B.E, VI Semester, Electronics & Communication Engineering

Course Title	MICROWAVE & ANTENNA	Semester	VI
Course Code	MVJ20EC61	CIE	50
Total No. of Contact Hours	50	SEE	50
No. of Contact Hours/week	4 (L : T : P :: 3: 2 : 0)	Total	100
Credits	4	Exam. Duration	3Hrs

Course objective is to:

- Describe the microwave properties and its transmission media.
- Describe microwave devices for several applications.
- Understand the concept behind microwave systems.
- Understand the basics of antenna theory.
- Select antennas for specific applications

Module-1	RBT Level L1, L2 ,L3	10Hrs.

Prerequisites: Electromagnetics, wave propagation, waveguides

Introduction to Microwaves: History of Microwaves, Microwave Frequency bands, General Applications of Microwaves, Advantages of Microwaves

Analysis of Microwave Transmission Lines: Transmission line equations & solutions, Smith Chart Basics, problems on smith chart, impedance matching using stub line, Introduction to strip lines, Micro strip lines, parallel strip lines, coplanar strip lines, shielded strip lines, Rectangular and circular waveguides-theory and analysis.

Laboratory Sessions/ Experimental learning:

1. Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench.

Applications: Power transmission line, Telephone lines, Traces on Printed Circuit Boards, Traces on Multi-Chip Modules, Traces on Integrated Circuit Packages.

Video link / Additional online information:

1. https://lake.videoken.com/nptel/category/933/

Module-2	RBT Level L1, L2 , L3	10Hrs.

Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, Wave-guide Corners, Bends, Twists, Attenuator, Circulator, Isolator and Resonator.

Microwave Active components: Tunnel diode, Varactor diodes, Step recovery diodes, Schottky Barrier diodes, PIN diodes, Gunn Diodes, IMPATT and TRAPATT diodes, Parametric Amplifiers, Microwave Transistors, Microwave oscillators and Mixers. Microwave tubes: Klystron, TWT, Magnetron.

Laboratory Sessions/ Experimental learning:

1. Study of the characteristics of Klystron tube and to determine its electronic tuning range.

Applications: Oscillators and mixers, power sources.

Video link / Additional online information:

1. https://lake.videoken.com/nptel/category/933/
2. https://www.daenotes.com/electronics/microwave-radar/microwave-tube-devices

Module-3	RBT Level L1, L2 , L3	10Hrs.

Microwave Systems: Wireless Communications system, Radar Systems, Radiometer Systems, Satellite Communication, Remote sensing, Microwave Propagation (Introduction and Block diagrams only)

Antenna Basics: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain, Antenna Apertures, Effective Height, Bandwidth, Friis Transmission Equation, Antenna Field Zones & Polarization.

Laboratory Sessions/ Experimental learning:

1. To perform PC to PC Communication using Microwave test bench

Applications: Satellite communications, remote sensing, RADAR systems.

Video link / Additional online information:

1. https://lake.videoken.com/nptel/category/933/
2. https://lake.videoken.com/nptel/category/1052/

Module-4	RBT Level L1, L2, L3 ,L4	10Hrs.

Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing, Phased Arrays.

Electric Dipoles: Introduction, Short Electric Dipole, Fields of a Short Dipole (General and Far Field Analyses), Radiation Resistance of a Short Dipole, Thin Linear Antenna (Field Analyses), Radiation Resistances of Lambda/2 Antenna.

Laboratory Sessions/ Experimental learning:

1. Simulation of antenna patterns using FEKO software.

Applications: two-way radio communications links, to broadcasting broadcast reception, general radio reception.

Video link / Additional online information:

1. https://lake.videoken.com/nptel/category/1052/

Module-5	RBT Level L1, L2, L3	10Hrs.

Antenna Types: Introduction to Loop Antenna, Small loop, Comparison of Far fields of Small Loop and Short Dipole, The Loop Antenna General Case, Far field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Microwave antennas, Horn antennas, Helical Antenna, Yagi-Uda array, Parabolic reflectors, Log periodic array, Plasma antenna, Antenna for GPR.

Laboratory Sessions/ Experimental learning:

1. Measurement of directivity and gain of Helical, Loop, Horn and Yagi antennas
2. Case study on 3-element printed Yagi-Uda antenna

Applications: wave propagation and communications

Video link / Additional online information:

1. https://lake.videoken.com/nptel/category/1052/

Course outcomes:	
CO1	Design and analyze microwave transmission lines.
CO2	Identify various passive microwave components for different applications.
CO3	Design and analyze microwave antennas
CO4	Examine various antenna parameters necessary for building an RF system.
CO5	Recommend various antenna configurations according to the applications.

Text Books:	
1.	Annapurna Das, Sisir K Das, "Microwave Engineering", TMH Publication, 2nd edition, 2010.
2.	Liao, "Microwave Devices and Circuits" , Pearson education, 3rd edition, 2003.
3.	John D. Krauss, Ronald J Marhefka and Ahmad S Khan, "Antennas and Wave Propagation", 4th Special Indian Edition , McGraw- Hill Education Pvt. Ltd., 2010.
Reference Books:	
1.	David M Pozar, "Microwave Engineering", John Wiley & Sons, Inc., 4th edition, 2014
2.	Constantine A. Balanis, "Antenna Theory: Analysis and Design", 3rd edition, John Wiley & Sons, 2009.

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	1	-	-	1	-	-	1
CO2	3	3	3	2	-	1	-	-	1	-	-	1
CO3	3	3	3	2	1	1	-	-	1	-	1	1
CO4	3	3	3	2	1	1	1	-	1	-	1	1
CO5	3	3	3	2	1	1	1	-	1	-	1	1

High-3, Medium-2, Low-1

Course Title	COMPUTER COMMUNICATION NETWORKS	Semester	VI
Course Code	MVJ20EC62	CIE	50
Total No. of Contact Hours	50	SEE	50
No. of Contact Hours/week	4 (L : T : P :: 3: 2 : 0)	Total	100
Credits	4	Exam. Duration	3Hrs

Course objective is to:

- Understand the layering architecture of OSI reference model and TCP/IP protocol suite.
- Know about the protocols associated with each layer.
- Learn the different networking architectures and their representations.
- Acquire a knowledge of various routing techniques and the transport layer services.
- Learn the security features and functionality of application layer protocols.

Module - 1	RBT Level L1, L2, L3	10Hrs.

Prerequisites: Basic knowledge on computers & programming

Introduction: Data Communications: Components, Representations, Data Flow, Networks: Network criteria, Physical Structures, Network Types: LAN, WAN, Switching, Internet.

Network Models: Protocol Layering: Scenarios, Principles, Logical Connections, TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP.

Laboratory Sessions/ Experimental learning:

1. Study and draw the layout of LAN connection in Computer Networks Lab in NetSim. List out the type of cabling involved.

Applications: Ethernet, Fibernet, Satellite Communication.

Video link / Additional online information:

1. http://www.redbooks.ibm.com/abstracts/gg243376.html 2. https://nptel.ac.in/courses/106/106/106106091/ 3. https://nptel.ac.in/courses/106/105/106105080/		
Module - 2	**RBT Level** **L1, L2, L3, L4**	**10Hrs.**
Data-Link Layer: Introduction: Nodes and Links, Services, Categories of link, Sublayers, Link Layer addressing: Types of addresses, ARP. Data Link Control (DLC) services: Framing, Flow and Error Control, Data Link Layer Protocols: Simple Protocol, Stop and Wait protocol, Piggybacking. **Media Access Control:** Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. **Wired LANs: Ethernet:** Ethernet Protocol: IEEE802, Ethernet Evolution, Standard Ethernet: Characteristics, Addressing, Access Method, Efficiency, and Implementation. **Wireless LANs:** Introduction: Architectural Comparison, Characteristics, Access control **Laboratory Sessions/ Experimental learning:** 1. Study and analyse packet transfer using CSMA/CD and CSMA/CA using NetSim. **Applications:** Collision detection and avoidance in wired and wireless network. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105183/		
Module - 3	**RBT Level** **L1, L2, L3, L4, L6**	**10Hrs.**
Wireless LANs: Introduction: Architectural Comparison, Characteristics, IEEE 802.11: Architecture, MAC Sublayer, Addressing Mechanism, Physical Layer, Bluetooth: Architecture, Layers. **Connecting Devices:** Hubs, Switches. **Virtual LANs:** Membership, Configuration, Communication between Switches and Routers, Advantages. **Network Layer:** Introduction, Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses, Address Space, Classful Addressing, Classless Addressing, DHCP. **Laboratory Sessions/ Experimental learning:** 1. Study of different types of connecting devices.		

Applications: Bluetooth, WiFi, WiMax **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/102/117102062/		
Module - 4	**RBT Level** **L1, L2, L3, L4**	**10Hrs.**
Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-Back-N Protocol, Selective repeat protocol. **Transport-Layer Protocols in the Internet:** User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, Flow control, Error control, TCP congestion control. **Laboratory Sessions/ Experimental learning:** 1. Study of IP addressing, subnet mask and subnetting. **Applications:** Routing and forwarding packets. **Video link / Additional online information:** 1. https://nptel.ac.in/content/storage2/courses/106105080/pdf/M6L2.pdf		
Module-5	**RBT Level** **L1, L2, L3**	**10Hrs.**
Application Layer: Introduction: providing services, Application- layer paradigms, Standard Client -Server Protocols: World wide web, Hyper Text Transfer Protocol, FTP: Two connections, Control Connection, Data Connection, Electronic Mail: Architecture, Wed Based Mail, Telnet: Local versus remote logging.Domain Name system: Name space, DNS in internet, Resolution, DNS Messages, Registrars, DDNS, security of DNS. **Laboratory Sessions/ Experimental learning:** 1. Transport analysis using TCP/UDP using NetSim. **Applications:** MS Teams, Zoom, Cisco webex **Video link / Additional online information:** 1. http://www.digimat.in/nptel/courses/video/106105183/L11.html 2. http://www.digimat.in/nptel/courses/video/106105183/L06.html		

Course outcomes:	
CO1	Analyze the layering architecture of computer networks and distinguish between the OSI reference model and TCP/IP protocol suite.
CO2	Apply the protocols and services of Physical and Data link layer.
CO3	Describe functions associated with network layer and connecting devices.
CO4	Analyze and apply the protocols and services of Transport layer.
CO5	Analyze and apply the protocols and services of application layer.

Text Books:	
1.	Behrouz A Forouzan," Data Communication and Networks", 3rd Ed. TMH.
2.	Andrew S Tanebaum, "Computer Networks", 4th Ed. PHI/ Pearson education.
Reference Books:	
1.	S. Keshav, "An Engineering approach to Computer Networks", 5th Ed. Pearson.
2.	W.A. Shay, "Understanding communication and Networks", Thomson.
3.	Irvine Olifer, "Computer Networks: Principles, Technology and Protocols", Wiley India.
4.	William Stalling, "Data and Computer communications", 7th Ed. PHI

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	-	-	1	-	-	1
CO2	3	3	3	2	2	1	-	-	1	-	-	1
CO3	3	3	3	3	2	1	-	2	1	-	-	1
CO4	3	3	3	3	2	1	-	-	1	-	-	1
CO5	3	3	3	2	2	1	-	2	1	-	-	1

High-3, Medium-2, Low-1

Course Title	REAL TIME OPERATING SYSTEMS	Semester	VI
Course Code	MVJ20EC631	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Acquire knowledge about concepts related to OS for Embedded Systems.
- Gain knowledge about different types of scheduling algorithms suitable for embedded real time systems.
- Introduce the principles of Inter process communication and multitasking applications.
- Explain the architecture of Linux Kernel and RTOS applications to Linux.
- Discuss Real-Time Programming in Linux and µC linux.

Module-1	RBT Level L1, L2, L3	8Hrs.

Prerequisites: Basic Concepts of Operating systems and basics of task management and task scheduling.

Real Time Systems: Introduction, issues in real time computing, Structure of a real time system, task classes, performance measures for real time systems, task assignment and scheduling algorithms, mode changes, Fault tolerant scheduling, Real Time Models.

Laboratory Sessions/ Experimental learning:

1. Create an application that creates two tasks that wait on a timer whilst the main task loops.
2. Create an application that creates tasks and scheduling tasks.

Applications: Kiel RTOS for ARM (Keil RTX - ARM)

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/105/106105036/
2. https://nptel.ac.in/courses/106/105/106105172/

Module-2	RBT Level L1, L2, L3	8Hrs.

µC/OS- II RTOS Concepts: Foreground/Background process, Resources, Tasks, Multitasking, Priorities, Schedulers, Kernel, Exclusion, Inter task communication, Interrupts, Clock ticks, µC/OS- II Kernel structure , µC/OS- II Initialisation, Starting µC/OS-II.

Laboratory Sessions/ Experimental learning:

1. Write an Keil RTOS code that demonstrates the multitasking priority.
2. Write an Keil RTOS code that assigns priority and sets the time slice period to illustrate time slicing.

Applications:

1. Email Spam and Malware Filtering
2. File Managers and Resource management systems

Video link / Additional online information:

2. https://nptel.ac.in/courses/106/106/106106198/
3. http://www.nptelvideos.in/2012/11/real-time-systems.html

Module-3	RBT Level L1, L2, L3	8Hrs.

µC/OS- II RTOS Functions: Task Management, Time management, Semaphore management, Mutual exclusion semaphore, Event Management, Message management, Memory management, porting µC/OS- II – comparison and study of various RTOS like QNX, VX Works, Psos.

Laboratory Sessions/ Experimental learning:

1. Write a Keil RTOS code to manage tasks to handle semaphore to overcome mutual exclusion.
2. Demonstrate Porting of µC/OS- II in Embedded processor.

Applications:Traffic light controller system

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/105/106105215/ 2. https://nptel.ac.in/courses/106/105/106105172/		
Module-4	**RBT Level** **L1, L2, L3**	**8Hrs.**
Embedded Linux: Embedded Linux, Features, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, User Space, Root File System, Linux Start, Up Sequence, GNU Cross Platform Tool chain, Porting Traditional RTOS Applications to Linux. **Laboratory Sessions/ Experimental learning:** 1. Write an application that display two different messages in LCD display in two lines. **Applications:** Smart Mobile Phone operating system development process demonstration. **Video link / Additional online information:** 1. http://1.https//nptel.ac.in/courses/11706087/ 2. https://nptel.ac.in/courses/106/106/106106198/		
Module-5	**RBT Level** **L1, L2, L3**	**8Hrs.**
Real time Linux: Linux and Real-Time, Real-Time Programming in Linux, Hard Real-Time Linux, Building and Debugging, Building the Kernel, Integrated Development Environment, Kernel Debuggers, Embedded Drivers, Boardsupport packages, Introduction to µC linux. **Laboratory Sessions/ Experimental learning:** 1. Creating and UART driver for USB bus. **Applications:** Demonstration of ABS system in automobiles **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102059/ 2. http://www.nptelvideos.in/2012/11/real-time-systems.html 3. https://www.youtube.com/watch?v=HlU5cYqGLZE		
Course outcomes:		
CO1	Summarize fundamental principles for programming of real time systems with time and resource limitations.	
CO2	Develop RTOS based embedded real time applications.	

CO3	Analyze the functions of real time operating systems.
CO4	Utilize RTOS software tool chain for Embedded Applications.
CO5	Develop real time kernals and Embedded Drivers.

Text Books:	
1.	Krishna C.M., Kang G. Shin, "Real Time Systems", Tata McGraw-Hill international Edition, 2010.
2.	Philip A.Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition-IEEE Press, IEEE Computer Society Press, 2001.
3	Jean J Labrosse, "MicroC/OS-II The Real Time Kernel" II Edition, CMP Books, 2002.
Reference Books:	
1.	P.Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development",Auerbach Publications, Taylor& Francis Group, 2006.
2.	Christopher Hallinan, "Embedded Linux Primer, A Practical, Real-World Approach", II Edition Pearson Education, Inc., 2011.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	2	1
CO2	3	3	3	2	1	1	_	_	1	_	2	1
CO3	3	3	3	2	1	1	_	_	1	_	2	1
CO4	3	3	3	2	1	1	_	_	1	_	2	1
CO5	3	3	3	2	1	1	_	_	1	_	2	1

High-3, Medium-2, Low-1

Course Title	DIGITAL IMAGE PROCESSING	Semester	VI
Course Code	MVJ20EC632	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Learn the fundamentals of digital image processing
- Understand the image transforms and other image enhancement techniques used in digital image processing.
- Study the image restoration techniques and methods used in digital image processing
- Understand region-based segmentation and segmentation using morphological watersheds.
- Know the color fundamentals and various morphological image processing techniques.

Module-1	RBT Level L1, L2, L3, L4	8Hrs.

Prerequisites: Discrete Fourier Transform, MATLAB Basics

Introduction to Digital Image Processing: What is Digital Image Processing? Origin of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.

Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing.

Laboratory Sessions/ Experimental learning:

1. Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB

Applications: Medical imaging, Robot vision, Character recognition, Remote Sensing.

Video link / Additional online information :

1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm		
Module-2	RBT Level L1, L2, L3, L4	8Hrs.
Spatial Domain:Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain**: Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image, Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering. **Laboratory Sessions/ Experimental learning**: 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications**: Image Enhancement, Image Analysis **Video link / Additional online information**: 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm		
Module-3	RBT Level L1, L2, L3,L4	8Hrs.
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error(Wiener) Filtering, Constrained Least Squares Filtering. **Laboratory Sessions/ Experimental learning**: 1. Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications**: Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information**: 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm		

Module-4	RBT Level L1, L2, L3, L4	8Hrs.
Segmentation: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds. **Representation and Description:** Representation, Boundary descriptors. **Laboratory Sessions/ Experimental learning:** 1. Develop and implement a matlab code for Image segmentation using thresholding technique. **Applications:** Object tracking, Pattern recognition **Video link / Additional online information :** 1.https://nptel.ac.in/courses/117/105/117105079/ 2.https://www.tutorialspoint.com/dip/index.htm		
Module-5	**RBT Level L1, L2, L3, L4**	**8Hrs.**
Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing. **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. Four morphological principles, Skeletons and object marking. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of multimodal image fusion using MATLAB. **Applications:** Color conversion, Object marking **Video link / Additional online information:** 1.https://nptel.ac.in/courses/117/105/117105079/ 2.https://www.tutorialspoint.com/dip/index.htm		

Course outcomes:	
CO1	Analyze image processing algorithms used for sampling and quantization.
CO2	Apply and analyze image processing techniques in both the spatial and frequency (Fourier) domains.
CO3	Implement and analyse various image restoration algorithms

CO4	Design image analysis techniques for image segmentation and evaluate the methodologies for segmentation.
CO5	Conduct independent study and analyze various Morphological Image Processing techniques.

Text Books:	
1.	Rafel C Gonzalez and Richard E. Woods, "Digital Image Processing"-, PHI 3rd Edition, 2010.
2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, –"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, Fourth Edition, 2013, ISBN: 978-81-315-1883-0
Reference Books:	
1.	S.Jayaraman, S.Esakkirajan, T.Veerakumar, "Digital Image Processing"- Tata McGraw Hill 2014.
2.	A. K. Jain, "Fundamentals of Digital Image Processing"- Pearson 2004.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	-	-	1	-	-	1
CO2	3	3	3	2	2	1	-	-	1	-	-	1
CO3	3	3	3	2	2	1	-	-	1	-	-	1
CO4	3	3	3	2	2	1	-	-	1	-	-	1
CO5	3	3	3	2	2	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Course Title	VIRTUAL & AUGMENTED REALITY	Semester	VI
Course Code	MVJ20EC633	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Establish and cultivate a broad and comprehensive understanding of the virtual reality and Augmented Reality.
- Exhibit various elements and components used in AR/VR Hardware
- Provide various factors involved in multisensory action of human being
- Provide a detailed analysis of the engineering, scientific and functional aspects of VR systems and the fundamentals of VR/AR modelling and programming.
- Understand virtual reality, augmented reality and using them to build Biomedical, engineering and robotics application.

Module-1	RBT Level L1, L2, L3	8Hrs.

Prerequisites: Intermediate programming ability in object-oriented languages, Basic linear algebra

Introduction to Immersive Technologies: A Brief History of Virtual Reality, The five Classic Components of a VR System, Early Commercial VR Technology , VR becomes an Industry, Reality, Virtuality and Immersion , VR, AR, MR, xR: similarities and differences.

Laboratory Sessions/ Experimental learning:

1. Choose an existing VR application and write a summary including a personal critical reflection on its look and feel especially in relation to immersion, presence, agency and interactivity.

Applications: VR in Sport, Mental Health, Medical Training.

Video link / Additional online information:

1. https://nptel.ac.in/courses/121/106/121106013/

Module-2	RBT Level L1, L2, L3	8Hrs.
Motion Tracking and Navigation: Position and Motion Trackers , Inside Out/Outside In , Tracker Performance Parameters , Optical, Active and Passive Trackers , Inertial and Hybrid Trackers, HMD Trackers , Magnetic Trackers , Mechanical Trackers , Ultrasonic Trackers , Navigation and Manipulation Interfaces , Tracker-Based Navigation/Manipulation Interfaces. **Laboratory Sessions/ Experimental learning**: 1. Design an immersive environment in Unity-3D or Unreal that will develop and enhance Work in groups. Start by building a simple 3D world that an interactive player can move around in. Connect the controllers and create a simple interaction loop. Measure velocity, acceleration, distances, and other motion and spatial parameters of the user and the controllers. **Applications**: Industrial Training and Simulation, Flight Training and Simulation, Pilot Head Tracking, Live Aircraft, Sports motion Analysis. **Video link / Additional online information**: 1. https://nptel.ac.in/courses/106/106/106106138/		
Module-3	**RBT Level L1, L2, L3**	**8Hrs.**
The Human behind the lenses: Human Perception and Cognition , The Human Visual System, VR Health and Safety Issues, Effects of VR Simulations on Users , Cyber sickness, before and now Guidelines for Proper VR Usage. **Laboratory Sessions/ Experimental learning**: 1. Create a well-rounded multisensory action that is meaningful, safe and accommodates all senses, visual, auditory and tactile. **Applications**: Human–Computer Interaction, e-Sports, Games, Cultural heritage **Video link / Additional online information**: 1. https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/		
Module-4	**RBT Level L1, L2, L3**	**8Hrs.**
Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality,		

Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems. **Laboratory Sessions/ Experimental learning:** 1. Experiment with Photo grammetry and improve the visual look and feel of your environment **Applications:** Healthcare **Video link / Additional online information:** 1. https://www.coursera.org/learn/ar-technologies-video-streaming

Module-5	RBT Level L1, L2, L3	8Hrs.
Medical Applications of xR: Behavioural Therapy, Virtual and Augmented Surgery, Triage and Diagnostics, Applications of VR in Robotics: Robot Programming, Robot Tele operation. **Laboratory Sessions/ Experimental learning:** 1. Add a training component to your existing prototype. Define the mechanics that will progressively improve user's performance to mastery through an interaction loop using the dual concept of challenge / reinforcing. **Video link / Additional online information:** 1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5622235/		

Course outcomes:	
CO1	Acquire various principles and concepts of virtual reality and its application.
CO2	Understand the optical motion tracking and navigation in virtual reality.
CO3	Analyse and solve problems related to their expertise in Augment and Virtual Environments.
CO4	Develop detailed analysis of the engineering, scientific and functional aspects of VR systems and the fundamentals of VR modelling and programming.
CO5	Illustrate the knowledge of integrating hardware, software, tools for AR/VR technology.

Text Books:	
1.	C. Burdea and Philippe Coiffet, "Virtual Reality Technology", First Edition, Gregory, John Wiley and Sons, Inc.,2008
2.	Steven M. LaValle, "Virtual Reality", 2016. Online version: http://msl.cs.uiuc.edu/vr/
3.	Alan B. Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann, First Edition, 2013.
4.	Dieter Schmalstieg and Tobias Hollerer, "Augmented Reality: Principles and Practice (Usability)" by Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
Reference Books:	
1.	Jason Jerald.,"The VR Book: Human-Centred Design for Virtual Reality", Association for Computing Machinery and Morgan and Claypool, New York, NY, USA, First Edition, 2015
2.	Steve Aukstakalnis, "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability)", Addison-Wesley Professional; 1st edition, 2016.
3.	Robert Scoble and Shel Israel, "The Fourth Transformation: How Augmented Reality and Artificial Intelligence Will Change Everything", Patrick Brewster Press; 1st edition, 2016.
4.	Tony Parisi, "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile", OReilly Media; 1st edition, 2015.
5.	Tony Parisi, "Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages", OReilly Media; 1st edition, 2014.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	-	-	1	-	-	1
CO2	3	3	3	2	3	1	-	-	1	-	-	1
CO3	3	3	3	2	3	1	-	-	1	-	-	1
CO4	3	3	3	2	3	1	-	-	1	-	-	1
CO5	3	3	3	2	3	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Course Title	DATA STRUCTURE USING C++	Semester	VI
Course Code	MVJ20EC634	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Understand the fundamentals of data structures and their applications in logic building and project assessment.
- Acquire the knowledge of algorithms of queues and stacks.
- Understand the concept of lists, trees and graphs.
- Analyze the importance of object oriented programming and class while developing an algorithm.

Module-1	RBT Level L1, L2, L3	8Hrs.

Prerequisites: C++ data types, indexing ,basic concept of OOPS

Introduction to Data Structure: Array, Functions and parameter's, Recursion, Class definition.

Performance analysis: Review of basic data structures - Stack, Queue, and Implementation using template classes in C++.

Laboratory Sessions/ Experimental learning:

1. Develop a mini project using C++, demonstrate the concept of Functions and Class.

Applications:

- Conversion from one form of expression to another
- Mathematical calculation for expression evaluation.

Video link / Additional online information :

1. https://nptel.ac.in/courses/106/102/106102064/
2. https://nptel.ac.in/courses/106/106/106106127/

Module-2	RBT Level L1, L2, L3	8Hrs.

Prerequisites: Programming using the concept of Arrays and pointers

Linear List: Structures of Linear list, Array Representation, Vector Representation, Singly Linked lists and chains, operations insertion and deletion of element in an array, Application of Linear List.

Stacks: The abstract data types, Array Representation, Linked Representation, Applications of stack.

Laboratory Sessions/ Experimental learning:

1. Implementation of Towers of Hanoi using Stacks.

Applications:

- Towers of Hanoi.
- Parenthesis matching in an expression

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/106/106106127/
2. https://www.youtube.com/playlist?list=PL0gIV7t6l2iIsR55zsSgeiOw9Bd_IUTbY

Module-3	RBT Level L1, L2, L3, L6	8Hrs.

Prerequisites: Basic definition of Queues and Heaps in C++.

Queues: The ADT Queues, Create an Array Representation, Create a Linked Representation, Demonstrate Applications of Queues.

Priority queue: Develop Algorithm of a priority queue, Representation using binary tree, Implementation of a Priority Queue, Applications of Priority Queues.

Laboratory Sessions/ Experimental learning:

1. Develop an algorithm using C++ to demonstrate the concept of queues.

Applications:

- Programs for Departmental store bills
- Programs for Railway booking

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/102/106102064/
2. https://drive.google.com/file/d/0BzTQ7doC5eGSQTBicHo1UDgtOVU/view

Module-4	RBT Level L1, L2, L3	8Hrs.

Prerequisites: Different searching and sorting algorithms using C++

Search trees: Definition, operations on search trees, implementation of a search tree.

Binary search trees: Definition, Operations like Searching, Insertion and Deletion from a binary tree, height of a Binary Tree, Applications of Binary trees.

Laboratory Sessions/ Experimental learning:

1. Solve Parenthesis Matching problem using binary search trees.

Applications:

- Can be used for Memory Management.
- In solving backtracking problems.

Video link / Additional online information :

1. https://nptel.ac.in/courses/106/106/106106127/
2. https://nptel.ac.in/courses/106/105/106105225/

Module-5	RBT Level L1, L2, L3, L6	8Hrs.

Prerequisites: Concept of binary trees, list and arrays

AVL trees: Definition, Develop algorithm to find height of an AVL Tree, Operations like Insertion, Deletion and Searching. Comparison between Search Trees, Application of AVL trees, Hashing, Dictionaries.

Laboratory Sessions/ Experimental learning:

1. Print all the Disarium numbers between 1 and 100
2. Perform Jump Search for a given key and report success or failure. Prompt the user to enter the key and a list of numbers.

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/106/106106133/
2. https://nptel.ac.in/courses/106/105/106105225/
3. https://nptel.ac.in/courses/106/106/106106127/

Course outcomes:	
CO1	Acquire knowledge of time complexity and space complexity in order to implement an Algorithm using C++.

CO2	Apply the conceptsof data structures like List, stack in various applications.
CO3	Analyze and design of algorithms for Queues.
CO4	Utilize the operations of search trees and their applications.
CO5	Implement hashing in data structure and AVL trees.

Text Books:	
1.	S. Sahni, "Data structures, Algorithms and Applications in C++", University Press (In Pvt.Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.
2.	Michael T. Goodrich, R. Tamassia and .Mount, "Data structures and Algorithms in C Wiley student edition, John Wiley and Sons.
Reference Books:	
1.	Mark Allen Weiss, "Data structures and Algorithm Analysis in C++", Pearson Educati Ltd., Second Edition.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	-	-	1	-	-	1
CO2	3	3	2	2	2	1	-	-	1	-	-	1
CO3	3	3	2	2	2	1	-	-	1	-	-	1
CO4	3	3	2	2	2	1	-	-	1	-	-	1
CO5	3	3	2	2	2	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Course Title	LABVIEW	Semester	VI
Course Code	MVJ20EC641	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Explore the basics of Virtual Instrumentation.
- Differentiate and handle the analog and digital I/Os.
- Use LabVIEW for real time experiments.
- Analyze tools and applications in Virtual Instrumentation.

Module-1	RBT Level L1, L2	8Hrs.

Prerequisites: *Fundamentals of C-Programing, Basic Electrical and Electronics.*

GRAPHICAL SYSTEM DESIGN: Graphical System Design (GSD) model, Design flow with GSD, VI and traditional instrument, Hardware and Software in VI, Test, control and design in the engineering process, VI beyond personal computer, GSD using LabView, Graphical Programming and Textual Programming.

INTRODUCTION TO LABVIEW: Introduction, Advantages of LabView, Software environment, Creating and Saving a VI, Front Panel Toolbar, Block Diagram Toolbar, Palettes, Panel Controls and Indicators, Data types, Keyboard Shortcuts.

Laboratory Sessions/Experimental Learning:

1. Perform basic arithmetic & Boolean Operations using LabView

Applications: Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI.

Video link/ Additional online information:

1. https://www.youtube.com/watch?v=VQ7kL6knMdo

Module-2	RBT Level L1, L2, L3	8Hrs.

MODULAR PROGRAMMING: Modular Programming In Labview, Build A VI Front Panel and Block Diagram, Creating an Icon, Building a Connector Pane, Creating, Opening And Editing SUBVIs,

REPETITION AND LOOPS: For Loops, While Loops, Structure Tunnels, Terminals Inside Or Outside Loops, Shift Registers, Feedback Nodes, Control Timing, Communicating Among Multiple Loops, Local & Global Variables.

ARRAYS: Creating 1-D, 2-D And Multidimensional Arrays, Deleting, Inserting, Replacing, Elements, Array Functions, Matrix Operations with Arrays, Polymorphism.

Laboratory Sessions/ Experimental learning:

1. Find the sum of 'n' numbers using FOR loop using LabView
2. To perform the factorial of a given number using WHILE loop
3. To sort even numbers using WHILE loop in an array
4. To find the maximum and minimum variable from an array.

Applications: Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI.

Video link/ Additional online information:

1. https://www.youtube.com/watch?v=WKvRDIuUNNs

Module-3	RBT Level L1, L2, L3	8Hrs.

PLOTTING DATA: Types of Waveforms, Graphs, Charts, Data Type, XY Graphs, Intensity Graphs And Charts, Digital Waveform Graphs, 3D Graphs, Customizing Graphs And Charts, Customizing Graphs, Customizing 3D Graphs, and Displaying Special Planes on the XY Graph.

STRUCTURES, STRINGS AND FILE I/O: Case, Sequence, Customizing Structures, Timed Structures, Formula Nodes, Event Structure, String Functions, Formatting Strings, Basics of File Input/Output, File I/O VIs, and Creating a Relative Path.

Laboratory Sessions/ Experimental learning:

1. To bundle and unbundle a cluster.
2. To perform functions using flat and stacked sequence.

3. To create a sine wave using formula node.

Applications: Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI.

Video link/ Additional online information:

1. https://www.youtube.com/watch?v=kdPyGcJNQbM
2. https://www.youtube.com/watch?v=c6hLkFsQ-VU

Module-4	RBT Level L1, L2, L3	8Hrs.

DATA ACQUISITION: Transducers, Signals And Signal Conditioning, DAQ Hardware Configuration, Analog Inputs & Outputs, Counters, DAG Software Architecture, Assistant, Selecting and Configuring a Data Acquisition Device, Components of Computer Based Measurement System.

Laboratory Sessions/ Experimental learning:

1. Temperature sensor using LabView and NI myDAQ.
2. To apply filtering technique for a given input signal
3. To perform discrete cosine transform on the given signal

Applications: Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI.

Video link/ Additional online information:

1. https://www.youtube.com/watch?v=fIy6XT3CdPQ

Module-5	RBT Level L1, L2, L3	8Hrs.

IMAQ VISION: Vision Basics, Image Processing and Analysis, Particle Analysis, Machine Vision, Machine Vision Hardware and Software.

Laboratory Sessions/ Experimental learning:

1. Build a complete machine vision system.
2. Acquire and Display images with NI-IMAQ driver software.

Applications: Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI.

Video link/ Additional online information:

1. https://www.youtube.com/watch?v=4vDS4CRGhL0&list=PL3qqtKcHarV1yCaDZBQHXunX6MAwhXny1

Course outcomes:	
CO1	Familiarize with basic concepts, tools and functions of LabView Programming.
CO2	Develop Virtual Instrumentation using LabVIEW.
CO3	Appreciate the technologies related to VI for Industrial Applications.
CO4	Use DAQ for Real Time Applications.
CO5	Illustrate the basic design approaches for various Tools and Functions in IMAQ Vision.

Text Books:	
1.	Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI publications, 2010
2.	BehzadEhsani, Data Acquisition using LabVIEW, Packt Publishing, 2016.
Reference Books:	
1.	John Essick, Hands-On-Introduction to LabVIEW for Scientists and Engineers – Fourth Edition, OXFORD Publications, 2016
2.	Richard Jennings & Fabiola De La Cueva, LabVIEW Graphical Programming - Fifth Edition, McGraw-Hill, 2018.
3.	Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	-	-	-	-	-	-	-
CO2	3	2	2	-	3	-	-	-	-	-	-	-
CO3	3	2	2	-	3	-	-	-	-	-	-	-
CO4	3	2	2	-	3	-	-	-	-	-	-	-
CO5	3	2	2	-	3	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	MEMS & SENSOR DESIGN	Semester	VI
Course Code	MVJ20EC642	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Understand the overview of Microsystems and their applications.
- Study the working principles of Micro sensors and Micro Actuators.
- Acquire the knowledge of various Microsystems Fabrication Processes.
- Illustrate the Microsystems Design consideration.
- Know the basics of NEMS and its applications.

Module-1	RBT Level L1, L2	8Hrs.

Prerequisites: *Fundamentals of Physics (Mechanics, Optics, Electricity and magnetism),Fundamentals of Inorganic Chemistry*

MEMS Overview: MEMS and Microsystems, Typical MEMS and Microsystems products: Microgears, Micromotors, Microturbines & Micro-optical components, History of MEMS development, Intrinsic characteristics of MEMS, Application of Microsystems in various Industries.

Laboratory Sessions/ Experimental learning:

1. An introduction to Comsol Multiphysics which is ideally suited for MEMS applications.

Applications: Airbag Systems, Controlling automotive movement changes.

Video link / Additional online information :

2. https://nptel.ac.in/courses/117/105/117105082/
3. https://nptel.ac.in/courses/108/108/108108147/
4. http://www.nptelvideos.in/2012/12/mems-microsystems.html
5. https://youtu.be/j9y0gfN9WMg

Module-2	RBT Level L1, L2, L3	8Hrs.
MEMS Sensors: Acoustic wave sensors, Biomedical & Biosensors, Chemical sensors, Optical sensors, Pressure sensor and thermal sensors, Piezo-resistive and Piezo-electric sensors. **Laboratory Sessions/ Experimental learning:** 1. Case study of Blood Pressure Sensors **Applications:** Satellite launch vehicle, industries, automobile, medical, consumer applications **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. https://nptel.ac.in/courses/108/108/108108113/ 3. https://nptel.ac.in/courses/108/108/108108147/ 4. http://www.nptelvideos.in/2012/12/mems-microsystems.html		
Module-3	**RBT Level** **L1, L2, L3**	**8Hrs.**
Microactuation: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric effect, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), **MEMS with Microactuators:** Microgrippers, Miniature Microphones, Micromotors, Microactutors with mechanical inertia, Microfluidics. **Laboratory Sessions/ Experimental learning:** 1. Case studies on MEMS Microphone. **Applications:** Optical, RF and industrial applications. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/		
Module-4	**RBT Level** **L1, L2, L3**	**8Hrs.**
Microsystems Fabrication Processes: Photolithography, Ion implantation, Diffusion, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition, Deposition by Epitaxy, Etching.		

Bulk Micro manufacturing: Overview of Etching, Isotropic & Anisotropic Etching, Wet Etchants, Etch Stop, Dry Etching.

Surface Micromachining: Description, Process, Mechanical Problems Associated with Surface Micromachining

Laboratory Sessions/ Experimental learning:

1. Study the process involved in LIGA micromanufacturing

Applications: Hybrid integrated circuits, integrated passive devices & sensors.

Video link / Additional online information:

4. https://nptel.ac.in/courses/117/105/117105082/
5. https://nptel.ac.in/courses/108/108/108108113/
6. https://nptel.ac.in/courses/108/108/108108147/
7. http://www.nptelvideos.in/2012/12/mems-microsystems.html

Module-5	RBT Level L1, L2, L3	8Hrs.

Microsystems Design: Introduction, Design Considerations, Process Design, Mechanical Design, Computer Aided Design.

Introduction to NEMS: Micro and Nanoscale Technologies, General Principle of Nanofabrication, Nanoproducts, Applications of Nanoproducts.

Laboratory Sessions/ Experimental learning:

1. Design Capacitive Pressure Sensor using Comsol Multiphysics.

Applications: To measure blood pressure within the body, detect ions, to perform biological tests, displays, tunable Lasers, smart phones, mobile infrastructure, IoT and defense.

Video link / Additional online information:

3. https://nptel.ac.in/courses/117/105/117105082/
4. http://www.nptelvideos.in/2012/12/mems-microsystems.html

Course outcomes:	
CO1	Appreciate the technologies related to MEMS.
CO2	Gain knowledge of various Microsensors.
CO3	Understand actuators for MEMS applications.

CO4	Analyze the fabrication process involved with MEMS devices
CO5	Illustrate the basic design approaches for various sensors. Understand overview of NEMS.

Text Books:	
1.	Tai-Ran Hsu, "MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering", 2nd Ed, John Wiley & Sons, Inc. 2008.
2.	Chang Liu, "Foundation of MEMS", 2011, 2nd ed., Pearson Education India.
Reference Books:	
1.	Rai Choudhury, "MEMS and MOEMS Technology and Applications", PHI Learning Private Limited, India, 2013.
2.	Marc Madou, "Fundamentals of Micro fabrication", CRC press, 1997.
3.	Stephen D. Senturia, "Micro system Design", Kluwer Academic Publishers, 2001.
4.	Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2002.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

iv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

v. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

vi. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	2	1	-	1	-	-	1
CO2	3	2	1	1	-	2	1	-	1	-	-	1
CO3	3	2	1	1	-	2	1	-	1	-	-	1
CO4	3	3	2	2	-	2	1	-	1	-	-	1
CO5	3	3	3	2	2	2	1	-	1	-	-	1

High-3, Medium-2, Low-1

Course Title	MACHINE LEARNING DESIGN & APPLICATIONS	Semester	VI
Course Code	MVJ20EC643	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Define machine learning and understand the basic theory underlying machine learning.
- Differentiate supervised, unsupervised and reinforcement learning.
- Understand the basic concepts of learning and decision trees.
- Understand neural networks and Bayesian techniques for problems appear in machine learning
- Gain the knowledge on instant based learning and reinforced learning.
- Perform statistical analysis of machine learning techniques.

Module-1	RBT Level L1, L2, L3	8Hrs.

Prerequisites: Basics of binary tree, Decision Tree

Introduction, Concept learning and Decision trees: Machine Learning Design, Applications of Machine learning, Learning Problems, Well posed learning problems, Designing a Learning system, Concept Learning, Perspective and Issues in Machine Learning.

Laboratory Sessions/ Experimental learning:

1. Implement and demonstrate the FIND-S Algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.

Applications: Data training samples, Speech Recognition algorithm.

Video link / Additional online information :

1. https://nptel.ac.in/courses/106/106/106106139/

2. https://www.digimat.in/nptel/courses/video/106105152/L01.html		
Module-2	RBT Level L1, L2, L3	8Hrs.

Prerequisites: Data structures, Decision Tree and binary tree

Decision Tree Learning and Artificial Neural Networks: Decision Tree Representation, Hypothesis Space Search, Inductive bias in decision tree, issues in Decision tree. Neural Network Representation, Perceptrons, Multilayer Networks and Back Propagation Algorithms.

Laboratory Sessions/ Experimental learning:

1. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

Applications: Email Spam and Malware Filtering,ID3 algorithm, Self-driving cars

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/106/106106198/
2. https://www.youtube.com/watch?v=fPLxFXiS9fU

Module-3	RBT Level L1, L2, L3, L6	8Hrs.

Bayesian and Computational Learning: Introduction, Analyze Bayes theorem, Bayes theorem demonstration and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm

Laboratory Sessions/ Experimental learning:

1. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.

Applications: Artificial Neural Network, Virtual Personal Assistant, Online Fraud Detection.

Video link / Additional online information:

1. https://nptel.ac.in/courses/106/105/106105215/

Module-4	RBT Level L1, L2, L3	8Hrs.
Instant Based Learning and Learning set of rules: Demonstrate K- Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning and Develop Sequential Covering Algorithms. **Reinforcement Learning:** Introduction, Evaluate Learning Task, Q Learning **Laboratory Sessions/ Experimental learning:** 1. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same dataset for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.		
Applications: Market segmentation, Document clustering **Video link / Additional online information :** 1. http://1.https//nptel.ac.in/courses/11706087/ 2. https://nptel.ac.in/courses/106/106/106106198/		
Module-5	**RBT Level** **L1, L2, L3, L6**	**8Hrs.**
Analytical Learning: Perfect Domain Theories, Explanation Based Learning, Inductive, Analytical Approaches, FOCL Algorithm. **Real life applications of Machine learning:** Develop an algorithm and flowchart for Traffic prediction, Image recognition and Self-driving cars. **Laboratory Sessions/ Experimental learning:** 1. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs. **Applications:** Regression algorithm, Tower of Hanoi. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102059/		

Course outcomes:	
CO1	Choose the learning techniques and investigate concept learning.
CO2	Identify the characteristics of decision tree and solve problems associated with
CO3	Apply effectively neural networks for appropriate applications.

CO4	Apply Bayesian techniques and derive effectively learning rules
CO5	Evaluate hypothesis and investigate instant based learning and reinforced learning.

Text Books:	
1.	Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.
Reference Books:	
1.	Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.
2.	T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st edition, 2001.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	2	-	-	1
CO2	3	3	3	2	2	1	-	-	2	-	-	1
CO3	3	3	3	3	3	1	-	-	2	-	-	1
CO4	3	3	3	3	3	1	1	-	2	-	-	1
CO5	3	3	3	3	2	2	2	-	2	-	-	1

High-3, Medium-2, Low-1

Course Title	MEDICAL ELECTRONICS	Semester	VI
Course Code	MVJ20EC644	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3Hrs

Course objective is to:

- Explain physiological parameters such as electrical, non-electrical and the recording methods.
- Learn the methods used for recording and measuring the biological signals
- Illustrate the various Medical Imaging devices used in the hospitals.
- Explain the telemetry systems and know the safety aspects required in medical equipment.
- Understand the various Therapeutic Devices and know about recent trends in medical system.

Module-1	RBT Level L1, L2, L3 & L6	8Hrs.

Prerequisites: Basics of Transducer

Fundamentals of Physiology and Transducer:

Types of Bioelectric Potentials: Introduction to different types of bioelectric potentials, Action and resting potentials, Propagation of action potentials.

Biological Systems: Nervous system and its fundamentals, Basic components of a biomedical system, Cardiovascular systems, Respiratory systems

Electrodes and Transducers in Medical systems: Different type of electrodes, sensors used in biomedicine. Physiological signals and transducers, Piezoelectric Transducers, ultrasonic transducers, Temperature measurement, Fibre optic temperature sensors. Selection criteria for transducer and electrodes.

Laboratory Sessions/ Experimental learning:

1. Practical applications of electrodes in medical field.

Applications: Ultrasonic scanning devices, Measures skin and body temperature, Measures Respiratory rate**Video link / Additional online information :**

1. https://nptel.ac.in/courses/102/104/102104043/ 2. https://www.youtube.com/watch?v=QiwxdcckPGc 3. https://www.youtube.com/watch?v=LOjK2wB_qcg&feature=youtu.be 4. https://youtu.be/7TabKYSbdH4		
Module-2	RBT Level L1, L2, L3 & L6	8Hrs.
Electrical and Non-Electrical Parameter Measurement: **Electro Physiological Measurement:** Biological amplifiers, ECG,EEG, EMG, PCG, typical waveforms and signal characteristics **Non Electrical Parameter Measurement:** Measurement of blood pressure, Ultra sound blood flow meter, Blood flow cardiac output, Heart rate, heart sound, measurement of gas volume, flow rate of CO2 and O2 in exhaust air, pH of blood **Laboratory Sessions/ Experimental learning:** 1. Measure the "PQRST ECG" signal in both normal and abnormal conditions. **Applications:** Psychology and Neuroscience, Brain Computer Interfaces (BCI) **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/108/108108167/ 2. https://www.youtube.com/watch?v=7cvgDIdtw8M 3. https://www.youtube.com/watch?v=mK6sPBbChqc		
Module-3	RBT Level L1, L2, L3 & L6	8Hrs.
Amplifiers used in Medical Electronics: Amplifiers, preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier **Medical Imaging:** X-ray machine, Computer tomography, Magnetic resonance imaging system, Positron emission tomography and endoscopy. **Laboratory Sessions/ Experimental learning:** 1. Graphical results of all Medical Images. **Applications:**Diagnose disease, blood clots, tumours, bone fractures ,inflammation or infection in an organ ,degenerative diseases ,strokes **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=N0Dwh3avx9A 2. https://www.youtube.com/watch?v=5_k6GVMwQ8w		

3. https://www.youtube.com/watch?v=1ftsuzhJ-vk		
Module-4	RBT Level L1, L2, L3	8Hrs.
Telemetry: Introduction to telemetry systems, Different types of biotelemetry systems, Retinal Imaging, Imaging application in Biometric systems. **Safety in Medical Environment:** Electrical safety in medical environment, shock hazards, leakage current, Instruments for checking safety parameters of biomedical equipment **Laboratory Sessions/ Experimental learning:** 1. Practical applications of telemetry in medical systems. **Applications:**In the branch of Ophthalmology **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=0UPoSdBFD48 2. https://www.youtube.com/watch?v=8SPHA_1tTw4		
Module-5	RBT Level L1, L2, L3	8Hrs.
Assisting and Therapeutic Devices: Cardiac pacemakers, Defibrillators, Ventilators, Surgical diathermy, Heart lung machine, Laser in surgery and medicine. **Recent Trends in medical System:** Insulin Pumps, Radio pill, Endo microscopy, Brain machine interface, Lab on a chip, ICCU patient monitoring system, Wearable Antennas. **Robotic Devices:** Nano Robots, Robotic surgery, Orthopedic prostheses fixation. **Laboratory Sessions/ Experimental learning:** 1. Functions of ICCU patient Monitoring Systems. **Applications:** Diagnosis of the gastrointestinal tract. Applications of BCI are neuroergonomics, medical, smart environment, education and self-regulation, games and entertainment, neuro marketing and advertisement **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=SMXBR_YFocs 2. https://www.youtube.com/watch?v=qUD865w2Drw 3. https://www.youtube.com/watch?v=KAvQsRL-jeo		
Course outcomes:		
CO1	Analyse the operation and characteristics of Electronic devices and use of them in applications.	

CO2	Evaluate the performance of electronic circuits.
CO3	Demonstrate the electronic systems and analyse their applicability
CO4	Analyse requirement of electronic devices and systems.
CO5	Design a simple prototype for a certain application.

Text Books:	
1.	R.S. Khandpur, "Hand book of Bio Medical Instrumentation" (2nd edition)- ISBN-13: 9789339205430.
2.	Mandeep Singh, "Introduction to Biomedical Instrumentation", ISBN-13: 9788120350236
Reference Books:	
1.	S.K. Guha, "Principles of Medical Electronics and biomedical Instrumentation" - ISBN-13: 978-8173712579.
2.	J.G.Webster(Wiley India), "Medical instrumentation Application and Design", ISBN-13: 978-0471676003.
3.	Joseph D. Bronzino, "The Biomedical Engineering Handbook", Third Edition, CRC Press-2006.
4.	John D. Enderle and Joseph D. Bronzino, "Introduction to Biomedical Engineering", Third Edition, Elsevier Inc.-2012.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	-	-	1	-	-	1
CO2	3	3	2	2	2	1	-	-	1	-	-	1
CO3	3	3	2	2	3	1	-	-	1	-	-	1
CO4	3	3	2	2	3	1	-	-	1	-	-	2
CO5	3	3	2	2	2	1	-	-	1	-	-	3

High-3, Medium-2, Low-1

Course Title	MICROWAVE & ANTENNA LAB	Semester	VI
Course Code	MVJ20ECL66	CIE	50
Total No. of Contact Hours	30	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 0 : 2 : 2)	Total	100
Credits	2	Exam. Duration	3Hrs

Course objective is to:

- Understand the Mode Characteristics of Reflex Klystron Oscillator.
- Study the Performance and Extract S-parameters of various Microwave components.
- Study the Radiation Pattern and Find the Field Intensity of a given Antenna/ Array.
- Understand Modelling of different planar microstrip patch antennas.

LABORATORY SESSIONS:

PART A: Hardware Experiments

Sl No	Experiment Name	RBT Level	Hours
1.	Measurement of frequency, guide wavelength, power, VSWR and attenuation in Microwave test bench.	L3	3
2.	Measurement of directivity and gain of microstrip Yagi antennas.	L3	3
3.	Determination of Coupling and isolation characteristics of microstrip directional coupler.	L3	2
4.	Determination of Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate.	L3	3
5.	Power division and isolation of microstrip power divider.	L3	2
6.	Study of Circulator. Extraction of S-Parameters.	L3	2

7.	Study of Isolator. Extraction of S-Parameters.	L3	2
8.	Study the I-V characteristics of Gunn diode.	L3	2
PART B: Lab experiments in CST Microwave Studio			
9.	Modelling of different planar microstrip patch antennas (square patch, circular patch, triangular patch etc.). Investigation of parametric requirements for simulation.	L3	2
10.	Simulation of planar microstrip square (or circular, or triangular etc.) patch (or monopole) antenna, and plotting the return loss bandwidth.	L3	3
11.	Simulation of planar microstrip square (or circular, or triangular, or complementary etc.) patch (or monopole) antenna, and investigating the gain and radiation patterns.	L3	3
12.	Design of planar microstrip square (or circular, or triangular etc.) patch (or monopole) antenna, incorporation of fractal design and plotting the return loss bandwidth, investigation of surface current patterns.	L3	3

Course outcomes:	
CO1	Analyse the Mode Characteristics of Reflex Klystron Oscillator.
CO2	Demonstrate the performance and extract S-Parameters of various Microwave Components.
CO3	Plot the Radiation Pattern and find the field Intensity of a given Antenna/ Array.
CO4	Analyse Coupling and isolation characteristics of microstrip directional coupler
CO5	Measure various parameters of planar microstrip patch antennas using CST Microwave Studio

Scheme of Evaluation	
Regular Lab work and Writing Lab records	(20+15) = 35 marks
Lab test and Viva-voce at the end of the semester	(10+5) = 15 marks
Total	50 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	1	-	-	2	-	-	1
CO2	3	3	3	2	-	1	-	-	2	-	-	1
CO3	3	3	3	2	-	1	-	-	2	-	-	1
CO4	3	3	3	2	-	1	-	-	2	-	-	1
CO5	3	3	3	2	-	1	-	-	2	-	-	1

High-3, Medium-2, Low-1

Course Title	COMPUTER COMMUNICATION NETWORKS LAB	Semester	VI
Course Code	MVJ20ECL67	CIE	50
Total No. of Contact Hours	30	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 0: 2 : 2)	Total	100
Credits	2	Exam. Duration	3Hrs

Course objective is to:

- Model a network and understand the protocols at various OSI reference levels.
- Design a suitable network and simulate using a Network simulator tool.
- Study the networking concepts and protocols using C/C++ programming.
- Analyse the networks for different configurations and observe the results.

LABORATORY SESSIONS:

Sl No	Experiment Name	RBT Level	Hours
Simulation experiments using NetSim or any other equivalent tool			
1	Implement a point to point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth.	L3	3
2	Implement a four node point to point network with links n0-n1, n1-n2 and n2-n3. Apply TCP agent between n1-n2 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP.	L4	3
3	Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.	L4	3
4	Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.	L3	3
5	Implementation of Link state routing algorithm.	L3	3
Implement the following in C/C++ in Linux platform			
6	Write a program for a HLDC frame to perform the following. i) Bit stuffing ii) Character stuffing.	L3	4

7	Write a program for distance vector algorithm to find suitable path for transmission. For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify the program for the cases. a. Without error, b. With error	L3	4
8	Implementation of Sliding Window Protocol.	L4	3
9	Write a program for congestion control using leaky bucket algorithm.	L4	4

Course outcomes:	
CO1	Implement Netsim tool for learning and practicing of network algorithms.
CO2	Apply the knowledge of C programming for network operation.
CO3	Evaluate the network with different configurations to measure the performance parameters.
CO4	Analyse the data link layer and routing protocols using C programming
CO5	Implement congestion control and avoidance protocol in wired and wireless networks.

Scheme of Evaluation	
Regular Lab work and Writing Lab records	(20+15) = 35 marks
Lab test and Viva-voce at the end of the semester	(10+5) = 15 marks
Total	50 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	-	-	-	2	-	-	1
CO2	3	3	3	2	3	-	-	-	2	-	-	1
CO3	3	3	3	3	3	-	-	-	2	-	-	1
CO4	3	3	3	3	3	-	-	-	2	-	-	1
CO5	3	3	2	2	3	-	-	-	2	-	-	1

High-3, Medium-2, Low-1