

**B.E, VII Semester, Electronics & Communication Engineering**

Course Title	VLSI SYSTEM DESIGN	Semester	VII
Course Code	MVJ20EC71	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 characteristics of CMOS circuit construction.
- Introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).
- Design CMOS combinational and sequential logic at the transistor level, with mask layout.
- Describe the general steps required for processing of CMOS integrated circuits.
- Study functional units including adders, multipliers, ROMs, SRAMs.

<b>Module-1</b>	<b>RBT Level</b> L1, L2, L3	<b>10Hrs.</b>
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*Prerequisites: Basics of transistor*

**Introduction to MOS Technology:** Semiconductor materials, enhancement mode MOS transistor, depletion mode MOS transistor, NMOS fabrication, CMOS fabrication, comparison of NMOS, CMOS, BICMOS, GaAs technologies.

**Introduction to ASICs :** Field Programmable gate array, Full custom, Semi-custom , ASIC Design flow.

**Laboratory Sessions/ Experimental learning:**

1. Design and demonstrate the MOS transistor connected as a diode using any CAD tool.

**Applications:** Design of Diode

**Video link / Additional online information :**

1. <https://www.youtube.com/watch?v=faiEVOOCe-s&t=2519s>
2. <https://www.youtube.com/watch?v=FRihw0Gpi0Y>

3. <https://www.youtube.com/watch?v=oSrUsM0hoPs>

Module-2	RBT Level L1, L2, L3	10Hrs.
<p>Basic Electrical Properties of MOS Circuits: Drain-to-Source current vs. voltage relationships, aspects of MOS transistor threshold voltage, MOS transistor transconductance and output conductance, the pass transistor, the NMOS inverter, determination of pull up to pull down ratio of NMOS transistor driven by another NMOS transistor, alternate forms of pull up, the CMOS inverter, MOS transistor circuit model, latch up in CMOS circuits.</p> <p>Laboratory Sessions / Experimental learning:</p> <p>1. Simulation of CMOS Inverter characteristics with different values of Inverter Ratio (<math>K_r</math>) using LTspice / pspice software.</p> <p>Applications: Design of nMOS and CMOS inverter circuit.</p> <p>Video link / Additional online information:</p> <p>1. <a href="https://www.youtube.com/watch?v=eqnMAaYU4OY">https://www.youtube.com/watch?v=eqnMAaYU4OY</a></p> <p>2. <a href="https://www.youtube.com/watch?v=zNqmhJHDwc">https://www.youtube.com/watch?v=zNqmhJHDwc</a></p>		
Module-3	RBT Level L1, L2, L3, L4	10Hrs.
<p>MOS Circuit Design Process: MOS layers, stick diagrams, design rules and layout, 2<math>\mu</math>m, 1.2<math>\mu</math>m CMOS rules. Layout diagrams, symbolic diagrams. Basic circuit concepts: Sheet resistance, area capacitance of layers, delay model, wiring capacitances, choice of layers. Scaling of MOS circuits: Scaling models, scaling function for device parameters and limitation of scaling.</p> <p>Laboratory Sessions/ Experimental learning:</p> <p>1. Draw layout of inverter using Cadence Tool</p> <p>Applications: Design of CMOS inverter circuit with different scaling functions.</p> <p>Video link / Additional online information:</p> <p>1. <a href="https://nptel.ac.in/courses/117106093/">https://nptel.ac.in/courses/117106093/</a></p> <p>2. <a href="https://nptel.ac.in/courses/117106092/">https://nptel.ac.in/courses/117106092/</a></p> <p>3. <a href="https://nptel.ac.in/courses/117101058/">https://nptel.ac.in/courses/117101058/</a></p>		

Module-4	RBT Level L1, L2, L3, L4	10Hrs.
<p><b>Sub System Design and Layout:</b> Architectural issues, switch logic, gate logic, examples of structural design (Combinational logic) and some clocked sequential circuits. Memory register and aspects of system timing, Some commonly used storage/memory elements, Subsystem design process, General arrangement of 4-bit arithmetic processor, regularity, Design of an ALU subsystem.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Design Manchester Carry-chain using CMOS transistors using any CAD tool</li> </ol> <p><b>Applications:</b> Designing of PLA and PLD</p> <p><b>Video link / Additional online information :</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/117106093/">https://nptel.ac.in/courses/117106093/</a></li> <li>2. <a href="https://nptel.ac.in/courses/117106092/">https://nptel.ac.in/courses/117106092/</a></li> <li>3. <a href="https://nptel.ac.in/courses/117101058/">https://nptel.ac.in/courses/117101058/</a></li> </ol>		
Module-5	RBT Level L1, L2, L3, L4	10Hrs.
<p><b>Test and Testability:</b> System partitioning, layout and testability, reset/ initialization, design for testability, testing combinational logic, testing sequential logic, practical design for test (DFT) guidelines, scan design techniques, built-in-self-test (BIST). CMOS design projects: Incrementer/ Decrementer, comparator for two n-bit numbers.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Perform a survey on Prime Time CAD tool from any open source software for timing Analysis.</li> </ol> <p><b>Applications:</b> Testing of Imperfections in chip fabrication.</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://youtu.be/V-GL-oQSa14">https://youtu.be/V-GL-oQSa14</a> ( Fault design &amp; Testability)</li> <li>2. <a href="https://youtu.be/P7AQJn7K8Os">https://youtu.be/P7AQJn7K8Os</a>(Combinational Circuit Test Pattern Generation-ATPG)</li> <li>3. <a href="https://youtu.be/NGoRLtDkPwU">https://youtu.be/NGoRLtDkPwU</a> (Sequential Circuit Testing and Scan Chains &amp; BIST)</li> </ol>		
<b>Course outcomes:</b>		
CO1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.	

CO2	Utilize the knowledge of physical design aspects to draw the basic gates using stick and layout diagrams.
CO3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements.
CO4	Interpret Memory elements along with timing considerations.
CO5	Summarize testing and testability issues in VLSI Design.

**Text Books:**

1.	Sung Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design" - Third Edition, Tata McGraw-Hill.
2.	Neil H. E. Weste, and David Money Harris, "CMOS VLSI Design- A Circuits and Systems Perspective"- 4th Edition, Pearson Education.
3.	Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition, Oxford University Press, International Version, 2009.

**Reference Books:**

1.	Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition – 1994).
2.	<a href="https://link.springer.com/chapter/10.1007%2F978-981-33-4642-0_2">https://link.springer.com/chapter/10.1007%2F978-981-33-4642-0_2</a>

**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
CO2	3	3	3	2	2	1	-	-	-	-	-	1
CO3	3	3	3	2	2	1	-	-	-	-	-	1
CO4	3	3	3	2	2	1	-	-	-	-	-	1
CO5	3	3	3	2	2	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	IOT & WIRELESS SENSOR NETWORK	Semester	VII
Course Code	MVJ20EC72	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:**

- Provide knowledge about IoT and M2M architecture.
- Understand various layers of IoT and their functionality.
- Describe Cloud computing and design principles of IoT
- Understand the architecture and design principles of WSNs.
- Provide knowledge about MAC and routing protocols in WSN

Module-1	RBT Level L1, L2, L3	10Hrs.
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*Prerequisites: Knowledge on Computer Networks*

**Introduction to IoT:** Genesis, Digitization, Impact- Connected Roadways, Buildings, IoT Challenges, Network Architecture and Design, Drivers Behind New Network Architectures, Security, Constrained Devices and Networks Comparing IoT Architectures, M2M architecture, IoT world forum standard, IoT Reference Model, Simplified IoT Architecture.

**Laboratory Sessions/ Experimental learning:**

1. Comparative study of Oracle, IBM and Cisco Architectures of IoT

**Applications:** Smart Cities, Home Automation System

**Video link / Additional online information :**

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://www.analyticsvidhya.com/blog/2016/08/10-youtube-videos-explaining-the-real-world-applications-of-internet-of-things-iot/>

Module-2	RBT Level L1, L2, L3	10Hrs.
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**IoT Layers and functionality :** IoT Network Architecture and Design Core IoT Functional Stack, Layer1(Sensors and Actuators) , Layer 2(Communications Sublayer), Access

network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IoT Network management. Layer 3(Applications and Analytics), Analytics vs Control, Data vs Network Analytics IoT Data Management and Compute Stack.

**Laboratory Sessions/ Experimental learning:**

1. Implement an IoT architecture to design an application of your own.

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/108/108/108108147/>
2. [https://onlinecourses.nptel.ac.in/noc20\\_cs69/unit?unit=17&lesson=18](https://onlinecourses.nptel.ac.in/noc20_cs69/unit?unit=17&lesson=18)

Module-3	RBT Level L1, L2, L3 & L6	10Hrs.
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**Data Collection, Storage and Computing using a Cloud Platform:** Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service models, IoT Cloud - based data collection, storage and computing services using Nimbits, The Hierarchy of Edge, Fog, and Cloud.

**Prototyping and Designing Software for IoT Applications:** Introduction, Prototyping Embedded device software, Programming Embedded Device, Arduino Platform using IDE, Reading data from sensors and devices, Devices, Gateways, Internet and Web/Cloud services software development.

**Laboratory Sessions/ Experimental learning:**

1. Weather monitoring using Blynk/ThingSpeak through cloud
2. Design a people counter using Node MCU
3. Christmas light show with Arduino

**Applications:** Google Cloud, SAAS, PAAS, Sensor applications

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/106/105/106105167/>
2. [https://onlinecourses.swayam2.ac.in/aic20\\_sp04/preview](https://onlinecourses.swayam2.ac.in/aic20_sp04/preview)

Module-4	RBT Level L1, L2, L3,L4	10Hrs.
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**Overview of Wireless Sensor Networks:** Challenges for Wireless Sensor Networks, 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, Design principles for WSNs, Service interfaces of WSNs Gateway Concepts.

**Laboratory Sessions/ Experimental learning:**

1. Do a case study on total energy conservation opportunities in Solar Power

**Applications:** Health care monitoring, Area monitoring, Industrial monitoring, Threat detection.

**Video link / Additional online information :**

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://nptel.ac.in/courses/106/105/106105160/>

<b>Module-5</b>	<b>RBT Level</b> L1, L2, L3,L4	10Hrs.
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**Communication Protocols:** Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Contention based protocols(CSMA,PAMAS), Schedule based protocols (LEACH) Address and Name Management in WSNs, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Hierarchical networks by clustering.

**Laboratory Sessions/ Experimental learning:**

1. Design an energy efficient system for a WSN using the routing protocols using NetSim or NS2

**Applications:** Environmental/Earth sensing, Air pollution monitoring, Forest fire detection, Landslide detection, Water quality monitoring

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/106/105/106105160/>
2. <https://nptel.ac.in/courses/106/105/106105195/>

**Course outcomes:** After studying this course, students will be able to:

CO1	Analyze different IOT Architecture and select them for a particular application.
CO2	Evaluate the sensor data generated and map it to IOT protocol stack.
CO3	Implement and execute programs using development tools.
CO4	Develop an energy efficient system for WSN.
CO5	Create a real life application involving Wireless Sensor Networks using IoT concepts.



<b>Text Books:</b>	
1.	Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743
2.	Raj Kamal, "Internet of Things-Architecture and design principles", McGraw Hill Education.
3.	Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.
<b>Reference Books:</b>	
1.	Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks Technology, Protocols, And Applications", John Wiley, 2007.
2.	Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
3.	Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547

<b>CIE Assessment:</b>
<p>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</p> <ul style="list-style-type: none"> <li>- Quizzes/mini tests (4 marks)</li> <li>- Mini Project / Case Studies (8 Marks)</li> <li>- Activities/Experimentations related to courses (8 Marks)</li> </ul>
<b>SEE Assessment:</b>
<p>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.</p> <p>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.</p> <p>iii. One question must be set from each unit. The duration of examination is 3 hours.</p>

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

High-3, Medium-2, Low-1

Course Title	OPTICAL COMMUNICATION	Semester	VII
Course Code	MVJ20EC731	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 basic principles of optical fiber communication with different modes of light propagation.
- Study of optical sources, detectors and receivers.
- Understand the transmission characteristics and losses in optical fiber and study optical components.
- Know the concept of WDM and system design.
- Learn the network standards in optical fiber and understand the network architectures along with its functionalities.

Module-1

RBT Level  
L1, L2

8Hrs.

**Optical fiber Communications:** Historical development, General system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index, Fiber Materials, Photonic crystal fibers.

**Laboratory Sessions/ Experimental learning:**

1. Measurement of numerical aperture of an optical fiber.

**Applications:** Networking, Telecommunication

**Video link / Additional online information :**

1. <https://youtu.be/9seDKvbaoHU>
2. <https://youtu.be/BGUhTDWkwx8>

Module-2	RBT Level L1, L2,L3	8Hrs.
<p><i>Pre-requisite: Knowledge of Semiconductor Devices</i></p> <p><b>Optical sources: Light Emitting diodes:</b> LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. <b>Laser Diodes:</b> Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant Frequencies.</p> <p><b>Photo detectors:</b> Physical principles of Photodiodes, Photo detector noise, Detector response time.</p> <p><b>Optical Receiver:</b> Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity, Quantum Limit.</p> <p><b>Applications:</b> Optical memories, OMEMS, Basic Principle Holography, Principle Of Hologram Recording</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. To Investigate the Transmission (Intermodal dispersion) Characteristics of Multi-mode Optical Fiber.</p> <p><b>Applications:</b> Networking, Telecommunication, Military and Space Applications</p> <p><b>Video link / Additional online information :</b></p> <p>1. <a href="https://youtu.be/15WulWvjWEg">https://youtu.be/15WulWvjWEg</a></p>		
Module-3	RBT Level L1, L2, L3	8Hrs.
<p><b>Transmission characteristics of optical fiber:</b> Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber.</p> <p><b>Optical Fiber Connectors:</b> Fiber Splicing, Splicing Techniques, Splicing Single-Mode Fibers, Optical Fiber Connectors, Connector Types, Single-Mode Fiber Connectors, Connector Return Loss.</p> <p><b>Optical amplifiers:</b> Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Measurement of propagation loss, bending loss of an optical fiber.</p> <p><b>Applications:</b> Networking, Telecommunication ,Automotive Industry</p> <p><b>Video link / Additional online information:</b></p>		

1. <a href="https://youtu.be/BGUhTDWkwx8">https://youtu.be/BGUhTDWkwx8</a>		
Module-4	RBT Level L1, L2	8Hrs.
<p><b>WDM Concepts and Components:</b> Overview of WDM: Operational Principles of WDM, WDM standards, Passive Optical couplers, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings.</p> <p><b>Optical System Design:</b> Point-to-Point Links, System Considerations, Link Power Budget, Rise Time Budget, Short-Wavelength Band, Attenuation-Limited Distances for Single-Mode Links.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Determine the wavelength of light from a monochromatic source using Interferometer and calculate the refractive index of a thin film.</li> </ol> <p><b>Applications:</b> Networking, Telecommunication</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://youtu.be/t8a25L58-m8">https://youtu.be/t8a25L58-m8</a></li> <li>2. <a href="https://vlab.amrita.edu/index.php?sub=1&amp;brch=189">https://vlab.amrita.edu/index.php?sub=1&amp;brch=189</a></li> </ol>		
Module-5	RBT Level L1, L2	8Hrs.
<p><b>Optical Networks:</b> Optical network evolution and concepts: Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, Public telecommunication network overview. Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching, Optical burst switching networks.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Analog and Digital (with TDM) communication link using optical fiber.</li> </ol> <p><b>Applications:</b> Networking, Telecommunication</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="http://ofcvlab.vesit.ves.ac.in/page2/honeycomb.html">http://ofcvlab.vesit.ves.ac.in/page2/honeycomb.html</a></li> </ol>		

2. <https://www.youtube.com/embed/f5EmFoXIYyQ>

**Course outcomes:**

CO1	Classify and working of optical fiber with different modes of signal propagation.
CO2	Analyze the characteristics of optical sources and detectors.
CO3	Describe the transmission characteristics and losses in optical fiber communication and identify various amplifiers..
CO4	Understand the concept of WDM and analyse the various aspects of system design.
CO5	Illustrate the networking aspects of optical fiber and describe various standards associated with it.

**Text Books:**

1.	Gerd Keiser , Optical Fiber Communication, 5th Edition, McGraw Hill Education(India) Private Limited, 2015. ISBN:1-25-900687-5.
2.	John M Senior, Optical Fiber Communications, Principles and Practice, 3rd Edition, Pearson Education, 2010, ISBN:978-81-317-3266-3

**Reference Books:**

1.	Joseph C Palais, Fiber Optic Communication , Pearson Education, 2005, ISBN:0130085103
2.	Ramaswami, Sivarajan and Sasaki "Optical Networks", Morgan Kaufmann, 2009.
3.	Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
4.	John F. Read, 'Industrial Applications of Lasers', Academic Press, 1978.

**CIE Assessment:**

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**CO-PO Mapping**

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CO2	3	3	3	1	-	1	-	-	-	-	-	1
CO3	3	3	3	1	-	1	-	-	-	-	-	1
CO4	3	3	3	1	-	1	-	-	-	-	-	1
CO5	3	3	3	1	-	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	WIRELESS & CELLULAR COMMUNICATION	Semester	VII
Course Code	MVJ20EC732	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 mobile radio communication principles and to study the recent trends adopted in cellular systems and wireless standards.
- Familiarize students to radio signal propagation mechanisms and to the characteristics of mobile radio channels, which both are needed in the designing of modern wireless communication systems and networks.
- Study the concepts of cellular communication system, architecture, functioning, various standards
- Learn the concepts of signal propagation in cellular environment
- Study the different multiple access techniques for Wireless Communication

Module-1

RBT Level  
L1, L2, L3

8Hrs.

**Introduction to Cellular Mobile Systems:** The Cellular concept, System design, Capacity improvement in cellular systems, Co-channel interference reduction. Intelligent cell concept and applications, technical Challenges.

**Laboratory Sessions/ Experimental learning:**

1. Understand how pulse shaping is realized using MATLAB® functions

**Applications:**

- Transmission of music, news, road conditions, weather reports, and other broadcast information are received via digital audio broadcasting (DAB) with 1.5Mbit/s.
- A universal mobile telecommunications system (UMTS) phone might be available offering voice and data connectivity with 384kbit/s.

**Video link / Additional online information:**

1. <https://www.coursera.org/lecture/wireless-communications/1-1-cellular-communication-KpitQ>



2. <https://nptel.ac.in/courses/117/102/117102062/>

Module-2	RBT Level L1, L2, L3	8Hrs.
<p><b>Mobile radio propagation:</b> Reflection, Diffraction, Fading, Multipath Propagation, Channel modeling, Diversity Schemes and Combining Techniques. The cellular fundamentals: cellular communication and frequency reuse, general architecture of a cellular system, channel assignment strategies, hand-off in a cellular system. Interference and cellular system capacity: co-channel interference and adjacent channel interference, power control.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Compute the power of the noise and the original signal. Find signal to noise ratio (SNR), compare it with the desired value and see if they are the same using MATLAB</p> <p><b>Applications:</b></p> <ul style="list-style-type: none"> <li>International broadcasting, long distance aircraft and ship communication, citizen band (CB) radios. Diffraction and reflection give rise to propagation beyond the horizon. Propagation at large distance, propagates well within buildings.</li> </ul> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://freevideolectures.com/course/2329/wireless-communication/14">https://freevideolectures.com/course/2329/wireless-communication/14</a></p> <p>2. <a href="https://nptel.ac.in/courses/108/108/108108148/">https://nptel.ac.in/courses/108/108/108108148/</a></p>		
Module-3	RBT Level L1, L2, L3	8Hrs.
<p><b>Signal propagation in mobile communication:</b> Design parameters at the base station, Practical link budget design using path loss models. propagation path loss, outdoor propagation models (Okumura model &amp; Hata model), indoor propagation models, power delay profile, channel parameters (delay spread, doppler spread, coherence bandwidth, coherence time, Smart antenna systems, Beam forming. MIMO Systems. RAKE receiver.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Performance of Baseband QAM/QPSK Under AWGN Channel</p> <p><b>Applications:</b></p> <ul style="list-style-type: none"> <li>Antennas mounted on these structures pump out wireless communications signals to devices in the field via electromagnetic waves.</li> </ul>		

- Wireless signal propagation is the movement of these radio waves (which move at the speed of light) to and from these sites and devices.

Video link / Additional online information:

1. <https://freevideolectures.com/course/2329/wireless-communication>
2. <https://web.stanford.edu/class/ee359/lectures.html>
3. <https://nptel.ac.in/courses/117/105/117105084/>

Module-4	RBT Level L1, L2, L3	8Hrs.
<p><b>Multiuser Systems:</b> CDMA- Principle, Network design, Link capacity, Power control, WCDMA-Network planning, MC-CDMA, OFDM, Cellular mobile communication beyond 3G. Wireless Personal Area Networks (Bluetooth, UWB and ZigBee), Wireless Local Area Networks (IEEE 802.11, network architecture, medium access methods, WLAN standards), Wireless Metropolitan Area Networks (WiMAX), Ad-hoc Wireless Networks.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Develop a detector and calculate BER with MATLAB Simulation</li> </ol> <p><b>Applications:</b> Radio and TV Broad casting</p> <p>Video link / Additional online information:</p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/108/104/108104157/">https://nptel.ac.in/courses/108/104/108104157/</a></li> <li>2. <a href="https://nptel.ac.in/courses/106/105/106105173/">https://nptel.ac.in/courses/106/105/106105173/</a></li> <li>3. <a href="https://nptel.ac.in/courses/111/102/111102130/">https://nptel.ac.in/courses/111/102/111102130/</a></li> </ol>		
Module-5	RBT Level L1, L2, L3	8Hrs.
<p><b>5G Radio Access Technologies:</b> Access Design Principles for Multi-user Communications – Multi-carrier with Filtering – Non orthogonal Schemes for Efficient Multiple Access – Radio Access for Dense Deployments – Radio Access for V2X Communication – Radio Access for Massive Machine-type Communication.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Implementation of channel estimation for multipath environment</li> </ol> <p><b>Applications:</b> Television remote control, Wi-Fi, Cell phones, wireless power transfer, computer interface devices</p> <p>Video link / Additional online information:</p>		

1. <https://www.technologyreview.com/collection/wireless-technology-innovations-lead-the-way-to-a-smartly-connected-future/>
2. <https://in.mathworks.com/videos/5g-new-radio-fundamentals-understanding-the-next-generation-of-wireless-technology-1561301737915.html>
3. <https://nptel.ac.in/courses/117/104/117104099/>

**Course outcomes:**

CO1	Discuss the cellular system design and technical challenges.
CO2	Analyze the Mobile radio propagation, fading, diversity concepts and the channel modelling.
CO3	Evaluate design parameters involved in the base station.
CO4	Discriminate Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts.
CO5	Describe the concepts of 5G Radio Access Technologies

**Text Books:**

1.	T.S Rapaport, "Wireless Communications" 2 nd edition, Pearson Education, Noida, India.
2.	A.F.Molisch, Wireless Communications, Wiley, 2005.

**Reference Books:**

1.	A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.
2.	Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
3.	Jonathan Rodriquez, "Fundamentals of 5G Mobile Networks", Wiley, 2015

**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
CO2	3	3	3	2	2	1	-	-	-	-	-	1
CO3	3	3	3	2	2	1	-	-	-	-	-	1
CO4	3	3	3	2	2	1	-	-	-	-	-	1
CO5	3	3	3	2	2	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	ROBOTICS & AUTOMATION	Semester	VII
Course Code	MVJ20EC733	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:

- Study the history, concept development and key components of robotics technologies.
- Know the concept of interfacing actuators and other components
- Understand basic mathematics manipulations of spatial coordinate representation and transformation.
- Learn basic robot forward and inverse kinematic problems
- Analyze basic robotic dynamics, path planning and control problems

Module-1

RBT Level  
L1, L2, L3 ,L4

8Hrs.

Basic concepts in robotics: Definition, anatomy of robot, basic structure of robot, Specifications and Classification of robot, Safety Measures in robotics, Industrial Applications of Robots. Drives for robots: Electric, hydraulic and pneumatic. Sensors: Internal-External, Contact-noncontact, position, velocity, force, torque, proximity and range.

Laboratory Sessions/ Experimental learning:

1. Interface various sensors with Microcontroller.

Applications: Machine Tending, Picking, Packing and Palletizing, painting, all Industrial applications

Video link / Additional online information:

1. <https://nptel.ac.in/courses/112/105/112105249/>
2. <https://nptel.ac.in/courses/112/101/112101098/>

Module-2	RBT Level L1, L2, L3 , L4	8Hrs.
<p><b>Robot drivers, Sensors and Vision:</b> Introduction to techniques, Image acquisition and processing, Different types of grippers- Mechanical, Magnetics ,vacuum, Adhesive, Gripper force Analysis and Gripper Design , overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors, DC motors and servomotors.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Interface motors using various Motor drivers.</p> <p><b>Applications:</b>Industrial application, agriculture robots, surgical robots</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a></p> <p>2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a></p>		
Module-3	RBT Level L1, L2, L3 ,L4	8Hrs.
<p><b>Robot Kinematics and Dynamics:</b> Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity.Link inertia tensor and manipulator inertia tensor, Newton –Eller formulation for RP and RP manipulators, Trajectory planning.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Interface servo motors to form gripper.</p> <p><b>Applications:</b> Pick and Place, Excavators, Robotic ARM.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a></p> <p>2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a></p>		
Module-4	RBT Level L1, L2, L3 ,L4	8Hrs.
<p><b>Robot Kinematics:</b> Dynamics and Programming methods, Robot language classification, Robot language structure, Kinematics and Path Planning: Solution of inverse kinematics problem, multiple solution jacobian work envelop, hill climbing techniques, robot programming languages elements and its functions. Simple programs on Sensing distance and direction, Line Following Algorithms, Feedback Systems.</p>		

<b>Laboratory Sessions/ Experimental learning:</b> 1. Design algorithm for Maze solving robot. <b>Applications:</b> Defence, Surveillance, Autonomous Vehicle. <b>Video link / Additional online information:</b> 1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a> 2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a>		
<b>Module-5</b>	<b>RBT Level</b> L1, L2, L3 , L4	<b>8Hrs.</b>
<b>Design and Applications:</b> Developing and building a robot, Models of flexible links and joints, Robotic arm – Components and structure, Types of joints and workspace, Design models for mechanic arms and lifting systems Mutiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot. <b>Laboratory Sessions/ Experimental learning:</b> 1. Case Study on Robots in material handling and assembly. Human Robot Interaction <b>Applications:</b> Humanoid, Robotic Arms. <b>Video link / Additional online information:</b> 1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a> 2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a>		

<b>Course outcomes:</b>	
CO1	Analyze the concept development and key components of robotics technologies
CO2	Select the components for interfacing actuators
CO3	Implement basic mathematics manipulations of spatial coordinate representation and Transformation.
CO4	Solve basic robot forward and inverse kinematic problems
CO5	Design robots which are capable to solve basic robotic dynamics, path planning and control problems
<b>Text Books:</b>	
1.	Introduction to Robotics By S.K.Saha , Tata McGraw Hill

2.	Robotics Control ,Sensing ,Vision and Intelligence by K.S. Fu, R.C .Gonzalez, C.S.G.Lee , Tata McGraw HillJ. Hirschhorn: Kinematics and Dynamics of Machinery, McGraw Hill book co.
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**Reference Books:**

1.	Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall india.
2.	Robotics Technology and Flexible Automation by S.R.Deb, S. Deb, Tata McGraw Hill
3.	Robot Motion and Control ( Recent Developments ) by M.Thoma& M. Morari

**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	-	-	1
CO2	3	3	3	2	1	1	-	-	1	-	-	1
CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

High-3, Medium-2, Low-1



Course Title	SYSTEM ON CHIP ARCHITECTURE	Semester	VII
Course Code	MVJ20EC734	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 needs of SoC architecture & design.
- Analyze various elements in SoC design.
- Study the overview of SoC memory system.
- Outline the reconfiguration mechanism of SoC.
- Learn the algorithms used in SoC system design

Module-1	RBT Level L1, L2	8Hrs.
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*Prerequisites: Moore's law, Basics of embedded system and embedded C programming, Motivation for SoC.*

**Introduction to the System Approach:** Need for SoC, System Architecture, and Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing, System level interconnection, an approach for SoC Design, System Architecture and Complexity.

**Laboratory Sessions/Experimental learning:**

1. Case study on Comparison on System-on-Board, System-on-Chip and System-in-Package.

**Applications:** Embedded System, mobile device.

**Video link / Additional online information:**

1. <http://www.nptelvideos.com/lecture.php?id=7838>
2. <https://www.youtube.com/watch?v=PRQXzjTrCJY>

Module-2	RBT Level L1, L2, L3	8Hrs.
<p><b>Processors:</b> Introduction, Processor Selection for SoC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling.</p> <p><b>Buffers:</b> Minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.</p> <p><b>Laboratory Sessions/Experimental learning :</b></p> <ol style="list-style-type: none"> <li>1. Design a model to generate a square wave using suitable programming language with appropriate delay.</li> <li>2. Design a model for generating a Interrupt using different addressing modes by selecting suitable programming language.</li> </ol> <p><b>Applications :</b> Supercomputers</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://youtu.be/4VRtujwa_b8">https://youtu.be/4VRtujwa_b8</a></li> <li>2. <a href="https://nptel.ac.in/courses/124107010/">https://nptel.ac.in/courses/124107010/</a></li> </ol>		
Module-3	RBT Level L1, L2, L3	8Hrs.
<p><b>Memory Design for SoC:</b> Overview of SoC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation , SoC Memory System, Models of Simple Processor, memory interaction.</p> <p><b>Laboratory Sessions/Experimental learning :</b></p> <ol style="list-style-type: none"> <li>1. Case study on on-chip peripherals of MSP430</li> </ol> <p><b>Applications:</b> Cloud, Data-centres.</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://youtu.be/cjNORC_00_A">https://youtu.be/cjNORC_00_A</a></li> <li>2. <a href="https://www.youtube.com/watch?v=A_bWZLI0TW">https://www.youtube.com/watch?v=A_bWZLI0TW</a></li> </ol>		

<b>Module-4</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
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**Interconnect:** Inter Connect Architectures, Bus: Basic Architectures, SoC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SoC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor.

**Laboratory Sessions/Experimental learning :**

- 1 Design a model to save and store data in SD card with MSP430 microcontroller.

**Applications :** Data-Centre interconnects, PC peripherals

**Video link / Additional online information:**

- 1 <https://youtu.be/PvZ5GXR9Ri8>

<b>Module-5</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
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**Application Studies / Case Studies:** SoC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression.

**Laboratory Sessions/Experimental learning :**

1. Implement an algorithm for JPEG compression using MATLAB.

**Applications:** Wireless security, processor security, encryption

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/105104183/>

<b>Course outcomes:</b>	
CO1	Interpret the need of SoC system design.
CO2	Outline the SoC Architecture design and basic concepts of processor.
CO3	Design memory organization in SoC system .
CO4	Utilize the reconfiguration mechanism of SoC in reconfigurable devices.
CO5	Apply various algorithm for SoC system design.
<b>Text Books:</b>	
1.	Michael J. Flynn and Wayne Luk, "Computer System Design System-on-Chip", Wiley India Pvt.Ltd.

2.	Ricardo Reis, "Design of System on a Chip: Devices and Components", 1st Edition, 2004, Springer
<b>Reference Books:</b>	
1.	Prakash Rashinkar, Peter Paterson and Leena Singh L, "System on Chip Verification n – Methodologies and Techniques", 2001, Kluwer Academic Publishers
2.	Web Source: <a href="#">What is a System on Chip (SoC)? - AnySilicon</a>

#### CIE Assessment:

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- 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.
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- 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
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CO3	3	3	3	2	1	1	-	-	-	-	-	1
CO4	3	3	3	2	1	1	-	-	-	-	-	1
CO5	3	3	3	2	1	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	AUTOMOTIVE EMBEDDED SYSTEMS	Semester	VII
Course Code	MVJ20EC741	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:

- Expose the students to the fundamentals and building of Electronic Engine Control systems.
- Teach on functional components and circuits for vehicles.
- Discuss on programmable controllers for vehicle management systems.
- Teach logics of automation & commercial techniques for vehicle communication.
- Introduce the embedded systems concepts for E-vehicle system development.

Module-1

RBT Level

L1,L2,L3,L4

8Hrs.

**BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS:** Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications – open source ECU- RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

**Laboratory Sessions/Experimental Learning:**

1. Display and analyze the basic components of automotive system.

**Applications:** Vehicle Control , Power Train

**Video link/ Additional online information:**

1. <https://www.youtube.com/watch?v=AZAvaZF1TcE>

Module-2

RBT Level

L1,L2,L3,L4

8Hrs.

**SENSORS AND ACTUATORS FOR AUTOMOTIVE:** Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR

sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

**Laboratory Sessions/Experimental Learning:**

- . 1. Interfacing Sensors like RTD, LVDT, Load Cell etc

**Applications:** Electric Vehicle

**Video link/ Additional online information:**

- 1. <https://www.youtube.com/watch?v=Y18LabELpx4>

<b>Module-3</b>	<b>RBT Level</b> L1,L2,L3,L4	<b>8Hrs.</b>
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**VEHICLE MANAGEMENT SYSTEMS:** Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition- Adaptive cruise control - speed control-anti-locking braking system-electronic suspension - electronic steering , Automatic wiper control- body control system ; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- Battery management system, power management system-electrically assisted power steering system- Adaptive lighting system- Safety and Collision Avoidance.

**Laboratory Sessions/Experimental Learning:**

- 1. To Control the speed of the motor using Electronics Controller.
- 2. To Change the direction of the Steering through Electronic Management Systems.

**Applications:** Automotive Industry, Real time tracking & Control

**Video link/ Additional online information:**

- 1. <https://www.youtube.com/watch?v=1LwNV10XTtQ>

<b>Module-4</b>	<b>RBT Level</b> L1,L2,L3,L4	<b>8Hrs.</b>
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**ONBOARD DIAGONSTICS AND TELEMATICS:** On board diagnosis of vehicles -System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications- Navigation- Connected Cars technology – Tracking- Security for data communication- dashboard display and Virtual Instrumentation, multimedia electronics- Role of IOT in Automotive systems.

**Laboratory Sessions/Experimental Learning:**

- 1. Case study on CAN BUS protocol in automobile industry

<b>Applications:</b> Vehicle –Vehicle Communication <b>Video link/ Additional online information:</b> 1. <a href="https://www.youtube.com/watch?v=LZQB9In4_0Y">https://www.youtube.com/watch?v=LZQB9In4_0Y</a>		
<b>Module-5</b>	<b>RBT Level</b> L1,L2,L3,L4	<b>8Hrs.</b>
<b>ELECTRIC VEHICLES:</b> Electric vehicles –Components- Plug in Electrical vehicle- Charging station – Aggregators- Fuel cells/Solar powered vehicles- Autonomous vehicles.  <b>Laboratory Sessions/Experimental Learning:</b> 1. Case studies on Autonomous Cars.  <b>Applications:</b> Autonomous vehicles <b>Video link/ Additional online information:</b> 1. <a href="https://www.youtube.com/watch?v=wypbLRe9xUg">https://www.youtube.com/watch?v=wypbLRe9xUg</a>		

<b>Course outcomes:</b>	
CO1	Know the significance of the role of embedded system for automotive applications.
CO2	Understand the need, selection of sensors and actuators and interfacing with ECU
CO3	Applying the Embedded concepts for vehicle management and control systems.
CO4	Understand various Vehicle Communication Protocols and role of IoT in
CO5	Understand the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs.

<b>Text Books:</b>	
1.	William B. Ribbens ,“Understanding Automotive Electronics”, Elseiver,2012
2.	Ali Emedi, Mehrded ehsani, John M Miller , “Vehicular Electric power system- land, Sea, Air and Space Vehicles” Marcel Decker, 2004..
<b>Reference Books:</b>	

1.	L.Vlacic , M .Parent , F.Harahima, "Intelligent Vehicl Technologies", SAE International, 2001.
2.	Jack Erjavec,Jeff Arias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles",Cengage ,2012
3.	Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford.
4.	Automotive Electricals / Electronics System and Components, Tom Denton, 3 rd Edition, 2004.
5.	Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1 edition, March 30, 2000 .
6.	Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4 th Edition, 2004.
7.	Automotive Hand Book, Robert Bosch, Bently Publishers, 1997.

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#### **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	3	2		1	-	-	-	-	-	-	-
CO2	3	3	2	1	1	-	-	-	-	-	-	-
CO3	3	2	2	1	1	-	-	-	-	-	-	-
CO4	3	3	2		-	-	-	-	-	-	-	-
CO5	3	3	2		-	1	-	1	1	-	-	-

High-3, Medium-2, Low-1

Course Title	SATELLITE & RADAR COMMUNICATION	Semester	VII
Course Code	MVJ20EC742	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:**

- Provide a conceptual knowledge of communication through satellites.
- Study the concept of navigation - both inertial and by navigation satellites.
- Understand typical challenges of satellite-based systems.
- Learn the basic principle of radar equation.
- Motivate to learn modern radar and navigational techniques.

Module-1	RBT Level L1, L2, L3	8Hrs.
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*Prerequisites: Digital Communication Systems*

**Introduction to Satellite Communication:** Orbital aspects of Satellite Communication: Introduction to geo-synchronous and geo-stationary satellites, Kepler's laws, Locating the satellite with respect to the earth, Sub-satellite point, Look angles, Mechanics of launching a synchronous satellite.

**Laboratory Sessions/ Experimental learning:**

1. To study the details regarding satellite communication toolbox in Matlab.

**Applications:** DTH, or satellite television, services (such as the DirecTV and DISH Network services)

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/117/105/117105131/#>
2. <https://youtu.be/n70zjMvm8L0>
3. <https://youtu.be/oYRMYSIVj1o>

Module-2	RBT Level L1, L2, L3	8Hrs.
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**Satellite sub-systems:** Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system, Space craft antennas, Multiple access

techniques, comparison of FDMA, TDMA, and CDMA. Earth station equipment, tracking systems.

**Satellite Link Design:** Basic transmission theory, System noise temperature and G/T Ratio, Noise figure and noise temperature, Calculation of system noise temperature, G/T ratio for earth stations, Link budgets - Uplink and downlink budget calculations, Error control for digital satellite links, Prediction of rain attenuation and propagation impairment counter measures.

**Laboratory Sessions/ Experimental learning:**

1. Study and analyze the parameters of RF-link satellite simulation using Matlab

**Applications:** Mobile Communication, Error detection and correction

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/117/105/117105131/#>
2. <https://www.youtube.com/watch?v=FTHt-c8hWKw>

Module-3	RBT Level L1, L2, L3	8Hrs.
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**Communication Satellites:** Introduction, Related Applications, Frequency Bands, Payloads, Satellite Vs. Terrestrial Networks, Satellite Telephony, Satellite Television, Satellite radio, Regional satellite Systems, National Satellite Systems.

**Remote Sensing Satellites:** Classification of remote sensing systems, orbits, Payloads, Types of images: Classification, Interpretation, Applications.

**Weather Forecasting Satellites:** Fundamentals: Images, Orbits, Payloads, And Applications.

**Navigation Satellites:** Development of Satellite Navigation Systems, GPS system, Applications.

**Laboratory Sessions/ Experimental learning:**

1. A Case Study of Using Remote Sensing Data and GIS for Land Management

**Applications:** Communication, Weather forecasting, Remote sensing, Navigation

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/117/105/117105131/#>
2. <https://nptel.ac.in/courses/121/107/121107009/>
3. [https://onlinecourses.nptel.ac.in/noc19\\_ce45/preview](https://onlinecourses.nptel.ac.in/noc19_ce45/preview)

Module-4	RBT Level L1, L2, L3	8Hrs.
<p><b>Introduction to Radar:</b> Radar block diagram and operation, Radar frequencies, Applications of radar, Prediction of range performance, Minimum detectable signal, Receiver noise, Probability density function, SNR, Integration of radar pulses, Radar cross-section of targets, PRF and range ambiguities, Transmitter power, System losses.</p> <p><b>Electronically steered Phased Array Antenna in Radar:</b> Phase shifters, Frequency scan arrays, Array elements, Feeds for arrays, Computer Control of Phased-Array Radar.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Implement the radar range equations for remote sensing.</p> <p><b>Applications:</b> Ground surveillance, missile control, fire control, air traffic control (ATC), moving target indication (MTI).</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li><a href="https://onlinecourses.nptel.ac.in/noc19_ee58/preview">https://onlinecourses.nptel.ac.in/noc19_ee58/preview</a></li> <li><a href="https://nptel.ac.in/courses/108/105/108105154/">https://nptel.ac.in/courses/108/105/108105154/</a></li> </ol>		
Module-5	RBT Level L1, L2, L3	8Hrs.
<p><b>Radar Technology and Applications:</b> Doppler Effect, CW radar, FM CW radar, Multiple frequency CW radar, MTI radar, Delay line canceller, Range gated MTI radar, Blind speeds, Staggered PRF, Limitations to the performance of MTI radar, Non-coherent MTI radar.</p> <p><b>Tracking radar:</b> sequential lobing, conical scan, Monopulse: amplitude comparison and phase comparison methods, Radar antennas. Radar displays.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Study the implementation and importance of MTI radar with Power amplifier.</p> <p><b>Applications:</b> Ground surveillance, weapons location, and vehicle search</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/108/105/108105154/">https://nptel.ac.in/courses/108/105/108105154/</a></li> <li><a href="https://youtu.be/XFapyIIZX_8">https://youtu.be/XFapyIIZX_8</a></li> <li><a href="https://freevidelectures.com/course/5299/introduction-radar-systems/42">https://freevidelectures.com/course/5299/introduction-radar-systems/42</a></li> </ol>		

Course outcomes:	
CO1	Apply the basics of digital transmission related to satellite communication
CO2	Comprehend the design of satellite subsystems
CO3	Evaluate spacecraft subsystem performance and trades
CO4	Model the characteristics of radar echoes from different types of targets and clutter.
CO5	Calculate and simulate receiver noise and losses.

Text Books:	
1.	T. Pratt, C.W. Boastian and Jeremy Allnutt, "Satellite Communication", 2013, 2nd edition, John Wiley and Sons, Bangalore, India.
2.	Merril. I. Skolnik, "Introduction to Radar Systems", 2/e, MGH, 1981.

Reference Books:	
1.	Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006
2.	Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd Edition, Wiley India Pvt. Ltd , 2017, ISBN: 978-81-265-0833-4

CIE Assessment:	
<p>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</p> <ul style="list-style-type: none"> <li>- Quizzes/mini tests (4 marks)</li> <li>- Mini Project / Case Studies (8 Marks)</li> <li>- Activities/Experimentations related to courses (8 Marks)</li> </ul>	
SEE Assessment:	
<p>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.</p> <p>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.</p>	

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	-	-	-	-	-	-	-
CO2	3	3	2	-	2	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	3	2	1	-	-	-	-	-	-	-
CO5	3	3	3	-	2	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	ARTIFICIAL INTELLIGENCE & DATA SCIENCE	Semester	VII
Course Code	MVJ20EC743	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:

- Identify the problems where AI is required and the different methods available.
- Compare and contrast different AI techniques available.
- Understand and explain learning algorithms.
- Obtain a Comprehensive knowledge of various tools and techniques for Data transformation and visualization.
- Learn the probability and probabilistic models of data science

Module-1	RBT Level L1, L2, L3	8Hrs.
<p><i>Prerequisites: Machine Learning</i></p> <p><b>Artificial Intelligence:</b> What is Artificial Intelligence? AI Technique, Level of the Model, Problem Spaces, and Search: Defining the Problem as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics and issues in the Design of Search Programs. Heuristic Search Techniques: Generate-and Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Write a program to solve 8 queens problem using PROLOG</p> <p><b>Applications:</b> Astronomy, Health care, Finance, Gaming, Data security</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/106/102/106102220/">https://nptel.ac.in/courses/106/102/106102220/</a>  <a href="https://www.simplilearn.com/artificial-intelligence-introduction-for-beginners-training-course">https://www.simplilearn.com/artificial-intelligence-introduction-for-beginners-training-course</a></p>		

Module-2	RBT Level L1, L2, L3	8Hrs.
<p><b>Analysis, Knowledge Representation:</b> Representations and Mappings, Approaches to Knowledge Representation, Using Predicate Logic: Representing Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution, Natural Deduction. Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Program to replace an integer from the list using PROLOG</p> <p><b>Applications:</b> Computer database</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/106/105/106105077/">https://nptel.ac.in/courses/106/105/106105077/</a>  <a href="https://www.youtube.com/watch?v=xUIqkAmfi8A">https://www.youtube.com/watch?v=xUIqkAmfi8A</a></p>		
Module-3	RBT Level L3,L4	8Hrs.
<p><b>Reasoning:</b> Symbolic Reasoning Under Uncertainty, Statistical Reasoning, Weak Slot and Filler, Structure, Semantic nets, Frames, Strong Slot and Filler Structure, Conceptual Dependency, Scripts, CYC.</p> <p><b>Natural Language Processing:</b> Natural Language Processing, Syntactic processing, semantic analysis, Parallel and Distributed AI, Psychological modeling- parallelism and distributed in reasoning systems, Learning, Connectionist Models, Hopfield networks, neural networks. Expert Systems.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Solve Robot (traversal) problem using means End Analysis using PROLOG</p> <p><b>Applications:</b> Search Autocorrect and Autocomplete, Language Translator, Social Media Monitoring.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/106/101/106101007/">https://nptel.ac.in/courses/106/101/106101007/</a></p> <p>2. <a href="https://www.youtube.com/watch?v=WHCo4m2VOws&amp;vI=en">https://www.youtube.com/watch?v=WHCo4m2VOws&amp;vI=en</a>  <a href="https://www.youtube.com/watch?v=dw6kp0jfi5w">https://www.youtube.com/watch?v=dw6kp0jfi5w</a></p>		



Module-4	RBT Level L3,L4,L5	8Hrs.
<p><i>Prerequisites: Mathematical and Statistical concepts, Programming skills like C or C++</i></p> <p><b>Data Visualization:</b> Introduction, Causality and Experiments - Data Pre-processing: Knowing data, Data cleaning, Data reduction, Data transformation, Data discretization - Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of Exploratory Data Analysis (EDA). Exploring Univariate Data - Histograms -Stem-and Leaf Quantile Based Plots - Continuous Distributions - Quantile Plots- QQ Plot- Box Plots</p> <p><b>Laboratory Sessions/ Experimental learning:</b> R as CALCULATOR APPLICATION</p> <ol style="list-style-type: none"> <li>Using with and without R objects on console</li> <li>Using mathematical functions on console</li> <li>Write an R script, to create R objects for calculator application and save in a specified location in disk.</li> </ol> <p><b>Applications:</b> Fraud and Risk Detection, Website Recommendations, Advanced Image Recognition, Airline Route Planning</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/106/106/106106179/">https://nptel.ac.in/courses/106/106/106106179/</a></li> <li><a href="https://nptel.ac.in/courses/106/107/106107220/">https://nptel.ac.in/courses/106/107/106107220/</a></li> </ol>		
Module-5	RBT Level L1, L2, L3	8Hrs.
<p><i>Prerequisites: Probability theory</i></p> <p><b>Big Data Analytics:</b> Hadoop Distributed File System Basics, Running Example Programs and Benchmarks, Hadoop Map Reduce Framework, Map Reduce Programming</p> <p><b>Applications:</b> Customer Relationship management, Health care, Education, Retail, Banking, Financial services, Insurance, Manufacturing, Telecom, Public Sector</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>Word Count Map Reduce program to understand Map Reduce Paradigm Installing and configuring Hadoop</li> </ol> <p><b>Applications:</b> Communication, Healthcare</p> <p><b>Video link / Additional online information:</b></p>		

1.	<a href="https://nptel.ac.in/courses/106/104/106104189/">https://nptel.ac.in/courses/106/104/106104189/</a>
2.	<a href="https://www.digimat.in/nptel/courses/video/106104189/L06.html">https://www.digimat.in/nptel/courses/video/106104189/L06.html</a>
<b>Course outcomes:</b>	
CO1	Identify the AI based problems
CO2	Apply techniques to solve the AI problems.
CO3	Demonstrate learning and various learning techniques
CO4	Apply pre-processing techniques to convert raw data so as to enable further analysis
CO5	Analyze the probability density function of transformations of random variables and use these techniques to generate data from various distributions

<b>Text Books:</b>	
1.	E. Rich , K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.
2.	Artificial Intelligence: A Modern Approach, Stuart Rusell, Peter Norving, Pearson Education 2nd Edition.
3.	Jiawei Han, Micheline Kamber, Jian Pei, Data Mining Concepts and Techniques, Third edition, Elsevier Publisher, 2006
<b>Reference Books:</b>	
1.	Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems – Prentice Hal of India
2.	N.P. Padhy "Artificial Intelligence and Intelligent Systems" , Oxford University Press- 2015
3.	Adi Adhikari and John De Nero, Computational and Inferential Thinking: The Foundations of Data Science, First edition, 2019
4.	Douglas Eadline,"Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1stEdition, Pearson Education, 2016. ISBN-13: 978-9332570351
5.	Anil Maheshwari, "Data Analytics", 1st Edition, McGraw Hill Education, 2017. ISBN-13: 978-9352604180

**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.
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**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	CRYPTOGRAPHY & CYBER SECURITY	Semester	VII
Course Code	MVJ20EC744	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:**

- Outline the basic principles of Cyber security and its applications
- Familiarize with Cryptography and very essential algorithms
- Use the theorems needed for cryptographic operations and compare & contrast different types of cryptography
- State the concepts & uses of Digital signature and web security
- Demonstrate the need and summarize the concept of Secure Electronic Transactions & Intrusion detection system.

**Module-1**

RBT Level

L1, L2, L3, L6

8Hrs.

**Introduction:** Services, Mechanisms, Mechanism Attacks, The OSI Security Architecture, A Model for Network Security, Cyber Attacks, Defence Strategies and Techniques, Guiding Principles

**Mathematical Background of Cryptography:** Integer Arithmetic, Modular Arithmetic, Matrices, The Greatest Comma Divisor, Useful Algebraic Structures, Chinese Remainder Theorem

**Applications:** Time Stamping, Electronic Money, Secure Network Communication

**Laboratory Sessions/ Experimental learning:**

1. [Breaking the Shift Cipher](#)

**Video link / Additional online information :**

1. <https://nptel.ac.in/courses/117103063/>
2. <https://nptel.ac.in/courses/117107095/>
3. <http://nptelvideos.com/video.php?id=2441>
4. <http://www.nptelvideos.com/video.php?id=429>

Module-2	RBT Level L1, L2, L3,L6	8Hrs.
<p><b>Basics of Cryptography:</b> Preliminaries, Elementary Substitution Ciphers, Elementary Transport Ciphers, Other Cipher Properties.</p> <p><b>Symmetric Ciphers:</b> Symmetric Ciphers model, Substitution Techniques, Transposition Techniques, Simplified DES, Data encryption Standard (DES), The strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and modes of operation, Evaluation Criteria for Advanced Encryption standard, The AES Cipher.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Breaking the Mono-alphabetic Substitution Cipher</p> <p><b>Applications:</b> wireless security, processor security, file encryption.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/117106087/">https://nptel.ac.in/courses/117106087/</a></p> <p>2. <a href="https://www.youtube.com/watch?v=ANHTfy9feZg">https://www.youtube.com/watch?v=ANHTfy9feZg</a></p> <p>3. <a href="https://nptel.ac.in/courses/108102095/">https://nptel.ac.in/courses/108102095/</a></p>		
Module-3	RBT Level L1, L2, L3, L6	8Hrs.
<p>Principles of public key Cryptosystem, The RSA algorithms, Key management, Diffie – Hellman key exchange, Elliptic Curve Arithmetic, Authentication functions, Hash functions.</p> <p>Digital Signatures, Authentication protocols, Digital signature standard. Web security consideration, Secure Socket Layer, Transport layer security, secure electronic transaction.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Diffie-Hellman Key Establishment</p> <p><b>Applications:</b> Random number generator, permutation generator</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://www.youtube.com/watch?v=m4sjTt7rhow">https://www.youtube.com/watch?v=m4sjTt7rhow</a></p> <p>2. <a href="https://nptel.ac.in/courses/117101106/">https://nptel.ac.in/courses/117101106/</a></p> <p>3. <a href="https://nptel.ac.in/courses/108108114/">https://nptel.ac.in/courses/108108114/</a></p>		

<b>Module-4</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
<p>Intruders, Intrusion Detection, Password Management, Malicious software programs – Viruses and related Threats, Virus Countermeasures Firewall Design Principles, Trusted Systems</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>Digital Signatures Scheme</li> <li>Cryptographic Hash Functions and Applications(HMAC)</li> </ol> <p><b>Applications:</b> Cyber-attacks, Cybercrime, Cyber security.</p> <p><b>Video link / Additional online information :</b></p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/108105113/">https://nptel.ac.in/courses/108105113/</a></li> <li><a href="https://nptel.ac.in/courses/117106086/">https://nptel.ac.in/courses/117106086/</a></li> </ol>		
<b>Module-5</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
<p><b>Transport Level Security:</b> Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH)</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>Cryptographic Hash Functions and Applications.</li> <li>Diffie-Hellman Key Establishment</li> </ol> <p><b>Applications:</b> Encryption, message authentication and integrity, and replay attack protection</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/117102052/">https://nptel.ac.in/courses/117102052/</a></li> </ol>		

<b>Course outcomes:</b>	
CO1	Analyse the importance of security attacks, service mechanism, basic network security model and its applications.
CO2	Design and develop simple cryptography algorithms and Explain basic structure of DES and AES
CO3	Apply the concepts of Primes, Testing, Factorization, Chinese remainder theorem and RSA Cryptosystem.

CO4	Illustrate the concept public key cryptography & apply digital signatures in email. Processing and Explain usages of email-security, IP security and web security.
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CO5	Describe different techniques used in key exchange protocols.
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**Text Books:**

1.	Cryptography and Network Security- Behrouz A Forouzan, Debdeep Mukhopadhyay,Mc-GrawHill, 3rd Edition, 2015
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2.	Cryptography and Network Security- William Stallings, Pearson Education, 7th Edition.
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**Reference Books:**

1.	Cryptography, Network Security and Cyber Laws – Bernard Menezes, Cengage Learning, 2010 edition.
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**CIE Assessment:**

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CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Course Title	VLSI SYSTEM DESIGN LAB	Semester	VII
Course Code	MVJ20ECL76	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:**

- Explore the CAD tool and understand the flow of the Full Custom IC design cycle.
- Learn DRC, LVS and Parasitic Extraction of the various designs.
- Design and simulate the various basic CMOS analog circuits and use them in higher circuits like data converters using design abstraction concepts.
- Design and simulate the various basic CMOS digital circuits and use them in higher circuits like adders and shift registers using design abstraction concepts.

**Laboratory Sessions**

Sl No	Experiment Name	RBT Level	Hours
<b>ASIC Digital Design</b>			
1	Write Verilog Code for <b>inverter</b> and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.	L3	3
2	Write Verilog Code for <b>buffer</b> and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.	L3	3
3	Write Verilog Code for <b>Transmission Gate</b> and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.	L3	3
4	Write Verilog Code for <b>Basic/universal gates</b> and Test Bench for verification, observe the waveform and synthesize the code with technological library with given	L3	3



	constraints. Do the initial timing verification with gate level simulation.		
5	Write Verilog Code for Flip flops -RS, D, JK, MS, T and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.	L3	3
6	Write Verilog Code for Serial & Parallel adder and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.	L3	2
7	Write Verilog Code for 4-bit counter [Synchronous and Asynchronous counter] and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.	L3	2
<b>Analog Design</b>			
8	<p>Design an Inverter with given specifications, completing the design flow mentioned below:</p> <ul style="list-style-type: none"> <li>• Draw the schematic and verify the following i) DC Analysis ii) Transient Analysis</li> <li>• Draw the Layout and verify the DRC, ERC</li> <li>• Check for LVS</li> </ul> <p>Verify &amp; Optimize for Time, Power and Area to the given constraint</p>	L5	3
9	<p>Design the Common source amplifier with given specifications, completing the design flow mentioned below:</p> <ul style="list-style-type: none"> <li>• Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis</li> <li>• Draw the Layout and verify the DRC, ERC</li> <li>• Check for LVS</li> </ul>	L5	2

	<ul style="list-style-type: none"> <li>• RC extraction</li> </ul>		
10	<p>Design the Common Drain amplifier with given specifications, completing the design flow mentioned below:</p> <ul style="list-style-type: none"> <li>• Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis</li> <li>• Draw the Layout and verify the DRC, ERC</li> <li>• Check for LVS</li> <li>• RC extraction</li> </ul>	L5	2
11	<p>Design a Single Stage differential amplifier, with given specifications, completing the design flow mentioned below:</p> <ul style="list-style-type: none"> <li>• Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis</li> <li>• Draw the Layout and verify the DRC, ERC</li> <li>• Check for LVS</li> <li>• RC extraction</li> </ul>	L5	2
12	<p>Design an <b>Operational-amp</b> with given specification using given differential amplifier Common source and Common Drain amplifier in library and completing the design flow mentioned below:</p> <ul style="list-style-type: none"> <li>• Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii). AC Analysis</li> <li>• Draw the Layout and verify the DRC, ERC</li> <li>• Check for LVS</li> <li>• RC extraction</li> </ul>	L5	2

**Course outcomes:**

CO1	Write test bench to simulate various digital circuits.
CO2	Interpret concepts of DC Analysis, AC Analysis and Transient Analysis in analog circuits.
CO3	Design and simulate basic CMOS circuits like inverter, common source amplifier and differential amplifiers.

CO4	Design higher level circuits like operational amplifier and analog/digital converters to meet desired parameters.
CO5	Use transistors to design gates and further using gates realize shift registers and adders to meet desired parameters.

<b>Scheme of Evaluation</b>	
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
<b>Total</b>	<b>50 marks</b>

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

High-3, Medium-2, Low-1

Course Title	IOT LAB	Semester	VII
Course Code	MVJ20ECL77	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:

- Gain knowledge on IoT ecosystem and Arduino board.
- Establish Wifi IOT module with Arduino uno.
- Interface IR, Temperature, humidity sensors to Arduino board.
- Implement protocols to move sensor data to cloud.

#### Laboratory Sessions

Sl No	Experiment Name	RBT Level	Hours
1	Write a program for interface Arduino Uno with DHT Sensor to print Humidity and Temperature.	L3	3
2	Write a program for interface Arduino Uno with Smoke Sensor to print digital and analog output.	L3	3
3	Write a program for interface Arduino Uno with LM-35 Sensor for analog output result.	L3	3
4	Write a program for interface Arduino Uno with LDR (Light Dependent Resistor) Sensor.	L4	3
5	Write a program for interface Arduino Uno with Magnetic Sensor.	L3	3
6	Write a program for sending the data of Serial communication between Gateway and Arduino.	L4	3
7	Write a program for establishing Wifi IOT module with Arduino uno.	L5	4
8	Write a program for Communication between gateways to an end node.	L3	4

9	Write a program for Send data on Thingspeak with end node and also display those data on lcd.	L5	4
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Course outcomes:	
CO1	Experience the use and outcome of different sensors
CO2	Interface Arduino Uno with LDR,LM-35,DHT sensor
CO3	Understand the communication between gateway to an end node
CO4	Create program for establishing Wifi IOT module with Arduino uno
CO5	Implement a program to move sensor data to cloud.

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
<b>Total</b>	<b>50 marks</b>

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

High-3, Medium-2, Low-1

Course Title	PROJECT PHASE – 1	Semester	VII
Course Code	MVJ20ECP78	CIE	50
Total No. of Contact Hours	-	SEE	-
No. of Contact Hours/week	- (L : T : P :: 0 : 0 : 4)	Total	50
Credits	2	Exam. Duration	-

**Course Objective:**

- To support independent learning.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To expand intellectual capacity, credibility, judgment, intuition.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

**Project Work Phase - I:** Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

**Course outcomes:** At the end of the course the student will be able to:

CO1	Describe the project and be able to defend it.
CO2	Learn to use modern tools and techniques.
CO3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

### Scheme of Evaluation :

Internal Marks: The Internal marks (50 marks) evaluation shall be based on Phase wise completion of the project work, Project report, Presentation and Demonstration of the actual/model/prototype of the project.

### CO-PO Mapping

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

High-3, Medium-2, Low-1

**B.E, VIII Semester, Electronics & Communication Engineering**

Course Title	PROJECT PHASE – 2	Semester	VIII
Course Code	MVJ20ECP81	CIE	50
Total No. of Contact Hours	-	SEE	50
No. of Contact Hours/week	(L : T : P :: 0 : 0 : 14)	Total	100
Credits	8	Exam. Duration	3 Hours

**Course Objective:**

- To support independent learning.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgment, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

**Project Work Phase - II:** Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

**Course outcomes:** At the end of the course the student will be able to:

CO1	Describe the project and be able to defend it. Develop critical thinking and problem solving skills.
CO2	Learn to use modern tools and techniques. Communicate effectively and to present ideas clearly and coherently both in written and oral forms.



CO3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

#### Scheme of Evaluation :

Internal Marks: The Internal marks (50 marks) evaluation shall be based on Phase wise completion of the project work, Project report, Presentation and Demonstration of the actual/model/prototype of the project.

Semester End Examination: SEE marks for the project (50 marks) shall be based on Project report, Presentation and Demonstration of the actual/model/prototype of the project, as per the norms by the examiners appointed

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

High-3, Medium-2, Low-1

Course Title	INTERNSHIP	Semester	VIII
Course Code	MVJ20ECI82	CIE	50
Total No. of Contact Hours	Industrial Oriented	SEE	50
No. of Contact Hours/week	-	Total	100
Credits	3	Exam. Duration	3 Hours

**Course Objective:**

- To get the field exposure and experience
- To apply the theoretical concept in field application
- To prepare the comparison statement of difference activities

**Internship:** This shall be carried out by students in industry set-up related to the construction/ materials testing laboratories/research organizations/project management consulting firms/QS and QA organizations/ planning and design offices/Professional organizations and other avenues related to the Electronics and Communication engineering domain in consultation and approval of internship guide/HOD /internship committees of the institutions.

**Course outcomes:** At the end of the course the student will be able to:

CO1	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO2	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO3	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

**Scheme of Evaluation :**

Internal Marks: The Internal marks (50 marks) evaluation shall be based on midterm and final presentation of the activities undertaken during the internship, to a panel comprising internship guide, a senior faculty from the department and head of the department. Each

student should submit the internship report at the end of semester with internship certificate.

Semester End Examination: Viva-Voce examination shall be conducted by a panel of examiners consisting of internship supervisor, a senior faculty from the department and head of the department.

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

High-3, Medium-2, Low-1

Course Title	SEMINAR	Semester	VIII
Course Code	MVJ20ECS83	CIE	50
Total No. of Contact Hours	-	SEE	50
No. of Contact Hours/week	(L : T : P :: 0 : 0 : 4)	Total	100
Credits	1	Exam. Duration	3 Hours

**Course Objective:**

- To inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

**Seminar:** Each student, under the guidance of a Faculty, is required to choose, preferably, a recent topic of his/her interest relevant to the course of specialization. Carryout literature survey; organize the Course topics in a systematic order.

- Conduct literature survey in the domain area to find appropriate topic.
- Prepare the synopsis report with own sentences in a standard format.
- Learn to use MS word, MS power point, MS equation and Drawing tools or any such facilities in the preparation of report and presentation.
- Present the seminar topic orally and/or through power point slides.
- Communicate effectively to answer the queries and involve in debate/discussion.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

**Course outcomes:** At the end of the course the student will be able to:

CO1	Develop knowledge in the field of Electronics and Communication Engineering and other disciplines through independent learning and collaborative study.
CO2	Identify and discuss the current, real-time issues and challenges in engineering & technology. Develop written and oral communication skills.
CO3	Explore concepts in larger diverse social and academic contexts.
CO4	Apply principles of ethics and respect in interaction with others.

CO5	Develop the skills to enable life-long learning.
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**Scheme of Evaluation :**

Internal Marks: The Internal marks (50 marks) evaluation shall be based on midterm and final presentation, to a panel comprising seminar guide, a senior faculty from the department and head of the department. Each student should submit the Seminar report at the end of semester Semester End Examination: Viva-Voce examination shall be conducted by a panel of examiners consisting of seminar supervisor, a senior faculty from the department and head of the department.

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

High-3, Medium-2, Low-1

Course Title	CERTIFICATION	Semester	VIII
Course Code	MVJ20ECC84	CIE	-
Total No. of Contact Hours	-	SEE	-
No. of Contact Hours/week	-	Total	-
Credits	2	Exam. Duration	3 Hours

**Course Objective:**

- To inculcate self-learning, enhance the skill in different field of Engineering

**Certification:** Each student, under the guidance of a Faculty, is required to undergo online certification course minimum of 30 hours (number of courses is not limited) preferably, a recent topic of his/her interest. Each student should submit the Course details and Qualification Certificates at the end of semester.

**Course outcomes:** At the end of the course the student will be able to:

CO1	Develop knowledge in different fields of Engineering
CO2	Develop the skills to enable life-long learning.

Open electives offered by Department of ECE:

Course Title	DIGITAL IMAGE PROCESSING	Semester	VI
Course Code	MVJ20EC651	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.

<p>Video link / Additional online information :</p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/117/105/117105079/">https://nptel.ac.in/courses/117/105/117105079/</a></li> <li><a href="https://www.tutorialspoint.com/dip/index.htm">https://www.tutorialspoint.com/dip/index.htm</a></li> </ol>		
Module-2	RBT Level L1, L2, L3, L4	8Hrs.
<p><b>Spatial Domain:</b>Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters</p> <p><b>Frequency Domain:</b> 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.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>Implementation and analysis of image smoothing and sharpening algorithms using MATLAB.</li> </ol> <p><b>Applications:</b> Image Enhancement, Image Analysis</p> <p>Video link / Additional online information:</p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/117/105/117105079/">https://nptel.ac.in/courses/117/105/117105079/</a></li> <li><a href="https://www.tutorialspoint.com/dip/index.htm">https://www.tutorialspoint.com/dip/index.htm</a></li> </ol>		
Module-3	RBT Level L1, L2, L3,L4	8Hrs.
<p><b>Restoration:</b> 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.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>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.</li> </ol> <p><b>Applications:</b> Image Enhancement, Image Analysis, Error detection and correction</p> <p>Video link / Additional online information:</p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/117/105/117105079/">https://nptel.ac.in/courses/117/105/117105079/</a></li> <li><a href="https://www.tutorialspoint.com/dip/index.htm">https://www.tutorialspoint.com/dip/index.htm</a></li> </ol>		



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

<b>Course outcomes:</b>	
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.
<b>Text Books:</b>	
1.	Rafel C Gonzalez and Richard E. Woods , "Digital Image Processing"-, PHI 3 <sup>rd</sup> Edition 2010.
2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, –"Image Processing, Analysis, and Machine Vision  ", Cengage Learning, 2013, ISBN: 978-81-315-1883-0
<b>Reference Books:</b>	
1.	S.Jayaraman, S Esakkirajan, T.Veerakumar, "Digital Image Processing", Tata McGraw Hill, 2011
4.	S.Jayaraman, S.Esakkirajan, T.Veerakumar, "Digital Image Processing"- Tata McGraw Hill 2014.
5.	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	PRINCIPLES OF COMMUNICATION	Semester	VI
Course Code	MVJ20EC652	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 and analyze the concepts of Analog Modulation schemes viz; AM, FM.
- Learn the concepts of digitization of signals viz; sampling, quantizing and encoding.
- Realize the basic concepts of various digital modulation techniques.
- Study the principles behind information theory and coding.
- Understand the basics of spread spectrum modulation.

Module-1

RBT Level

L1, L2, L3

8Hrs.

*Prerequisites: Modulation, Need for Modulation and types of Modulation.*

**Analog Modulation:** Amplitude Modulation - AM, DSBSC, SSBSC, VSB - PSD, modulators and demodulators, Angle modulation - PM and FM - PSD, modulators and demodulators - Super heterodyne receivers.

**Laboratory Sessions/ Experimental learning:**

1. Introduction to Matlab
2. Generation of AM signal using Matlab

**Applications:** Broadcast transmissions, Air band radio, Quadrature amplitude modulation

**Video link / Additional online information :**

1. <https://nptel.ac.in/courses/117/105/117105143/>
2. <https://youtu.be/00ZbuhPruJw>
3. [https://youtu.be/rt08yTGv\\_z4](https://youtu.be/rt08yTGv_z4)

Module-2	RBT Level L1, L2,L3	8Hrs.
<p><b>Pulse Modulation:</b> Low pass sampling theorem, Quantization, PAM, Line coding, PCM, DPCM, DM, and ADPCM and ADM, Channel Vocoder, Time Division Multiplexing, Frequency Division Multiplexing.</p>		
<p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>Delta modulation using Matlab</li> </ol> <p><b>Applications:</b> Speech recognition systems, pattern recognition systems, digital audio in computers, CDs, digital telephony, telephone and radio communications, television systems.</p> <p><b>Video link / Additional online information :</b></p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/117/105/117105077/">https://nptel.ac.in/courses/117/105/117105077/</a></li> <li><a href="https://nptel.ac.in/courses/117/101/117101051/">https://nptel.ac.in/courses/117/101/117101051/</a></li> <li><a href="https://youtu.be/s6vIXP3mYXk">https://youtu.be/s6vIXP3mYXk</a></li> <li><a href="https://youtu.be/HIGJ6xxbz8s">https://youtu.be/HIGJ6xxbz8s</a></li> </ol>		
Module-3	RBT Level L1, L2, L3	8Hrs.
<p><b>Digital Modulation And Transmission:</b> Phase shift keying, BPSK, DPSK, QPSK, Principles of M-ary signaling M-ary PSK &amp; QAM, Comparison, ISI Pulse shaping, Duo binary encoding, Cosine filters, Eye pattern, equalizers.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>Eye diagram using Matlab</li> <li>Generation of BPSK Using LabVIEW</li> </ol> <p><b>Applications:</b> LAN, CDMA, WiMAX, wireless communication, mobile communication, Satellite Communication, Bluetooth, RFID.</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li><a href="https://nptel.ac.in/courses/117/105/117105077/">https://nptel.ac.in/courses/117/105/117105077/</a></li> <li><a href="https://nptel.ac.in/courses/117/101/117101051/">https://nptel.ac.in/courses/117/101/117101051/</a></li> </ol>		

<b>Module-4</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
<p><b>Information Theory and Coding:</b> Measure of information, Entropy, Source coding theorem – Shannon Fanon coding, Huffman Coding, LZ Coding, Channel capacity, Shannon-Hartley law – Shannon’s limit, Error control codes, Cyclic codes, Syndrome calculation, Convolution Coding, Sequential and Viterbi decoding.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Huffman coding using Matlab</p> <p><b>Applications:</b> Data Compression, audio/video transmission, data transmission and file transfer</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/108/102/108102117/">https://nptel.ac.in/courses/108/102/108102117/</a></p> <p>2. <a href="https://nptel.ac.in/courses/117/104/117104129/">https://nptel.ac.in/courses/117/104/117104129/</a></p>		

<b>Module-5</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
<p><b>Spread Spectrum Multiple Access Techniques:</b> PN sequences, properties, m-sequence, DSSS – Processing gain, Jamming, FHSS, Synchronization and tracking, Multiple Access FDMA, TDMA, CDMA.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Direct Sequence Spread spectrum Signal Generation &amp; Detection using Matlab</p> <p><b>Applications:</b> CDMA, Wi-Fi, WPAN, etc.,</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/117/105/117105077/">https://nptel.ac.in/courses/117/105/117105077/</a></p> <p>2. <a href="https://nptel.ac.in/courses/117/101/117101051/">https://nptel.ac.in/courses/117/101/117101051/</a></p> <p>3. <a href="https://nptel.ac.in/courses/117/105/117105136/">https://nptel.ac.in/courses/117/105/117105136/</a></p> <p>4. <a href="https://youtu.be/Ojmv3I4kDn4">https://youtu.be/Ojmv3I4kDn4</a></p>		

<b>Course outcomes:</b>	
CO1	Examine the concepts of AM and FM modulation and demodulation.
CO2	Apply the concepts of sampling, quantization and encoding for digitization of signals.

CO3	Evaluate the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
CO4	Analyze source and error control coding.
CO5	Illustrate the digital communication system with spread spectrum modulation.

#### Text Books:

1.	H Taub, D L Schilling, G Saha, "Principles of Communication Systems" 3/e, TMH 2007
2.	Simon Haykins, "An Introduction to Analog and Digital Communication", John Wiley, 2003.

#### Reference Books:

1.	Simon Haykin, "Digital Communication Systems", John Wiley & sons, First Edition, 2014, ISBN 978-0-471-64735-5.
4.	B.P.Lathi, "Modern Digital and Analog Communication systems", 3 <sup>rd</sup> edition, Oxford University Press, 2007
5.	H P Hsu, Schaum Outline Series – "Analog and Digital Communications" TMH 2006
6.	B.Sklar, "Digital Communications Fundamentals and Applications" 2/e Pearson Education 2007
7.	K Giridhar, "Information Theory And Coding", 4th Edition, Pooja Publication, Bangalore, 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	1	1	-	-	-	-	-	1
CO2	3	3	3	2	1	1	-	-	-	-	-	1
CO3	3	3	3	2	1	1	-	-	-	-	-	1
CO4	3	3	3	2	1	1	-	-	-	-	-	1
CO5	3	3	3	2	1	1	-	-	-	-	-	1

High-3, Medium-2, Low-1



Course Title	SENSOR TECHNOLOGY	Semester	VI
Course Code	MVJ20EC653	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 various technologies associated in manufacturing of sensors.
- Provide better familiarity with different sensors and their applications in real life.
- Acquire knowledge about types of sensors used in modern digital systems.
- Evaluate the technological and physical limitations of a specific sensor.
- Propose a suitable sensor for a given measurement situation.

Module-1

RBT Level

L1,L2,L3

8Hrs.

*Prerequisite: Basic Electronics, Knowledge on physical quantities*

**Sensors Fundamentals and Characteristics:** General Concepts and Terminology, Sensor Classification, Static Characteristics, Dynamic Characteristics, Materials for Sensors, Microsensor Technology.

**Laboratory Sessions/ Experimental learning:**

1. Study on applications of sensors

**Applications:** Biological, Chemical, Electric, magnetic, or electromagnetic wave, Heat, temperature, Mechanical displacement or wave, Radioactivity, radiation and other.

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/108/105/108105064/>

2. <https://nptel.ac.in/courses/108/108/108108147/>

Module-2	RBT Level L1,L2,L3	8Hrs.
<p><b>Primary sensors:</b> Temperature sensors, Pressure sensors, Flow-velocity and flow-rate sensors, Level sensors, Force and torque sensors, Acceleration and inclination sensors and Velocity sensors.</p> <p><b>Resistive Sensors:</b> Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas sensors.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Strain measurement with Bridge circuit</p> <p><b>Applications:</b> Patient monitoring in medical applications, Manufacturing and industrial equipment and motorsport applications.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/108/105/108105064/">https://nptel.ac.in/courses/108/105/108105064/</a></p> <p>2. <a href="https://nptel.ac.in/courses/108/106/108106165/">https://nptel.ac.in/courses/108/106/108106165/</a></p>		
Module-3	RBT Level L1,L2,L3	8Hrs.
<p><b>Reactance Variation and Electromagnetic Sensors:</b> Capacitive sensors: Variable capacitor and Differential capacitor, Inductive sensors: Variable reluctance sensors, Eddy current sensors, Linear Variable Differential Transformers (LVDTs), Electromagnetic sensors: Sensors based on Faraday's Law and Hall effect sensors.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Develop a displacement measurement system with inductive sensors (LVDT)</p> <p><b>Applications:</b> Smart phones, Industrial automation, Communication, automobile and aerospace.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/108/105/108105064/">https://nptel.ac.in/courses/108/105/108105064/</a></p>		
Module-4	RBT Level L1,L2,L3	8Hrs.
<p><b>Self-Generating sensors:</b> Thermoelectric sensors, Piezoelectric sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors, Proximity sensors.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p>		

1. Develop a sensor system for force measurement using piezoelectric sensors  
**Applications:** Temperature controlled devices: refrigeration and air conditioning, Alarm clocks, Medical devices, PIN pads, photonics and pharmaceutical compositions, Robotics.  
**Video link / Additional online information:**  
 1. <https://nptel.ac.in/courses/108/105/108105064/>

Module-5	RBT Level L1,L2,L3	8Hrs.
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**Digital sensors:** Position encoders, Resonant sensors: SAW sensors, Vibrating wire strain gages, Vibrating cylinder sensors, Digital flow meters  
**Other sensing methods:** Charge-Coupled sensors – Fundamentals & types of CCD, Fiber-Optic sensors, Ultrasonic-based sensors, Gyroscope sensors, optical sensors, IR sensors.  
**Laboratory Sessions/ Experimental learning:**  
 1. Measure strain, temperature and pressure using LabVIEW.  
**Applications:** Industries, digital cameras, photocopiers.  
**Video link / Additional online information:**  
 1. <https://nptel.ac.in/courses/108/105/108105064/>  
 2. <https://nptel.ac.in/courses/112/103/112103174/>

<b>Course outcomes:</b>	
CO1	Understand the concept of sensors and its characteristics.
CO2	Explain the working principles of primary and resistive sensors.
CO3	Understand the inductive, capacitive and Electromagnetic sensors and its applications
CO4	Identify alternative methods to measure common quantities such as temperature, pressure, force and acceleration.
CO5	Select appropriate sensors used for various applications
<b>Text Books:</b>	
1.	Ramon Pallas & John G. Webster, "Sensors and signal conditioning", John Wiley & Sons., 2 <sup>nd</sup> Ed., 2001.

2.	J. Fraden, "Handbook of Modern Sensors: Physical, Designs, and Applications", AIP Press, Springer, 3 <sup>rd</sup> Ed.,2004.
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**Reference Books:**

1.	D. Patranabis, "Sensors and Transducers", PHI Publication, 2 <sup>nd</sup> Ed.,2004 New Delhi.
2.	Webster John G, "Instrumentation and sensors Handbook", CRC Press, 1 <sup>st</sup> Ed., 1999.
3.	Shawhney A.K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 1994.

**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	1	-	2	-	-	-	-	2	1
CO2	3	2	2	1	1	2	-	-	-	-	2	1
CO3	3	2	2	1	1	2	-	-	-	-	2	1
CO4	3	2	2	1	1	2	-	-	-	-	2	1
CO5	3	2	2	1	2	2	-	-	-	-	2	1

High-3, Medium-2, Low-1

Course Title	INTRODUCTION TO MATLAB & SIMULINK	Semester	VI
Course Code	MVJ20EC654	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:**

- To provide a foundation in programming for engineering problem solving using the MATLAB software package.
- To acquaint the student with some of the terminology in this very new field and relate it to the basic engineering process of design.
- To provide an introduction to the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- To develop the skills to analyse and break down an engineering program and solve it algorithmically using MATLAB

**Module-1**

RBT Level

L1, L2, L3 ,L4, L5

8Hrs.

Introduction to Matlab, Creating Variables, Some Useful MATLAB Functions Data Types creating simple and multiple data set in single plot, Matrix generation, Array operations and Linear equations

Introduction to programming in MATLAB, Visualization and Programming ,Control flow and operators

**Laboratory Sessions/ Experimental learning:**

1. Write MATLAB commands to analyze arithmetic, logical and Boolean operations.
2. Write MATLAB commands to analyze vector operations and magic matrixes.
3. Write a MATLAB program to demonstrate if and else if statement for comparing Two numbers.

**Video link / Additional online information :**

1. <https://in.mathworks.com/videos/writing-a-matlab-program-69023.html>
2. <https://youtu.be/ygGF3RR1NyM>
3. [https://www.halvorsen.blog/documents/programming/matlab/matlab\\_basics.php](https://www.halvorsen.blog/documents/programming/matlab/matlab_basics.php)

Module-2	RBT Level L1, L2, L3 ,L4,L5	8Hrs.
<p>Solving Equations, Curve Fitting, and Numerical Techniques :Linear Algebra, Polynomials, Optimization, Differentiation/Integration, Differential Equations</p> <p><b>Advanced Methods:</b> Probability and Statistics, Data Structures, Images, File I/O</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://www.youtube.com/watch?v=14H4UFoxZjs">https://www.youtube.com/watch?v=14H4UFoxZjs</a></li> <li>2. <a href="https://www.youtube.com/watch?v=fqS873TnMDs">https://www.youtube.com/watch?v=fqS873TnMDs</a></li> </ol>		
Module-3	RBT Level L1, L2, L3,L4 & L6	8Hrs.
<p><b>Various functions and toolboxes:</b> Documentation, Misc. Useful Functions, Graphical User Interfaces, Simulink, Symbolic Toolbox</p> <p><b>Applications:</b> App Designing using GUI, Image processing</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://in.mathworks.com/matlabcentral/fileexchange/44634-design-of-graphical-user-interface-application-with-matlab">https://in.mathworks.com/matlabcentral/fileexchange/44634-design-of-graphical-user-interface-application-with-matlab</a></li> <li>2. <a href="https://in.mathworks.com/videos/app-designer-overview-1510748719083.html">https://in.mathworks.com/videos/app-designer-overview-1510748719083.html</a></li> </ol>		
Module-4	RBT Level L1, L2, L3,L4 & L6	8Hrs.
<p><i>Prerequisites: Types of filters</i></p> <p><b>Introduction to SIMULINK:</b> Multiple plots creating models, blocks, Systems and sub-systems, Simulating Dynamic System, Solving a model, solvers, MATLAB SIMULINK integration, S-function); MATLAB Toolboxes training (Signal Processing, Neural Network, FUZZY logic, Control System, Communication, Power System toolboxes);</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Create a spreadsheet file with some data (or use an existing spreadsheet with data if you have) and import the data into MATLAB.</li> <li>2. Matlab 2D and 3D Plot</li> </ol> <p><b>Video link / Additional online information :</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://www.youtube.com/watch?v=iOmqqewj5XI">https://www.youtube.com/watch?v=iOmqqewj5XI</a></li> <li>2. <a href="https://in.mathworks.com/learn/tutorials/simulink-onramp.html">https://in.mathworks.com/learn/tutorials/simulink-onramp.html</a></li> <li>3. <a href="https://www.halvorsen.blog/documents/teaching/courses/matlab/matlab3.php">https://www.halvorsen.blog/documents/teaching/courses/matlab/matlab3.php</a></li> </ol>		

4. <https://www.youtube.com/watch?v=EW544PfgBrs>

Module-5	RBT Level L1, L2, L3	8Hrs.
<b>Applications of Matlab:</b> Diode Characteristics, Fourier Analysis, Signal Processing, Deep learning, Image processing		
<b>Laboratory Sessions/ Experimental learning:</b>		
1. Image Enhancement Using Intensity Transformations,		
2. Morphological and Other Set Operations		
3. Two-Dimensional Fast Fourier Transform		
<b>Video link / Additional online information:</b>		
1. <a href="https://in.mathworks.com/videos/image-processing-and-computer-vision-in-matlab-and-simulink-96760.html">https://in.mathworks.com/videos/image-processing-and-computer-vision-in-matlab-and-simulink-96760.html</a>		
2. <a href="https://in.mathworks.com/videos/introduction-to-deep-learning-and-applications-in-image-processing-1606855547622.html">https://in.mathworks.com/videos/introduction-to-deep-learning-and-applications-in-image-processing-1606855547622.html</a>		

<b>Course outcomes:</b>	
CO1	Students should be able to apply computer methods for solving a wide range of engineering problems.
CO2	Students should be able to use computer engineering software to solve and present problem solutions in a technical format.
CO3	Students should be able to utilize computer skills to enhance learning and performance in other engineering and science courses.
CO4	Understand how signals, images, and data are represented and manipulated in MATLAB
CO5	Students should be able understand the various programming constructs and how they can be used to solve a computational problem.

<b>Text Books:</b>	
1.	Proakis & Monalakis, "Digital signal processing – Principles Algorithms & Applications", 4th Edition, Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.

2.	Li Tan, Jean Jiang, "Digital Signal processing – Fundamentals and Applications", Academic Press, 2013, ISBN: 978-0-12-415893.
<b>Reference Books:</b>	
1.	S. Salivahanan, C. Gnanpriya, Digital Signal processing , McGraw Hill

**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.

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

High-3, Medium-2, Low-1



Course Title	REAL TIME OPERATING SYSTEMS	Semester	VII
Course Code	MVJ20EC751	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  $\mu$ C 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/>

<b>Module-2</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
<p><math>\mu</math>C/OS- II RTOS Concepts: Foreground/Background process, Resources, Tasks, Multitasking, Priorities, Schedulers, Kernel, Exclusion, Inter task communication, Interrupts, Clock ticks, <math>\mu</math>C/OS- II Kernel structure , <math>\mu</math>C/OS- II Initialisation, Starting <math>\mu</math>C/OS- II.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Write an Keil RTOS code that demonstrates the multitasking priority.</li> <li>2. Write an Keil RTOS code that assigns priority and sets the time slice period to illustrate time slicing.</li> </ol> <p><b>Applications:</b></p> <ol style="list-style-type: none"> <li>1. Email Spam and Malware Filtering</li> <li>2. File Managers and Resource management systems</li> </ol> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/106/106/106106198/">https://nptel.ac.in/courses/106/106/106106198/</a></li> <li>2. <a href="http://www.nptelvideos.in/2012/11/real-time-systems.html">http://www.nptelvideos.in/2012/11/real-time-systems.html</a></li> </ol>		
<b>Module-3</b>	<b>RBT Level</b> L1, L2, L3	<b>8Hrs.</b>
<p><math>\mu</math>C/OS- II RTOS Functions: Task Management, Time management, Semaphore management, Mutual exclusion semaphore, Event Management, Message management, Memory management, porting <math>\mu</math>C/OS- II – comparison and study of various RTOS like QNX- VX Works-Psos.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Write an Keil RTOS code to manage tasks to handle semaphore to overcome mutual exclusion.</li> <li>2. Demonstrate Porting of <math>\mu</math>C/OS- II in Embedded processor.</li> </ol> <p><b>Applications:</b> Traffic light controller system</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/106/105/106105215/">https://nptel.ac.in/courses/106/105/106105215/</a></li> </ol>		

2. <a href="https://nptel.ac.in/courses/106/105/106105172/">https://nptel.ac.in/courses/106/105/106105172/</a>		
Module-4	RBT Level L1, L2, L3	8Hrs.
<p><b>Embedded Linux:</b> 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.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Write an application that display two different messages in LCD display in two lines.</p> <p><b>Applications:</b> Smart Mobile Phone operating system development process demonstration.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/11706087/">https://nptel.ac.in/courses/11706087/</a></p> <p>2. <a href="https://nptel.ac.in/courses/106/106/106106198/">https://nptel.ac.in/courses/106/106/106106198/</a></p>		
Module-5	RBT Level L1, L2, L3	8Hrs.
<p><b>Real time Linux:</b> 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 <math>\mu</math>C linux.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Creating and UART driver for USB bus.</p> <p><b>Applications:</b> Demonstration of ABS system in automobiles</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/117102059/">https://nptel.ac.in/courses/117102059/</a></p> <p>2. <a href="http://www.nptelvideos.in/2012/11/real-time-systems.html">http://www.nptelvideos.in/2012/11/real-time-systems.html</a></p> <p>3. <a href="https://www.youtube.com/watch?v=HlU5cYqGLZE">https://www.youtube.com/watch?v=HlU5cYqGLZE</a></p>		

<b>Course outcomes:</b>	
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 Edition, 2010.
2.	Philip A.Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition-IEEE Press, IEEE Computer Society Press, 2001.

#### Reference Books:

1.	Jean J Labrosse, "MicroC/OS-II The Real Time Kernel" II Edition, CMP Books, 2002.
2.	P.Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development",Auerbach Publications, Taylor& Francis Group, 2006.
3.	Christopher Hallinan, "Embedded Linux Primer, A Practical, Real-World Approach", II Edition PearsonEducation, 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	INDUSTRIAL IOT	Semester	VII
Course Code	MVJ20EC752	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	3 Hours

Course objective is to:

- Learn the basic issues, policy and challenges in the Internet.
- Bring the IoT perspective in thinking and building solutions
- Acquire an idea of some of the application areas where Internet of Things can be applied.
- Understand the cloud and internet environment.
- Analyse the various modes of communications with Internet.

Module-1	RBT Level L1,L2, L3	8Hrs.
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*Prerequisites : Basic Knowledge about C or C++*

**Introduction to IoT:** IoT Vs. IIoT, History of IIoT, Components of IIoT: Sensors, Interface, Networks, People & Process, Hype cycle, IoT Market, Trends & future Real life examples, Key terms: IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining & Manipulation; Role of IIoT in Manufacturing Processes Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges & Benefits in implementing IIoT

**Video link / Additional online information (related to module if any):**

1. <http://www.theinternetofthings.eu/what-is-the-internet-of-things>.
2. [https://www.engineersgarage.com/article\\_page/sensors-different-types-of-sensors/](https://www.engineersgarage.com/article_page/sensors-different-types-of-sensors/)
3. <https://www.educba.com/applications-of-sensors/>

Module-2	RBT Level L2, L3	8Hrs.
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**Architectures:** Overview of IoT components ,Various Architectures of IoT and IIoT, Advantages & disadvantages, Industrial Internet, Reference Architecture; IIoT System

components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT.

Applications: IoT Protocol Applications

Video link / Additional online information (related to module if any):

1. <https://inductiveautomation.com/resources/article/what-is-scada>
2. <https://iotbytes.wordpress.com/application-protocols-for-iot/>
3. <https://data-flair.training/blogs/iot-protocols/>
4. <https://www.avsystem.com/blog/iot-protocols-and-standards/>

<b>Module-3</b>	<b>RBT Level</b> L2, L3,L4	<b>8Hrs.</b>
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**Sensor and Interfacing:** Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT , Various types of sensors , Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet , Current, M2M etc

Video link / Additional online information (related to module if any):

1. <https://www.digiteum.com/rfid-technology-internet-of-things>
2. <https://www.uio.no/studier/emner/matnat/ifi/INF5910CPS/h10/undervisningsmateriale/RFID-IoT.pdf>

<b>Module-4</b>	<b>RBT Level</b> L3,L4,L6	<b>8Hrs.</b>
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**Protocols and Cloud:** Need of protocols, Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI , I2C, IIoT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ IIoT cloud platforms : Overview of cloud platforms, predix, thingworks, azure etc. Data analytics, cloud services, Business models: Saas, Paas, Iaas.

Video link / Additional online information (related to module if any):

1. <https://www.simform.com/home-automation-using-internet-of-things/>
2. <https://iot5.net/iot-applications/smart-home-iot-applications/>
3. <https://maker.pro/raspberry-pi/tutorial/how-to-connect-and-interface-raspberry-pi-with-arduino#>
4. <https://create.arduino.cc/projecthub/ruchir1674/how-to-interface-arduino-with-raspberrypi-504b06>

Module-5	RBT Level L4,L5,L6	8Hrs.
<p><b>IoT Analytics and Applications:</b> IoT Analytics, Role of Analytics in IoT, Data visualization Techniques, Introduction to R Programming, Statistical Methods. Internet of Things Applications: Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIoT in Manufacturing Sector</p> <p><b>Video link / Additional online information (related to module if any):</b></p> <ol style="list-style-type: none"> <li><a href="https://www.water-io.com/iot-vs-wot">https://www.water-io.com/iot-vs-wot</a></li> <li><a href="https://www.talend.com/resources/iot-cloud-architecture/">https://www.talend.com/resources/iot-cloud-architecture/</a></li> </ol>		
<b>Course outcomes:</b>		
CO1	Describe IoT and IIoT	
CO2	Analyse various IoT Layers and their relative importance	
CO3	Design and develop the real life IoT applications using off the shelf hardware software	
CO4	Realize the importance of Data Analytics in IoT	
CO5	Apply the concepts of Design Thinking	
<b>Text Books:</b>		
1.	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications 2.Bernd Scholz-Reiter, Florian	
2.	Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743	
3.	Raj Kamal,"Internet of Things-Architecture and design principles", McGraw Hill Education.	
<b>Reference Books:</b>		
1.	Honbo Zhou, "The Internet of Things in the Cloud:A Middleware Perspective" -C Press-2012	
2.	Dieter Uckelmann, Mark Harrison, "Architecting the Internet of Things", Springer201	
3.	Arshdeep Bahga, Vijay Madiseti, "Internet of Things (A Hands-On-Approach)", V 2014.	



4.	Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – applications and Protocols", Wiley, 2012.
5.	Luigi Atzori, Antonio Lera, Giacomo Morabito, "The Internet of Things: A Survey", Journal on Networks, Elsevier Publications, October, 2010.

**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
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CO2	3	3	3	2	1	1	-	-	1	-	1	1
CO3	3	3	3	2	1	1	-	-	1	-	1	1
CO4	3	3	3	2	1	1	-	-	1	-	1	1
CO5	3	3	3	2	1	1	-	-	1	-	1	1

High-3, Medium-2, Low-1

Course Title	MACHINE LEARNING DESIGN & APPLICATION	Semester	VII
Course Code	MVJ20EC753	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
- Understand the instant based learning and reinforced learning
- Perform statistical analysis of machine learning techniques.

**Module-1**

RBT Level  
L1, L2, L3

8Hrs.

**Introduction, Concept learning:** 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-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.
<p><b>Decision Tree Learning and Artificial Neural Networks:</b> 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, Support Vector Machines.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>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.</li> </ol> <p><b>Applications:</b></p> <ol style="list-style-type: none"> <li>1. Email Spam and Malware Filtering</li> <li>2. ID3 algorithm</li> <li>3. Self-driving cars</li> </ol> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/106/106/106106198/">https://nptel.ac.in/courses/106/106/106106198/</a></li> <li>2. <a href="https://www.youtube.com/watch?v=fPLxFXiS9fU">https://www.youtube.com/watch?v=fPLxFXiS9fU</a></li> </ol>		
Module-3	RBT Level L1, L2, L3 & L6	8Hrs.
<p><b>Bayesian and Computational Learning:</b> Evaluating Hypotheses: Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms. Bayes theorem demonstration and concept learning, Bayes Optimal Classifier, Naive Bayes classifier, Bayesian belief networks, EM algorithm.</p> <p>Computational Learning Theory: Sample Complexity for Finite Hypothesis spaces, Sample Complexity for Infinite Hypothesis spaces.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"> <li>1. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.</li> </ol> <p><b>Applications:</b></p> <ol style="list-style-type: none"> <li>1. Artificial Neural Network.</li> <li>2. Virtual Personal Assistant.</li> <li>3. Online Fraud Detection.</li> </ol> <p><b>Video link / Additional online information:</b></p>		

1. <a href="https://nptel.ac.in/courses/106/105/106105215/">https://nptel.ac.in/courses/106/105/106105215/</a>		
Module-4	RBT Level L1, L2, L3	8Hrs.
<p><b>Instance Based Learning and Learning set of rules:</b> Demonstrate K- Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning.</p> <p><b>Reinforcement Learning:</b> Introduction, Evaluate Learning Task, Q Learning</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>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.</p> <p><b>Applications:</b> Market segmentation, Document clustering</p> <p><b>Video link / Additional online information :</b></p> <p>1. <a href="http://1.https://nptel.ac.in/courses/11706087/">http://1.https://nptel.ac.in/courses/11706087/</a></p> <p>2. <a href="https://nptel.ac.in/courses/106/106/106106198/">https://nptel.ac.in/courses/106/106/106106198/</a></p>		
Module-5	RBT Level L1, L2, L3 & L6	8Hrs.
<p><b>Analytical Learning:</b> Perfect Domain Theories, Explanation Based Learning, Inductive-Analytical Approaches, FOCL Algorithm.</p> <p><b>Real life applications of Machine learning:</b> Develop an algorithm and flowchart for, Traffic prediction, Image recognition and Self-driving cars.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>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.</p> <p><b>Applications:</b></p> <ol style="list-style-type: none"> <li>1. Regression algorithm.</li> <li>2. Tower of Hanoi.</li> </ol> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/117102059/">https://nptel.ac.in/courses/117102059/</a></p>		

<b>Course outcomes:</b>	
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", 2 <sup>nd</sup> 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:

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- Quizzes/mini tests (4 marks)
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- 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	1	1
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CO3	3	3	3	3	3	1	-	-	2	1	2	1
CO4	3	3	3	3	3	1	1	-	2	1	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Course Title	ROBOTICS & AUTOMATION	Semester	VII
Course Code	MVJ20EC754	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:

- Study the history, concept development and key components of robotics technologies.
- Know the concept of interfacing actuators and other components
- Understand basic mathematics manipulations of spatial coordinate representation and transformation.
- Learn basic robot forward and inverse kinematic problems
- Analyze basic robotic dynamics, path planning and control problems

Module-1

RBT Level  
L1, L2, L3 ,L4

8Hrs.

Basic concepts in robotics: Definition, anatomy of robot, basic structure of robot, Specifications and Classification of robot, Safety Measures in robotics, Industrial Applications of Robots. Drives for robots: Electric, hydraulic and pneumatic. Sensors: Internal-External, Contact-noncontact, position, velocity, force, torque, proximity and range.

Laboratory Sessions/ Experimental learning:

1. Interface various sensors with Microcontroller.

Applications: Machine Tending, Picking, Packing and Palletizing, painting, all Industrial applications

Video link / Additional online information:

1. <https://nptel.ac.in/courses/112/105/112105249/>
2. <https://nptel.ac.in/courses/112/101/112101098/>

Module-2	RBT Level L1, L2, L3 , L4	8Hrs.
<p><b>Robot drivers, Sensors and Vision :</b> Vision Introduction to techniques, Image acquisition and processing, Different types of grippers- Mechanical, Magnetics ,vacuum, Adhesive, Gripper force Analysis &amp; Gripper Design , overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors, DC motors and servomotors.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Interface motors using various Motor drivers.</p> <p><b>Applications:</b> Industrial application, agriculture robots, surgical robots</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a></p> <p>2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a></p>		
Module-3	RBT Level L1, L2, L3 ,L4	8Hrs.
<p><b>Robot Kinematics and Dynamics:</b> Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity. Lagrangian formulation, Link inertia tensor and manipulator inertia tensor, Newton –Eller formulation for RP and RP manipulators, Trajectory planning.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <p>1. Interface servo motors to form gripper.</p> <p><b>Applications:</b> Pick and Place, Excavators, Robotic ARM.</p> <p><b>Video link / Additional online information:</b></p> <p>1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a></p> <p>2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a></p>		
Module-4	RBT Level L1, L2, L3 ,L4	8Hrs.
<p><b>Robot Kinematics:</b> Dynamics and Programming methods, Robot language classification, Robot language structure, KINEMATICS AND PATH PLANNING: Solution of inverse kinematics problem – multiple solution jacobian work envelop, hill climbing techniques, robot programming languages elements and its functions. Simple programs on Sensing distance and direction, Line Following Algorithms, Feedback Systems.</p>		



**Laboratory Sessions/ Experimental learning:**

1. Design algorithm for Maze solving robot.

**Applications:** Defence, Surveillance, Autonomous Vehicle.

**Video link / Additional online information:**

1. <https://nptel.ac.in/courses/112/105/112105249/>
2. <https://nptel.ac.in/courses/112/101/112101098/>

Module-5	RBT Level L1, L2, L3 , L4	8Hrs.
<p>Developing and building a robot, Models of flexible links and joints, Robotic arm, Components and structure, Types of joints and workspace, Design models for mechanic arms and lifting systems</p> <p>Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot.</p> <p><b>Laboratory Sessions/ Experimental learning:</b></p> <ol style="list-style-type: none"><li>1. Robots in material handling and assembly. Human Robot Interaction</li></ol> <p><b>Applications:</b> Humanoid, Robotic Arms.</p> <p><b>Video link / Additional online information:</b></p> <ol style="list-style-type: none"><li>1. <a href="https://nptel.ac.in/courses/112/105/112105249/">https://nptel.ac.in/courses/112/105/112105249/</a></li><li>2. <a href="https://nptel.ac.in/courses/112/101/112101098/">https://nptel.ac.in/courses/112/101/112101098/</a></li></ol>		

**Course outcomes:**

CO1	Analyze the concept development and key components of robotics technologies
CO2	Select the components for interfacing actuators
CO3	Implement basic mathematics manipulations of spatial coordinate representation and Transformation.
CO4	Solve basic robot forward and inverse kinematic problems
CO5	Design robots which are capable to solve basic robotic dynamics, path planning and control problems

Text Books:	
1.	Introduction to Robotics By S.K.Saha , Tata McGraw Hill
2.	Robotics Control ,Sensing ,Vision and Intelligence by K.S. Fu, R.C .Gonzalez, C.S.G.Lee ,Tata McGraw HillJ. Hirschhorn: Kinematics and Dynamics of Machinery, McGraw Hill book co.

Reference Books:	
1.	Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall india.
2.	Robotics Technology and Flexible Automation by S.R.Deb, S. Deb, Tata McGraw Hill
3.	Robot Motion and Control ( Recent Developments ) by M.Thoma& M. Morari

CIE Assessment:	
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CO5	3	3	3	2	1	1	-	-	1	-	-	1

High-3, Medium-2, Low-1