources for resource-constrained devices, Operating systems for resource-constrained devices. **4 Hrs**

Unit 2: Internet in general and Internet of Things: layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia. **4 Hrs**

Unit 3: Network layer: forwarding & routing algorithms (Link, DV), IP-addresses, DNS, NAT, and routers. Transport services: TCP, UDP, socket programming. Service Orinted Protocols (COAP).Communication protocols based on the exchange of messages (MQTT). **4 Hrs**

Unit 4: Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular internet access, and Machine-to-machine. **4 Hrs**

Unit 5: Mobile Networking: roaming and hand-offs, mobile IP, and ad hoc and in-frastrctureless networks. **4 Hrs**

Unit 6: Real-time networking: soft and real time, quality of service/information, resource reservation and scheduling, and performance measurements**.** **3 Hrs**

SLE Components: Applications: Smart Grid. Home Automation. Smart City.

Laboratory classes and Mini Projecs: 2 Labs/week (each 2 Hrs duration)

Laboratory Recommended literature and teaching resources:

1. Interacting with device peripherals (GPIO , ADC , servos)
2. Connecting to the Internet (eg. the device showing the current weather forecast)
3. Exposition of device functionality as services (1) (COAP protocol)
4. Machine-to-machine communication (broadcast communication protocols)
5. Machine-to-machine communication (communication based on the message exchange – MQTT protocol). 6. Interfacing with devices used in heakthcare, automation, transportation using Gelilio board.

Self Reading and Mini Projects: (Suggested)

ENGINEERING MANAGEMENT (4:0:0)

Sub. Code: EC0416	CIE: 50% Marks
Hrs/week: 4	SEE: 50% Marks
SEE Hrs: 3	Max Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Differentiate theories such as scientific approach, administrative approach to management
2. Concepts such as Planning, Organizing, Staffing, Directing and Controlling
3. Instill entrepreneurial thinking
4. Prepare a plan, project report
5. Undertake feasibility study such as market, finance

PART – A – MANAGEMENT

Unit1: Management:

Introduction - Meaning - nature and characteristics of Management, Scope and functional areas of Management - Management as a Science, Art or Profession Management & Administration - Roles of Management, Levels of Management, Development of Management Thought-Early Management Approaches-Modern Management Approaches. **7 Hrs**

Unit2:Planning:

Nature, importance and purpose of planning process - Objectives - Types of plans (Meaning only) - Decision making - Importance of planning - steps in planning & planning premises - Hierarchy of plans. **6 Hrs**

Unit3:Organising and Staffing:

Nature and purpose of organization - Principles of organization - Types of organization - Departmentation - Committees – Centralisation Vs Decentralisation of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of Staffing - Process of Selection & Recruitment (in brief). **6 Hrs**

Unit4:Directing & Controlling:

Meaning and nature of directing - Leadership styles, Motivation Theories, Communication - Meaning and importance – Coordination, meaning and importance and Techniques of Co - ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control. **7 Hrs**

PART – B – ENTREPRENEURSHIP

Unit5: Entrepreneur:

Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur - an emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers. **6 Hrs**

Unit6: Small Scale Industry:

Definition; Characteristics; Need and rationale: Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start an SSI - Government policy towards SSI; Different Policies of S.S.I.; Government Support for S.S.I. during 5 year plans, Impact of Liberalization, Privatization, Globalization on S.S.I., Effect of WTO/GATT Supporting Agencies of Government for S.S.I Meaning; Nature of Support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only). **7 Hrs**

Unit7: Institutional support:

Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI; NSIC; SIDBI; KSFC. **6 Hrs**

Unit8: Preparation of Project:

Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of Business Opportunities - Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. **7 Hrs**

Text Books:

1. **'Principles of Management',** 'P. C. Tripathi, P. N. Reddy'; Tata McGraw Hill.
2. **'Dynamics of Entrepreneurial Development & Management',** 'Vasant Desai', Himalaya Publishing House.
3. **Entrepreneurship Development Small Business Enterprises',** 'Poornima M Charantimath', Pearson Education – 2006.

Reference Books:

1. **'Management Fundamentals Concepts, Application, Skill Development',** 'Robert Lusier', Thomson.
2. **'Entrepreneurship Development',** 'S S Khanka,' S Chand & Co.
3. **'Management', 'Stephen Robbins',** Pearson Education, PHI -17th Edition, 2003.

Business Analytics for Management Decision (0:0:2)

Sub. Code: EC0112	CIE: 50% Marks
Hrs /Week: 2	SEE: 50% Marks
SEE Hrs: 2 Hrs	Max. Marks: 100

Course Outcome:

On successful completion of the course, the students will be able to

1. Exposure on data analysis, modeling and spreadsheet use with business analytics for decision making.

Introduction to Business Analytics, Exploring Data and Analytics on Spreadsheets, Descriptive Analytics, Inferential Analytics, Predictive Analytics, Prescriptive Analytics, Decision Analytics

MOOC: https://nptel.ac.in/courses/110105089/#

STACK PROJECT

Sub. Code: EC0303 **Max Marks: 50**

Course Outcome:

On successful completion of the course, the students will be able to

1. Identify real world problems.
2. Apply design methods and implementation.
3. Prepare a technical report.
4. Manage a group task with in a deadline.
5. Communicate and present a technical report.

PROJECT WORK

Sub. Code: EC0601 **Max Marks: 100**

Course Outcome:

On successful completion of the course, the students will be able to

1. Identify real world problems.
2. Apply design methods and implementation.
3. Prepare a technical report.
4. Manage a group task with in a deadline.
5. Communicate and present a technical report.