V SEMESTER

Semester: V		
TECHNICAL MANAGEMENT &ENTREPRENEURSHIP (Theory)		
Course Code:	MVJ21EC51	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Study the concepts of management, planning, organizing, and staffing.	
2	Acquire the knowledge required to become an entrepreneur.	
3	Understand and choose the appropriate institutional support to succeed as an entrepreneur.	
4	Study the requirements towards the small-scale industries and project preparation.	
5	Understand the general principles of IPR, Concept and Theories, Criticisms of Intellectual Property Rights.	

UNIT 1	
Prerequisites: *Basics of management system, roles and responsibilities.* **Management:** Introduction, Meaning, nature and characteristics of Management, Scope and Functional areas of management, Management as a science, art of profession, Management &Administration, Roles of Management, Levels of Management, Managerial Skills, Management & Administration, Development of Management Thought early management approaches, Modern management approaches. **Planning:** Nature, Importance, Types, Steps and Limitations of Planning, Decision Making: Meaning, Types and Steps in Decision Making **Laboratory session/Experiment:** 1. Choose, Conduct & document a survey on the Management structure of an organization. **Applications:** IT sectors and Institutional Research sectors. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/110/107/110107150/	**8Hrs.**

https://nptel.ac.in/courses/110/105/110105146/	
UNIT 2	
Organizing and Staffing: Nature and purpose of organization, Principles of organization, Span of Management, Types of organization, Departmentation Committees, Centralization Vs Decentralization of authority and responsibility, Span of control, MBO and MBE (Meaning Only) Nature and importance of staffing: Need and Importance, Recruitment and Selection Process. **Directing and Controlling:** Meaning and nature of directing Leadership styles, Motivation Theories, Communication: Meaning and importance, Leadership: Meaning, Characteristics, Behavioral Approach of Leadership; Coordination: Meaning, importance and Techniques of Coordination. Meaning and steps in Controlling, Essentials of a sound control system and Methods of establishing control system. **Laboratory session/Experiment:** 1. Document the job responsibilities of a manager level employee of an organization. **Applications:** IT sectors, Banking sectors and Institutional Research sectors. **Video link / Additional online information:** https://nptel.ac.in/courses/110/107/110107151/	**8Hrs.**
UNIT 3	
Entrepreneur: Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneurs, Entrepreneur - an emerging. Classification of Entrepreneurs, Concept of Entrepreneurship, Evolution of Entrepreneurship, Development of Entrepreneurship, Stages in entrepreneurial process, Role of Entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship- its Barriers. **Laboratory session/Experiment:** 1. Find, Fill and Document the application forms which are all need to start an enterprise. **Applications:** Core Industrial sectors, New Enterprises sectors. **Video link / Additional online information:** https://nptel.ac.in/courses/110/106/110106141/	**8Hrs.**

UNIT 4	
Small Scale Industries: Definition, Characteristics, Need and rationale, Objectives, Scope, role of SSI in Economic Development. Advantages of SSI, Steps to start and SSI-Government policy, Different Policies of SSI, Government Support for SSI during 5year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GATT, Sickness in SSI sector, Problems for Small Scale Industries, Supporting Agencies of Government for SSI, Meaning, Nature of support, Objectives, Functions, Types of Help, Ancillary Industry and Tiny Industry. **Laboratory session/Experiment:** 1. Find, Fill and Document the application forms which are all need to start a small-scale industry. **Applications:** Industrial sectors, and Institutional Research sectors. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=2I0XdF_uOuA https://www.youtube.com/watch?v=jmx7SiCzay8	8Hrs.
UNIT 5	
Intellectual Property Rights: Introduction to Intellectual Property Rights, Copyrights, Trademarks, Designs and Design Patents, Semiconductor Integrated Circuits and Layout Designs. Ideas and Intellectual Property Rights, Contents of a Patent, Patent Draft, Filing Patent Applications, IPR Strategy and IPR Policy **Laboratory session/Experiment:** 1. Conduct a survey on Forms and Fees related to IPR. Document the application forms for the Grant of Patent. https://www.ipindia.gov.in/form-and-fees.htm **Applications:** Research works copyrights, Paper Publication and Patent filing. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=RLQivEQUgUc 2. https://www.youtube.com/watch?v=NFTBbfYGM6A	8Hrs.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain about the management and planning.
CO2	Apply the knowledge on organizing, staffing, directing, and controlling.

CO3	Analyse the concept of Entrepreneurship.
CO4	Choose the requirements towards the small-scale industries and project preparation.
CO5	Understand the Concepts of Intellectual Property Rights

Reference Books:	
1.	P.C.Tripathi, P.N.Reddy , "Principles of Management", Tata Mc Graw Hill, 5th edition, 2008.
2.	Poornima M Charantimath, "Entrepreneurship Development Small Business Enterprises", Pearson Education, 2008, ISBN 978-81-7758-260-4.
3.	Rachna Singh Puri & Arvind Viswanathan, "Practical Approach to Intellectual Property Rights", 1/e, I K International Publishing House Pvt. Ltd, 2009.
4.	Vasant Desai, "Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House, 6th Edition, 2018.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: V		
COMPUTER ORGANIZATION & ARCHITECTURE (Theory)		
Course Code:	MVJ21EC52	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Explain the basic sub systems of a computer, their organization, structure and Operation.	
2	Illustrate the concept of programs as sequences of machine instructions.	
3	To understand the different ways of communicating with I/O devices and to introduce memory types including cache memories.	
4	Describe memory hierarchy and concept of virtual memory.	
5	To analyse concepts of Pipelining and other computing systems.	

UNIT 1	
Basic Structure of Computers: Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance – Processor Clock, Basic Performance Equation. **Machine Instructions and Programs:** Numbers, Arithmetic Operations and Characters, IEEE standard for Floating point Numbers, Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing. **Laboratory Sessions/ Experimental learning:** 1. Understanding various parts of CPU of a PC. 2. Study of Microprocessor and understanding of its various instruction **Applications:** Understand the functionality of the various units of computer. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=K7fnDf-P6_c#action=share 2. https://www.youtube.com/watch?v=9-9z32T-5WU#action=share 3. https://www.youtube.com/watch?v=Szn_lwHal04#action=share	**8Hrs.**
UNIT 2	
Prerequisite : *Number system*	**8Hrs.**

Addressing Modes: Assembly Language, Basic Input and Output Operations, Stacks and Queues, Subroutines, Additional Instructions. **Laboratory Sessions/ Experimental learning:** 1. Write an ALP to find the sum of two numbers and verify if the sum is an even or odd number and simulate the output. 2. Write an ALP to transfer a block of data from one location to other and simulate the output. **Applications:** Project based on microprocessor. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=s4cVdsK3XiQ#action=share 2. https://www.youtube.com/watch?v=xKTNgA_ee58	
UNIT 3	
Input/Output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Direct Memory Access, and Buses. **Laboratory Sessions/ Experimental learning:** Study any one input/output device and examine its various input output ports details. **Applications:** Interfacing of Peripheral devices **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=Y17TLZCSe4M#action=share 2. https://www.youtube.com/watch?v=Zw79moR2gFs	**8Hrs.**
UNIT 4	
Memory System: Basic Concepts, Semiconductor RAM Memories-Internal organization of memory chips, Static memories, Asynchronous DRAMS, Read Only Memories, Cash Memories, Mapping Functions, Replacement Algorithm, Virtual Memories, Secondary Storage-Magnetic Hard Disks. **Laboratory Sessions/ Experimental learning:** Implement and simulate a simple memory unit which is capable of reading and writing data within a single clockcycle. **Applications:** Understanding the various memories **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=lpVyGPNyjEs#action=	**8Hrs.**

2. https://www.youtube.com/watch?v=NhyIUpOj5V8#action=share 3. https://www.youtube.com/watch?v=xXk3WiPGux8#action=share 4. https://www.youtube.com/watch?v=aeDyDIo-G44#action=share	

UNIT 5	
Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hardwired Control, Micro programmed Control ,Pipelining ,Basic concepts, Role of Cache memory, Pipeline Performance **Laboratory Sessions/ Experimental learning:** Evaluate the possible control sequence for implementing a multiplication instruction using registers for a single bus organization **Applications:** Microprocessor **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=R41DfN3NpIM#action=share https://www.youtube.com/watch?v=b5thcNYBrQc	8Hrs.

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the functional units of the processor and the factors affecting the performance of a computer
CO2	Demonstrate the ability to classify the addressing modes, instructions sets and design programs.
CO3	Understand the different ways of accessing an input / output device including interrupts.
CO4	Illustrate the organization of different types of semiconductor and other secondary storage memories.
CO5	Illustrate the simple processor organization based on hardwired control and micro programmed control.

Reference Books:	
1.	Carl Hamacher, ZvonkoVranesic, SafwatZaky: "Computer Organization", 6th Edition, Tata McGraw Hill, 2011.
2.	Andrew S. Tanenbaum, Todd Austin, "Structured Computer Organization", 6th Edition, Pearson, 2013.

3.	David A. Patterson, John L. Hennessy: "Computer Organization and Design – The Hardware / Software Interface ARM Edition", 4th Edition, Elsevier, 2009.
4.	William Stallings: "Computer Organization & Architecture", 7th Edition, PHI, 2006.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: V		
DIGITAL SIGNAL PROCESSING (Theory and Practical)		
Course Code:	MVJ21EC53	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	Understand the frequency domain sampling and reconstruction of discrete time signals.	
2	Study the properties and the development of efficient algorithms for the computation of DFT.	
3	Learn the procedures to design IIR filters from the analog filters using impulse invariance and bilinear transformation.	
4	Study the different windows used in the design of FIR filters and design appropriate filters based on the specifications.	
5	Learn DSP Processor Architecture and study the real time applications of DSP	

UNIT 1	
Prerequisites: *DTFT and its properties.* **Discrete Fourier Transforms (DFT):** Frequency domain sampling and reconstruction of discrete time signals, DFT as a linear transformation, its relationship with other transforms, Properties of DFT. **Laboratory Sessions/ Experimental learning:** 1. DFT computation of square pulse and Sinc function using MATLAB. **Applications:** Spectral Analysis of Signals, Frequency Response of Systems, Convolution via the Frequency Domain. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105134/ 2. https://youtu.be/gpv4h2fcKdA https://youtu.be/BPa2Ysel834	8Hrs.
UNIT 2	
Linear filtering methods based on the DFT: Use of DFT in Linear Filtering, Filtering of Long	8Hrs.

Data Sequences, overlap-save and overlap-add method. **Fast-Fourier-Transform (FFT) algorithms** : Efficient Computation of the DFT: Radix-2 FFT algorithms for the computation of DFT and IDFT, decimation-in-time and decimation-in-frequency Algorithms. **Laboratory Sessions/ Experimental learning:** 1. Computation of FFT of a given image and to plot magnitude and phase spectrum using MATLAB. **Applications:** Frequency domain filtering, video and audio signal processing. **Video link / Additional online information:** 1. https://youtu.be/ADnSkJnprBY 2. https://youtu.be/gg2lgResMc0 https://youtu.be/3fVu__fCSg0	
UNIT 3	
Prerequisites: *L- Hospital rule, Sinc function* **Design of FIR Filters:** Symmetric and Antisymmetric FIR filters, Design of Linear-phase FIR filters using windows - Rectangular, Hamming, Hanning, Bartlett windows. Design of FIR filters using frequency sampling method. Structure for FIR Systems: Direct form, Cascade form and Lattice structures. **Laboratory Sessions/ Experimental learning:** 1. Design and implementation of Low pass FIR filter to meet the desired specifications (using different window techniques) and test the filter with an audio file. Plot the spectrum of audio signal before and after filtering. **Applications:** Noise suppression, Enhancement of selected frequency ranges, Removal or attenuation of selected frequencies **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/102/117102060/ 2. https://nptel.ac.in/courses/108/105/108105055/ 3. https://www.youtube.com/watch?v=nsK7mmRSTDY	**8Hrs.**
UNIT 4	
Prerequisites: *Types of filters*	**8Hrs.**

IIR filter design: Characteristics of commonly used analog filter – Butterworth and Chebyshev filters, analog to analog frequency transformations. Design of IIR Filters from analog filter using Butterworth filter: Impulse invariance, Bilinear transformation. **Laboratory Sessions/ Experimental learning:** 1. Design and implementation of Low pass IIR filter to meet the desired specifications (using different window techniques) and test the filter with an audio file. Plot the spectrum of audio signal before and after filtering **Applications:** Audio equalization, biomedical sensor signal processing, IoT/IIoT smart sensors and high-speed telecommunication/RF applications. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/102/117102060/ 2. https://nptel.ac.in/courses/108/105/108105055/	

UNIT 5

Prerequisites: *Binary number system, basics of computer architecture* **Digital Signal Processors:** DSP Architecture, DSP Hardware Units, Fixed point format, Floating point Format, IEEE Floating point formats, FIR and IIR filter implementations in Fixed point systems. **Application of DSP to real systems** : Voice Processing, Music processing, Image processing and Radar processing. **Laboratory Sessions/ Experimental learning:** 1. Generation of sinusoid and Plotting with CCS (TMS320C6713) **Applications:** Audio, Military, Video & Imaging, Wireless **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=I-ltsu9S_uA https://www.youtube.com/watch?v=SKuywStjBLY	8Hrs.

Laboratory Sessions	
Sl No	Experiment Name
Programming using Matlab	
1	Verification of sampling theorem.
2	Linear and circular convolution of two given sequences, Commutative, distributive and associative property of convolution.

3	Auto and cross correlation of two sequences and verification of their properties Solving a given difference equation.
4	Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum (using DFT equation and verify it by built-in routine).
5	Verification of DFT properties (like Linearity and Parseval's theorem, etc.).
6	Design and Implementation of FIR filter to meet given specifications (using different window techniques).
7	Design and implementation of IIR filter to meet given specifications.
Implementation using DSP Kit	
8	Linear convolution of two sequences.
9	Circular convolution of two sequences.
10	N Point DFT of a given sequence.
11	Impulse response of first order and second order system.

Course outcomes:	
CO1	Compute DFT of real and complex discrete time signals
CO2	Analyse the computational complexity of DFT and FFT algorithms
CO3	Solve problems on FIR filter design and realize using digital computations.
CO4	Design and realize IIR digital filters
CO5	Illustrate the DSP processor architecture and to apply knowledge to various real time cases.

Reference Books:	
1.	Proakis & Monalakis, "Digital signal processing – Principles Algorithms & Applications", 4th Edition, Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.
2.	Dr.D.Ganesh Rao, "Digital Signal Processing", Pearson Education, 2nd edition, 2011.
3	Li Tan, Jean Jiang, "Digital Signal processing - Fundamentals and Applications", Academic Press, 2013, ISBN: 978-0-12-415893.
4..	Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2013,

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

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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

Semester: V		
MICROCONTROLLERS & EMBEDDED SYSTEMS (Theory and Practice)		
Course Code:	MVJ21EC54	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	Provide students with the Knowledge of Microprocessors and its memory organization.	
2	Provide a strong foundation about the principles, programming of Microcontrollers.	
3	Programming and system design used in industrial and commercial applications.	
4	Make the students to understand the necessary Hardware components of embedded system.	
5	Emphasize the necessity of Real time operating system for embedded system Applications.	

UNIT 1	
Prerequisites: Basics of Microprocessor **Introduction to 8051 Microcontroller** -: Overview of 8051 Microcontrollers, 8051- Architecture, I/O Ports, Memory Organization, Addressing Modes, Instruction Set of 8051 - Timer, Serial I/O, Parallel I/O, Instruction set – Simple programs. **Laboratory Sessions/ Experimental learning: 8051 ALP Programming** **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/104/117104072/ 2.http://nptel.ac.in/downloads/106108100/	8 Hrs.
UNIT 2	
Prerequisites: Basics of Microcontroller **Introduction to RISC processors** : ARM features applications - ARM microcontrollers architecture – ARM Thumb architecture – ARM pipeline –	8 Hrs.

Registers - Memory organization –Stack – Modes - Exceptions - ARM Cache – Virtual memory **Laboratory Sessions/ Experimental learning: ARM programming exercises** **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/106/117106111/ 2.https://nptel.ac.in/courses/106/105/106105193/	
UNIT 3	
ARM Interrupts- Interrupt Latency, Basic Interrupt Stack design and implementation, Interrupt Handling Scheme **ARM Instruction Set** - Fundamentals of ARM instructions, Barrel shifter, Classification and explanation of instructions with examples. LPC 2148 PHILIPS ARM7 BASED MICROCONTROLLER Board Details. **Laboratory Sessions/ Experimental learning:** Basic ARM programming with C language. Addition, Subtraction, Multiply, Divide etc. **Applications:** • Interface a simple Switch and display its status through Relay, Buzzer and LED. • DisplaytheHexdigits0toFona7-segmentLEDinterface,withanappropriatedelayin between and Interface a steppermotor and rotate it in clockwise and anti-clockwise direction. **Video link / Additional online information:** 1. http://www.ocfreaks.com/lpc2148-gpio-programming-tutorial/ 2. http://www.ocfreaks.com/lpc214x-pll-tutorial-for-cpu-and-peripheral-clock/ 3,http://www.ocfreaks.com/lpc2148-timer-tutorial/	8 Hrs.
UNIT 4	
Introduction to the THUMB instruction set: Introduction, THUMB register usage, ARM – THUMB interworking, other branch instructions, Data processing instructions, Stack instructions, Software interrupt instructions. **Laboratory Sessions/ Experimental learning:** Basic ARM Thumb programming exercise.	8 Hrs.

Applications: • Interoperability between ARM and Thumb states.. • Thumb instruction set with Arithmetic and logical operations, load/store data movements. **Video link / Additional online information:** 1. http://www.ocfreaks.com/lpc2148-gpio-programming-tutorial/ 2. http://www.ocfreaks.com/lpc214x-pll-tutorial-for-cpu-and-peripheral-clock/	
UNIT 5	
Embedded System Components: Embedded Vs General computing systems, Classification of Embedded systems, Major application and purpose of ES, Elements of Embedded systems, Differences between RISC and C-SIC, Harvard and Princeton, Big- and Little-Endian Formats – Introduction RTOS - RTOS for Embedded Systems **Laboratory Sessions/ Experimental learning:** Develop an embedded system using sensors and relay for any real time application. **Applications:** Vehicle control systems, Telecommunication, radio and satellite communications, medical systems, Military, Systems with artificial intelligence and robotics. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=gScYun0wzjA 2. http://www.nptelvideos.in/2012/11/embedded-systems.html 3. https://nptel.ac.in/courses/108/102/108102045/	8 Hrs.

Laboratory Sessions	
Sl No	**Experiment Name**
Assembly Language Program (ALP) using ARM Cortex M3 Registers using an evaluation board/simulator and the required software tool.	
1	Write an ALP to multiply two 16-bit binary numbers.
2	Write an ALP to find the sum of first 10 integer numbers.
3	Write an ALP to find number of 1's and 0's in 32-bit data.
4	Write an ALP to determine whether the given 16-bit number is ODD or EVEN.
5	Write an ALP to write data to RAM.

Simulation using EDA software: ARM CORTEX M3 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler	
6	Display "Hello World" message using Internal UART.
7	Interface and Control speed of a DC Motor.
8	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
9	Interface a DAC and generate Triangular and Square waveforms.
10	Interface a 4x4 keyboard and display the key code on an LCD.
11	Demonstrate the use of an external interrupt to toggle an LED On/Off.
12	Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between.
13	Measure Ambient temperature using a sensor and SPI ADC IC.

Course Outcomes: After completing the course, the students will be able to	
CO1	Students will understand the functionalities of 8085 architectures and Assembly language programming.
CO2	Understand the instruction set of 32-bit microcontroller ARM Cortex M3, and the software tool required for programming in Assembly and C language
CO3	Develop assembly language programs using ARM Cortex M3 for different applications.
CO4	Interface external devices and I/O with ARM Cortex M3.
CO5	Develop C language programs and library functions for embedded system applications.

Reference Books:	
1.	Douglas V. Hall: Microprocessors and Interfacing, Revised 2nd Edition, TMH, 2006.
2.	A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing, second edition, Tata McGraw-Hill.
3.	Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers.
4.	Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, 2nd Edition, Newnes, (Elsevier), 2010.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

Semester: V		
ENVIRONMENTAL STUDIES		
Course Code:	MVJ21CV56	CIE Marks: 50
Credits:	L:T:P: 1:0:0	SEE Marks: 50
Hours:	15 L	SEE Duration: 2 Hrs.
Course Learning Objectives: The students will be able to		
1	Relate interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes	
2	Study drinking water quality standards and to illustrate qualitative analysis of water.	
3	Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability.	

UNIT-I	
Introduction to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development. **Ecosystems (Structure and Function):** Forest, Desert, Rivers, Ocean **Biodiversity:** Types, Hot spots; Threats and Conservation of biodiversity, Deforestation. Video link: https://nptel.ac.in/courses/127/106/127106004/	3 Hrs
UNIT-II	
Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, Tidal and Wind. **Natural Resource Management (Concept and case-study):** Disaster Management, Sustainable Mining and Carbon Trading. Video link: https://nptel.ac.in/courses/121/106/121106014/	3 Hrs
UNIT-III	
Environmental Pollution: Surface and Ground Water Pollution, Noise pollution, Soil Pollution and Air Pollution. **Waste Management & Public Health Aspects:** Bio-medical Waste, Solid waste, Hazardous waste and E-waste. Video link: • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/105/103/105103205/	3 Hrs

• https://nptel.ac.in/courses/120/108/120108005/ • https://nptel.ac.in/courses/105/105/105105160/	
UNIT-IV	
Global Environmental Concerns (Concept, policies, and case-studies): Global Warming, Climate Change, Acid Rain, Ozone Depletion and Fluoride problem in drinking water. Video link: • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/120108004/ • https://onlinecourses.nptel.ac.in/noc19_ge23/preview	**3 Hrs**
UNIT-V	
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems. Video link: • https://nptel.ac.in/courses/105/102/105102015/ • https://nptel.ac.in/courses/120/108/120108004/	**3 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.
CO2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
CO3	Demonstrate ecology knowledge of a complex relationship between biotic and Abiotic components.
CO4	Apply their ecological knowledge to illustrate and graph a problem
CO5	Describe the realities that managers face when dealing with complex issues.

Reference Books	
3.	Principals of Environmental Science and Engineering, Raman Siva kumar, Cengage learning, Singapur, 2nd Edition, 2005.
4.	Environmental Science – working with the Earth G.Tyler Miller Jr. Thomson Brooks /Cole, 11th Edition, 2006
3.	Textbook of Environmental and Ecology, Pratiba Singh, Anoop Singh & Piyush Malaviya , ACME Learning Pvt. Ltd. New Delhi, 1st Edition.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE for 50 marks, executed by way of tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 40 marks and assignment is evaluated for 10 marks. The three tests are conducted for 40 marks each and the average of all the tests are calculated for 40. The marks for the assignments are 10 (2 assignments for 5 marks each). The marks obtained in test and assignment are added and report CIE for 50 marks.

Semester End Examination (SEE):

SEE for 50 marks, executed by means of an examination. The Question paper contains objective type questions for 100 marks covering the entire syllabus having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

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

Semester: V		
RESEARCH METHODOLOGY & IPR (Theory)		
Course Code:	MVJ21EC57	CIE Marks:100
Credits:	L:T:P: 1:2:0	SEE Marks: 100
Hours:	40L+26T	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To give an overview of the research methodology and explain the technique of defining a research problem and explain the functions of the literature review in research.	
2	To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review and explain the art of interpretation and the art of writing research reports	
3	To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.	
4	To discuss leading International Instruments concerning Intellectual Property Rights.	

UNIT 1	
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem. **Video link / Additional online information:** https://youtu.be/E2gGF1rburw	**6 Hrs.**
UNIT 2	
Reviewing the literature: Place of the literature review in research, Improving research methodology, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design,	**6Hrs.**

Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Video link / Additional online information:** https://youtu.be/E2gGF1rburw	
UNIT 3	
Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, **Data Collection:** Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, **Video link / Additional online information:** 1. https://youtu.be/E2gGF1rburw	**6Hrs.**
UNIT 4	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **Video link / Additional online information:** 1.https://youtu.be/E2gGF1rburw	**6Hrs.**
UNIT 5	
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957, The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered	**6Hrs.**

under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. **Video link / Additional online information:** 1.https://youtu.be/5fvpsqPWZac	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the research problem and research process.
CO2	Understand research ethics.
CO3	Prepare a well-structured research paper and scientific presentations
CO4	Explore on various IPR components and process of filing.
CO5	Understand the adequate knowledge on patent and rights

Reference Books:	
1.	C.R. Kothari, Gaurav Garg "Research Methodology: Methods and Techniques", New Age International. 4th Edition, 2018
2.	Ranjit Kumar, "Research Methodology a step – by step guide for beginners. (For the topic Reviewing the literature under module 2)", SAGE Publications Ltd 3rd Edition, 2011
3	Study Material, Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013
4.	Trochim, "Research Methods: the concise knowledge base", Atomic Dog Publishing. 2005

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting

quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: V		
UNIVERSAL HUMAN VALUES		
Course Code:	MVJ21UHVI58	CIE Marks: 50
Credits:	L:T:P: 2:0:0	SEE Marks: 50
Hours:	30 L	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.	
2	Facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.	
3	Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.	

UNIT-I	
Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations. **Practical Sessions** : (1) Sharing about Oneself (2) Exploring Human Consciousness (3) Exploring Natural Acceptance Video link: • https://www.youtube.com/watch?v=85XCw8SU084 • https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3p Z3yA7g_OAQz • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs
UNIT-II	

Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health. **Practical Sessions** : (4) Exploring the difference of Needs of Self and Body (5) Exploring Sources of Imagination in the Self (6) Exploring Harmony of Self with the Body Video link: • https://www.youtube.com/watch?v=GpuZo495F24 • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs
UNIT-III	
Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order. **Practical Sessions** : (7) Exploring the Feeling of Trust (8) Exploring the Feeling of Respect (9) Exploring Systems to fulfill Human Goal Video link: • https://www.youtube.com/watch?v=F2KVW4WNnS • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs
UNIT-IV	
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence. **Practical Sessions** : (10) Exploring the Four Orders of Nature (11) Exploring Co-existence in Existence	6 Hrs

Video link: • https://www.youtube.com/watch?v=1HR-QB2mCF0 • https://www.youtube.com/watch?v=lfN8q0xUSpw • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	
UNIT-V	
Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession **Practical Sessions** : (12) Exploring Ethical Human Conduct (13) Exploring Humanistic Models in Education (14) Exploring Steps of Transition towards Universal Human Order Video link: • https://www.youtube.com/watch?v=BikdYub6RY0 • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore themselves, get comfortable with each other and with the teacher
CO2	Enlist their desires and the desires are not vague.
CO3	Restate that the natural acceptance (intention) is always for living in harmony, only competence is lacking
CO4	Differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them
CO5	Present sustainable solutions to the problems in society and nature

Reference Books	
5.	AICTE SIP UHV-I Teaching Material, https://fdp-si.aicte india.org/ AicteSipUHV _download.php

6.	A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
3.	Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
4.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Continuous Internal Evaluation (CIE):

CIE for 50 marks is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

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

Professional Elective-I

Semester: V		
MACHINE LEARNING DESIGN & APPLICATIONS (Theory)		
Course Code:	MVJ21EC551	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Understand the basic theory of machine learning.	
2	To formulate machine learning problems related to different applications.	
3	To describe the range of machine learning algorithms along with their hypothesis.	
4	To apply the algorithms to real time applications and optimize the results by applying the models.	

UNIT 1	
Prerequisites: *Basics of binary tree, Decision Tree* **Introduction, Concept learning and Decision trees:** Machine Learning Design, Applications of Machine learning, Learning Problems, Well posed learning problems, Designing a Learning system, Concept Learning, Perspective and Issues in Machine Learning. **Laboratory Sessions/ Experimental learning:** 1. Implement and demonstrate the FIND-S Algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file. **Applications:** Data training samples, Speech Recognition algorithm. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/106/106/106106139/ 2. https://www.digimat.in/nptel/courses/video/106105152/L01.html	**8Hrs.**
UNIT 2	
Prerequisites: *Data structures, Decision Tree and binary tree*	**8Hrs.**

Decision Tree Learning and Artificial Neural Networks: Decision Tree Representation, Hypothesis Space Search, Inductive bias in decision tree, issues in Decision tree. Neural Network Representation, Perceptron's, Multilayer Networks and Back Propagation Algorithms. **Laboratory Sessions/ Experimental learning:** 1. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample. **Applications:** Email Spam and Malware Filtering, ID3 algorithm, Self-driving cars **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106198/ https://www.youtube.com/watch?v=fPLxFXiS9fU	
UNIT 3	
Bayesian and Computational Learning: Introduction, Analyze Bayes theorem, Bayes theorem demonstration and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm **Laboratory Sessions/ Experimental learning:** 1. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets. **Applications:** Artificial Neural Network, Virtual Personal Assistant, Online Fraud Detection. **Video link / Additional online information:** https://nptel.ac.in/courses/106/105/106105215/	**8Hrs.**
UNIT 4	
Instant Based Learning and Learning set of rules: Demonstrate K- Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning and Develop Sequential Covering Algorithms. Reinforcement Learning: Introduction, Evaluate Learning Task, Q Learning Laboratory Sessions/ Experimental learning:	**8Hrs.**

1. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same dataset for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. Applications: Market segmentation, Document clustering Video link / Additional online information : 1. http://1.https//nptel.ac.in/courses/11706087/ 2. https://nptel.ac.in/courses/106/106/106106198/	
UNIT 5	
Analytical Learning: Perfect Domain Theories, Explanation Based Learning, Inductive, Analytical Approaches, FOCL Algorithm. **Real life applications of Machine learning:** Develop an algorithm and flowchart for Traffic prediction, Image recognition and Self-driving cars. **Laboratory Sessions/ Experimental learning:** 1. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs. **Applications:** Regression algorithm, Tower of Hanoi. **Video link / Additional online information:** https://nptel.ac.in/courses/117102059/	**8Hrs.**

Course outcomes:	
CO1	Choose the learning techniques and investigate concept learning.
CO2	Identify the characteristics of decision tree and solve problems associated with
CO3	Apply effectively neural networks for appropriate applications.
CO4	Apply Bayesian techniques and derive effectively learning rules
CO5	Evaluate hypothesis and investigate instant based learning and reinforced learning.

Reference Books:

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: V		
OPERATING SYSTEM (Theory)		
Course Code:	MVJ21EC552	CIE Marks:100
Credits:	L:T:P: 3:0:0:0	SEE Marks: 100
Hours:	40L+26T	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Understand the services provided by an operating system.	
2	Learn how processes are synchronized and scheduled.	
3	Identify different approaches of memory management and virtual memory management.	
4	Study the structure and organization of the file system	
5	Understand inter process communication and deadlock situations.	

UNIT 1	
Prerequisites: *Computer Organization and Architecture* **Introduction to Operating Systems:** OS, Goals of an OS, Operation of an OS, Program's, Resource allocation techniques, Efficiency, System Performance and User Convenience, Classes of operating System, Batch processing, Multi programming, Time Sharing Systems, Real Time , distributed and modern Operating Systems. **Laboratory Sessions/ Experimental learning:** 1. Case study: Basics of LINUX OS. **Applications:** • Controls the backing store and peripherals such as scanners and printers. • Maintains security and access rights of users. • Spooling (Simultaneous Peripheral Operation on Line) **Video link / Additional online information :** 1. https://nptel.ac.in/courses/106/105/106105214/ 2. https://www.youtube.com/watch?v=qJ_bXhrUOkc&t=12s 3. https://www.youtube.com/watch?v=29JPq5JuKj8	8Hrs.
UNIT 2	
Process Management: OS View of Processes, PCB, Process States and Transitions, Threads, Kernel and User level Threads, Non-preemptive scheduling-	8Hrs.

FCFS and SRN, Preemptive Scheduling- RR and LCN, Long term, medium term and short term scheduling in a time sharing system. **Laboratory Sessions/ Experimental learning:** 1. Case study on Processes and threads in Linux/ Windows/ UNIX Scheduling Algorithms **Applications:** • Organizes the use of memory between programs. • Organizes processing time between programs and users. • Install Operating Systems - Ubuntu Linux. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=Lf3xYcIzgeQ 2. https://www.youtube.com/watch?v=s1KsWNqezbY https://www.youtube.com/watch?v=Q6rniXYg1UM	
UNIT 3	
Memory Management: Static and Dynamic memory allocation, Contiguous Memory allocation, Non-Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging, Virtual Memory Management, Demand Paging, Paging Hardware, VM handler, Page replacement policies - FIFO, LRU. **Laboratory Sessions/ Experimental learning:** 1. Case Study on Linux/ UNIX Memory Management. **Applications:** • Memory Management deals with the transfer of programs in and out of memory. • Dynamically allocate portions of memory to programs at their request, and free it for reuse when no longer needed. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=MLbdsuxYAF4 2. https://www.youtube.com/watch?v=WqnwrWODLKs 3. https://www.youtube.com/watch?v=EbnaTJIf0ZE	**8Hrs.**
UNIT 4	

File Systems: File systems and IOCS, Files and File Operations, Fundamental File Organizations, Directory structures, File Protection, Interface between File system and IOCS, Allocation of diskspace, Implementing file access, and File sharing schematics. **Laboratory Sessions/ Experimental learning:** 1. Case Study on UNIX/ Windows/ Linux File System. **Applications:** • Understand file handling operations (read, write, and append). • Basic understanding of how pointers are used **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=Fjz3PKJGe5s 2. https://www.youtube.com/watch?v=E3PshX16WEY	**8Hrs.**
UNIT 5	
Message Passing and Deadlocks : Overview of Message Passing, Implementing message passing, Mailboxes, Deadlocks, Deadlocks in resource allocation, Handling Deadlocks, Deadlock detection algorithm, Deadlock Prevention, Deadlock avoidance-Bankers algorithm. **Laboratory Sessions/ Experimental learning:** 1. Simulate Bankers Algorithm for Dead Lock Avoidance. **Applications:** Email management **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=rCHnS-ZX7PE 2. https://www.youtube.com/watch?v=vOfKOg0rFg4 3. https://www.youtube.com/watch?v=eJBoT0LbK2k	**8Hrs.**

Course outcomes:	
CO1	Summarize the goals, structure, operation and types of operating systems.
CO2	Apply scheduling techniques to find performance factors.
CO3	Apply suitable techniques for contiguous and non-contiguous memory allocation.
CO4	Interpret the organization of file systems and IOCS.

CO5	Describe message passing, deadlock detection and prevention methods.

Reference Books:	
1.	Dhamdare, "Operating Systems – A concept based approach", by TMH, 2nd edition, 2009.
2.	Silberschatz and Galvin, "Operating systems concepts", John Wiley India Pvt. Ltd,5th edition, 2001.
3	William Stalling, "Operating system–internals and design system", Pearson Education, 4th ed, 2006.
4	Tannanbhaum, "Design of operating systems", TMH, 2001.

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: V		
MEMS & SENSOR DESIGN (Theory)		
Course Code:	MVJ21EC553	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Understand the overview of Microsystems and their applications.	
2	Acquire the knowledge of various Microsystems Fabrication Processes.	
3	Study the working principles of Micro sensors and Micro Actuators.	
4	Illustrate the Microsystems Design consideration.	
5	Know the basics of NEMS and its applications.	

UNIT 1	
Prerequisites: *Fundamentals of Physics (Mechanics, Optics, Electricity, and magnetism), Fundamentals of Inorganic Chemistry* **MEMS Overview:** MEMS and Microsystems, Typical MEMS, and Microsystems products: Micro gears, Micromotors, Microturbines & Micro-optical components, History of MEMS development, Intrinsic characteristics of MEMS, Application of Microsystems in various Industries. **Laboratory Sessions/ Experimental learning:** 1. An introduction to COMSOL Multiphysics which is ideally suited for MEMS applications. **Applications:** Airbag Systems, Controlling automotive movement changes. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. https://nptel.ac.in/courses/108/108/108108147/ 3. http://www.nptelvideos.in/2012/12/mems-microsystems.html 4. https://youtu.be/j9y0gfN9WMg	8Hrs.
UNIT 2	

MEMS Sensors: Acoustic wave sensors, Biomedical & Biosensors, Chemical sensors, Optical sensors, Pressure sensor and thermal sensors, Piezo-resistive and Piezo-electric sensors. **Laboratory Sessions/ Experimental learning:** 1. Case study of Blood Pressure Sensors **Applications:** Satellite launch vehicle, industries, automobile, medical, consumer applications **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. https://nptel.ac.in/courses/108/108/108108113/ 3. https://nptel.ac.in/courses/108/108/108108147/ http://www.nptelvideos.in/2012/12/mems-microsystems.html	**8Hrs.**
UNIT 3	
Micro actuation: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric effect, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), **MEMS with Micro actuators:** Microgrippers, Miniature Microphones, Micromotors, Micro actuators with mechanical inertia, Microfluidics. **Laboratory Sessions/ Experimental learning:** 1. Case studies on MEMS Microphone. **Applications:** Optical, RF and industrial applications. **Video link / Additional online information:** https://nptel.ac.in/courses/117/105/117105082/	**8Hrs.**
UNIT 4	
Microsystems Fabrication Processes: Photolithography, Ion implantation, Diffusion, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition, Deposition by Epitaxy, Etching. **Bulk Micro manufacturing:** Overview of Etching, Isotropic & Anisotropic Etching, Wet Etchants, Etch Stop, Dry Etching. **Surface Micromachining:** Description, Process, Mechanical Problems Associated with Surface Micromachining **Laboratory Sessions/ Experimental learning:**	**8Hrs.**

1. Study the process involved in LIGA micromanufacturing **Applications:** Hybrid integrated circuits, integrated passive devices & sensors. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. https://nptel.ac.in/courses/108/108/108108113/ 3. https://nptel.ac.in/courses/108/108/108108147/ http://www.nptelvideos.in/2012/12/mems-microsystems.html	
UNIT 5	
Microsystems Design: Introduction, Design Considerations, Process Design, Mechanical Design, Computer Aided Design. **Introduction to NEMS:** Micro and Nanoscale Technologies, General Principle of Nanofabrication, Nanoproducts, Applications of Nanoproducts. **Laboratory Sessions/ Experimental learning:** 1. Design Capacitive Pressure Sensor using COMSOL Multiphysics. **Applications:** To measure blood pressure within the body, detect ions, to perform biological tests, displays, tunable Lasers, smart phones, mobile infrastructure, IoT and defence. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ http://www.nptelvideos.in/2012/12/mems-microsystems.html	**8Hrs.**

Course outcomes:	
CO1	Appreciate the technologies related to MEMS.
CO2	Gain knowledge of various Microsensors.
CO3	Understand actuators for MEMS applications.
CO4	Analyze the fabrication process involved with MEMS devices
CO5	Illustrate the basic design approaches for various sensors. Understand overview of NEMS.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: V		
APPLICATIONS WITH MATLABPROGRAMMING & SIMULINK		
Course Code:	MVJ21EC554	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To provide a foundation in programming for engineering problem solving using the MATLAB software package.	
2	Break a complex task up into smaller, simpler tasks with some of the terminology in this very new field and relate it to the basic engineering process of design.	
3	To introduce the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.	
4	To develop the skills to analyze and break down an engineering program and solve it algorithmically using MATLAB	

UNIT 1	
Prerequisites: *Vector Calculus, Dot product and Cross Product* **MATLAB FUNDAMENTALS:** MATLAB Basic Operations, Matrix Operations, Array Operations , Complex Numbers, Quadratic Equation, Graph Functions-Voltage and current of a RL Circuit, logarithmic and polar plot, Control Statements, **Laboratory Sessions/ Experimental learning:** 1. Write a MATLAB function to obtain the roots of the quadratic equation $ax^2 + bx + c = 0$. 2. Write a MATLAB program to generate a table of current, voltage and power dissipation. **Video link / Additional online information:** https://in.mathworks.com/learn/training/matlab-fundamentals.html	8Hrs.
UNIT 2	
DC ANALYSIS- Nodal Voltages of a Simple Circuit, Power Dissipation and Source Current, Transient Analysis, Charging of a Capacitor with Different Time Constants, Ac Analysis And Network Functions- Power Calculations of One-port Network, Magnitude and Phase Response of an RLC Circuit	8Hrs.

Laboratory Sessions/ Experimental learning: **1. Write a** MATLAB to plot the voltage across the capacitor for different R values. 2. Write a MATLAB code to determine the average power, rms value of v(t) and the power factor using (a) analytical solution and (b) numerical solution. **Video link / Additional online information:** https://in.mathworks.com/help/physmod/sps/ug/transient-analysis-of-a-linear-circuit.html	
UNIT 3	
Various functions and toolboxes: Documentation, Misc. Useful Functions, Graphical User Interfaces, Simulink, Symbolic Toolbox, App Designing using GUI, Image processing **Laboratory Sessions/ Experimental learning:** **1.** Program to perform convolution of two given sequences. 2. Program to compute step response from the given impulse response. **Applications:** Image Processing, Signal Filtering, Audio Processing, Artificial Intelligence **Video link / Additional online information:** 1. https://in.mathworks.com/learn/tutorials/simulink-onramp.html https://www.halvorsen.blog/documents/teaching/courses/matlab/matlab3.php	**8Hrs.**
UNIT 4	
Digital Image Processing with MATLAB: Pixel, Spatial resolution, Image file formats, Basic image processing with MATLAB, Image enhancement, Colour, Morphologic operations, Sample application. **Laboratory session/Experiment:** Write a MATLAB code for extracting of some morphological features of multiple apricots in a digital image. **Applications:** Advanced Image processing for multiple applications. **Video link / Additional online information:** 1. https://in.mathworks.com/videos/introduction-to-matlab-with-image-processing-toolbox-90409.html 2. https://in.mathworks.com/videos/image-processing-made-easy-81718.html 3. https://in.mathworks.com/videos/image-acquisition-and-processing-using-matlab-81586.html	**8Hrs.**

UNIT 5	
Information Entropy: Introduction, Histogram function, Entropy, Entropy filtration, Entropy thresholding and segmentation, Point Information Gain. **Laboratory session/Experiment:** 1. Design process and analysis of the color images through entropy. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=-dkib4Ei1Wg https://www.youtube.com/watch?v=RPNxSG9LD78	8Hrs.

Course outcomes:	
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.
Textbooks:	
1.	JOHN O. ATTIA "ELECTRONICS and CIRCUIT ANALYSIS using MATLAB", Department of Electrical Engineering,Prairie View A&M University
2.	MATLAB and SIMULINK for Engineers by Kumar Tyagi Agam, OUP India, 9780198072447, 9780198072447,2011
3.	Jan Valdman, "Applications from Engineering with MATLAB Concepts", Published by Intech Janeza Trdine 9, 51000 Rijeka, Croatia.
Reference Books:	
1.	Modelling, Analysis and Design of Control Systems in MATLAB and Simulink, Dingyü Xue, YangQuan Chen, World Scientific Publishing Co., 2015

2.	A Guide to MATLAB for Beginners and Experienced Users, Brian R. Hunt Ronald L. Lipsman Jonathan M. Rosenberg, Cambridge Press, Cambridge,

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: V		
VIRTUAL & AUGMENTED REALITY (Theory)		
Course Code:	MVJ21EC555	CIE Marks:100
Credits:	L:T:P: 3:1:0:0	SEE Marks: 100
Hours:	40L+26T	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Establish and cultivate a broad and comprehensive understanding of the virtual reality and Augmented Reality.	
2	Exhibit various elements and components used in AR/VR Hardware.	
3	Provide various factors involved in multisensory action of human being.	
4	Provide a detailed analysis of the engineering, scientific and functional aspects of VR systems and the fundamentals of VR/AR modelling and programming.	
5	Understand virtual reality, augmented reality and using them to build Biomedical, engineering and robotics application.	

UNIT1	
Prerequisites: *Intermediate programming ability in object-oriented languages, Basic linear algebra* **Introduction to Immersive Technologies** : A Brief History of Virtual Reality, The five Classic Components of a VR System, Early Commercial VR Technology, VR becomes an Industry, Reality, Virtuality and Immersion, VR, AR, MR, xR: similarities and differences. **Laboratory Sessions/ Experimental learning:** 1. Choose an existing VR application and write a summary including a personal critical reflection on its look and feel especially in relation to immersion, presence, agency and interactivity. **Applications:** VR in Sport, Mental Health, Medical Training. **Video link / Additional online information:** https://nptel.ac.in/courses/121/106/121106013/	**8Hrs.**
UNIT 2	
Motion Tracking and Navigation : Position and Motion Trackers, Inside Out/Outside In , Tracker Performance Parameters , Optical, Active and Passive Trackers , Inertial and Hybrid Trackers, HMD Trackers , Magnetic Trackers ,	**8Hrs.**

Mechanical Trackers , Ultrasonic Trackers , Navigation and Manipulation Interfaces , Tracker-Based Navigation/Manipulation Interfaces. **Laboratory Sessions/ Experimental learning:** 1. Design an immersive environment in Unity-3D or Unreal that will develop and enhance Work in groups. Start by building a simple 3D world that an interactive player can move around in. Connect the controllers and create a simple interaction loop. Measure velocity, acceleration, distances, and other motion and spatial parameters of the user and the controllers. **Applications:** Industrial Training and Simulation, Flight Training and Simulation, Pilot Head Tracking, Live Aircraft, Sports motion Analysis. **Video link / Additional online information:** https://nptel.ac.in/courses/106/106/106106138/	
UNIT 3	
The Human behind the lenses : Human Perception and Cognition, The Human Visual System, VR Health and Safety Issues, Effects of VR Simulations on Users , Cyber sickness, before and now Guidelines for Proper VR Usage. **Laboratory Sessions/ Experimental learning:** 1. Create a well-rounded multisensory action that is meaningful, safe and accommodates all senses, visual, auditory, and tactile. **Applications:** Human–Computer Interaction, e-Sports, Games, Cultural heritage **Video link / Additional online information:** https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/	**8Hrs.**
UNIT 4	
Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems. **Laboratory Sessions/ Experimental learning:** 1. Experiment with Photo grammetry and improve the visual look and feel of your environment	**8Hrs.**

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

Course outcomes:	
CO1	Acquire various principles and concepts of virtual reality and its application.
CO2	Understand the optical motion tracking and navigation in virtual reality.
CO3	Analyse and solve problems related to their expertise in Augment and Virtual Environments.
CO4	Develop detailed analysis of the engineering, scientific and functional aspects of VR systems and the fundamentals of VR modelling and programming.
CO5	Illustrate the knowledge of integrating hardware, software, tools for AR/VR technology.
Text Books:	
1.	C. Burdea and Philippe Coiffet, "Virtual Reality Technology", First Edition, Gregory, John Wiley and Sons, Inc.,2008
2.	Steven M. LaValle, "Virtual Reality", 2016. Online version: http://msl.cs.uiuc.edu/vr/
3.	Alan B. Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann, First Edition, 2013.
4.	Dieter Schmalstieg and Tobias Hollerer, "Augmented Reality: Principles and Practice (Usability)" by Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575

Reference Books:	
1.	Jason Jerald.,"The VR Book: Human-Centred Design for Virtual Reality", Association for Computing Machinery and Morgan and Claypool, New York, NY, USA, First Edition, 2015
2.	Steve Aukstakalnis, "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability)", Addison-Wesley Professional; 1st edition, 2016.
3.	Robert Scoble and Shel Israel, "The Fourth Transformation: How Augmented Reality and Artificial Intelligence Will Change Everything", Patrick Brewster Press; 1st edition, 2016.
4.	Tony Parisi, "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile", OReilly Media; 1st edition, 2015.
5.	Tony Parisi, "Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages", OReilly Media; 1st edition, 2014.

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Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

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

High-3, Medium-2, Low-1