PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR
SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester VI			**B Tech in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
			L	**T**	**P**	**C**	**Hrs/ Wk**	**Theory**			**Practical**		**Total**
								CE	**MS**	**ES**	**CE**	**ES**	**Marks**
1	18IC311T	Embedded Systems	4	0	0	4	4	25	25	50	-	-	100
2	18IC312T	Digital Signal Processing	4	0	0	4	4	25	25	50	-	-	100
3	18IC313	Wireless Communication & Coding	4	0	0	4	4	25	25	50	-	-	100
4	18CP311T	Artificial Intelligence	4	0	0	4	4	25	25	50	-	-	100
5	18XX315X	Elective-I	3	0	0	3	3	25	25	50	-	-	100
6	18XX315X	Elective-II	3	0	0	3	3	25	25	50	-	-	100
7	18IC 311P	Digital Signal Processing Lab	0	0	2	1	2	-	-	-	25	25	50
8	18IC 312P	Embedded Systems Lab	0	0	2	1	2	-	-	-	25	25	50
9	18CP311P	Artificial Intelligence Lab	0	0	2	1	2	-	-	-	25	25	50
		Total	22	0	6	25	28						750

CE- Continuous Evaluation, MS-Mid Semester; ES – End Semester Exam

Subject Code	**Elective I & II**	**Credit**	**L-T-P**	**Category**
18CP3151	Advanced Computer Architecture	3	3-0-0	Computing System
18IC3152	VLSI Design	3	3-0-0	Computing System
18CP3158	Wireless Sensor Networks	3	3-0-0	Networking
18CP3154	Natural Language Processing	3	3-0-0	Data Science
18CP3155	Data Warehousing and Data Mining	3	3-0-0	Data Science
18IC3151	Satellite Communication	3	3-0-0	Communication System
18IC3153	Modern Antenna Design	3	3-0-0	Communication System
18IC3154	Optical Communication	3	3-0-0	Communication System

Course Code: 18IC 311T					Course Name: Embedded Systems			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
4	0	0	4	4	25	25	50	100

Prerequisites: Digital Electronics, Computer Organization and Programming

Learning objectives:

- To get familiarize with different embedded system design techniques.
- To facilitate the understanding of the microcontrollers used in embedded systems.
- To facilitate the understanding of interfacing of different devices with microcontroller to have interactive embedded system.

Unit wise allocation of course content

UNIT 1 (05 L)

Introduction to Embedded Systems:

Modern definition of embedded systems, Embedded system and general purpose computers, Characteristics, Classifications, Applications, Purposes and Examples of embedded systems, Embedded system components: Core of the Embedded System, Memories, Embedded Firmware, PCB and Passive Components, Embedded System Design Process.

UNIT 2 (20 L)

Designing Embedded Systems with Microcontrollers:

Factors to be considered in selecting microcontroller, An exemplary Microcontroller (MCS-51/AVR/PIC/ARM etc.): CPU Architecture and Organization, Pin diagram, Packages, Oscillator and Clock circuit, Reset Circuits: Power on reset and Brown out protection, Power Supply, Register set, On chip memory organization, Program and data memory buses, Instruction Set and Assembly language programing, Typical Data transfer, Arithmetic, Logic and Branch instructions, Addressing Modes, T-state, Machine cycle and Instruction Cycle, Looping, Branching, Indexing, Counting and Time Delays using instructions, Stack and Stack operations, Subroutines and Procedures, Timers and Counters Circuits and Programing, Power down modes.

UNIT 3 (20 L)

Interfacing and Communicating with Microcontrollers:

I/O Ports, Interfacing LEDs, 7 segment LED display, Opto coupler, Drivers and Buffers, Stepper Motor, DC Motors, PWM ports and Speed Control, Relays, Buzzers, Push button, Toggle and Proximity switches, Matrix keypad, Text and Graphics LCD, Touch Screen Unit, Interfacing using ADC, Interfacing of Sensors and Actuators, Obtaining DAC and waveform generation, Parallel and Serial Communication, Serial Communication Interfaces: UART, SPI and I2C, RS-232, RS-422 and RS-485 interfaces, RTC interfacing, USB and Firewire, Interfacing Wireless Communication Devices: IrDA, Bluetooth, WiFi, Zigbee, GPRS, Emulation of Various Interfaces on USB, Use of Interrupts in real time interfacing of serial and parallel I/O devices, Concept of device drivers, Watchdog Timer and its Applications.

UNIT 4 (07 L)

Embedded System Design and Development Tools

Hardware development, Electronic Design Automation (EDA) Tools, Schematic Design using EDA Tools, PCB layout design and fabrication, Embedded Firmware Design Approaches, Development Languages, Programing in Embedded C, Integration of Hardware and Firmware, Integrated Development Environment (IDE), Types of File Generation and Cross compilation, Simulators, Emulators, Target Hardware Debugging, Programmers: Out of System, In System and In Application Programming, Boot loaders, Boundary Scan, JTAG, RTOS: Introduction,

Features and applications of RTOS, Recent Trends in Embedded System Design.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 52 Hrs

Approximate Total: 52 Hrs

Texts and References:

1. Shibu K. V, Introduction to Embedded Systems, TMH.
2. Frank Vahid, Tony Givargis, Embedded system design: A unified Hardware/Software introduction, Wiley.
3. Rajkamal, Embedded System: Architecture, Programming and Design, TMH.
4. Wayne Wolf, Morgan, Computer as Components: Principles of Embedded Computing System Design, Kaufmann Publication.
5. Muhammad Ali Mazidi, 8051 Microcontroller And Embedded Systems: Using Assembly And C, Pearson education India.
6. Muhammad Ali Mazidi, AVR Microcontroller And Embedded Systems: Using Assembly And C, Pearson education India.
7. Muhammad Ali Mazidi, PIC Microcontroller And Embedded Systems: Using Assembly And C, Pearson education India.
8. Steve Furber, ARM System on Chip Architecture, Pearson Education.
9. Data Sheet of the Devices.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand concepts related to embedded system design.
2. Understand microcontroller programming in assembly and C.
3. Understand the interfacing of input-output device and controlling them using microcontroller.
4. Understand the interfacing and programing of sensors and actuators.
5. Design a small scale embedded systems.
6. Understand the complexity of embedded systems.

Course Code: 18IC312T					Course Name: Digital Signal Processing			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
4	0	0	4	4	25	25	50	100

Prerequisites: Signals and Systems, Analog and Digital Electronics

Learning objectives:

- To understand the methods for processing discrete time signals.
- To design and implement digital filters with different structures.
- To facilitate the understanding of digital signal processor and application development around it.

Unit wise allocation of course content

UNIT 1 (08 L)

Overview ofDiscrete Time Signals and Systems:

Introduction to Digital Signal Processing, A review of Continuous Time and Discrete Time Signals, Sampling Theorem, Z-transform, Poles and Zeros, Convolution, Stability and Causality of LTI systems, Discrete Time Fourier Transform (DTFT) and Important Properties, Frequency Response of Discrete Time Systems.

UNIT 2 (17 L)

Digital Filters: Design and Structures

Introduction to Digital Filters, FIR and IIR Filters, Linear Phase and Implications, Stability and Causality, Filter Design Steps, Design of Linear Phase FIR Filters, FIR Filter Design using Window Method, IIR Filter Design, Pole-Zero Placement Method: Low-pass, High-pass, Band-pass, Notch and All-pass Filters, Filter Coefficients from Analog Filter, Bilinear Transformation, Basic Structures for FIR and IIRSystems implementation, Direct,Transposed Cascade andParallel form Structures, Effects of Co-efficient Quantization.

UNIT 3 (17 L)

DFT and FFT Algorithms:

Sampling the Discrete Time FourierTransform, DFT and IDFT, Important Properties of DFT, Linear and Circular Convolution,FFT-Efficient Computation of DFT, Radix2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms, Geortzel Algorithm, Application of DFT in Linear Filtering.

Introduction to random signals and random signal processing, Mathematical tools for random signal processing.

UNIT 4 (10 L)

Digital Signal Processors and Development Tools:

Need and Features of Digital Signal Processors, Harvardand Modified Harvard Architecture, Pipelining, Multiplier-Accumulator (MAC) Unit,Circular Buffer, Architectures of Fixed and Floating point DSP Processors,Handling finite Precision Arithmetic, Audio-Video Codecs andInterfacing, Hardware and Software Development Tools for DSP Application Development, Recent Trends in DSP Based System Design.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 52Hrs
Tutorial: 00Hrs

Approximate Total: 52Hrs

Texts and References:

1. Proakis and Manolakis, "Digital Signal Processing: Principles, Algorithm & Application", Pearson.
2. EmmanuelIfeacher, and Barrie W..Jervis, "Digital Signal processing-A Practical Approach", Pearson Education.
3. S.Salivahanan, A.Vallavaraj, C.Gnapriya, "Digital Signal Processing", TMH.
4. B.Venkatramani, M Bhaskar, "Digital Signal Processors, Architecture, programming and applications", Mc-Graw Hill.
5. Sen M. Kuo, Woon-Seng S. Gan, "Digital Signal Processors: Architectures, Implementations, and Applications", Pearson education India.
6. Data Sheet of the Devices.

Course Outcomes (COs):

At the end of this course students will be able to

1. Design FIR and IIR filters.
2. Implement FIR and IIR filters in software and hardware.
3. Understand the use of efficient algorithms for computation of frequency response.
4. Understand the interfacing of audio and video signals with digital signal processor.
5. Design a small scale DSP based system.
6. Understand the complexity of DSP based systems.

Course Code: 18IC313					Course Name: Wireless Communication& Coding			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
4	0	0	4	4	25	25	50	100

Prerequisites: Communication Systems, RF Engineering

Learning objectives:

- To get fundamentals about concepts that forms the basis for wireless communication systems and networks.
- To get exposure to recent emerging trends in wireless communication.
- To understand the principles and techniques behindrobust and error resilienceapplications of digital communication system.

Unit wise allocation of course content

UNIT 1 (09 L)

Wireless Cellular Systems:

Introduction to Mobile, Cellular and Personal Communication Systems,Types and Comparisons of Wireless Communication Systems, The Cellular Concept – System Design Fundamentals, Frequency Reuse, Channel Assignments, Hand-offs, Interference, Power Control, Grade of Service, Improving Coverage and Capacity.

UNIT 2 (17 L)

Multiple Access Techniques and Wireless Network Standards:

Comparisons of Multiple Access StrategiesTDMA,CDMA, FDMA, OFDM, CSMA Protocols,GSM system architecture, Frequency Bands and Channels, GPRS, Concept of Spread Spectrum, Performance of CDMA System, RAKE Receiver,International Mobile Telecommunications (IMT-2000), Spectrum Allocation, Services provided by 3G Cellular Systems, Harmonized 3G Systems, Universal Mobile Telecommunications Systems (UMTS), WCDMA, HSPA, HSPA+, Introduction to 4G, LTE, VoLTE and Towards 5G, Introduction to Wi-Fi, WiMAX, ZigBee Networks, SoftwareDefined Radio, UWB Radio, Wireless Adhoc Network and MobilePortability, Security issues and challenges in a Wireless network.

UNIT 3 (10 L)

Information Theory and Source Coding:

Uncertainty and Information, Average Mutual Information and Entropy, Measure of Information,Source CodingTheorem, Huffman and Shanon-FanoCoding, Uniqueness Property, Channel Models, Channel Capacity, Error free Communication Over a Noisy Channel, Information Capacity Theorem, The Shannon Limit.

UNIT 4 (15 L)

Error Control Coding (Channel Coding):

Selection of Channel Codes, Error Correcting Codes: Linear Block Codes, Matrix Description, Syndrome Decoding, Error Probability, Hamming Distance, Perfect Codes And Hamming Codes, Low Density Parity Check (LDPC) Codes, Cyclic Codes, Polynomial Representation, Generation And Decoding of Cyclic Codes, Burst Error Correcting And Detecting Code, Golay Codes, Cyclic Redundancy Check (CRC) Codes, Circuit Implementation of Cyclic Codes, Introduction to BCH Codes, Reed-Solomon Codes, Convolution Codes and Turbo Codes, Encoding and Decoding Algorithms in Brief, Comparison of Coded and Un-Coded System.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 52Hrs
Tutorial: 00Hrs
Approximate Total: 52Hrs

Texts and References:

1. T. Rappaport, "Wireless Communications – Principles and Practice",Prentice Hall.
2. Jochen Schiller, "Mobile Communications", Pearson Education.
3. Ranjan Bose, "Information Theory, Coding and Cryptography", PHI.
4. B.P.Lathi, Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press.
5. Thomas M. Cover, Joy. A. Thomas, "Elements of Information Theory", John Wiley.
6. Shu Lin, Daniel J. Costello, "Error Control Coding", Pearson Education.
7.AmitabhBhattacharya, "Digital Communication", TMH.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand concepts of cellular communication.
2. Understand wireless network standards.
3. Understand wireless network architectures.
4. Understand importance of source coding and its application in data compression.
5. Understand error correcting mechanisms used in communication systems.
6. Create foundation for studying secured communication systems.

Course Code: 18CP311T					Course Name: Artificial Intelligence			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
4	0	0	4	4	25	25	50	100

Prerequisites: Computer Fundamentals

Learning objectives:

- Identify the problems where AI is required and the different methods available
- Compare and contrast different AI techniques available.
- Define and explain learning algorithms
- Identify problems in game playing
- Learn Neural Networks
- Learn Expert systems

Unit wise allocation of course content

UNIT 1 (13 L)

Introduction to AI: AI Problems, Intelligent Agents, Problem Formulation, Basic Problem Solving Methods. Searching : Search strategies, Uniformed Search Strategies, State-Space Search, Bi-Directional Search, BFS, DFS, Heuristic Search Strategies, Local Search Algorithms, Hill Climbing, Greedy Best First Search, A* Search, Simulated Annealing, Measure of performance and analysis of search algorithms.

UNIT 2 (14 L)

Knowledge Representation and Inference: Game playing, Knowledge representation using-Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic, Structured representation of knowledge. Production based system, Frame based system. First order logic. Inference in first order logic, propositional Vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution.

UNIT 3 (13 L)

Neural Networks: Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units.

UNIT 4 (12 L)

Expert Systems: Introduction to Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Example of expert systems - MYCIN, DART, XOON, Expert systems shells, Introduction to Planning.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 52 Hrs
Tutorial: 0 Hrs
Approximate Total: 52 Hrs

Texts and References:

1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
2. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", McGraw Hill.
3. Dan W. Patterson, "Introduction to AI and ES", Pearson Education.
4. G.Luger, W.A. Sttubblefield, "Artificial Intelligence", Addison-Wesley Longman.
5. N.J.Nilson, "Principles of Artificial Intelligence", Narosa Publishing House.
6. K. Boyer, L. Stark, H. Bunke, "Applications of AI, Machine Vision and Robotics" World Scientific Pub Co.
7. Artificial Intelligence and Expert Systems Development by D W Rolston-Mc Graw hill.
8. N.P. Padhy "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Course Outcomes (COs):

At the end of this course students will be able to

- Identify the AI based problems
- Apply techniques to solve the AI problems
- Define learning and explain various learning techniques
- Discuss on Neural Networks
- Able to understand Game playing
- Able to learn expert systems

Lab Code: 18IC311P					Lab Name: Embedded Systems Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Wk	Practical		Total
					Continuous evaluation	End semester exam	Marks
0	0	2	1	2	25	25	50

Prerequisites: Digital Electronics

Course objectives:

- To impart knowledge of flow process of embedded system design.
- To facilitate the understanding of interfacing of different devices with microcontroller to have interactive embedded system.
- To implement algorithms on software and hardware platforms

List of Experiments:
Embedded Systems:

1. Familiarization with IDE and trainer kits/boards.
2. Program for blinking LED, pattern generation, timing, sequence generation etc.
3. Program for interfacing multi-digit 7 segment display and implementing counter etc.
4. Program for interfacing toggle and push button switches, simple keypad and matrix keypad, controlling LEDs using switches.
5. Program for interfacing Buzzer, Relay, DC motor, Servo motor, Stepper motor etc. and controlling them through input devices.
6. Program for interfacing LCD and displaying text on it.
7. Program for interfacing various sensors and displaying quantity on LCD.
8. Program for interfacing speech and voice recognition modules and controlling peripherals.
9. Program for interfacingcamera modules.
10. Program for interfacing RS 232 serial modules and file transfer using it. Use of softwares like terminal and hyper-terminal.
11. Program for interfacing Ethernet module and transferring files using it.
12. Program for interfacing wireless modules: Zigbee, Bluetooth, GSM modem, GPS module, RFID etc.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand use of IDEs and write program in assembly and C using IDE.
2. Understand the interfacing of input-output device and controlling them using microcontroller.
3. Understand the interfacing and programing of sensors and actuators.
4. Design a small scale embedded systems.
5. Implement different kinds of algorithms on software and hardware platforms.
6. Understand the complexity of microcontroller based embedded systems.

Lab Code: 18IC312P					Lab Name: Digital Signal Processing Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Wk	Practical		Total
					Continuous evaluation	End semester exam	Marks
0	0	2	1	2	25	25	50

Prerequisites: Signals and Systems

Course objectives:

- To impart knowledge of flow process of signal processing.
- To facilitate the understanding of signal processing algorithms.
- To implement signal processing algorithms on software and hardware platforms

List of Experiments:

1. Implementation of basic signal generation and transformations.
2. Implementation of moving average, cumulative average, accumulator, differentiator etc.
3. Implementation of DFT and FFT algorithms.
4. Implementation of various filter structures on DSP software and hardware platforms.
5. Design and implementation of FIR and IIR filter for given design specifications.
6. Application of different filters on Speech and Image signals.
7. Interfacing of MATLAB-SIMULINK with DSP Hardware.
8. Embedded application development on DSP hardware using IDE and MATLAB-SIMULINK; for e.g. audio equalizer, echo canceller, noise canceller, arbitrary waveform generation etc.
9. Interfacing and processing of audio-image-video with Digital Signal Processor.
10. Designing of systems based on DSP.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand use of IDEs and write program using IDE.
2. Understand the interfacing of speech and audio codec.
3. Understand the signals and systems in transform domain and algorithms for that.
4. Design a small scale DSP based system.
5. Implement different kinds of filters on software and hardware platforms.
6. Understand the complexity of DSP based systems.

Lab Code 18CP311P					Lab Name: Artificial Intelligence Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Wk	Practical		Total
					Continuous evaluation	End semester exam	Marks
0	0	2	1	2	25	25	50

Prerequisites: Computer Programming

Course objectives:

- Understand data structure and its applications like DFS and Best FS
- Apply the concepts to solve game theory problems.
- Understand learning algorithms
- Implement Neural Networks
- Implement and explore tools for Expert systems

List of Experiments:

1. Write a program for Depth First Search
2. Write a program for Best First Search
3. Write a program to generate the output for A* algorithm
4. Write a program to solve water Jug problem using Heuristic functions
5. Write a program to show the Tic Tac Toe game from 0 and X
6. Write a program for expert system using Forward Chaining
7. Hands-on on Matlab/Python for AI related problems like Neural Network, Genetic Algorithm, etc.
8. Project work as decided by Tutor. (all tools related to AI can be explored)

Course Outcomes (COs):

At the end of this course students will be able to

- Empowering humans to perform collaborative activities in complex and dynamic settings.
- Exploit and integrate information coming from different sources.
- Design and implement distributed cognitive systems for information exploitation and collaboration.
- Understand Neural Network.
- Learn Genetic Algorithms.
- Work on Intelligent systems.

Course Code: 18CP3151					Course Name: Advanced Computer Architecture			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Learning Objective

- Give students a broad and deep knowledge of contemporary computer architecture issues and techniques.
- Give students knowledge of advanced hardware-based techniques for exploiting instruction level parallelism.
- Give students knowledge of various architectures and techniques used for building high performance scalable multithreaded and multiprocessor systems.
- Give students ability to apply the learned knowledge to conduct computer architecture research using performance simulators.

UNIT I (9 L)

Architecture And Machines: Some definition and terms, interpretation and microprogramming. The instruction set, Basic data types, Instructions, Addressing and Memory. Virtual to real mapping. Basic Instruction Timing. Time, Area And Instruction Sets: Time, cost-area, technology state of the Art, The Economics of a processor project: A study, Instruction sets, Professor Evaluation Matrix

UNIT II (10 L)

Cache Memory Notion: Basic Notion, Cache Organization, Cache Data, adjusting the data for cache organization, write policies, strategies for line replacement at miss time, Cache Environment, other types of Cache. Split I and D-Caches, on chip caches, Two level Caches, write assembly Cache, Cache references per instruction, technology dependent Cache considerations, virtual to real translation, overlapping the Tcycle in V-R Translation, studies. Design summary.

UNIT III (10 L)

Memory System Design: The physical memory, models of simple processor memory interaction, processor memory modeling using queuing theory, open, closed and mixed-queue models, waiting time, performance, and buffer size, review and selection of queuing models, processors with cache.

UNIT IV(10 L)

Concurrent Processors: Vector Processors, Vector Memory, Multiple Issue Machines, Comparing vector and Multiple Issue processors. Shared Memory Multiprocessors: Basic issues, partitioning, synchronization and coherency, Type of shared Memory multiprocessors, Memory Coherence in shared Memory Multiprocessors.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. Advance computer architecture by Hwang & Briggs, TMH.
2. Pipelined and Parallel processor design by Michael J. Fiynn, Narosa

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand and apply concept and principle of cache memory and virtual memory to high-performance computer architecture.
2. Understand pipelining and its speed advantage and design pipelined logic.
3. Understand design of multiprocessing systems.
4. Understand concept of memory management in multiprocessing systems.
5. Design the overall organization of cache and virtual memories, and pipelined processors.
6. Compare the features of advanced processors.

Course Code: 18IC3152					Course Name: VLSI Design			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Basic Electronics, Analog and Digital Electronics.

Learning objectives:

- To understand different MOS devices.
- To understand the design of digital systems using CMOS.
- To understand VLSI design methodology.

Unit wise allocation of course content

UNIT 1 (10L)

Evolution of VLSI, MOS transistor theory, MOS structure, enhancement & depletion transistor, threshold voltage, MOS device design equations, MOSFET scaling and small geometry effects, MOSFET capacitances. NMOS inverter, CMOS inverter, DC characteristics, static load MOS inverter, pull up/pull down ratio, static & dynamic power dissipation, CMOS & NMOS process technology – explanation of different stages in fabrication, body effect, latch up in CMOS

UNIT 2 (10L)

Stick diagram and design rules, lambda based design rules, switching characteristics & inter connection effects: rise time, fall time delays, noise margin. CMOS logic gate design: NAND, NOR, XOR and XNOR gates, Transistor sizing, combinational MOS logic circuits: pass transistor and transmission gate designs, Pseudo NMOS logic.

UNIT 3 (9L)

Sequential MOS logic circuits: SR latch, clocked latch and flip flop circuits, CMOS D latch and edge triggered flip flop, dynamic logic circuits; basic principle, non ideal effects, domino CMOS logic, high performance dynamic CMOS circuits, clocking issues, clock distribution.

UNIT 4 (9L)

VLSI designing methodology, design flow, design Hierarchy, concept of regularity, modularity & locality, VLSI design style, Design quality, computer aided design technology, adder design and multiplier design examples. Low power design concepts using CMOS Technology. Designing with CPLD and FPGA, Design Tools.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39Hrs
Tutorial:00Hrs
Approximate Total: 39Hrs

Texts and References:

1. Pucknell Douglas A., Eshraghian Kamran, “Basic VLSI Design”, PHI Learning Pvt Limited.
2. N. Weste and D. Harris, "CMOS VLSI Design: A Circuits and Systems Perspective”, Pearson Education, India.
3. S. M. Kang, Y. Lebiebici, “CMOS digital integrated circuits analysis & design” Tata McGraw Hill.

4. Ken Martin, "Digital Integrated Circuit Design", Oxford University Press.
5. YaniiisTsividis and Colin Mcandrew, "The MOS Transistor", Oxford University Press.
6. J. M. Rabaey, "Digital Integrated Circuits", PHI Learning Pvt Limited, India
7. J. P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc., New York, NY

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand different MOS devices
2. Understand the design rules related to digital circuits
3. Understand the design of sequential MOS circuit design
4. To implement different logic gates using CMOS
5. Understand different performance parameters of digital circuit
6. Understand the VLSI design methodology.

Course Code: 18CP3158					Course Name: Wireless Sensor Networks			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Learning Objective

- To understand the concepts of sensor networks
- To understand the MAC and transport protocols for ADHOC networks
- To understand the various routing protocols in sensor networks
- To understand the security of sensor networks
- To understand the applications of Adhoc and sensor networks
- To critique protocol designs in terms of their energy-efficiency

UNIT I (9 L)

OVERVIEW OF WIRELESS SENSOR NETWORKS: Key definitions of sensor networks, Advantages of sensor Networks, Unique constraints an challenges, Driving Applications, Enabling Technologies for Wireless Sensor Networks.

ARCHITECTURES: Single-Node Architecture – Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT II (10 L)

MAC Protocols for Wireless Sensor Networks: Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention – Based Protocols, Contention – Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

UNIT III (10 L)

ROUTING PROTOCOLS: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols, Proactive Routing.

UNIT IV (10 L)

TRANSPORT LAYER AND SECURITY PROTOCOLS: Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

SECURITY IN WSNs: Security in Ad Hoc Wireless Networks, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management, Secure Routing in Ad Hoc Wireless Networks.

SENSOR NETWORK PLATFORMS AND TOOLS: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node- level software platforms, Node-level Simulators, State-centric programming.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. Ad-Hoc Wireless Networks: Architectures and Protocols – C. Siva Ram Murthy and B.S.Manoj, PHI
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control – Jagannathan Sarangapani, CRC Press
3. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley.
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, and Applications", John Wiley.
5. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier.
6. Ad-Hoc Mobile Wireless Networks: Protocols & Systems, C.K. Toh, Pearson Education.
7. Wireless Sensor Networks – C. S. Raghavendra, Krishna M. Sivalingam, Springer.
8. Wireless Sensor Networks – S Anandamurugan , Lakshmi Publications

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand and explain the concept of wireless sensor networks and their applications.
2. Understand typical node and network architectures.
3. To critique protocol design in terms of their energy-efficiency.
4. To design and implement sensor network protocol in different environment.
5. Setup and evaluate measurements of protocol performance in wireless sensor networks.
6. To understand security issues in wireless sensor networks.

Course Code: 18CP3154					Course Name: Natural Language Processing			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Computer Programming

Learning objectives:

- To understand the structure of natural language for processing
- To understand the basic operations of NLP such as Tokenization, Stemming, POS tagging
- To understand the concepts of linguistic rules and machine learning approaches for classification
- To understand the syntax of Natural languages for grouping local words for parsing
- To understand the concept of shallow parsing
- To study the various applications of NLP- machine translation, sentiment analysis, summarization.

Unit wise allocation of course content

UNIT 1 (9 L)

Introduction to NLP. Language Structure and Analyzer - Overview of language, requirement of computational grammar. Words and their Analysis. Tokenization. Stemming. Morphological Analysis. POS tagging.

UNIT 2 (9 L)

Classical approaches to NLP with knowledge bases and linguistic rules; Data Driven and Machine Learning Approaches to NLP; Efficient, Robust and Scalable NLP

UNIT 3 (9 L)

Linguistics Fundamentals: Syntax and Parsing: Meaning: Empirical or Statistical NLP: Probabilistic Methods on Introductory Graphical Models for NLP: Shallow Parsing: Probabilistic Parsing

UNIT 4 (12 L)

Applications: Machine Translation, Information Retrieval, Sentiment Analysis, Summarization, Information Extraction

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs

Tutorial: 0 Hrs

Approximate Total: 39 Hrs

Texts and References:

1. Jurafsky, Daniel, and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics, Prentice Hall, 2000.
2. Christopher D. Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing. Cambridge, MIT Press, 1999.

3. James Allen, Natural Language Understanding, Benjamin/Cummings, 1995.
4. Eugene Charniak, Statistical Language Learning, MIT Press, 1996.
5. Martin Atkinson, David Britain, Harald Clahsen, Andrew Redford, Linguistics, Cambridge University Press, 1999.
6. P. Lieberman, toward an evolutionary biology of language, Harvard University Press, 2006.
7. Natural Language Processing: A Paninian Perspective by Akshar Bharati, Vineet Chaitanya and Rajeev Sangal

Course Outcomes (COs):

At the end of this course students will be able to

1. Process the Natural Language based on structure.
2. Perform Tokenization, Stemming, POS tagging for processing the language.
3. Apply machine learning and linguistic rules for classification related problems.
4. Develop parsers and shallow parser for different languages.
5. Develop various applications of NLP- machine translation.
6. Predict sentiments from different data sets.

Course Code: 18CP3155					Course Name: Data Warehousing & Data Mining			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Database Management System

Learning Objective

- Study data warehouse principles and its working.
- Learn data mining concepts understand association rules mining.
- Discuss classification algorithms.
- Learn how data is grouped using clustering techniques.

UNIT I (09 L)

Data warehouse: Introduction to Data warehouse, Difference between operational database systems and data warehouses. Data warehouse Characteristics, Data warehouse Architecture and its Components, Extraction – Transformation – Loading, Logical (Multi – Dimensional), Data Modelling, Schema Design, Star and Snow – Flake Schema, Fact Consultation, Fact Table, Fully Addictive, Semi – Addictive, Non Addictive Measures; Fact Consultation, Fact Table, Fully Addictive, Semi – Addictive, Non Addictive Measures; Fact – Less – Facts, Dimension Table Characteristics; OLAP Cube, OLAP Operations, OLAP Server Architecture – ROLAP, MOLAP and HOLAP.

UNIT II (10 L)

Introducing to Data Mining : Introduction, What is Data Mining, Definition, KDD, Challenges, Data Mining Tasks, Data Preprocessing, Data Cleaning, Missing data, Dimensionality Reduction, Feature Subset Selection, Discretization and Binaryzation, Data Transformation; Measures of Similarity and Dissimilarity – Basics.

UNIT III (10 L)

Association Rules : problems Definition, Frequent Item Set Generation, The APRIORI Principle, Support and Confidence Measures, Association Rule Generation; APRIOIRI Algorithm, The Partition Algorithms, FP-Growth Algorithms, Compact Representation of Frequent Item set- Maximal Frequent Item Set, Closed Frequent Item Sets.

Classification : Problem Definition, General Approaches to solving a classification problem, Evaluation of classifiers, Classification Techniques, Decision Tree – Decision tree Construction, Methods for Expressing attribute test conditions, Measures for Selecting the Best Split, Algorithm for Decision tree Induction;

UNIT IV (10 L)

Naive Bayes Classifier, Bayesian Belief Networks; K – N earnest neighbour classification – Algorithm and Characteristics. Clustering: Problem Definition, Clustering Overview, Evaluation of Clustering Algorithms, Partitioning Clustering -K-Means Algorithm, K-Means Additional issues, PAM Algorithm; Hierarchical Clustering – Agglomerative Methods and divisive methods, Basic Agglomerative Hierarchical Clustering, Strengths and Weakness; Outlier Detection.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. Data Mining – Concepts and Techniques – Jiawei Han, Michelinen Kamber, Morgan Kaufmann Publishers, Elsevier.
2. Introduction to Data Mining, Pang – Ning Tan, Vipin Kumar, Michael Steinbanch, Pearson Education.
3. Data Mining Techniques, Arun K Pujari, Universities Press.
4. Data Warehouse Fundamentals, Pualraj Ponnaiah, Wiley Student Edition.
5. Data Mining, Vikaram Pudi, P Radha Krishna, Oxford University Press

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand why the data warehousing is important in addition to database systems.
2. Perform the preprocessing of data and apply mining techniques on it.
3. Identify the association rules, classification and clusters in large data sets.
4. Solve real world problems in business and scientific information using data mining.
5. Use data analysis tools for scientific applications.
6. Implement various supervised machine learning algorithms.

Course Code: 18IC3151					Course Name: Satellite Communication			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Communication Systems

Learning objectives:

- To understand different satellite orbits, space and earth segments.
- To understand the satellite link budget calculation and planning.
- To understand various applications of satellite communication.

Unit wise allocation of course content

UNIT 1 (08 L)

Satellite Orbits:

Kepler's Laws, Newton's law, Orbital Parameters, Orbital Perturbations, Station Keeping, Geostationary and Non-Geostationary Orbits, Look Angle Determination, Limits of Visibility, Eclipse Sub Satellite Point, Sun Transit Outage, Launching Procedures, Launch Vehicles and Propulsion.

UNIT 2 (09 L)

Propagation Impairments, Space Link And Space Segment:

Propagation Impairments, Atmospheric Loss, Ionospheric Effects, Rain Attenuation, Other Impairments. Space Link: EIRP, Transmission Losses, Link Power Budget, System Noise, CNR, Uplink, Down link, Effects of Rain, Combined CNR. Space Segment: Power Supply Units, Altitude Control, Station Keeping, Thermal Control, TT&C, Transponders, Antenna Subsystem.

UNIT 3 (12 L)

Earth Segment, Interference and Satellite Access:

Earth Segment, Receive Only Home TV System, Outdoor Unit, Indoor Unit, MATV, CATV, Tx – Rx Earth Station, Interference Between Satellite Circuits, Satellite Access, Single Access, Pre-assigned FDMA, SCPC (spade system), TDMA, Pre-assigned TDMA, Demand assigned TDMA, Down link Analysis, Comparison of Uplink Power Requirements for TDMA & FDMA, On Board Signal Processing, Satellite Switched TDMA.

UNIT 4 (10 L)

Satellite Services And Applications:

Direct Broadcast Satellite Television and Radio: C-Band and Ku-Band Home Satellite TV, Digital DBS TV, DBSTV System Design, DBS-TV Link Budget, Error Control in Digital DBS-TV, Master Control Station and Uplink, Installation of DBSTV Antennas, Satellite Radio Broadcasting, Digital Video Broadcast(DVB) Standards, Digital Video Broadcast – Terrestrial(DVB-T)

Satellite Mobile and Specialized Services: Satellite Mobile Services, VSATs, Radarsat, Global Positioning Satellite System (GPS), Orbcomm, Indian Satellite Systems.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39Hrs
Tutorial:00Hrs

Approximate Total: 39Hrs

Texts and References:

1. Dennis Roddy, " Satellite Communications", McGraw Hill.
2. Wilbur L. Pritchard, Henri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", Pearson.
3. Timothy Pratt, Charles Bostian, Jeremy Allnutt, "Satellite Communication", John Wiley & Sons.
4. Anil K. Maini, VarshaAgarwal, "Satellite Technology, Principles and Applications", Wiley.
5. G. Maral, M.Bousquet, Z.Sun, "Satellite Communications Systems: Systems, Techniques and Technology", John Willy and sons.
6. M.Richharia, "Satellite Communication Systems-Design Principles",Macmillan Pub.
7. Bruce R. Elbert,"The Satellite Communication Applications: Hand Book", Artech House Bostan, London,

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand principle, working and operation of various sub systems of satellite as well asthe earth station.
2. Apply various communication techniques for satellite applications.
3. Analyze and design satellite communication link.
4. Learn advanced techniques and regulatory aspects of satellite communication.
5. Understand role of satellite in various applications.
6. Create foundation for studying advance communication systems.

Course Code: 18IC3153					Course Name: Modern Antenna Design			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisite: Physics, RF Engineering

Learning objectives:

- To understand to the process of electromagnetic Radiation.
- To learn the concept of different types of Antenna
- To understand the concept microstrip antenna and measurement.

Unit wise allocation of course content

UNIT 1 (10L)

Review of electromagnetic theory, Antenna and their different types, Radiation Mechanism and Current Distribution, Fundamental Parameters related to antenna (Radiation Pattern, Radiation Power Density, Directivity, Gain, Beamwidth, Antenna Efficiency, Bandwidth, Polarization, Radiation Efficiency, Antenna Factor) Radiation Integrals, Auxiliary Potential Functions and Construction of Solution, Solution of the inhomogeneous vector Potential Wave Equation, Far Field Radiation

UNIT 2 (8L)

Infinitesimal dipole, Small Dipole, Finite length and Half-Wavelength Dipole – Analysis using assumed current Distribution Small Circular loop, Circular Loop with constant current, Two Element Array N-Element Linear Array with uniform amplitude and spacing, Broadside and End-Fire Array, N-Element Linear Array.

UNIT 3 (8L)

Long Wire – Designing, V and Rhombic Antenna – Designing, Helical Antenna – Designing of normal and axial mode, Rectangular apertures with different configurations, E-Plane Sectoral Horn – Analysis and Design, H-Plane Sectoral Horn – Analysis and Design, Pyramidal Horn.

UNIT 4 (13L)

Introduction, Advantages and limitations of Microstrip antenna ,radiation mechanism of a Microstrip antenna , configuration , Microstrip patch antenna ,printed dipole antenna ,printed slot antenna, Microstrip travelling –wave antennas ,feeding techniques and modeling ,coaxial feed /probe coupling, Microstrip feeds ,proximity coupled feed ,aperture –coupled Microstrip feed ,coplanar waveguide feed, radiation fields ,vector potentials and radiation field formulation ,Microstrip antenna characteristic calculations, surface wave and photonic band gap structures ,mobile and satellite communications applications.

Analytical models for Microstrip antennas

Introduction, various transmission line models like simple, with mutual coupling, generalized transmission. Gain Measurement, Radiation Pattern Measurement, Anechoic Chamber.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. C.A.Balanis, 'Antenna Theory Analysis and Design' Wiley Publication.
2. K.D. Prasad, 'Antenna and Wave Propagation' SatyaPrakashan, 1996
3. Ramesh Garg, P. Bhartia, InderBahl and A. Ittipiboon, 'MicrostripDesign Handbook', Artech House.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand the radiation mechanism from antenna
2. Understand the different antenna parameters and their significance
3. Understand the working of different antenna
4. Understand the concept of antenna array
5. Understand the concept of microstrip antenna
6. To measure various antenna parameters

Course Code: 18IC3154					Course Name: Optical Communication			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisite: RF Engineering, Communication Systems

Learning Objective:

1. To introduce the students to various optical fiber modes, configurations and various signal degradation factors associated with optical fiber
2. To understand various optical sources and optical detectors
3. To understand the optical communication system, optical amplifiers.
4. To study different fiber network elements, basic optical components.

Unit wise allocation of course content

UNIT 1 (10L)

Introduction: Basic Optical Communication System, Advantage of Optical Communication System.Propagation in Dielectric Waveguides: Introduction, Step-index Fibers, Graded Index Fibers, Modes & Rays, Slab Wave Guide.

UNIT 2 (10L)

Attenuation in Optical Fibers: Introduction, Absorption, Scattering, Very Low Loss Materials, All Plastic & Polymer-Clad-Silica FibersS

Wave Propagation: Wave Propagation in Step-Index & Graded Index Fiber, Overall Fiber Dispersion-Single Mode Fibers, Multimode Fibers, Dispersion-Shifted Fiber, Dispersion, Flattened Fiber, Polarization.

UNIT 3 (10L)

Source & Detectors: Design of LED's for Optical Communication, Semiconductor Lasers for Optical Fiber Communication System, Semiconductor Photodiode Detectors, Avalanche Photodiode Detectors & Photo multiplier Tubes.

Optical Fiber Communication System: Telecommunication, Local Distribution Series, Computer Networks Local Data Transmission & Telemetry, Digital Optical Fiber Communication System-First Generation, System, Second Generation System, Future System.

UNIT 4 (9L)

Data Communication Networks- Network Topologies, Mac Protocols, Analog System. Advanced Multiplexing Strategies- Optical TDM, Sub carrier Multiplexing, WDM Network Architectures; SONET/SDH, Optical Transport Network, Optical Access Network, Optical Premise Network.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs

Tutorial: 00 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. Gerd Keiser, "Optical Fiber Communications", 4th Edition McGraw Hill.
2. John M. Senior, "Optical Fiber Communication" PHI/Pearson.
3. Djafar Mymbaev& Lowell L, Scheiner, "Fiber optical communication Technology" Pearson.
4. G. Agrawal, "Fiber optic Communication Systems", John Wiley and sons.

Course Outcomes (COs):

At the end of this course students will be able to

1. Comprehend the basic elements of optical fiber transmission link, fiber modes and structure configurations.
2. Visualize the significance of the different kind of losses, signal distortion in optical wave guides, signal degradation factors and dispersion management techniques in optical system performance.
3. Understand various optical source materials, LED structures, quantum efficiency as well as structures and figure of merit of Laser diodes.
4. Analyze the system performance of optical transmitters, receivers and optical amplifiers.
5. Analyze and deign optical fiber link with encapsulation of different system components.
6. Understand different optical Components