B.E, III Semester, Industrial Internet of Things

Semester: III		
Mathematics for AV Communication		
Course Code:	**MVJ22IO31**	**CIE Marks: 50**
Credits:	**L: T:P:S: 2:2:0:0**	**SEE Marks: 50**
Hours:	**30L+10T**	**SEE Duration: 3 Hrs.**

Course Learning Objectives: The students will be able to	
1	Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
2	Understand the concepts of Complex variables and transformation for solving Engineering Problems.
3	Apprehend and apply Fourier Series.
4	Demonstrate Fourier Transform as a tool for solving Integral equations
5	Realize and use of Z-Transforms

UNIT-I	
Probability Theory: Random variables (discrete and continuous), probability density function, cumulative density function. **Probability Distributions:** Binomial distribution, Poisson distribution. Normal distribution, Exponential distribution. Joint probability distributions.	**8 Hrs**
UNIT-II	
Complex Variables: Functions of complex variables, Analytic function, Cauchy-Riemann equations in Cartesian and polar coordinates, Construction of analytic function (Using Milne-Thomson method) Consequences of Cauchy-Riemann equations, Properties of analytic functions. Application to flow problems- complex potential, velocity potential, equipotential lines, stream functions, stream lines.	**8 Hrs**
UNIT-III	
Fourier Series: Periodic functions, Dirichlet's condition, Fourier series of periodic functions with period 2π and arbitrary period $2c$. Fourier series of even and odd functions. Half range Fourier Series, Practical harmonic Analysis and Problems.	**8 Hrs**
UNIT-IV	
Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse. Fourier sine and cosine transforms, Convolution theorem	**8 Hrs**
UNIT-V	
Z-Transforms: Definition, standard Z-transforms, properties of Z- transforms- Shifting property, Reversal property, Multiplication by n, initial value and final value theorems. Inverse Z- transform, convolution theorem (proof and problems) Application of Z-transforms to solve difference equations.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
CO2	Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory
CO3	Know the use of periodic signals and Fourier series to analyze circuits and system.
CO4	Demonstrate Fourier Transform as a tool for solving Integral equations.
CO5	Learn to evaluate Z-transform to solve difference equations.

Reference Books	
1.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 44th Edition, 2013.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition, 2014.
3.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition
4.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 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												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO2	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO3	**3**	**3**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO4	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO5	**3**	**2**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Semester: III		
Analysis and Design of Digital Circuits		
Course Code:	**MVJ22IO32**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03 Hours**

Course Learning Objectives: The students will be able to

1	Familiarize with the simplification techniques & design various combinational digital circuits using logic gates.
2	Introduce the analysis and design procedures for synchronous and asynchronous sequential circuits.
3	Analysing & designing different applications of Combinational & Sequential Circuits
4	Analysing & designing sequential circuits using SR, JK, D, T flip-flops and Mealy & Moore machines
5	Know the importance of programmable devices used for designing digital circuits.

UNIT-I

Prerequisites: *Number systems, Boolean Algebra, Logic Gates, Comparison of Combinational & Sequential Circuits.* **Principles of combinational logic**: Introduction, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 variables, Incompletely specified functions (Don't care terms), Quine- McClusky techniques- 3 & 4 variables. **Laboratory Sessions/ Experimental learning**: 1. Study of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. 2. Design a 4-bit Binary to Gray code converter using logic gates. **Applications:** OR gate in detecting exceed of threshold values and producing command signal for the system and AND gate in frequency measurement. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=FT03XrQ8Bi4	**8 Hrs**

UNIT-II

Prerequisites**:** *Decoder, Encoders, Multiplexers & Demultiplexer* **Design and Analysis of combinational logic:** Full Adder & Subtractors, Parallel	**8 Hrs**

Adder and Subtractor, Look ahead carry Adder, Binary comparators, Decoders & Multiplexers as minterm/maxterm Generator. **Laboratory Sessions/ Experimental learning:** 1. Design a full adder with two half adders using logic gates. 2. Design an Adder cum Subtractor circuit which adds when input bit operation=1 or subtract if 0, using logic gates. 3. Design 4-bit comparator using IC7485. 4. Realize a Boolean expression using decoder IC74139. **Applications:** Communication systems, Speed synchronization of multiple motors in industries. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=RZQTTfU9TNA, 2. https://www.youtube.com/watch?v=36hCizOk4PA, 3. https://www.youtube.com/watch?v=397DDnkBm8A	
UNIT-III	
Prerequisites*: *SR, JK, D, T flipflops **Flip-Flops and its Applications:** Latches and Flip Flops, Master-slave JK flip-flop, Timing concerns in sequential circuits, Shift Registers – SISO, SIPO, PISO PIPO, Universal shift register, Counters – Synchronous and Asynchronous. **Laboratory Sessions/ Experimental learning:** 1. Develop SR, D, JK &T flip flop using logic gates 2. Design a 6-bit Register using D-Flipflop **Applications:** Frequency divider circuit, frequency counter. **Video link / Additional online information:** **1.** https://www.youtube.com/watch?v=Nxpei7Kp4Vs	**8 Hrs**
UNIT-IV	
Sequential Circuit Design: Characteristic equations, Design of a synchronous mod-n counter using clocked JK, D, T and SR flip-flops, Melay& Moore Models. **Laboratory Sessions/ Experimental learning:** 1. Design a Synchronous Counter for a given sequence- 0, 2, 4, 6, 0 2. Design a 4-bit Asynchronous up/down counter	**8 Hrs**

3. Design a 4-bit binary Synchronous up/down **Applications:**Data synchronizer, Counter. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=O3If0Nr9to0	
UNIT-V	
Applications of Digital Circuits: Design of a Sequence Detector, Guidelines for construction of state graphs, Design Example – Code Converter, Design of Binary Multiplier, Design of Binary Divider. **Programmable Logic Devices:** PLA, PAL, FPGA. **Laboratory Sessions/ Experimental learning:** 1. Designing of sequence detector using necessary digital components. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117108040/	**8 Hrs**
LABORATORY EXPERIMENTS	
Simulate & design the Digital Circuits using NI ELVIS II+ and NI Multisim 1.Design of Logic Gates and Realization using K-Map 2.Design of Half Adder and Half Subtractor 3.Implementation of Binary to Gray Code Converter 4.Realization of SR, JK, D and T flip flop 5.Design of Multiplexer and Demultiplexer 6. Implementation of Encoder and Decoder	

Course outcomes:	
CO1	Illustrate simplification of Algebraic equations using K-map & Quine-McCluskey Technique.
CO2	Design the combinational logic circuits.
CO3	Analyse& design different applications of Combinational & Sequential Circuits to meet desired need within realistic constraints.
CO4	Design the sequential circuits using SR, JK, D, T flip-flops and Mealy & Moore machines

CO5	Know the importance of programmable devices used for designing digital circuits.
Reference Books:	
1.	John M Yarbrough, “Digital Logic Applications and Design”, Thomson Learning, 2001.
2.	Donald D. Givone, “Digital Principles and Design”, McGraw Hill, 2002.
3.	Charles H Roth Jr., Larry L. Kinney –Fundamentals of Logic Design, CengageLearning, 7th Edi
4.	. Morris Mano, –Digital Design‖, Prentice Hall of India, Third Edition.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three qquizzes are onducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. aculty may adopt innovative methods for conducting quizzes eeffectively. The number of quizzes ıay be more than three (conduct additional quizzes aand take best three). The three tests are onducted for 50 marks each and the average of aall the tests are calculated for 50. The marks for the elf -study are 20 (2 presentations are b held for 10 marks each). The marks obtained in test, quiz and elf -studies are added to gget marks out of 100 and report CIE for 50 marks.

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 complete 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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping:

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: III		
Analog Electronic Circuits		
Course Code:	**MVJ22IO33**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03+03 Hours**
Course Learning Objectives: The students will be able to		
1	To know low frequency response for various configurations of BJT and FET amplifier.	
2	Understand the different topologies of feedback amplifiers and oscillators.	
3	Analyse the Power amplifier circuits in different modes of operation	
4	Sketch and explain typical Frequency Response graphs for each of the Filter circuits and switching circuits of Op-Amps and analyse its operations.	
5	Differentiate between various types of DACs and ADCs, Timer IC's and evaluate the performance of each with neat circuit diagrams.	

Module -I	
Prerequisites: *Operation of Transistor* **Transistor Biasing:** Fixed bias circuits, Emitter stabilized biased circuits, Voltage divider biased circuits. **Transistor at Low Frequencies:** BJT transistor modeling, CE Fixed bias configuration, Voltage divider bias, Emitter follower, Analysis of circuits re model. **Laboratory Sessions/ Experimental learning:** 1. 8Plot the transfer and drain characteristics of a BJT and calculate its drain	**8 Hrs**

resistance, mutual conductance and amplification factor. **Applications:** Analog switches, Phase shift oscillator, chopper, and current limiter. **Video link/ Additional online information:** http://www.nptelvideos.in/2012/12/electronics.html	
Module -II	
Prerequisites: *Working of JFET* FET Amplifiers: JFET small signal model, Fixed bias configuration, Voltage divider configuration, Common Gate configuration, **Feedback Amplifier:** The Four Basic Feedback Topologies, The series-shunt, series-series, shunt-shunt and shunt-series amplifiers. **Laboratory Sessions/ Experimental learning:** 1. Design and test the voltage-shunt feedback amplifier and calculate the parameters using with and without feedback. **Applications:** Radios, Televisions, Communication systems, Computers, Industrial controlled applications. **Video link/ Additional online information:** https://www.youtube.com/watch?v=xHNDrbB-iWY	**8 Hrs**
Module -III	
Oscillators: Oscillator operation, FET based Phase shift oscillator, Wien bridge oscillator, LC and Crystal Oscillators. **Output Stages and Power Amplifiers:** Introduction, Classification of output stages, Class A output stage, Class B output stage: Transfer Characteristics, Power Dissipation, Power Conversion efficiency, Class AB output stage, Class C tuned Amplifier. **Laboratory Sessions/ Experimental learning:** 1. Plot the frequency response using any class of power amplifier **Applications:** Audio power amplifiers, Switching type power amplifiers, and Wireless Communication **Video link/ Additional online information:** http://www.nptelvideos.in/2012/12/electronics.html	**8 Hrs**
Module -IV	
OP-Amps as DC Amplifiers: Direct coupled voltage followers, Non-inverting amplifiers,	**8 Hrs**

inverting amplifiers. **Op-Amps as AC Amplifiers:** Capacitor coupled voltage follower, Capacitor coupled non inverting amplifiers, Capacitor coupled inverting amplifiers, Capacitor coupled difference amplifier. **Application:** Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Zero Crossing Detector, Schmitt trigger. **Laboratory Sessions/ Experimental learning:** 1. Design and find the gain of a Differential Amplifier. **Applications:** Industrial areas (Temperature Indicator, Light Intensity Meter, Temperature Controller) **Video link / Additional online information:** https://www.youtube.com/watch?v=GjG8oshYNLQ	
Module -V	
Op-Amp Circuits: DAC - Weighted resistor and R-2R ladder, ADC- Successive approximation type, Active Filters, First and second order low-pass and high-pass Butterworth filters, Band-pass filters, Band reject filters. **555 Timer and its applications:** Mono-stable and Astable Multivibrators. **Laboratory Sessions/ Experimental learning:** 1. Demonstrate a simple light circuit that uses a decade counter to drive two traffic lights and uses 555 timer chips as clock. **Applications:** PWM (Pulse Width Modulation) & PPM (Pulse Position Modulation), Analog frequency meters, Digital logic probes. **Video link / Additional online information**: https://www.youtube.com/watch?v=-KMAQxc3J3g	**8 Hrs**
Laboratory Experiments Simulation using EDA software (EDWinXP, PSpice, MultiSim, Proteus, CircuitLab or any other equivalent tool can be used) 1. Monostable Multivibrator using 555 Timer. 2. Astable Multivibrator using 555 Timer.	

3. RC Phase shift oscillator. 4. Inverting Schmitt Trigger. 5. Narrow Band-pass Filter and Narrow band-reject filter 6. Precision full-wave rectifier.

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyse the DC biasing & frequency response of BJT Amplifier and FET amplifier
CO2	Design various Feedback amplifiers.
CO3	Evaluate the efficiency of power amplifiers and working of oscillator.
CO4	Describe DC amplifier, AC Amplifiers and its application.
CO5	Acquire knowledge about Active Filters, DAC, ADC and Timer.

Reference Books	
1.	Robert L.Boylestad and louis Nashelsky, "Electronic Devices and circuit Theory", PHI/Pearson Education,11 TH Edition.
2.	Adel S Sedra, Kenneth C Smith "Microelectronic Circuits, Theory and Applications", 6th Edition, Oxford, 2015.ISBN:978-0-19-808913-1.
3.	Behzad Razavi, "Fundamentals of Microelectronics", John Weily ISBN 2013 978-81-265-2307-8,2nd Edition, 2013.
4.	K.A.Navas, "Electronics Lab Manual", Volume I, PHI, 5th Edition, 2015, ISBN: 9788120351424.
5	"Operational Amplifiers and Linear IC"s", David A. Bell, 2nd edition, PHI/Pearson, 2004. ISBN 978-81-203-2359-9.
6	"Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.

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 self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies 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 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 complete 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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

Semester: III		
NETWORK ANALYSIS		
Course Code:	**MVJ22IO34**	**CIE Marks: 50**

Credits:	L: T:P: 2:0:2	SEE Marks: 50
Hours:	40L	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to

1	Describe basic network concepts emphasizing source transformation source shifting, mesh and nodal techniques to solve for resistance/impedance, voltage, current and power.
2	Explain network Thevenin's, Millman's, Superposition, Reciprocity, Maximum Power transfer and Norton's Theorems and apply them in solving the problems related to Electrical Circuits.
3	Describe Series and Parallel Combination of Passive Components as resonating circuits, related parameters and to analyze frequency response.
4	Explain the behavior of networks subjected to transient conditions. Use applications of Laplace transform to solve network problems.
5	Study two port network parameters like Z, Y, T and h and their inter-relationships.

UNIT-I	
Prerequisites: *Ohm's law, Kirchhoff's laws* **Basic Concepts:** Introduction, Practical sources, Source transformations, Star – Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC networks, Concepts of super node and super mesh. **Laboratory Sessions/ Experimental learning:** 1. Find the current through and voltage across the load in the given circuit. **Applications:** Simplification and analysis of analog circuits, microwave circuit analysis **Video link / Additional online information :** **1.** https://www.youtube.com/watch?v=UMhBgyK8F0U	**8 Hrs**
UNIT-II	
Graph Theory and Network equations: Graph of a network, Trees, Co-trees	**8 Hrs**

and Loops, Incidence Matrix, Cut-set Matrix, Tie-set Matrix and loop currents, Number of possible trees of a graph, Analysis of networks, Duality. **Laboratory Sessions/ Experimental learning:** NA **Applications:** Simplification and analysis of analog circuits, microwave circuit analysis **Video link / Additional online information:** https://www.youtube.com/watch?v=F8qiM3o0Jc0	
UNIT-III	
Network Theorems: Superposition Theorem, Millman's theorem, Thevenin's and Norton's theorems, Reciprocity theorem, Maximum Power transfer theorem. **Laboratory Sessions/ Experimental learning**: 1. Verify superposition theorem for a given circuit. **Applications:** Simplification and analysis of analog circuits, microwave circuit analysis. **Video link / Additional online information:** https://www.youtube.com/watch?v=bnjiLg4xfh8	**8 Hrs**
UNIT-IV	
Prerequisites: *Laplace Transforms, Properties of Laplace Transform and Inverse Laplace Transform using partial fraction method.* **Transient behaviour and initial conditions:** Behaviour of circuit elements under switching condition and their Representation, evaluation of initial and final conditions in RL, RC and RLC circuits for DC excitations, Applications of Laplace Transforms in circuit analysis. **Laboratory Sessions/ Experimental learning:** 1. Plot the response of a series RLC circuit. **Applications:** In the analysis of transmission lines and waveguides. **Video link / Additional online information :** https://www.youtube.com/watch?v=g-CGI7oUSCA	**8 Hrs**
UNIT-V	
Two port network parameters: Introduction, open circuit impedance parameter, short circuit admittance parameter, hybrid parameters, transmission parameter, relationship between parameters.	**8 Hrs**

Laboratory Sessions/ Experimental learning: 1. Plot the frequency response characteristics for a series RL, RC circuit. 2. Plot the frequency response characteristics for a parallel RL circuit. 3. Measure two port parameters for a given network **Applications:** For analysis of communication systems and antennas. **Video link / Additional online information:** https://www.youtube.com/watch?v=YLGrugmDvc0	

Course Outcomes: After completing the course, the students will be able to	
CO1	Determine currents and voltages in a circuit using network simplification techniques.
CO2	To solve the network problems using graphical methods.
CO3	To simplify the complex circuits using network theorems.
CO4	To analyze simple DC circuits and applies the concepts to transient conditions.
CO5	Solve the given network using specified two port network parameters like Z or Y or T or h and Evaluate frequency response related parameters through the RLC elements, in resonant circuits.

Reference Books	
1.	M.E. Van Valkenberg (2000), "Network analysis", Prentice Hall of India, 3rd edition, 2000, ISBN: 9780136110958.
2.	Roy Choudhury, "Networks and systems", 2nd edition, New Age International Publications, 2006, ISBN: 9788122427677.
3.	Hayt, Kemmerly and Durbin –Engineering Circuit Analysis", TMH 7th Edition, 2010.
4.	J. David Irwin /R. Mark Nelms, "Basic Engineering Circuit Analysis", John Wiley, 8th edition, 2006.

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Theory for 50 Marks

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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

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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**
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

Semester:III		
Analog and Digital Electronics Laboratory		
Course Code:	**MVJ22IOL35**	**CIE Marks: 50**

Credits:	L:T:P:0:0:2	SEE Marks: 50
Hours:	20	SEE Duration: 3 Hrs

Course Learning Objectives: The students will be able to	
1	Demonstrate various circuits using PSPICE and verify functionality.
2	To be exposed to the operation and application of electronic devices and their circuits.
3	To analyze circuit characteristics with signal analysis using Op-amp ICs.
4	Familiarize with Modern EDA tool such as Verilog.
5	Acquire knowledge on different types of description in Verilog.

PART A

1. Design and set up the RC coupled Single stage BJT amplifier and determine the gain-frequency response, input, and output impedances
2. Design an oscillator with tank circuit having two inductances and one capacitance and compare the practical frequency with theoretical frequency.
3. Design an oscillator with tank circuit having two capacitance and one inductance and compare the practical frequency with theoretical frequency.
4. Design an oscillator whose frequency is 2MHZ and compare with the theoretical frequency.
5. Design active second order Butterworth low pass filters.
6. Design Astable Multivibrator using 555 Timer.
7. Design Monostable Multivibrator using 555 Timer.

PART B

8. Verify

a) The sum-of product expression using universal gates.
b) The product-of-sum expression using universal gates.

9. Design and implement

(a) Full Adder using basic logic gates.
(b) Full subtractor using basic logic gates.

10. Design and implement 4-bitParallelAdder/ Subtractor using IC 7483.
11. Design and implement BCD to Excess-3 code conversion and vice-versa using IC 7483.
12. Realize 4-variable function using IC 74151(8:1MUX)

Course outcomes:

CO1	Demonstrate various circuits using PSPICE and verify functionality.
CO2	Design and test of analog circuits using OPAMPs
CO3	Design and implement basic circuits using IC (OPAMP and 555 timers).
CO4	Use the modern engineering tool such as Verilog necessary for engineering practice.
CO5	Design and Verify functionality of digital circuit/system.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**2**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Engineering Science Course:

Semester: III
Digital System Design using Verilog

Course Code:	MVJ22IO361	CIE Marks:50
Credits:	L: T:P: 3:0:0	SEE Marks: 50
Hours:	40L	SEE Duration: 03 Hours

Course Learning Objectives: The students will be able to	
1	Understand the concepts of Verilog Language
2	Study of verilog data flow descriptions.
3	Study of design and operation of behavioral programming using verilog
4	Understand the concepts of Verilog Structural Language
5	Design and diagnosis of verilog circuits using synthesis module.

UNIT 1	
Introduction to Verilog: Structure of verilog Module, Operators, Data types, Units and ports, Verilog constructs. **Laboratory Sessions/ Experimental learning:** 1. Develop a mini project to demonstrate the concept of de morgan's theorem. **Applications:** 1. Conversion from one form of expression to another **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=FT03XrQ8Bi4	**8Hrs.**
UNIT 2	
Data-Flow Description: Highlights Of Data-Flow Description, Signal Declaration And Assignment Statement , Constant Declaration and Constant Assignment Statements , Assigning a Delay Time to the Signal-Assignment Statement **Laboratory Sessions/ Experimental learning:** 1. Develop an algorithm using data flow description **Applications:** 1. Programs for simple mathematical calculations **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=RZQTTfU9TNA, 2. https://www.youtube.com/watch?v=36hCizOk4PA, 3. https://www.youtube.com/watch?v=397DDnkBm8A	**8Hrs.**
UNIT 3	

Behavioral Description: Behavioral Description Highlights, Structure of the Verilog Behavioral Description , Sequential Statements: IF Statement , The case Statement , Verilog casex and casez , The wait-for Statement , The Loop Statement: For-Loop, While-Loop , Verilog repeat , Verilog forever **Laboratory Sessions/ Experimental learning:** 1. Develop an algorithm using behavioural description **Applications:** 1. Comparators using behavioural description. 2. Multiplexers using behavioural description. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=Nxpei7Kp4Vs	**8Hrs.**
UNIT 4	
Structural Description: Highlights of Structural Description, Organization of Structural Description , Half adder and full adder design using structural description, Half subtractor and full subtractor design using structural description, generate and parameter (Verilog) , Exercises **Laboratory Sessions/ Experimental learning:** 1. Code converters using behavioural description. **Applications:** 1. Decoders using Structural description. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=O3If0Nr9to0	**8Hrs.**
UNIT 5	
Synthesis Basics: Highlights of Synthesis, Synthesis Information From Module , Mapping Always in the Hardware Domain ,Mapping the Signal-Assignment Statement to Gate Level, Mapping Logical Operators, Mapping the IF Statement, Mapping the case Statement , Mapping the Loop Statement **Laboratory Sessions/ Experimental learning:** 1. Weather analysis of a weak using synthesis module 2. synthesis verilog code for state machine	**8Hrs.**

Video link / Additional online information: 1. https://nptel.ac.in/courses/117108040/	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand verilog programming basics
CO2	Describe how dataflow description of verilog code works and write simple programs using dataflow description.
CO3	Describe how Behavioural description of verilog code works and write simple programs using dataflow description.
CO4	Design simple circuits using verilog structural description.
CO5	Synthesize different assign statements and simple applications using verilog.

Text Books:	
1.	HDL WITH DIGITAL DESIGN VHDL AND VERILOG, Nazeih Botros, MERCURY LEARNING INFORMATION Dulles, Virginia Boston, Massachusetts New Delhi, 2015.

Reference Books:	
1.	Samir Palnitkar "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Sec Edition
2.	Charles H Roth Jr., Larry L. Kinney "Fundamentals of Logic Design", Cengage Learning, 7th Editio

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 marksis 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**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
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: III		
SENSOR AND INSTRUMENTATION		
Course Code:	**MVJ22IO362**	**CIE Marks:50**

Credits:	L:T:P: 3:0:0	SEE Marks: 50
Hours:	40 L	SEE Duration: 03 Hours

Course Learning Objectives: The students will be able to	
1	To understand the basic concepts of transducers.
2	To identify the mathematical model of transducer and its response for various inputs.
3	To understand the construction and working principle of resistive type transducers.
4	To impart knowledge on capacitive type and inductive type transducer.
5	To understand the construction and working principle of sensors and its real time applications.

UNIT-I	
Prerequisites: *knowledge of basic of sensors* General block diagram of measurements systems – Methods of measurements – Classification and selection of transducers – Error analysis – Statistical methods – Odds and uncertainty, classification of instruments, applications of measurement systems. **Laboratory Sessions/ Experimental learning:** Displacement versus output voltage characteristics of a potentiometer transducer. **Applications:** Selection of appropriate sensors for different industrial applications. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=pFM9K9JrsU4&list=PLm_MSClsnwm9HsQaejlrxvkNPWbvxgwWs 2. https://www.youtube.com/watch?v=Z6evuxYjYMs&list=PLSGws_74K019wiWyVU3CnVMMqAcF3_sxz	**8 Hrs**
UNIT-II	
Static characteristics – Accuracy, precision, resolution, sensitivity, linearity – Dynamic characteristics – Mathematical model of transducer – Zero, first and second order transducers – Response for impulse, step, ramp and sinusoidal inputs **Laboratory Sessions/ Experimental learning:** 1. Characteristics of Strain gauge. 2. Characteristics of Load cell.	**8 Hrs**

Applications: Platform Weighing **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=78NpGnA1sX4	
UNIT-III	
Principle of operation – Construction details – Characteristics and application of resistance potentiometer – Strain gauge – Resistance thermometer – Thermistor – Hot-wire anemometer – Humidity sensor – Induction potentiometer – Variable reluctance transducers – LVDT. **Laboratory Sessions/ Experimental learning:** 1. Characteristics of thermocouple. 2. Characteristic of LDR and thermistor. 3. Step response characteristics of RTD. **Applications:** Air conditioning Heating and Ventilation Devices. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=lUjBmV4wMtA 2. https://www.youtube.com/watch?v=kb3W-1_deLc	**8 Hrs**
UNIT-IV	
Capacitive transducer and types – Capacitor microphone – Frequency response – Piezoelectric transducer – Hall effect transducer – Magnetostrictive – Digital transducers – Fiber optic sensors – Thick and thin film sensors (Bio sensor and chemical sensor) **Laboratory Sessions/ Experimental learning:** 1. Characteristics of LVDT. 2. Characteristics of Hall effect transducer. **Applications:** Power turbines, hydraulics, automation, aircraft, satellites, nuclear reactors, current transformers, Position sensing. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=emtskVpbtyY 2. https://www.youtube.com/watch?v=E0NMM_Pq0IY	**8 Hrs**
UNIT-V	
Environmental monitoring sensors (Water quality and air pollution) – Photo electric	**8 Hrs**

transducer – Vibration sensor – Ultrasonic based sensors – Introduction to MEMS and Nanotechnology – Applications – Robotics – Home appliance. **Laboratory Sessions/ Experimental learning:** Study of smart transducers. **Applications:** Smart city developments with latest technological sensors. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=hyHcnZsgbRU 2. https://www.youtube.com/watch?v=jQF4_hO_2qw	

Course Outcomes: After completing the course, the students will be able to	
CO1	Choose appropriate sensors for the measurement of various physical parameters.
CO2	Obtain the mathematical model of the transducer and its response for various inputs.
CO3	Choose appropriate resistive type transducer for the measurement of various physical parameters.
CO4	Select capacitive and inductive type transducers for the measurement of various physical parameters.
CO5	Select the suitable type of sensors for real time applications.

Reference Books	
1.	"A Course in Electrical and Electronics Measurements and Instrumentation", Sawhney A K, Dhanpat Rai and Sons, New Delhi, 2013
2.	"Sensors and Transducers", Patranabis D, Prentice Hall of India, Second Edition, 2010
3.	"Transducers and Instrumentation", Murthy D V S, Prentice Hall of India, New Delhi, Second Edition, 2010.

Continuous Internal Evaluation (CIE):

Theory for 100 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 100 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**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

Semester: III		
COMPUTER ORGANIZATION & ARCHITECTURE		
Course Code:	**MVJ22IO363**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
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* **Addressing Modes:** Assembly Language, Basic Input and Output Operations, Stacks and	**8Hrs.**

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 clock cycle. **Applications:** Understanding the various memories **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=lpVyGPNyjEs#action= 2. https://www.youtube.com/watch?v=NhyIUpOj5V8#action=share	**8Hrs.**

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:** 2. https://www.youtube.com/watch?v=R41DfN3NpIM#action=share 3. 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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	-	-	1	-	-	1
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: IV		
Applied Numerical Methods		
Course Code:		**CIE Marks:50**
Credits:	**L:T:P:S: 2:2:0:0**	**SEE Marks: 50**
Hours:	**20L+20T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
Demonstrate, understanding of common numerical methods and apply to obtain approximate solutions to mathematical problems.		

UNIT-I	
Algebraic equations: Systems of linear equations: Gauss Elimination method, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method.	**8 Hrs**
UNIT-II	
Numerical solutions of PDE – Classification of second order equations, finite difference approximation to derivatives, solution of heat equations, solution of wave equations and solution of Laplace equation.	**8 Hrs**
UNIT-III	
Finite Element Method: Basic concept of the finite element method. Variational formulation of BVP's, Rayleigh-Ritz approximation, weighted residual methods, finite element analysis of one-dimensional problems.	**8 Hrs**
UNIT-IV	
Numerical Integration: Romberg Integration, Gaussian quadrature, system of first order and higher order differential equations by Euler's and Runge-Kutta methods, The Chebyshev approximation	**8 Hrs**
UNIT-V	
Numerical Methods for the Solution of Systems of Equations: Linear Algebra Review, Linear Systems and Gaussian Elimination, The LU Factorization, Cholesky Decomposition, Iterative Methods for Linear Systems: A Brief Survey, Nonlinear Systems: Newton's Method.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Solve algebraic equations using direct and iteration methods.
CO2	Understands the basic theory underlying the numerical solution of partial differential equations.
CO3	Understand the concepts behind formulation methods in FEM
CO4	find approximate solutions for ODE.
CO5	Learn to solve system of equations using numerical techniques.

Reference Books

3.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
4.	Sastry, S.S: "Introductory Methodsof Numerical Analysis"., Prentice Hall India.
3.	Reddy, J.N: " Finite Element Methods".
4.	Jain, M.K, Jain, R.K and Iyenger, S.R.K.: "Numerical Methods for Scientific and Engineering Computations", New Age International Publication Pvt. Ltd.

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	2	0	0	0	0	0	0	0	1	1
CO2	3	3	2	0	0	0	0	0	0	0	1	1
CO3	3	3	2	0	0	0	0	0	0	0	1	1
CO4	3	3	2	0	0	0	0	0	0	0	1	1
CO5	3	3	2	0	0	0	0	0	0	0	0	0

Semester: III		
Additional Mathematics-I (Common to all branches)		
Course Code:	**MVJ22MATDIP-I**	**CIE Marks:50**
Credits:	**L:T:P:S: 3:0:0:0**	**SEE Marks: 50**
Hours:	**30L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To familiarize the important and introductory concepts of Differential calculus	
2	Aims to provide essential concepts integral calculus.	
3	To gain knowledge of vector differentiation	
4	To learn basic study of probability.	
5	Ordinary differential equations of first order and analyze the engineering problems.	

UNIT-I

Differential calculus: Recapitulation of successive differentiation -nth derivative - Leibnitz theorem (without proof) and Problems, Polar curves - angle between the radius vector and tangent, angle between two curves, pedal equation, Taylor's and Maclaurin's series expansions- Illustrative examples.	**8 Hrs**
UNIT-II	
Integral Calculus: Statement of reduction formulae for the integrals of $\sin^n(x)$, $\cos^n(x)$, $\sin^n(x)\cos^n(n)$ and evaluation of these integrals with standard limits-problems. Double and triple integrals-Simple examples.	**8 Hrs**
UNIT-III	
Vector Differentiation: Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. **Vector identities** - $div(\phi \vec{A})$, $curl(\phi \vec{A})$, $curl(grad(\phi))$, $div(curl \vec{A})$.	**8Hrs**
UNIT-IV	
Probability: Basic terminology, Sample space and events. Axioms of probability. Conditional probability – illustrative examples. Bayes theorem-examples.	**8Hrs**
UNIT-V	
Ordinary Differential Equations of First Order: Introduction – Formation of differential equation, solutions of first order and first degree differential equations: variable separable form, homogeneous, exact, linear differential equations.	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge of calculus to solve problems related to polar curves and its applications
CO2	Apply the concept of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes.
CO3	Illustrate the applications of multivariate calculus to understand the solenoidal and irrotational vectors and also exhibit the inter dependence of line, surface and volume integrals.
CO4	Understand the basic Concepts of Probability
CO5	Recognize and solve first-order ordinary differential equations occurring in different branches of engineering.

Reference Books	
5.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
6.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,201
3.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
4.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8 Edition.

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	0	2	0	0	0	0	0	0	0	1
CO2	3	3	0	2	0	0	0	0	0	0	0	1
CO3	3	3	0	3	0	0	0	0	0	0	0	1
CO4	3	2	0	3	0	0	0	0	0	0	0	1
CO5	3	2	0	2	0	0	0	0	0	0	0	1

B.E, IV Semester, Industrial Internet of Things

Semester: IV		
Engineering Electromagnetics		
Course Code:	**MVJ22IO41**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the applications of Coulomb's law and Gauss law to different charge Distributions.	
2	Understand the physical significance of Biot-Savart's Law, Amperes' Circuital Law and Stokes' theorem for different current distributions.	
3	Know the physical interpretation of Maxwell's equations and its applications in plane waves.	
4	Understand the concepts of Smith Chart for impedance matching.	
5	Acquire knowledge on different types of transmission lines.	

UNIT 1	
Prerequisites: *Vector Algebra, Coordinate systems (Rectangular Coordinate System, Cylindrical Coordinate System and Spherical Coordinate System), gradient, divergence and curl* **Electrostatics: Coulomb's Law, Electric Field Intensity, Flux density and potential:** Coulomb's law , Electric field intensity, Field due to line charge, Field due to Sheet of charge, Field due to continuous volume charge distribution, Electric flux, Electric flux density, Electric potential, Potential difference, relation between Electric field intensity (E) & potential (V), potential gradient, Electric dipole, Energy density in electrostatic fields. **Laboratory Sessions/ Experimental learning:** 1. Determine the electric field intensity at a point due to uniform linear charge (ρ L) and point charges using MATLAB. 2. Determine the electric field intensity at a point due to surface charge using MATLAB. 3. Determine the potential difference between two points on a ring having linear charge density, ρ L using MALAB.	**8 Hrs.**

Applications: The Van de Graaff generator, Xerography, Ink Jet Printers and Electrostatic Painting, Smoke Precipitators and Electrostatic Air Cleaning **Video link / Additional online information:** 1. https://youtu.be/ckAVB3_NP2Q 2. https://youtu.be/IH2fFNaR9YM 3. https://youtu.be/JhTT-wew-OE	
UNIT 2	
Gauss' law, Divergence, Poisson's and Laplace's Equations: Gauss law, Maxwell's First equation, Application of Gauss' law, Divergence theorem, Current, Current density, Conductor, The continuity equation, Boundary conditions (dielectric-dielectric, conductor-dielectric, conductor-free space), Poisson's and Laplace's Equations, Uniqueness theorem. **Laboratory Sessions/ Experimental learning:** 1. Evaluate the current flowing through a given surface using MATLAB. 2. Verify the Divergence theorem using MATLAB. **Applications:** Used for calculation electrical field for a symmetrical distribution of charges **Video link / Additional online information:** 1. https://youtu.be/N_jUbFnlqEg 2. https://youtu.be/XtH2WAhvYIM 3. https://youtu.be/gu934FBac6g	**8 Hrs.**
UNIT 3	
Magnetostatics: Steady Magnetic Field-Biot-Savart Law, Ampere's circuital law, Curl, Stokes' theorem, Gauss's law for magnetic fields, Magnetic flux and Magnetic flux density, Maxwell's equations for static fields, Magnetic Scalar and Vector Potentials. **Magnetic Forces and magnetic materials:** Force on a moving charge and differential current element, Force between differential current elements, Magnetization, magnetic susceptibility, permeability, Magnetic boundary conditions, Inductances, magnetic energy, magnetic circuit. **Laboratory Sessions/ Experimental learning:** Determine the magnetic field intensity at a point due to magnetic field using MATLAB. **Applications:** Motors, Generators, Loudspeakers, MRI	**8 Hrs.**

Video link / Additional online information : 1. https://youtu.be/ebGM_q19gY0 2. https://youtu.be/uXQbYJVzlQ0 3. https://youtu.be/aYRBXI63Oqk	
UNIT 4	
Time varying Fields and Electromagnetic wave propagation: Time varying fields & Maxwell's equations, Faraday's law, Transformer and Motional Electro - Motive Forces, Displacement current, Maxwell's equation in differential and integral form, Time varying potentials. **Electromagnetic wave propagation:** Derivation of wave equations from Maxwell's equations, Relation between E and H, Wave propagation in - lossy dielectrics, lossless dielectrics, free space and good conductor, skin-effect, Poynting theorem. **Laboratory Sessions/ Experimental learning:** Determine the parameters of wave using MATLAB. **Applications:** Optoelectronics **Video link / Additional online information :** 1. https://youtu.be/xxIb9Qv6t7E 2. https://youtu.be/_X061_y9Lqw 3. https://youtu.be/OoQS1ex4kJA	**8 Hrs.**
UNIT 5	
Transmission line: Introduction, Transmission line parameters, Transmission line equations, input impedance, standing wave ratio and power, Smith Chart basic fundamentals, types of transmission lines - coaxial line, strip line, micro strip line. **Applications of transmission line**: Impedance matching and tuning: single stub tuning, double stub tuning, and the quarter wave transformer. **Laboratory Sessions/ Experimental learning:** Simulation of micro strip transmission line using FEKO software. **Applications:** Telephone, Cable TV, Broadband network **Video link / Additional online information:** 1. https://youtu.be/z9GbnMPDCVA 2. https://youtu.be/yk1Mu9fQ6mA	**8 Hrs.**

3. https://youtu.be/PO5ExHOKIJM	

Course Outcomes: After completing the course, the students will be able to	
CO1	Evaluate problems on electrostatic force, electric field due to point, linear, surface charge and volume charges.
CO2	Apply Gauss law to evaluate Electric fields due to different charge distributions by using Divergence Theorem. Determine potential and capacitance using Laplace equation and Poisson equation.
CO3	Apply Biot-Savart's and Ampere's laws for evaluating Magnetic field for different current configurations.
CO4	Apply Maxwell's equations for time varying fields and evaluate power associated with EM waves using Poynting theorem.
CO5	Determine the parameters of transmission lines and use Smith chart for determining the impedance and admittance.

Reference Books:	
1.	Matthew N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, Edition VII, 2018.
2.	David M Pozar, "Microwave Engineering", John Wiley & Sons, Inc., 4th edition, 2014.
3.	W.H. Hayt. J.A. Buck & M Jaleel Akhtar, "Engineering Electromagnetics", Tata McGraw – Hill, Edition VIII, 2014.

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	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

Semester: IV		
Modern Control systems		
Course Code:	**MVJ22IO42**	**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	Formulate the mathematical modelling of systems and understand the concepts of transfer function	
2	Obtain transfer function using block diagram reduction and signal flow graph techniques.	
3	Analyse the response of first and second order systems using standard test signals and analyse steady state error.	
4	Analyse stability of systems using RH criteria, Root Locus, Nyquist, Bode plot and polar plot.	
5	Obtain state variable model for electrical systems.	

UNIT 1	
Introduction to Control Systems: open loop and closed loop systems, Types of feedback, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. **Block diagrams and signal flow graphs:** Transfer functions, Block diagram algebra and Signal Flow graphs. **Laboratory Sessions/ Experimental learning:** 1. Determine and plot poles and zeros from the transfer function using MATLAB. **Applications:** Electric Hand Drier, Automatic Washing Machine, DC motor,Automatic Electric Iron, Voltage Stabilizer **Video link / Additional online information :** 1. https://youtu.be/R0E3uKSKdME 2. https://youtu.be/zXMklO-jxIo	**10Hrs.**
UNIT 2	
Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems for underdamped system, steady state errors and	**10Hrs.**

error constants. **Introduction to Controllers:** P, PI, PD and PID Controllers. **Laboratory Sessions/ Experimental learning:** 1. Obtain step and impulse response of a unity feedback first order system for a given forward path transfer function using MATLAB. 2. Obtain step and impulse response of a unity feedback second order system for a given forward path transfer function using MATLAB. **Applications:** Industrial Control systems **Video link / Additional online information :** 1. https://youtu.be/ziu1OTwUrbw https://youtu.be/YuZ3iwA-47I	
UNIT 3	
Stability analysis using RH Criteria and root locus: Concepts of stability, Necessary conditions for stability, Routh Hurwitz stability criterion, Relative stability analysis, Introduction to Root-Locus Techniques, the root locus concepts, Construction of root loci. **Laboratory Sessions/ Experimental learning:** 1. Obtain Root Locus Plot of the system for a given forward path transfer function using MATLAB. **Applications:**Used to determine the dynamic response of a s system **Video link / Additional online information:** 1. https://youtu.be/cez4InLZ7Pw 2. https://youtu.be/sUDoTw_LIbk 3. https://youtu.be/Irxppc_LCUk	**10Hrs.**
UNIT 4	
Stability analysis using Nyquist criteria and Bode plots: Polar plot, Nyquist Stability criterion, Nyquist plots, Bode plots, Gain and phase margin. **Laboratory Sessions/ Experimental learning:** 1. Obtain Bode Plot of the system for a given forward path transfer function using MATLAB. 2. Obtain Nyquist Plot of the system for a given forward path transfer function using MATLAB. **Applications:** To determine a stability of a system	**10Hrs.**

Video link / Additional online information: 1. https://youtu.be/QzTCRk4nkDg	
UNIT 5	
Introduction to State variable analysis: Concepts of state, state variable and state models for electrical systems, Solution of state equations, State transition matrix and its properties.Lag, lead and lag lead compensation. **Laboratory Sessions/ Experimental learning:** 1. Determining the solution of state equations using MATLAB. **Applications:** State variables are used to describe the future response of a dynamic response **Video link / Additional online information:** https://youtu.be/xajgSUci9zs	**10Hrs.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Write the mathematical model for electrical systems and find the transfer function using block diagram reduction technique and signal flow graph.
CO2	Analyze transient and steady state response of second order systems using standard test signals and analyze steady state error.
CO3	Analyze the stability of the systems by applying RH criteria and root locus techniques.
CO4	Analyze the stability of the system using frequency domain techniques such as Nyquist and Bode plots.
CO5	Write state space equations and solutions of a given electrical system.

Reference Books:	
1.	Nagarath and M.Gopal, – Control Systems Engineering‖, New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-
2.	Modern Control Engineering, K.Ogata, Pearson Education Asia/PHI, 4th Edition, 2002. ISBN 978-81-203-4010-7.
3.	Automatic Control Systems‖, Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.

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

High-3, Medium-2, Low-1

Semester: IV		
Principles of Communication Systems		
Course Code:	**MVJ22IO43**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the concepts of Analog Modulation schemes viz; AM, FM.
2	Interpret the different types of noise in communication system.
3	Learn the concepts of digitization of signals viz; sampling, quantizing, and encoding.
4	Analyze the Base Band data transmission system.
5	Realize the basic concepts of coherent and non-coherent digital modulation techniques and understand the basics of spread spectrum modulation.

UNIT 1	
Prerequisites: *Modulation, Need for Modulation, and types of Modulation.* **Amplitude Modulation:** Introduction to AM, Time-Domain description, Frequency-Domain description, Generation of AM wave: Square Law Modulator, Switching modulator,Detection of AM waves: Envelop detector. **Double side band suppressed carrier modulation (DSBSC):** Time-Domain description, Frequency-Domain representation, Generation of DSBSC waves: Ring modulator. Coherentdetection of DSBSC modulated waves. Costas loop. **Single Side-Band Modulation (SSB):** Single side-band modulation, Time-Domain description, Frequency-Domain description of SSB wave, Phase discrimination method for generating an SSB modulated wave. **Laboratory Sessions/ Experimental learning:** 1. Generation of AM signal using MATLAB 2. Generation of DSBSC signal using transistor **Applications:** Broadcast transmissions, Air band radio, Quadrature amplitude modulation **Video link / Additional online information :**	**8Hrs.**

1. https://nptel.ac.in/courses/117/105/117105143/ 2. https://youtu.be/00ZbuhPruJw	
UNIT 2	
Frequency Modulation: Basic definitions, FM, narrow band FM, wide band FM, transmission bandwidth of FM waves, and generation of FM waves: indirect FM and direct FM. **Demodulation of FM waves:** Phase-locked loop, Nonlinear model of the phase – lockedloop, Linear model of the phase – locked loop, Nonlinear effects in FM systems. **Laboratory Sessions/ Experimental learning:** 1. Generation of FM signal using MATLAB 2. Design of mixer **Applications:** FM radio broadcasting, telemetry, radar, seismic prospecting, and monitoring new-born for seizures via EEG, two-way radio systems, sound synthesis, magnetic tape- recording systems and some video-transmission systems. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105143/	**8 Hrs.**
UNIT 3	
NOISE: Shot Noise, Thermal noise, White Noise, Noise Figure, Equivalent noise temperature, Noise Equivalent Bandwidth. NOISE IN ANALOG MODULATION: Introduction, Receiver Model, Noise in DSB-SC receivers. Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis, and De-emphasis in FM **Laboratory Sessions/ Experimental learning:** ASK modulation and demodulation. **Applications:** Biomedical engineering, communication system **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/	**8 Hrs.**
UNIT 4	

Inter-symbol Interference & Signal Space representation: Base band transmission: Discrete PAM Signals, Power spectra of Discrete PAM Signals, Inter Symbol Interference, Nyquist criterion for Distortion less Base band Binary Transmission, Eye diagram, Geometric representation of signals, Gram-Schmidt Orthogonalization procedure, Optimum receivers for coherent detection: Correlation Receivers and Matched Filter receiver. **Laboratory Sessions/ Experimental learning:** 1. Eye diagram using MATLAB **Applications:** Ethernet, RFID marker localization signals, Radar Systems **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105077/ **2.** https://nptel.ac.in/courses/117/101/117101051/	**8 Hrs.**
UNIT 5	
Prerequisites: *Probability & Random Process* **Pass band transmission:** Digital modulation techniques: Phase shift Keying techniques using Coherent detection: Generation, Detection and Error probabilities of BPSK and QPSK, QAM, Frequency shift keying techniques using Coherent detection: BFSK generation, detection, and error probability. **Non-coherent orthogonal modulation techniques:** BFSK, DPSK Symbol representation, Block diagrams of Transmitter and Receiver, Probability of error (without derivation of probability of error equation) **Principles of Spread Spectrum Communication Systems:** Model of a Spread Spectrum, Digital Communication System, Direct Sequence Spread Spectrum Systems (DSSS),Some applications of DS Spread Spectrum Signals, Generation of PN Sequences, Frequency Hopped Spread Spectrum (FHSS). **Laboratory Sessions/ Experimental learning:** 1. Analyze constellation of 16-QAM Using MATLAB **Applications:** CDMA, WiMAX (16d, 16e), telemetry, caller ID, garage door openers, wireless communication, mobile communication and Satellite Communication, LANs, Bluetooth, RFID, GPS, Wi-Fi, etc., **Video link / Additional online information :**	**8 Hrs.**

1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/ 3. https://nptel.ac.in/courses/117/105/117105136/	

Lab Experiments

1. Simulation of ASK, FSK, and BPSK generation schemes
2. Simulation of DPSK, QPSK and QAM generation schemes
3. Simulation of signal constellations of BPSK, QPSK and QAM
4. Simulation of ASK, FSK and BPSK detection schemes
5. Simulation of Linear Block and Cyclic error control coding schemes
6. Simulation of Convolutional coding scheme
7. Communication link simulation

Course outcomes:	
CO1	Examine the concepts of analog modulation techniques such as amplitude, modulations andits variations like DSB-SC and SSB-SC.
CO2	Analyze frequency modulation and compute performance of different types of noise.
CO3	Apply the concepts of noise in analog modulation and analysis of pre-emphasis and deemphasis circuit.
CO4	Analyze the signal space representation of digital signals.
CO5	Evaluate the performance of a baseband and pass band digital communication system. and spread spectrum techniques.

Reference Books:	
1.	Simon Haykins& Moher, Communication Systems, 5th Edition, John Wiley, India Pvt. Ltd, 2010, ISBN 978 – 81 – 265 – 2151 – 7.
2.	Simon Haykins, “An Introduction to Analog and Digital Communication”, John Wiley, 2003.
3.	John G Proakis and MasoudSalehi, “Fundamentals of Communication Systems”, 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.
4	B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press., 4th edition, 2010, ISBN: 97801980738002.

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. The 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 ofquizzes 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 tests, quizzes andassignment are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the timetable 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 encouragedto implement additional innovative experiments in the lab and are awarded 10 marks. Total marksfor the laboratory are 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 questionmay have a maximum of three subdivisions. Each unit will have an internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

Semester:IV		
Communication laboratory		
Course Code:	**MVJ22IOL44**	**CIEMarks:50**
Credits:	**L:T:P:0:0:2**	**SEEMarks: 50**
Hours:	**26P**	**SEEDuration:03Hours**
Course Learning Objectives: The students will be able to		
1	To visualize the effects of sampling and TDM	
2	To Implement AM & FM modulation and demodulation	
3	To implement PCM & DM	
4	To simulate Digital Modulation schemes	

	EXPERIMENTS
1	Signal Sampling and reconstruction
2	Time Division Multiplexing
3	AM Modulator and Demodulator
4	FM Modulator and Demodulator
5	Pulse Code Modulation and Demodulation
6	Delta Modulation and Demodulation
7	Line coding schemes
8	DSB SC Modulation
9	Pre-Emphasis & de-emphasis
10	Pulse Amplitude Modulation abd Detection
11	Generation of PWM/PPM Signal
12	Generation and Detection of ASK Waveform

Course Outcomes: After completing the course, the students will be able to	
CO1	Validation of the the various functional modules of a communication system.
CO2	Demonstrate their knowledge in base band signaling schemes through Implementation of digital modulation schemes.
CO3	Apply various channel coding schemes & demonstrate their capabilities.
CO4	Towards the improvement of the noise performance of communication system

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

Semester: IV		
Signals and Systems		
Course Code:	**MVJ22EC451**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs.**

Course Learning Objectives: The students will be able to

1	Understand the mathematical description of continuous and discrete time signals and systems.
2	Analyze the signals in time domain using convolution sum and Integral.
3	Determine the response of the LTI system to any input signal.
4	Analyze Linear Time Invariant (LTI) systems in time and transform domains.
5	Apply the knowledge of frequency-domain representation and analysis concepts using Fourier analysis tools and Z-transform.

UNIT I

Prerequisites: Definition of step, ramp, impulse response.

Introduction and Classification of signals: Definition of a signal and systems, communication and control system as examples, Classification of signals.

Basic Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration, time scaling, time shift and time reversal.

Elementary signals/Functions: Exponential, sinusoidal, step, impulse and ramp functions. Expression of triangular, rectangular and other waveforms in terms of elementary signals.

8Hrs.

1. Exploring concepts with MATLAB- Generation of both continuous time and discrete time signals of various kinds.
   a) Plot $y(x) = x^2\cos(x)$, $g(x) = x\cos(x)$, $f(x) = 2^x\sin(x)$, $0 \leq x \leq 2\pi$ in the same figure.
2. Generation of Signals & Signal Operations

Plot in the time interval $-5 \leq t \leq 10$, the following signals:

a) $\delta(t) + 2\,\delta(t)$

b) $u(t) + 2\,u(t)+1$

c) $r(t)+u(t)$

Applications: Time shifting operation can be used in artificial intelligence, such as in systems that use Time Delay Neural Network, Multiplication of signals is exploited in the field of analog communication when performing amplitude modulation (AM), Differentiation of a signal is used in the field of image or video processing.

Video link / Additional online information :

https://archive.nptel.ac.in/courses/108/106/108106151/

https://onlinecourses.nptel.ac.in/noc21_ee28/preview

https://archive.nptel.ac.in/courses/108/104/108104100/

UNIT II

System Classification and properties: Linear-nonlinear, Time variant-invariant, Causal-non causal, static-dynamic, stable-unstable, invertible. **Time domain representation of LTI System**: Impulse response of an LTI system, convolution sum, Convolution integral. Properties of convolution - Commutative property, Distributive property, Associative Property and system interconnection. Computation of convolution sum and convolution integral using graphical method for unit step and unit step, unit step and exponential, exponential and exponential, unit step and rectangular, and rectangular and rectangular. **Laboratory Sessions/ Experimental learning:** 1. To compute convolution of two signals using MATLAB. a) A system is described by the impulse response h (t) =t, $0 \le t \le 10$. Compute and plot the response of the system to the input signal $x(t)=0.8^{t}$, $0 \le t \le 10$. b) Compute the convolution between the complex sequence =[3+2j,1+j,4+6j] and h=[1-2j,j,3-2j,2]. **Applications:** Convolution concepts are used in Artificial Intelligence, Image Processing, Signal filtering, Audio processing **Video link / Additional online information :** https://archive.nptel.ac.in/courses/108/106/108106151/ https://archive.nptel.ac.in/courses/108/106/108106163/ https://archive.nptel.ac.in/courses/108/104/108104100/	**8Hrs.**
UNIT III	
Prerequisites: Basics of Fourier series concepts **LTI system Properties in terms of impulse response**: Memoryless, Causal, Stable, Invertible, and step response. **Fourier Representation of Periodic Signals:** CTFS and DTFS definition and basic problems (excluding properties). **Laboratory Sessions/ Experimental learning:** 1. To analyse the spectrum of signal with Fourier series using MATLAB. a) Verify the linearity property of the given periodic signals x(t)=cos(t) and y(t)=sin(2t),scalars are a=3+2j,b=2. b) Verify the time reversal property of the given periodic signal $x(t)=t\cos(t)$,$0 \le t \le 2\Pi$ in one period. **Applications**: Signal Processing, Control Theory, Communications Systems, Image and Video Processing, Biomedical Engineering (ECG, MRI), Oil extraction (Seismology), Music Industry (Audio) and Power Quality Analysis. **Video link / Additional online information :** 1. https://archive.nptel.ac.in/courses/108/106/108106163/ 2. https://archive.nptel.ac.in/courses/108/104/108104100/	8Hrs.

UNIT IV	
Prerequisites: Basics of Fourier transform concepts **Fourier Representation of aperiodic Signals**: Introduction to Fourier Transform, Definition and basic problems. Properties of Fourier Transform: Linearity, Time shift, Frequency shift, scaling, Differentiation and Integration, Convolution and Modulation, Parseval's theorem and problems on properties of Fourier Transform. **Laboratory Sessions/ Experimental learning:** 1. Application of Fourier Transform in Modulation and Demodulation Technology using MATLAB. a) Compute the Fourier transform of the function $x(t) = e^{-t} u(t)$ b) Suppose that a signal x(t) is given by $x(t)=te^{-3t}$. Compute the Fourier transform X (w) of the signal of the signal x(t) and plot for $-20 \leq w \leq 20$ rad/sec. **Applications**: Fourier Transform in Modulation and Demodulation Technology, Frequency division multiplexing and time division multiplexing, In Filtering Technology **Video link / Additional online information :** https://archive.nptel.ac.in/courses/108/106/108106151/ https://archive.nptel.ac.in/courses/108/106/108106163/ https://archive.nptel.ac.in/courses/108/104/108104100/	8 Hrs
UNIT V	
Prerequisites: Basics of Z-transform concepts **The Z-Transforms:** Z transform, properties of the Region of Convergence, properties of the Z-transform, Inverse Z-transform, Causality and stability, Transform analysis of LTI systems. **Laboratory Sessions/ Experimental learning:** 1. To compute Z-transform of finite duration sequence using MATLAB. a) Compute the z-transform of the sequence fx(n)-[-3,5,6,7,8], $-2 \leq n \leq 2$. b) Compute the z-transform of the discrete-time signal $x(n)= n^2 u(n)$. c) Compute the convolution between the signals $X_1(z)=$ z/z-0.9 and $X_2(z)=$z /z+6 **Applications**: In analysis of digital filters, Used to simulate the continuous systems, Analyse the linear discrete system, Used to finding frequency response, Analysis of discrete signal, Helps in system design and analysis and also checks the systems stability, For automatic controls in telecommunication. **Video link / Additional online information:** 1. https://archive.nptel.ac.in/courses/108/106/108106151/	8Hrs.

2. https://archive.nptel.ac.in/courses/108/106/108106163/ 3. https://archive.nptel.ac.in/courses/108/104/108104100/	

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze the different types of signals and systems.
CO2	Develop input output relationship for linear time invariant system and understand the convolution operator for continuous and discrete time system.
CO3	Understand and resolve the signals in frequency domain using Fourier series.
CO4	Determine the spectral characteristics of continuous and discrete time signal using Fourier transform.
CO5	Compute Z-transforms, inverse Z- transforms and transfer functions of complex LTI systems

Reference Books:	
1	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab,"Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
2	Michael Roberts**,** "Fundamentals of Signals & Systems", 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
3	Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.
4	H.P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 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 for50 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 threetests 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	2	2	2	-	-	-	-	-	1	1
CO2	3	3	2	3	3	-	-	-	-	-	3	2
CO3	3	3	2	3	3	-	-	-	-	-	3	1
CO4	3	3	2	2	3	-	-	-	-	-	3	1
CO5	3	2	2	3	2	-	-	-	-	-	3	2

High-3, Medium-2, Low-1

Semester: IV		
Data Structures and Algorithms using Python		
Course Code:	**MVJ22EC452**	**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 fundamentals of data structures and their applications in logic building and project assessment.	
2	Understand the concept of linked lists and sorting techniques.	
3	Acquire the knowledge of algorithms of queues and stacks.	
4	Analyze the concepts of Binary trees.	
5	To Understand Graphs and its algorithms.	

UNIT 1	
Python Primer: Python Overview, Objects in Python, Expressions, Operators, Control Flow, Functions, Simple i/p and o/p, Modules. **Basic Concepts of Data Structures and Algorithms:** Introduction- Variables, Datatypes, Data Structures, ADT, what is an algorithm, How to compare algorithms, Rate growth, Types of analysis, Asymptotic Notation, Performance Analysis: Space complexity, Time complexity, Guidelines for asymptotic analysis. **Searching Techniques:** Linear Search and Binary Search Applications: developing computational tools and bioinformatics software, Mathematics. **Video link / Additional online information (related to module if any):** 1. http://www.nptelvideos.com/video.php?id=1442 2 2. https://nptel.ac.in/courses/106105085/ **Laboratory Sessions/ Experimental learning**: 1. Develop a mini project to demonstrate the concept Binary Search. **Applications:** 1. Conversion from one form of expression to another 2. Mathematical calculation for expression evaluation	8Hrs.
UNIT 2	
Prerequisites: Programming using the concept of Arrays and pointers **Linked Lists:** Definition, Linked list operations: Traversing, Searching, Insertion, and	8Hrs.

Deletion. Doubly Linked lists and its operations, Circular linked lists and its operations. **Sorting Techniques:** Bubble Sort, Insertion Sort, Selection Sort, Quick Sort and Merge Sort. **Laboratory Sessions/ Experimental learning:** Develop an algorithm to demonstrate the concept of Linked lists. **Applications:** 1. Programs for Departmental store bills 2. Programs for Railway booking **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/102/106102064/ 2. https://drive.google.com/file/d/0BzTQ7doC5eGSQTBicHo1UDgtOVU/view	
UNIT 3	
Stacks: Definition, Stack Implementation using arrays/lists and linked lists, Stack ADT, Stack Operations (Insertion and Deletion), Array Representation of Stacks, Stack Applications: Infix to postfix conversion, Tower of Hanoi. **Queues:** Definition, Array Representation, Queue Implementation using arrays/lists and linked lists, Queue ADT, Operations on queues (Insertion and Deletion), Circular Queues and its operations, Priority Queues and its operations. **Laboratory Sessions/ Experimental learning:** 1. Implementation of Towers of Hanoi using Stacks. **Applications:** 1. Towers of Hanoi. 2. Parenthesis matching in an expression **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106127/ 2. https://www.youtube.com/playlist?list=PL0gIV7t6l2iIsR55zsSgeiOw9Bd_IUTbY	8Hrs.
UNIT 4	
Trees: Terminology, Binary Trees, Types of Binary trees, Properties of Binary trees, Array Representation of Binary Trees, Binary Tree Traversals – Inorder, Postorder, Preorder. Binary Search Trees – Definition, Insertion, Deletion, Searching, Implementation of Binary tree, Heaps and Heap Sort, Construction of Expression Trees, AVL Trees. Laboratory Sessions/ Experimental learning:	8Hrs.

1. Solve Parenthesis Matching problem using binary search trees. Applications: 1. Can be used for Memory Management. 2. In solving backtracking problems. Video link / Additional online information: 1. https://nptel.ac.in/courses/106/106/106106127/ 4. https://nptel.ac.in/courses/106/105/106105225/	
UNIT 5	
Graphs: Definitions, Terminologies, Matrix and Adjacency List Representation of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search, DAG, Minimum Spanning Trees: Prim – Kruskal algorithm, Single Source Shortest Path: Weighted graphs, Dijkstra algorithm. Laboratory Sessions/ Experimental learning: 1. Print all the nodes of graph using DFS and BFS. 2. Apply various algorithms on a graph and analyse it. Video link / Additional online information: 1. https://nptel.ac.in/courses/106/106/106106133/ 2. https://nptel.ac.in/courses/106/105/106105225/ 1. https://nptel.ac.in/courses/106/102/106102064/	8Hrs.

Course Outcomes: After completing the course, the students will be able to	
CO1	Acquire knowledge of Python fundamentals and data structures.
CO2	Analyse and design of algorithms for Linked lists and sorting techniques.
CO3	Apply the concepts of Stacks and queues.
CO4	Utilize the operations of search trees and their applications.
CO5	Understand the concepts of Graphical algorithms.

Reference Books:	
1.	Rance D Necaise “Data Structures and Algorithms using Python”, Wiley, John Wiley and Sons
2.	Michael T. Goodrich, R. Tamassia and Michael H Goldwasser “Data structures and Algorithms

	in python", Wiley student edition, John Wiley and Sons.
3.	Narasimha Karumanchi "Data Structures and Algorithmic Thinking with Python", CareerMonk Publications.

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 marksis 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	2	2	-	1	-	-	1	-	-	1
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: IV		
Operating System		
Course Code:	**MVJ22IO453**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**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	8Hrs.
UNIT 2	
Process Management: OS View of Processes, PCB, Process States and Transitions, Threads, Kernel and User level Threads, Non-preemptive scheduling- FCFS and SRN, Preemptive Scheduling- RR and LCN, Long term, medium term and short term scheduling in a time sharing system.	8Hrs.

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	
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	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:**	8Hrs.

• 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	
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	8Hrs.

Course Outcomes: After completing the course, the students will be able to

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.

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

High-3, Medium-2, Low-1

Semester: III		
Engineering Statistics and Linear Algebra		
Course Code:	**MVJ22IO454**	**CIE Marks: 50**
Credits:	**L: T:P:S: 2:2:0:0**	**SEE Marks: 50**
Hours:	**30L+10T**	**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
• To organize, manage, and present data using statistical methods. • To familiarize the important tools of linear algebra, that are essential in all branches of engineering. • To develop the knowledge/skills of linear transformation and decomposition techniques in a comprehensive manner.		

UNIT-I

Correlation and Regression: Correlation, Regression coefficients, line of regression problems. **Curve fitting:** Fitting of the curves of the form $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$ by the method of least squares.	**8 Hrs**
UNIT-II	
Design of Experiments (ANOVA): One way and Two way classifications, Completely randomized design, Randomized block design, Latin square design.	**8 Hrs**
UNIT-III	
Linear Equations: Consistent and inconsistent systems and its solution sets; LU-decomposition. **Vector Spaces:** Vector spaces; subspaces, Linearly independent and dependent vectors, Bases and dimension, coordinate vectors, computations concerning subspaces-Illustrative examples.	**8 Hrs**
UNIT-IV	
Linear Transformations: Linear transformations, algebra of transformations, representation of transformations by matrices, linear functional, Non singular Linear transformations, inverse of a linear transformation, Problems on Rank-Nullity theorem.	**8 Hrs**
UNIT-V	
Inner Product Spaces: Inner products, inner product spaces, orthogonal sets and orthogonal projections, Gram-Schmidt orthogonalization process, QR- decomposition.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.
CO2	Understand the need and application of analytics.
CO3	Analyze whether a system is consistent or inconsistent, its solution is unique or infinite and find bases and dimension of vector spaces required in network analysis.
CO4	Linearly transform the system from one dimension to another in matrix form, required to analyze image processing problems.
CO5	Compute orthogonal and orthonormal basis vectors required to analyze image and signal processing problems.

Reference Books	
1.	Introduction to Linear Algebra, Gilbert Strang, Wellesley Cambridge Press, 5th Edition, 2016.
2.	Linear Algebra and its Applications, David C. Lay, Cambridge University Press, 3rd Edition, 2017.
3.	Fundamentals of Statistics, S C Gupta, Himalaya Publications 2012.
4.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 44th Edition, 2013.

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**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO2	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO3	**3**	**3**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO4	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
CO5	**3**	**2**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Semester: IV		
Additional Mathematics-II (Common to all branches)		
Course Code:	**MVJ22MATDIP-II**	**CIE Marks:50**
Credits:	**L:T:P:S: 3:0:0:0**	**SEE Marks: 50**
Hours:	**30L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To familiarize the important concepts of linear algebra.	
2	Aims to provide essential concepts differential calculus, beta and gamma functions.	
3	Introductory concepts of three-dimensional geometry along with methods to solve them.	
4	Linear differential equations	
5	Formation of partial differential equations.	

UNIT-I	
Linear Algebra: Introduction - Rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Diagonalization of a square matrix of order two.	**8 Hrs**
UNIT-II	
Differential calculus: Indeterminate forms: L-Hospital rule (without proof), Total derivatives, and Composite functions. Maxima and minima for a function of two variables. **Beta and Gamma functions:** Beta and Gamma functions, Relation between Beta and Gamma function-simple problems.	**8Hrs**
UNIT-III	
Analytical solid geometry : Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems.	**8Hrs**
UNIT-IV	
Differential Equations of higher order: Linear differential equations of second and higher order equations with constant coefficients. Inverse Differential operator, Operators methods for finding particular integrals , and Euler –Cauchy equation.	**8 Hrs**
UNIT-V	
Partial differential equation: Introduction- Classification of partial differential	**8 Hrs**

equations, formation of partial differential equations. Method of elimination of arbitrary constants and functions. Solutions of non-homogeneous partial differential equations by direct integration. Solution of Lagrange's linear PDE.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Make use of matrix theory for solving system of linear equations and compute eigenvalues and eigen vectors required for matrix diagonalization process.
CO2	Learn the notion of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions and Jacobians.
CO3	Understand the Three-Dimensional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance .
CO4	Demonstrate various physical models through higher order differential equations and solve such linear ordinary differential equations.
CO5	Construct a variety of partial differential equations and solution by exact methods.

Reference Books	
3.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
4.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014.
3.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
4.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8 Edition.

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	0	2	0	0	0	0	0	0	0	1
CO2	3	3	0	2	0	0	0	0	0	0	0	1
CO3	3	3	0	3	0	0	0	0	0	0	0	1
CO4	3	2	0	3	0	0	0	0	0	0	0	1
CO5	3	2	0	2	0	0	0	0	0	0	0	1

B.E, V Semester, Industrial Internet of Things

Semester: V		
TECHNICAL MANAGEMENT & ENTREPRENEURSHIP		
Course Code:	**MVJ22IO51**	**CIE Marks:50**
Credits:	**L: T:P: 3:0:0**	**SEE Marks: 50**
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/ 2. https://nptel.ac.in/courses/110/105/110105146/	**8Hrs.**
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.	**8Hrs.**

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:** 1. https://nptel.ac.in/courses/110/107/110107151/	
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:** 1. 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	**8Hrs**.

small-scale industry.

Applications: Industrial sectors, and Institutional Research sectors.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=2I0XdF_uOuA
2. https://www.youtube.com/watch?v=jmx7SiCzay8

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

https://www.youtube.com/watch?v=NFTBbfYGM6A

Course Outcomes

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

Text 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.

Reference Books:

1.	Vasant Desai, "Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House, 6th Edition, 2018.
2.	Stephen P Robbins, "Management", Pearson Education/PHI1, 7thEdition, 2003.
3.	Roberts Lusier Thomson, "Management Fundamentals - Concepts, Application, Skill Development", Fifth Edition, Thomson Publications, 2011.

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
CO2	-	3	3	-	-	1	-	3	3	2	2	1
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 Communication Networks		
Course Code:	**MVJ22IO52**	**CIE Marks:50**
Credits:	**L: T:P: 3:0:2**	**SEE Marks: 50**
Hours:	**40L+26P**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the layering architecture of OSI reference model and TCP/IP protocol suite.	
2	Know about the protocols associated with each layer.	
3	Learn the different networking architectures and their representations.	
4	Acquire a knowledge of various routing techniques and the transport layer services.	
5	Learn the security features and functionality of application layer protocols.	

UNIT 1	
Prerequisites: Basic knowledge on computers & programming **Introduction:** Data Communications: Components, Representations, Data Flow, Networks: Network criteria, Physical Structures, Network Types: LAN, WAN, Switching, Internet. **Network Models:** Protocol Layering: Scenarios, Principles, Logical Connections, TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP. **Laboratory Sessions/ Experimental learning**: 1. Study and draw the layout of LAN connection in Computer Networks Lab in NetSim. List out the type of cabling involved. **Applications:** Ethernet, Fibernet, Satellite Communication. **Video link / Additional online information:** 1. http://www.redbooks.ibm.com/abstracts/gg243376.html 2. https://nptel.ac.in/courses/106/106/106106091/ 3. https://nptel.ac.in/courses/106/105/106105080/	**8Hrs.**
UNIT 2	
Data-Link Layer: Introduction: Nodes and Links, Services, Categories of link, Sublayers, Link Layer addressing: Types of addresses, ARP. Data Link Control (DLC) services: Framing, Flow and Error Control, Data Link Layer Protocols: Simple Protocol, Stop and Wait protocol, Piggybacking. **Media Access Control:** Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. **Laboratory Sessions/ Experimental learning:**	**8Hrs.**

2. Study and analyse packet transfer using CSMA/CD and CSMA/CA using NetSim. **Applications:** Collision detection and avoidance in wired and wireless network. **Video link / Additional online information:** 3. https://nptel.ac.in/courses/106/105/106105183/	
UNIT 3	
Network Layer: Introduction, IPV4 Addresses, Address Space, Classful Addressing, Classless Addressing, DHCP. **Unicast Routing:** Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing, Unicast Routing Protocol: Internet Structure, Routing Information Protocol, Open Shortest Path First. **Laboratory Sessions/ Experimental learning**: 2. Study of IP addressing, subnet mask and subnetting. **Applications:** Routing and forwarding packets in routers. **Video link / Additional online information:** 3. https://nptel.ac.in/content/storage2/courses/106105080/pdf/M6L2.pdf	**8Hrs.**
UNIT 4	
Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-Back-N Protocol, Selective repeat protocol. **Transport-Layer Protocols in the Internet:** User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram. **Laboratory Sessions/ Experimental learning**: 1. Transport analysis using TCP/UDP using NetSim. **Applications:** MS Teams, Zoom, Cisco webex **Video link / Additional online information:** 1. http://www.digimat.in/nptel/courses/video/106105183/L11.html 2. http://www.digimat.in/nptel/courses/video/106105183/L06.html	**8Hrs**.
UNIT 5	
Application Layer: Introduction: providing services, Application- layer paradigms, Standard Client - Server Protocols: World wide web, Hyper Text Transfer Protocol, FTP: Two connections, Control Connection, Data Connection, Electronic Mail: Architecture, Wed Based Mail, Telnet: Local versus	

remote logging, Domain Name system: Name space, DNS in internet, Resolution, DNS Messages, Registrars, DDNS, security of DNS.

Laboratory Sessions/ Experimental learning:

Applications: All applications like MS Office, Facebook, Instagram, etc.

Video link / Additional online information:

1 https://archive.nptel.ac.in/courses/106/105/106105183/2.

2 https://www.youtube.com/watch?v=mGRClHHgNdk

Lab Experiments

1. Implement a point-to-point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth.

2. Implement a four-node point to point network with links n0-n1, n1-n2 and n2-n3. Apply TCP agent between n1-n2 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP.

3. Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.

4. Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.

5. Implementation of Link state routing algorithm.

Implement the following in C/C++ in Linux platform

6. Write a program for a HLDC frame to perform the following.

i) Bit stuffing ii) Character stuffing.

7. Write a program for distance vector algorithm to find suitable path for transmission. For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify the program for the cases. a. Without error, b. With error

8.Implementation of Sliding Window Protocol.

9. Write a program for congestion control using leaky bucket algorithm.

Course Outcomes

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

Reference Books:	
1.	Behrouz A Forouzan,“ Data Communication and Networks”, 3rd Ed. TMH.
2.	Andrew S Tanebaum, “Computer Networks”, 4th Ed. PHI/ Pearson education.
3.	S. Keshav, “An Engineering approach to Computer Networks”, 5th Ed. Pearson.
4.	W.A. Shay, “Understanding communication and Networks”, Thomson.

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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
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		
Signal Processing		
Course Code:	**MVJ22IO53**	**CIE Marks: 50**
Credits:	**L:T:P: 4:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs.**

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 I	
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 3. https://youtu.be/BPa2Ysel834	8Hrs.
UNIT 2	

Linear filtering methods based on the DFT: Use of DFT in Linear Filtering, Filtering of Long Data Sequences, overlap-save and overlap-add method. **Fast-Fourier-Transform (FFT) algorithms**: Efficient Computation of the DFT: Radix-2 FFT	8Hrs.

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 3. https://youtu.be/3fVufCSg0	
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. Lattice structure point **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 2. https://www.youtube.com/watch?v=SKuywStjBLY	8Hrs.

Course Outcomes: After completing the course, the students will be able to	
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

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 self - study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies 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 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 complete syllabus. Part – B Students have to answer five questions, one from each unit for 16marks 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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

Semester: V		
Signal Processing Laboratory		
Course Code:	**MVJ22IOL54**	**CIE Marks: 50**
Credits:	**L:T:P:0:0:2**	**SEE Marks: 50**
Hours:	**20**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To understand the basic concepts of Signal processing techniques with their Properties both in time and frequency domain.	
2	To understand the basic concepts of Signal processing techniques with their Properties both in time and frequency domain.	
3	To Implement signal processing techniques/operations and Digital filters using Processor	
4	To Documentation of the complete experimental process and result	
5	Acquire knowledge on different types of signals.	

PART A
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 4. Solving a given difference equation.
PART B
1. 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). 2. I) Verification of DFT properties (like Linearity and Parseval's theorem, etc.) Ii)DFT computation of square pulse and Sinc function etc. 3. Design and implementation of FIR filter to meet given specifications (using different window techniques). 4. Design and implementation of IIR filter to meet given specifications

Course outcomes:	
CO1	To use computational tools to do basic operations for signal processing.
CO2	To develop algorithms for designing and implementation of FIR and IIR filters with standard techniques.
CO3	Use the Fast Fourier Transform in a variety of applications including: signal analysis, fast convolution, spectral and temporal interpolation, and filtering

CO4	Quickly choose and design digital filters
CO5	Select and utilize appropriate methods for basic signal processing applications

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: V		
MACHINE LEARNING		
Course Code:	**MVJ22IO551**	**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 algorithm.	

UNIT 1	
Introduction to ML: Well posed learning problems, Designing a Learning system, Perspectives and Issues in Machine Learning. **Concept Learning:** Introduction, A Concept Learning Task, Find S algorithm, Candidate Elimination algorithm, Inductive Bias. **Applications:** Data training samples, Speech Recognition algorithm. **Laboratory Sessions/ Experimental learning:** 1. Implement and demonstrate the FIND-S Algorithm for finding the most 2. specific hypothesis based on a given set of training data samples. Read the **3.** training data from a .CSV file. **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	
Decision Tree Learning: Introduction, Decision Tree Representation, Appropriate Problems, Hypothesis Space Search, Inductive bias in decision tree, issues in Decision tree. **Instance Based Learning:** Introduction, KNN, Locally Weighed Regression, Radial Basis Functions and Case Based Reasoning **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	**8Hrs.**

knowledge to classify a new sample. **Applications:** Email Spam and Malware Filtering, ID3 algorithm, Self-driving cars **Video link / Additional online information:** 4. https://nptel.ac.in/courses/106/106/106106198/ 5. https://www.youtube.com/watch?v=fPLxFXiS9fU	
UNIT 3	
Bayesian Learning: Introduction, Analyze Bayes theorem, Bayes theorem demonstration and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Optimal Bayes Classifier, Naive Bayes classifier, Bayesian belief networks, EM algorithm. **Laboratory Sessions/ Experimental learning:** 1. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same dataset for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering **Applications:** Virtual Personal Assistant, Online Fraud Detection. **Video link / Additional online information:** 4. https://nptel.ac.in/courses/106/105/106105215/	**8Hrs.**
UNIT 4	
Artificial Neural Network: Introduction, Appropriate Problems, Perceptron, Multilayer Networks and Backpropagation algorithm. **Genetic Algorithms:** Motivation, Genetic Algorithms, an illustrative example, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning, Parallelizing Genetic Algorithms. **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 for building linear and non-linear networks. **Video link / Additional online information:** 1. https//nptel.ac.in/courses/11706087/ 2. https://nptel.ac.in/courses/106/106/106106198/	**8Hrs.**

UNIT 5	
Analytical Learning: Introduction, Learning with perfect domain theories. **Combining inductive and analytical learning:** Motivation, Inductive – Analytical Approaches to learning. **Reinforcement Learning:** Introduction, The Learning Task, Q Learning **Real Time Applications:** Design an algorithm / flowchart for Autonomous Vehicle, Image Recognition and Traffic Prediction. **Laboratory Sessions/ Experimental learning:** 1. Implementation of game based om action reward strategy. **Applications:** Gaming, NLP **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102059/	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Choose the learning techniques and investigate concept learning.
CO2	Identify the characteristics of decision tree and solve problems associated with it.
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		
CRYPTOGRAPHY		
Course Code:	**MVJ22EC552**	**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	Outline the basic principles of Cyber security and its applications	
2	Familiarize with Cryptography and very essential algorithms.	
3	Use the theorems needed for cryptographic operations and compare & contrast different types of cryptography.	
4	State the concepts & uses of Digital signature and web security.	
5	Demonstrate the need and summarize the concept of Secure Electronic Transactions & Intrusion detection system.	

UNIT 1	
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:** 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	**8Hrs.**
UNIT 2	
Basics of Cryptography: Preliminaries, Elementary Substitution Ciphers, Elementary Transport Ciphers, Other Cipher Properties. **Symmetric Ciphers:** Symmetric Ciphers model, Substitution Techniques, Transposition	**8Hrs.**

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. **Laboratory Sessions/ Experimental learning:** Breaking the Mono-alphabetic Substitution Cipher **Applications:** wireless security, processor security, file encryption **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117106087/ 2.https://www.youtube.com/watch?v=ANHTfY9feZg 6. https://nptel.ac.in/courses/108102095/	
UNIT 3	
Block Cipher Operation: Electronic Codebook, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode **Public Key Cryptography:** Principles of public key Cryptosystem, The RSA algorithms, Key management, Diffie – Hellman key exchange, Elgamal Cryptographic system, PRNG based on Asymmetric Cipher **Digital Signatures:** Digital Signatures and Digital Signature Standard. **Laboratory Sessions/ Experimental learning:** 1. Diffie-Hellman Key Establishment **Applications:** Random number generator, permutation generator **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=m4sjTt7rhow 5. https://nptel.ac.in/courses/117101106/ 6. https://nptel.ac.in/courses/108108114/	**8Hrs.**
UNIT 4	
Key Management and Distribution: Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of Public keys, X.509 Certificates, Public key infrastructure**.** **Laboratory Sessions/ Experimental learning:** 1. Digital Signatures Scheme 2. Cryptographic Hash Functions and Applications (HMAC)	**8Hrs.**

Applications: Cyber-attacks, Cybercrime, Cyber security. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/108105113/ 2. https://nptel.ac.in/courses/117106086/	
UNIT 5	
Intruders, Intrusion Detection, Password Management, Malicious software programs – Viruses and related Threats, Virus Countermeasures **Firewall:** Need of firewalls, Firewall Characteristics, Types of Firewalls, Design Principles, Trusted Systems **Laboratory Sessions/ Experimental learning:** Program for SSL operation. **Applications:** Encryption, message authentication and integrity, and replay attack protection **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102052/	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to	
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	Illustrate the concept public key cryptography & apply digital signatures in email
CO4	Describe different techniques used in key exchange protocols.
CO5	Analyzing various malicious software and firewalls.

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

3.	Cryptography, Network Security and Cyber Laws – Bernard Menezes, Cengage Learning, 2010 edition.

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	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

Semester: V		
Artificial Neural Networks		
Course Code:	**MVJ22IO553**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
1	To understand the biological neural network and to model equivalent neuron models.	
2	To understand the architecture, learning algorithm and issues of various feed forward and feedback neural networks	
3	To understand the architecture, learning algorithms	
4	To know the issues of various feed forward and feedback neural networks.	
5	To explore the Neuro dynamic models for various problems.	

UNIT I	
Prerequisites: **Linear Algebra, Statistics and Probability will smoothen the process of learning the surface of the subject** **Introduction**: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation **Learning Process:** Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process **Laboratory Sessions/ Experimental learning:** To find the basis and properties of statistical nature learning process. **Applications:** To make a successful stock prediction in real time a **Multilayer Perceptron MLP** *(class of feedforward artificial intelligence algorithm)* is employed. Facial Recognition Systems are serving as robust systems of surveillance. As CNN is used in image processing, the medical imaging data retrieved from tests is analyzed and assessed based on neural network models. **Laboratory Sessions/ Experimental learning:** **Perceptron learning** The objective of this experiment is to illustrate the concept of perceptron learning in the context of pattern classification task. Following are the goals of the experiment:	**8Hrs.**

To demonstrate the perceptron learning law. To illustrate the convergence of the weights for linearly separable classes. To observe the behavior of the neural network for two classes which are not linearly separable. **Video link / Additional online information :** https://nptel.ac.in/courses/117105084	
UNIT 2	
Single Layer Perceptron's: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment **Multilayer Perceptron:** Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection **Laboratory Sessions/ Experimental learning:** **To Multilayer Feedforward Neural Networks** The objective of this experiment is to demonstrate the ability of a multilayer feedforward neural network (MLFFNN) in solving linearly inseparable pattern classification problems. **Applications: Perceptron is a linear classifier, and is used in supervised learning** **Video link / Additional online information :** https://www.digimat.in/nptel/courses/video/106106202/L35.html https://www.digimat.in/nptel/courses/video/106101007/L01.html	**8Hrs.**
UNIT 3	
Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning **Laboratory Sessions/ Experimental learning:** How the choice of activation function effect the output of neuron experiment with the following function backpropagation purelin(n), bimary threshold(hardlim(n) haradlims(n)) ,Tansig(n) logsig(n) **Applications:** The neural network is trained to enunciate each letter of a word and a sentence	**8Hrs.**

It is used in the field of speech recognition It is used in the field of character and face recognition. **Video link / Additional online information :** https://freevideolectures.com/course/2677/neural-networks-and-applications/19 http://www.digimat.in/nptel/courses/video/106106211/L38.html	
UNIT 4	
Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification **Laboratory Sessions/ Experimental learning:** **Solution to Travelling Salesman Problem Using Self Organizing Maps** The objective of this experiment is to provide a suboptimal solution to the Travelling Salesman Problem (TSP), using the properties of self-organization feature maps (SOM). The focus is: • To illustrate the principle of self-organization for addressing the travelling salesman problem • To observe the suboptimal nature of the solution provided by SOM • To study the effect of structure of SOM on the solution **Applications:** One of the earliest and well-known applications of the SOM is the phonetic typewriter of Kohonen. It is set in the field of speech recognition, and the problem is to classify phonemes in real time so that they could be used to drive a typewriter from dictation. **Video link / Additional online information:** **https://archive.nptel.ac.in/courses/117/105/117105084/** **https://cosmolearning.org/courses/intelligent-systems-and-control/video-lectures/**	**8Hrs.**
UNIT 5	
Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network **Paradigm Hopfield Models** – Hopfield Models, Computer Experiment **Laboratory Sessions/ Experimental learning:** **Hopfield Models for Solution to Optimization Problems**	**8Hrs.**

Weighted matching problem: Deterministic, stochastic and mean field annealing of a Hopfield model The objective of this experiment is to demonstrate the use of Hopfield models for solving optimization problems. The main issue in solving optimization problems using neural networks is mapping of the problem to a neural network architecture. This experiment demonstrates how an optimization problem such as the graph bipartition problem, can be mapped on to an Hopfield model (feedback neural network). **Applications**: Neural Network for Machine Learning Face Recognition using it Neuro-Fuzzy Model and its applications Neural Networks for data-intensive applications **Video link / Additional online information:** **https://nptel.ac.in/courses/101104061** **https://scte-iitkgp.vlabs.ac.in/exp/neural-networks-perceptron/references.html**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Create different neural networks of various architectures both feed forward and feed backward
CO2	Perform the training of neural networks using various learning rules
CO3	Perform the testing of neural networks and do the perform analysis of these networks for various pattern recognition applications.
CO4	Understand the similarity of Biological networks and Neural networks Perform the training of neural networks using various learning rules.
CO5	Understanding the concepts of forward and backward propagations. Understand and Construct the Hopfield models.

Reference Books:	
1.	Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.
2.	Artificial Neural Networks - B. Vegnanarayana Prentice Hall of India P Ltd 2005

3.	Neural Networks in Computer Inteligance, Li Min Fu MC GRAW HILL EDUCATION 2003
4.	Neural Networks -James A Freeman David M S Kapura Pearson Education 2004.
5.	Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 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												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

CO3	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Semester: V		
Cloud Computing and IOT Analytics		
Course Code:	**MVJ22IO554**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs.**

Course Learning Objectives: The students will be able to	
1	Discuss the concepts, characteristics, delivery models and benefits of cloud computing.
2	Explore the key technical, organizational and compliance challenges of cloud computing.
3	Grasp the concepts of virtualization efficiently. Gain knowledge on combination of functionalities and services of networking.
4	Able to explain the definition and significance of the Internet of Things.
5	Discuss the architecture, operation and business benefits of an IoT solution.

UNIT I	
Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Opensource software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems. **Applications:** A cloud application is software that runs its processing logic and data storage between 2 different systems: client-side and server-side. Some processing takes place on an end user's local hardware, such as a desktop or mobile device, and some takes place on a remote server **Video link / Additional online information:** https://www.javatpoint.com/cloud-computing https://www.tutorialspoint.com/cloud_computing/index.htm https://www.digimat.in/nptel/courses/video/106105167/L01.html https://www.digimat.in/nptel/courses/video/106105167/L03.html	**8Hrs.**
UNIT 2	
Cloud Computing: Application Paradigms: Challenges of cloud computing, Architectural	**8Hrs.**

styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre (Generic Routing Encapsulation) The Web application, Cloud for science and engineering, High performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing **Applications:** An application architecture describes the patterns and techniques used to design and build an application. **Video link / Additional online information:** https://www.digimat.in/nptel/courses/video/106105167/L04.html https://www.digimat.in/nptel/courses/video/106105167/L05.html https://www.digimat.in/nptel/courses/video/106105167/L06.html	
UNIT 3	
Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization. **What is IoT:** What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IoT Definitions, IoT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview **Applications:** Virtualization is technology that can be used to create virtual representations of servers, storage, networks, and other physical machines. Virtual software mimics the functions of physical hardware to run multiple virtual machines simultaneously on a single physical machine. An IoT framework can be defined as a set of protocols, tools, and standards that provide a specific structure for developing and deploying IoT applications and services **Video link / Additional online information:** https://www.digimat.in/nptel/courses/video/106105167/L07.html https://www.tutorialspoint.com/internet_of_things/internet_of_things_overview.htm https://www.javatpoint.com/iot-internet-of-things	**8Hrs.**

https://www.digimat.in/nptel/courses/video/106105166/L01.html	
UNIT 4	
Fundamental IoT Mechanism and Key Technologies-Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M, Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP), IPSO **Applications:** In many IoT based environs, RPL supports for low energy consumed communications. In IoT, several heterogeneous things are connected via the Internet. That is, sensors, smart devices, and cameras are IoT devices. In RPL, control messages are sent between nodes to give-and-take packets. **Video link / Additional online information:** https://www.digimat.in/nptel/courses/video/106105166/L05.html https://www.digimat.in/nptel/courses/video/106105166/L06.html https://www.digimat.in/nptel/courses/video/106105166/L09.html	**8Hrs.**
UNIT 5	
Data and Analytics for IoT **Data Analytics for IoT** – Introduction, Apache Hadoop, Using Hadoop-MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Realtime Data Analysis, Structural Health Monitoring Case Study. **Applications**: By applying IoT predictive analytics to a predictive maintenance model, companies can better understand the current condition of devices—as well as their future needs. **Video link / Additional online information:** https://www.digimat.in/nptel/courses/video/106105166/L55.html https://www.digimat.in/nptel/courses/video/106105166/L56.html https://www.digimat.in/nptel/courses/video/106105166/L57.html https://www.digimat.in/nptel/courses/video/106105166/L58.html	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Compare the strengths and limitations of cloud computing.
CO2	Identify the architecture, infrastructure and delivery models of cloud computing.
CO3	Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service on that. Choose appropriate schemes for the applications of IOT in real time scenarios.
CO4	Manage the Internet resources through different protocols used in each layer
CO5	Identify how IoT differs from traditional data collection systems

Reference Books:	
1.	Cloud Computing: Theory and Practice, Dan C Marinescu Elsevier (MK), 201
2.	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley, 2013.
3.	Srinivasa K G, “Internet of Things”, CENGAGE Leaning India, 2017
4.	Cloud Computing Implementation, Management and Security John W Rittinghouse, James F Ransome, CRC Press, 2013.
5.	Computing Principles and Paradigms, Rajkumar Buyya , James Broberg, Andrzej Goscinsk, i Willey, 2014.

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**
CO 1	**3**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO 2	**3**	**-**	**1**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**
CO 3	**3**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**	**-**
CO 4	**3**	**3**	**1**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**2**	**-**
CO 5	**2**	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**2**	**2**	**2**	**2**

High-3, Medium-2, Low-1

Semester: V			
RESEARCH METHODOLOGY AND IPR			
Course Code:		**MVJ22RMI57**	**CIE Marks:50**
Credits: L:T:P:S:		**3:0:0:0**	**SEE Marks: 50**
Hours:		**40**	**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 basic ethics in research.		
2	To develop a suitable outline for research studies through various sources of information from literature review and data collection.		
3	To develop an understanding of the results and on analysis of the work carried.		
4	To Demonstrate enhanced Scientific writing skills.		
5	To Develop an Understanding on Various Intellectual Property Rights and importance of filing patents.		

UNIT-I	
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. Technique Involved in defining a problem and Illustrations. ***Ethics in Engineering Research:*** Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.	**8 Hrs**
UNIT-II	
Research Writing and Journal Publication Skills: Understanding the importance of quality research papers, Differences between conference papers, journal articles, and other academic publications, criteria for selecting a journal, understanding impact factors and journal rankings. place of the literature review in research, how to review the literature, structure of a research paper, effective use of figures and tables, preparing a cover letter and author contributions, Responding to reviewers' comments. **Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Tools for citation management, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.	**8 Hrs**
UNIT-III	
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs case of Exploratory research studies, case of descriptive and diagnostic research, case of hypothesis -testing , Basic Principles of Experimental Designs, Important Experimental Designs. ***Results and Analysis:*** Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.	**8 Hrs**
UNIT-IV	
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, types of reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	**8 Hrs**
UNIT-V	
Introduction to Intellectual Property Rights: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights.	**8 Hrs**

Kinds of Intellectual property rights—Copy Right, Patent, Trademark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge. **Patents:** Trips Definition, Patentable and Non-Patentable inventions, Legal requirements for patents. **Patent application process:** Prior art search, drafting of a patent, Filing of a patent, Patent document: specification and claims, Granting of patent, Management of IP, Commercialization of IP – Assignment, licensing and infringement.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Formulate the research problem and follow research ethics.
CO2	Carry out a Literature survey for the topic identified
CO3	Analyse the research and interpret the outcomes of the research.
CO4	Enhance their technical writing skills
CO5	Understand the importance of Patenting, Licensing and technology transfer.

Text Books	
1.	**C.R. Kothari, Research Methodology, Methods and Techniques, 2nd Revised edition,** New Age International Publishers, 2015
2.	**Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, PHI Learning Pvt Ltd, 2014**

Reference Books	
1.	**Geoffrey Marczyk, David De Matteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.**
2.	**Carol Ellison (2010) McGraw-Hill's Concise Guide to Writing Research Papers, McGraw-Hill**
3.	**Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess Publications. 2nd volume.**
4.	**Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing**

Assessment Details (both CIE and SEE)

· The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.

· The student has to obtain a minimum of 40% of maximum marks in CIE and a minimum of 40% of maximum marks in SEE.

· Semester End Exam (SEE) is conducted for 50 marks (2 hours duration).

· Based on this grading will be awarded.

· The student has to score a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

· Three Unit Tests each of 30 Marks (30 MCQ's) (duration 01 hour)

1. First test at the end of 5th week of the semester.

2. Second test at the end of the 10th week of the semester.

3. Third test at the end of the 15th week of the semester.

· Report Writing /Presentation/ Assignment to attain the COs and POs for 20 Marks, (Students can decide the topic for Mini Project and start doing literature survey, report of literature survey can be considered for assignments) At the end of the 13th week of the semester

· The average of three tests and report writing/presentation/Assignment summing to 50 marks

Semester End Examination:

· Theory SEE will be conducted by College as per the scheduled timetable, with common question paper for the subject

· SEE paper will be set for 50 questions of each of 01 marks. The pattern of the question paper is MCQ. The time allotted for SEE is 02 hours.

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

High-3, Medium-2, Low-1

Semester: VI		
Internet of Things		
Course Code:	**MVJ22IO61**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:2 (4 Credits)**	**SEE Marks: 50**
Hours:	**40T+26P**	**SEE Duration: 03 Hours**
Course Learning Objectives: The students will be able to		
1	To understand the various modes of communications with Internet.	
2	To learn the basic issues, policy, and challenges on the Internet	
3	To get an idea of some of the application areas where Internet of Things can be applied.	
4	To understand the cloud and internet environment	

B.E, VI Semester, Industrial Internet of Things

B.E, V Semester, Industrial Internet of Things

Module -I	
Prerequisites : Basic Knowledge about C or C++ **Introduction to IoT:** Definition – Foundations – Challenges and Issues - Identification - Security. Components in internet of things: Control Units – Sensors – Communication modules –Power Sources – Communication Technologies – RFID – Bluetooth – Zigbee – Wifi – Rflinks –Mobile Internet – Wired Communication-IoT Platform Overview-Raspberry pi-Arduino boards. * **Laboratory Sessions/ Experimental learning:** Comparative study of Oracle, IBM and Cisco Architectures of IoT **Applications:** Sensors in IoT. **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 3. https://www.educba.com/applications-of-sensors/	**8 Hrs**

* Programming Assignments are Mandatory.	
Module -II	
IoT Protocols: Protocol Standardization for IoT-M2M and WSN Protocols-SCADA and RFID Protocols-Issues with IoT Standardization-Protocols-IEEE 802.15.4-BACNet Protocol-Zigbee Architecture - Network layer – APS Layer – Security. * **Laboratory Sessions/ Experimental learning:** Implement an IoT architecture to design an application of your own. **Applications:** IoT Protocol Applications **Video link / Additional online information (related to module if any):** https://inductiveautomation.com/resources/article/what-is-scada https://iotbytes.wordpress.com/application-protocols-for-iot/ https://data-flair.training/blogs/iot-protocols/ https://www.avsystem.com/blog/iot-protocols-and-standards/ * Programming Assignments are Mandatory.	**8 Hrs**
Module -III	
Resource Management in the Internet of Things: Clustering - Software Agents - Data Synchronization - Clustering Principles in an Internet of Things Architecture - The Role of Context - Design Guidelines -Software Agents for Object – Data Synchronization- Types of Network Architectures - Fundamental Concepts of Agility and Autonomy-Enabling Autonomy and Agility by the Internet of Things - The Evolution from the RFID-based EPC Network to an Agent based Internet of Things- Agents for the Behaviour of Objects.* **Laboratory Sessions/ Experimental learning:** 1. Weather monitoring using Blynk/ThingSpeak 2. Design a people counter using Node MCU 3. Christmas light show with Arduino	**8 Hrs**

Applications: RFID Applications **Video link / Additional online information (related to module if any):** RFID Applications: 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 * Programming Assignments are Mandatory.	
Module -IV	
Case Study and IoT Application Development: IoT applications in home-infrastructures security-Industries- IoT electronic equipment's. Use of Big Data and Visualization in IoT Industry 4.0 concepts - Sensors and sensor Node – Interfacing using Raspberry Pi/Arduino- Web Enabled Constrained Devices. * **Laboratory Sessions/ Experimental learning:** Interfacing using Raspberry Pi/Arduino **Applications:** Elements in group **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 * Programming Assignments are Mandatory.	**8 Hrs**
Module -V	
Web of Things: Web of Things versus Internet of Things-Architecture Standardization for WoT-Platform Middleware for WoT- WoT Portals and	**8 Hrs**

Business Intelligence-Cloud of Things: Grid/SOA and Cloud Computing-Cloud Standards –Cloud of Things Architecture-Open Source e-Health sensor platform. **Laboratory Sessions/ Experimental learning:** Web Application Development **Applications:** Multiple IoT domains, Including Smart Home, Industrial, Smart City, Retail, and Health applications **Video link / Additional online information (related to module if any):** 1. https://www.water-io.com/iot-vs-wot 2. https://www.talend.com/resources/iot-cloud-architecture/ * Programming Assignments are Mandatory.	

LABORATORY EXPERIMENTS

1. Write a program for interface Arduino Uno with DHT Sensor to print Humid Temperature.
2. Write a program for interface Arduino Uno with Smoke Sensor to print digital and output.
3. Write a program for interface Arduino Uno with LM-35 Sensor for analog output r
4. Write a program for interface Arduino Uno with LDR (Light Dependent R Sensor.
5. Write a program for interface Arduino Uno with Magnetic Sensor.
6. Write a program for sending the data of Serial communication between Gatew Arduino.
7. Write a program for establishing Wifi IOT module with Arduino uno.
8. Write a program for Communication between gateways to an end node.
9. Write a program for Send data on Thing speak with end node and display those da LCD.

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the components of IoT.
CO2	Analyse various protocols of IoT.
CO3	Design portable IoT using appropriate boards.
CO4	Develop schemes for the applications of IOT in real time scenarios.
CO5	Design business Intelligence and Information Security for WoT

Reference Books	
1.	Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective" -CRC Press-2012.
2.	Dieter Uckelmann, Mark Harrison, "Architecting the Internet of Things", Springer2011.
3.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things (A Hands-On-Approach)", VPT, 2014.
4.	Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key 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.

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 self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies 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 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 complete 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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

High-3, Medium-2, Low-1

Semester: VI		
VLSI Design and Testing		
Course Code: MVJ22IO62		**CIE Marks:50**
Credits: L:T:P: 3:0:0		**SEE Marks: 50**
Hours:40 L		**SEE Duration: 03Hours**
Course Learning Objectives: The students will be able to		
1	Understand the characteristics of CMOS circuit construction.	
2	Introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).	
3	Design CMOS combinational and sequential logic at the transistor level, with mask layout.	
4	Describe the general steps required for processing of CMOS integrated circuits.	
5	Study functional units including adders, multipliers, ROMs, SRAMs.	

UNIT-I	
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 https://www.youtube.com/watch?v=oSrUsM0hoPs	**8 Hrs**
UNIT-II	
Basic Electrical Properties of MOS Circuits: Drain-to-Source current vs. voltage relationships, aspects of MOS transistor threshold voltage, MOS	**8 Hrs**

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. **Laboratory Sessions / Experimental learning:** 1. Simulation of CMOS Inverter characteristics with different values of Inverter Ratio (Kr) using LTspice / pspice software. **Applications:** Design of nMOS and CMOS inverter circuit. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=eqnMAaYU4OY https://www.youtube.com/watch?v=zNqmohJHDwc	
UNIT-III	
MOS Circuit Design Process: MOS layers, stick diagrams, design rules and layout, 2ìm, 1.2ìm 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. **Laboratory Sessions/ Experimental learning:** **1.** Draw layout of inverter using Cadence Tool **Applications:** Design of CMOS inverter circuit with different scaling functions. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117106093/ 1. https://nptel.ac.in/courses/117106092/ 2. https://nptel.ac.in/courses/117101058/	**8 Hrs**
UNIT-IV	
Sub System Design and Layout: 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,	**8 Hrs**

Design of an ALU subsystem. **Laboratory Sessions/ Experimental learning:** 1. Design Manchester Carry-chain using CMOS transistors using any CAD tool **Applications:** Designing of PLA and PLD **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117106093/ 2. https://nptel.ac.in/courses/117106092/ https://nptel.ac.in/courses/117101058/	
UNIT-V	
Test and Testability: 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. **Laboratory Sessions/ Experimental learning:** 1. Perform a survey on Prime Time CAD tool from any open source software for timing Analysis. **Applications:** Testing of Imperfections in chip fabrication. **Video link / Additional online information:** 1. https://youtu.be/V-GL-oQSa14 (Fault design & Testability) 2. https://youtu.be/P7AQJn7K8Os(Combinational Circuit Test Pattern Generation-ATPG)	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
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.

Reference 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.
4	Douglas A Pucknell & Kamran Eshragian, “Basic VLSI Design”, PHI 3rd Edition, (original Edition – 1994).

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 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**	**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

Semester: VI		
SATELLITE COMMUNICATION		
Course Code:	**MVJ22IO631**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Provide a conceptual knowledge of communication through satellites.	
2	Study of electronic systems associated with a satellite and the earth station.	
3	Understand typical challenges of satellite-based systems.	
4	Study satellite applications focusing various domains services such as remote sensing, weather forecasting and navigation.	
5	Learn the basic principle of radar equation.	

UNIT 1	
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	**8Hrs.**
UNIT 2	
Elements of Communication Satellite Design: Satellite subsystems - Attitude and orbit control electronics - Telemetry and tracking - Power subsystems - Communication subsystems - Satellite antennas - Reliability and redundancy- Frequency modulation techniques.	**8Hrs.**

Digital Transmission Basics - Multiple access techniques – FDMA, TDMA, CDMA, SDMA, ALOHA and its types – Onboard processing- Satellite switched TDMA – Spread spectrum transmission and reception for satellite networks. **Laboratory Sessions/ Experimental learning:** 1. Investigate the design elements that ensure high reliability and fault tolerance in satellite communication systems. Consider redundancy mechanisms, power backup systems, and error correction techniques to minimize system downtime. **Applications:** Mobile Communication **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://vvvnu.youtube.com/watch?v=FTHt-c8hWKw	
UNIT 3	
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	**8Hrs.**
UNIT 4	
Introduction to Radar: Radar block diagram and operation, Radar frequencies, Applications of radar, Prediction of range performance, Minimum detectable signal,	**8Hrs.**

Receiver noise, Probability density function, SNR, Integration of radar pulses, Radar cross-section of targets, PRF and range ambiguities, Transmitter power, System losses. Electronically steered Phased Array Antenna in Radar: Phase shifters, Frequency scan arrays, Array elements, Feeds for arrays, Computer Control of Phased-Array Radar. **Laboratory Sessions/ Experimental learning:** 1. Implement the radar range equations for remote sensing. **Applications:** Ground surveillance, missile control, fire control, air traffic control (ATC), moving target indication (MTI). **Video link / Additional online information:** 1. https://onlinecourses.nptel.ac.in/noc19_ee58/preview **2.** https://nptel.ac.in/courses/108/105/108105154/	
UNIT 5	
Radar Technology and Applications: 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. Tracking radar: sequential lobing, conical scan, Monopulse: amplitude comparison and phase comparison methods, Radar antennas. Radar displays. **Laboratory Sessions/ Experimental learning:** 1. Study the implementation and importance of MTI radar with Power amplifier. **Applications:** Ground surveillance, weapons location, and vehicle search **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105154/ 2. https://youtu.be/XFapyIIzX_8 3. https://freevideolectures.com/course/5299/introduction-radar-systems/42	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to

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

Reference Books:	
1.	T. Pratt, C.W. Boastian and Jeremy Allnutt, “Satellite Communication”, 2013, 2nd edition, John Wiley and Sons, Bangalore, India.
2.	Anil K Maini, Varsha Agrawal, Satellite Communication, Wiley India Pvt. Ltd., 2015, ISBN: 978-81265-2071-8.
3.	Merril. I. Skolnik, “Introduction to Radar Systems”, 2/e, MGH, 1981.
4.	Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 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												
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**

CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
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: VI		
Network and Cyber Security		
Course Code:	**MVJ22IO632**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Know about security concerns in Email.	
2	Understand the security factors in Internet Protocol.	
3	Understand cyber security concepts.	
4	List the problems that can arise in cyber security.	
5	Discuss the various cyber security frame work.	

UNIT 1	
Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH) **Laboratory Sessions/ Experimental learning:** 1. Study of HTTP client server 2. Study of SSH session with a laboratory router **Applications:** Encrypting the communication between web applications and servers, in VOIP, Video, Audio. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=tcQQ9A8M2L0 2. https://www.youtube.com/watch?v=LcdlBTYe6vo	8Hrs.
UNIT 2	
E-mail Security: Pretty Good Privacy, S/MIME, Domain keys identified mail **Laboratory Sessions/ Experimental learning:** 1. Study "How to make strong passwords" and "passwords cracking techniques". 2. Analysis of the security vulnerabilities of E-Mail Application. **Applications:** Security of confidential data, Improve spam and phishing protection for mail. **Video link / Additional online information:** 1. https://archive.nptel.ac.in/courses/106/106/106106234/ 2. https://heimdalsecurity.com/blog/email-security/	8Hrs.

UNIT 3	
IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations Internet Key Exchange. Cryptographic Suites **Laboratory Sessions/ Experimental learning:** **1.** Study the steps to hack a strong password. **2.** Study the Kali Tools for Cryptography. **Applications:** Remote Internet Access security. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=ipQkQopBLfU 2. https://www.youtube.com/watch?v=gtFZMvqXD1g	8Hrs.
UNIT 4	
Cyber network security concepts: Security Architecture, anti pattern: signature based malware detection versus polymorphic threads, document driven certification and accreditation, policy driven security certifications. Refactored solution: reputational, behavioural and entropy based malware detection. The problems: cyber anti patterns concept, forces in cyber anti patterns, cyber anti pattern templates, cyber security anti pattern catalog **Laboratory Sessions/ Experimental learning:** 1. Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures. 2. Demonstrate intrusion detection system (ids) using any tool (snort or any other s/w) **Applications:** Network and software security, Security against DDOS **Video link / Additional online information :** 1. https://www.simplilearn.com/tutorials/cyber-security-tutorial/what-is-cyber-security 2. https://onlinecourses.nptel.ac.in/noc23_cs127/preview	8Hrs.
UNIT 5	
Cyber network security concepts contd. : Enterprise security using Zachman framework Zachman framework for enterprise architecture, primitive models versus composite	8Hrs.

models, architectural problem solving patterns, enterprise workshop, matrix mining, mini patterns for problem solving meetings. Case study: cyber security hands on – managing administrations and root accounts, installing hardware, reimaging OS, installing system protection/ antimalware, configuring firewalls **Laboratory Sessions/ Experimental learning:** 1. Analysis the Security Vulnerabilities of E-commerce services. **Applications:** Security of enterprise applications. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=PHTGKqj8L0U 2. https://www.youtube.com/watch?v=lWMaUc1rJgM	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain network security protocols
CO2	Understand the basic concepts of cyber security
CO3	Discuss the cyber security problems
CO4	Explain Enterprise Security Framework
CO5	Apply concept of cyber security framework in computer system administration

Reference Books:	
1.	William Stallings, Cryptography and Network Security Principles and Practice, Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-3251877-3.
2.	Thomas J. Mowbray, Cyber Security – Managing Systems, Conducting Testing, and Investigating Intrusions, Wiley.
3.	Cryptography and Network Security, Behrouz A. Forouzan, TMH, 200
4.	Cryptography and Network Security, Atul Kahate, TMH, 2003

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	2	2	-	1	-	-	1	-	-	1
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: VI		
VIRTUAL & AUGMENTED REALITY		
Course Code:	**MVJ22IO633**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**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.	

Module-1	
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.**
Module-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 , Mechanical Trackers , Ultrasonic Trackers , Navigation and Manipulation Interfaces , Tracker-Based	**8Hrs.**

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/	
Module-3	**8Hrs.**
The Human behind the lenses: Human Perception and Cognition , The Human Visual System, VR Health and Safety Issues, Effects of VR Simulations on Users , Cyber sickness, before and now Guidelines for Proper VR Usage. **Laboratory Sessions/ Experimental learning:** 1. Create a well-rounded multisensory action that is meaningful, safe and accommodates all senses, visual, auditory and tactile. **Applications:** Human–Computer Interaction**,** e-Sports, Games**,** Cultural heritage **Video link / Additional online information:** https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/	
Module-4	**8Hrs.**
Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems. **Laboratory Sessions/ Experimental learning:** 1. Experiment with Photo grammetry and improve the visual look and feel of your environment	

Applications: Healthcare **Video link / Additional online information:** https://www.coursera.org/learn/ar-technologies-video-streaming	
Module-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:** 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.

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

High-3, Medium-2, Low-1

Semester:VI		
Digital Image Processing		
Course Code:	**MVJ22IO634**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Learn the fundamentals of digital image processing	
2	Understand the image transforms and other image enhancement techniques used in digital image processing.	
3	Study the image restoration techniques and methods used in digital image processing	
4	Understand region-based segmentation, representation and descriptions	
5	Know the color fundamentals and various morphological image processing techniques	

UNIT 1	
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 **Applications of Image Processing:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB **Applications:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Video link / Additional online information :** **1.** https://nptel.ac.in/courses/117/105/117105079/ **2.** https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**

UNIT 2	
Image Enhancement in the Spatial Domain: Some Basic Relationships Between Pixels, Linear and Nonlinear Operations, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain:** Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications:** Image Enhancement, Image Analysis **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 3	
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering **Laboratory Sessions/ Experimental learning:** **1.** Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications:** Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**

UNIT 4	
Segmentation: Point, Line, and Edge Detection: Detection of Isolated Points, Line Detection, Edge Models, Basic Edge Detection, Advanced Technique for Edge Detection, Thresholding: Optimum Global Thresholding Using Otsu's Method, Region-Based Segmentation: Region growing, Region splitting and merging **Representation and Description:** Representation, Boundary descriptors. **Laboratory Sessions/ Experimental learning:** **1.** Develop and implement a matlab code for Image segmentation using thresholding technique. **Applications:** Object tracking, Pattern recognition **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2 . https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 5	
Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing. **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of multimodal image fusion using MATLAB. **Applications:** Color conversion, Object marking **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
Course Outcomes: After completing the course, the students will be able to	

CO1	Analyze image processing algorithms used for sampling and quantization.
CO2	Apply and analyze image processing techniques in both the spatial and frequency (Fourier) domains.
CO3	Implement and analyse various image restoration algorithms
CO4	Design image analysis techniques for image segmentation and evaluate the methodologies for segmentation.
CO5	Conduct independent study and analyze various Morphological Image Processing techniques.

Text Books:

1.	Rafel C Gonzalez and Richard E. Woods, "Digital Image Processing"-, PHI 3rd Edition, 2010.
2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, —"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, Fourth Edition, 2013, ISBN: 978-81-315-1883-0

Reference Books:

1.	S.Jayaraman, S.Esakkirajan, T.Veerakumar, "Digital Image Processing"- Tata McGraw Hill 2014.
2.	A. K. Jain, "Fundamentals of Digital Image Processing"- Pearson 2004.

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**	**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

Semester:VI		
Real Time Operating Systems		
Course Code:	**MVJ22IO641**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Acquire knowledge about concepts related to OS for Embedded Systems.	
2	Gain knowledge about different types of scheduling algorithms suitable for embedded real time systems.	
3	Introduce the principles of Inter process communication and multitasking applications.	
4	Explain the architecture of Linux Kernel and RTOS applications to Linux.	
5	Discuss Real-Time Programming in Linux and µC linux	

Module-1	
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/	**8Hrs.**
Module-2	
µC/OS- II RTOS Concepts: Foreground/Background process, Resources, Tasks, Multitasking, Priorities, Schedulers, Kernel, Exclusion, Inter task communication, Interrupts, Clock ticks, µC/OS- II Kernel structure , µC/OS- II Initialisation, Starting µC/OS-	**8Hrs.**

II. **Laboratory Sessions/ Experimental learning:** 1. Write an Keil RTOS code that demonstrates the multitasking priority. 2. Write an Keil RTOS code that assigns priority and sets the time slice period to illustrate time slicing. **Applications:** 1. Email Spam and Malware Filtering 2. File Managers and Resource management systems **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106198/ http://www.nptelvideos.in/2012/11/real-time-systems.html	
Module-3	
µC/OS- II RTOS Functions: Task Management, Time management, Semaphore management, Mutual exclusion semaphore, Event Management, Message management, Memory management, porting µC/OS- II – comparison and study of various RTOS like QNX- VX Works-Psos. **Laboratory Sessions/ Experimental learning:** **1.** Write an Keil RTOS code to manage tasks to handle semaphore to overcome mutual exclusion. **2.** Demonstrate Porting of µC/OS- II in Embedded processor. **Applications:** Traffic light controller system **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105215/ https://nptel.ac.in/courses/106/105/106105172/	**8Hrs.**
Module-4	
Embedded Linux: Embedded Linux, Features - Embedded Linux Distributions -Architecture of Embedded Linux - Linux Kernel Architecture – User Space -Root File System - Linux Start-Up Sequence - GNU Cross Platform Tool chain -Porting Traditional RTOS Applications to Linux. **Laboratory Sessions/ Experimental learning:** 1. Write an application that display two different messages in LCD display in	**8Hrs.**

two lines. **Applications:** Smart Mobile Phone operating system development process demonstration. **Video link / Additional online information:** 1. http://1.https//nptel.ac.in/courses/11706087/ https://nptel.ac.in/courses/106/106/106106198/	
Module-5	**8Hrs.**
Real time Linux: Linux and Real-Time, Real-Time Programming in Linux, Hard Real-Time Linux - Building and Debugging, Building the Kernel, Integrated Development Environment, Kernel Debuggers, Embedded Drivers, Boardsupport packages, Introduction to µC linux. **Laboratory Sessions/ Experimental learning:** 1. Creating and UART driver for USB bus. **Applications:** Demonstration of ABS system in automobiles **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102059/ 2. http://www.nptelvideos.in/2012/11/real-time-systems.html https://www.youtube.com/watch?v=HlU5cYqGLZE	

Course outcomes:	
CO1	Summarize fundamental principles for programming of real time systems with time and resource limitations.
CO2	Develop RTOS based embedded real time applications.
CO3	Analyze the functions of real time operating systems .
CO4	Utilize RTOS software tool chain for Embedded Applications.
CO5	Develop real time kernals and Embedded Drivers.
Text Books:	
1.	Krishna C.M., Kang G. Shin, “Real Time Systems”, Tata McGraw-Hill 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.

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**	**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:VI		
Sensor Technology		
Course Code:	**MVJ22IO642**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand various technologies associated in manufacturing of sensors	
2	Provide better familiarity with different sensors and their applications in real life.	
3	Acquire knowledge about types of sensors used in modern digital systems.	
4	Evaluate the technological and physical limitations of a specific sensor.	
5	Propose a suitable sensor for a given measurement situation.	

Module-1	
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/ https://nptel.ac.in/courses/108/108/108108147/	**8Hrs.**
Module-2	
Primary sensors: Temperature sensors, Pressure sensors, Flow-velocity and flow-rate sensors, Level sensors, Force and torque sensors, Acceleration and inclination sensors and Velocity sensors. **Resistive Sensors:** Resistive Temperature Detectors (RTDs),Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas sensors.	**8Hrs.**

Laboratory Sessions/ Experimental learning: 1. Strain measurement with Bridge circuit **Applications:** Patient monitoring in medical applications, Manufacturing and industrial equipment and motorsport applications. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105064/ https://nptel.ac.in/courses/108/106/108106165/	
Module-3	**8Hrs.**
Reactance Variation and Electromagnetic Sensors: 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. **Laboratory Sessions/ Experimental learning:** 1. Develop a displacement measurement system with inductive sensors (LVDT) **Applications:** Smart phones, Industrial automation, Communication, automobile and aerospace. **Video link / Additional online information:** https://nptel.ac.in/courses/108/105/108105064/	
Module-4	**8Hrs.**
Self-Generating sensors: Thermoelectric sensors, Piezoelectric sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors, Proximity sensors. **Laboratory Sessions/ Experimental learning:** 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:** https://nptel.ac.in/courses/108/105/108105064/	
Module-5	**8Hrs.**
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/ https://nptel.ac.in/courses/112/103/112103174/	

Course outcomes:	
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
Text Books:	
1.	Ramon Pallas & John G.Webster, "Sensors and signal conditioning", John Wiley & Sons., 2nd Ed.,2001.
2.	J. Fraden, "Handbook of Modern Sensors: Physical, Designs, and Applications", AIP Press, Springer, 3rd Ed.,2004.
Reference Books:	
1.	D. Patranabis, "Sensors and Transducers", PHI Publication, 2nd Ed.,2004 New Delhi.
2.	Webster John G, "Instrumentation and sensors Handbook", CRC Press, 1st Ed., 1999.
3.	Shawhney A.K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 1994.

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	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

Semester:VI		
Principles of Communication Systems		
Course Code:	**MVJ22IO643**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand and analyze the concepts of Analog Modulation schemes viz; AM, FM.	
2	Learn the concepts of digitization of signals viz; sampling, quantizing and encoding.	
3	Realize the basic concepts of various digital modulation techniques.	
4	Study the principles behind information theory and coding.	
5	Understand the basics of spread spectrum modulation.	

Module-1	
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	**8Hrs.**
Module-2	**8Hrs.**
Pulse Modulation: Low pass sampling theorem, Quantization, PAM, Line coding, PCM, DPCM, DM, and ADPCM and ADM, Channel Vocoder, Time Division Multiplexing, Frequency Division	

Multiplexing. **Laboratory Sessions/ Experimental learning:** 1. Delta modulation using Matlab **Applications:** Speech recognition systems, pattern recognition systems, digital audio in computers, CDs, digital telephony, telephone and radio communications, television systems. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/ 3. https://youtu.be/s6vlXP3mYXk 4. https://youtu.be/HlGJ6xxbz8s	
Module-3	
Digital Modulation And Transmission: Phase shift keying, BPSK, DPSK, QPSK, Principles of M-ary signaling M-ary PSK & QAM, Comparison, ISI Pulse shaping, Duo binary encoding, Cosine filters, Eye pattern, equalizers. **Laboratory Sessions/ Experimental learning:** 1. Eye diagram using Matlab 2. Generation of BPSK Using LabVIEW **Applications:** LAN, CDMA, WiMAX**,** wireless communication, mobile communication, Satellite Communication, Bluetooth, RFID. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105077/ **2.** https://nptel.ac.in/courses/117/101/117101051/	**8Hrs.**
Module-4	
Information Theory and Coding: 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. **Laboratory Sessions/ Experimental learning:** 1. Huffman coding using Matlab **Applications:** Data Compression, audio/video transmission, data transmission and file transfer	**8Hrs.**

Video link / Additional online information: **1.** https://nptel.ac.in/courses/108/102/108102117/ **2.** https://nptel.ac.in/courses/117/104/117104129/	
Module-5	**8Hrs.**
Spread Spectrum Multiple Access Techniques: PN sequences, properties, m-sequence, DSSS – Processing gain, Jamming, FHSS, Synchronization and tracking, Multiple Access FDMA, TDMA, CDMA. **Laboratory Sessions/ Experimental learning:** 1. Direct Sequence Spread spectrum Signal Generation & Detection using Matlab **Applications:** CDMA, Wi-Fi, WPAN, etc., **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/ **3.** https://nptel.ac.in/courses/117/105/117105136/ **4.** https://youtu.be/Ojmv3I4kDn4	

Course outcomes:	
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.
2.	B.P.Lathi, “Modern Digital and Analog Communication systems”, 3rd edition, Oxford University

	Press, 2007
3.	H P Hsu, Schaum Outline Series – "Analog and Digital Communications" TMH 2006
4.	B.Sklar, "Digital Communications Fundamentals and Applications" 2/e Pearson Education 2007
5.	K Giridhar, "Information Theory And Coding", 4th Edition, Pooja Publication, Bangalore, 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**	**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

Semester:VI		
Introduction To MATLAB & SIMULINK		
Course Code:	**MVJ22IO644**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**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	To acquaint the student with some of the terminology in this very new field and relate it to the basic engineering process of design.	
3	To provide an introduction to the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.	
4	To develop the skills to analyse and break down an engineering program and solve it orithmically using MATLAB	

Module-1	
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	**8Hrs.**
Module-2	
Solving Equations, Curve Fitting, and Numerical Techniques :Linear Algebra, Polynomials, Optimization, Differentiation/Integration, Differential Equations	**8Hrs.**

Advanced Methods: Probability and Statistics, Data Structures, Images, File I/O **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=14H4UFoxZjs https://www.youtube.com/watch?v=fqS873TnMDs	
Module-3	**8Hrs.**
Various functions and toolboxes: Documentation, Misc. Useful Functions, Graphical User Interfaces, Simulink, Symbolic Toolbox **Applications:** App Designing using GUI, Image processing **Video link / Additional online information:** 1. https://in.mathworks.com/matlabcentral/fileexchange/44634-design-of-graphical-user-interface-application-with-matlab https://in.mathworks.com/videos/app-designer-overview-1510748719083.html	
Module-4	**8Hrs.**
Prerequisites: *Types of filters* **Introduction to SIMULINK:** 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); **Laboratory Sessions/ Experimental learning:** **1.** Create a spreadsheet file with some data (or use an existing spreadsheet with data if you have) and import the data into MATLAB. 2. Matlab 2D and 3D Plot **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=iOmggewj5XI 2. https://in.mathworks.com/learn/tutorials/simulink-onramp.html 3. https://www.halvorsen.blog/documents/teaching/courses/matlab/matlab3.php https://www.youtube.com/watch?v=EW544PfgBrs	
Module-5	**8Hrs.**
Applications of Matlab: Diode Characteristics, Fourier Analysis, Signal Processing, Deep learning, Image processing **Laboratory Sessions/ Experimental learning:**	

1. Image Enhancement Using Intensity Transformations, 2. Morphological and Other Set Operations **3.** Two-Dimensional Fast Fourier Transform **Video link / Additional online information:** 1. https://in.mathworks.com/videos/image-processing-and-computer-vision-in-matlab-and-simulink-96760.html https://in.mathworks.com/videos/introduction-to-deep-learning-and-applications-in-image-processing-1606855547622.html	

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.

Text Books:	
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.
Reference Books:	
1.	S. Salivahanan, C. Gnanpriya, Digital Signal processing , McGraw Hill

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**	**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

PROJECT PHASE – I		
Course Code:	**MVJ22IOP65**	**CIE Marks:100**
Credits:	**L:T:P: 0:0:4**	**SEE Marks: 100**
Hours:	**-**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To support independent learning.	
2	To develop interactive, communication, organization, time management, and presentation skills.	
3	To impart flexibility and adaptability.	
4	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

Semester: VI		
VLSI Laboratory		
Course Code:	**MVJ22IOL66**	**CIE Marks: 50**
Credits:	**L:T:P:0:0:2**	**SEE Marks: 50**
Hours:	**20**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Explore the CAD tool and understand the flow of the Full Custom IC design cycle.	
2	Learn DRC, LVS and Parasitic Extraction of the various designs.	
3	Design and simulate the various basic CMOS analog circuits and use them in higher circuits like data converters using design abstraction concepts.	
4	Design and simulate the various basic CMOS digital circuits and use them in higher circuits like adders and shift registers using design abstraction concepts	

PART A
ASIC Digital Design
1.Write Verilog Code for **inverter** 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. 2. Write Verilog Code for **buffer** 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. 3. Write Verilog Code for **Transmission Gate** 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. 4.Write Verilog Code for **Basic/universal gates** 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. 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. 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.

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.

PART B

Analog Design

1.Design an Inverter with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) DC Analysis ii) Transient Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS

Verify & Optimize for Time, Power and Area to the given constraint

2. Design the Common source amplifier with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

3. Design the Common Drain amplifier with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

4. Design a Single Stage differential amplifier, with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

5. Design an Operational-amp with given specification using given differential amplifier Common source and Common Drain amplifier in library and completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii). AC Analysis
- Draw the Layout and verify the DRC, ERC

• Check for LVS • RC extraction

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.

CO-PO Mapping												
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

B.E, VII Semester, Industrial Internet of Things

Semester: VII		
PYTHON FOR IOT		
Course Code: MVJ22IO71		**CIE Marks:50**
Credits: L:T:P: 3:0:2		**SEE Marks: 50**
Hours:40 L+ 26 P		**SEE Duration: 03Hours**
Course Learning Objectives: The students will be able to		
1	To know the basics of Python Programming and to read and write simple Python programs with expression and statements.	
2	To develop Python programs with conditionals and loops.	
3	To define Python functions and call the function.	
4	To implement Python Programming in Arduino.	
5	To Understand the Python programming for Data Science.	

UNIT-I	
Prerequisite: *Basic mathematical calculation skills and logical skills* **The Context of Software Development:** Software, Development Tools, Learning Programming with Python, The Python Interactive Shell. Values and Variables, Integer and String Values, Variables and Assignment, Identifiers, Floating-point Numbers, Control Codes within Strings, User Input, Controlling the print, String , Multi-line Strings Writing a Python Program and a Longer Python program. **Laboratory Sessions/ Experimental learning:** Print "Python foundation for IIOT Engineering" by executing python programming. **Applications:** Printing of Results from the modules. **Video link / Additional online information:** https://pythonprogramming.net › introduction-learn-python-3-tutorials	**8 Hrs**
UNIT-II	
Expressions and Arithmetic: Expressions; Mixed Type Expressions; Operator Precedence and Associativity; Formatting Expressions; Errors; Syntax Errors; Run-time Exceptions; Logic Errors ; Arithmetic Operators; **Conditional Execution:** Boolean Expressions, Statements, Compound Boolean Expressions, Floating-point Equality, Nested Conditionals, Multi-way Versus Sequential Conditionals, Conditional Expressions, Errors, Logic Complexity **Laboratory Sessions/ Experimental learning:** Find the Greatest Number among "12345, 32145 and 23154" by executing python programming. **Applications:** Arithmetic / Conditional Operations	**8 Hrs**

Video link / Additional online information: https://www.coursera.org/lecture/interactive-python-1/arithmetic-expressions-rMvoA	
UNIT-III	
Iterations And Functions; Iteration: While Statement; Definite Loops vs Indefinite Loops; for Statement; Nested Loops; Abnormal Loop Termination; while/else and for/else; Infinite. **Functions:** Introduction to Using Functions; Functions and Modules ; Function Basics ; Types of Functions; Parameter Passing ; Documenting Functions and Custom Functions vs. Standard Functions Turtle Graphics ; Techniques for Importing Functions and Modules; Writing Functions. **Laboratory Sessions/ Experimental learning:** Compute Square Root, drawing a Tree, Printing Prime Numbers and Insisting on Proper Input by using Iterations. **Applications:** Iterative operations can be implemented Video link / Additional online information: https://www.codementor.io/@kaushikpal/user-defined-functions-in-python-8s7wyc8k2	**8 Hrs**
UNIT-IV	
Lists, Tuples, Dictionaries; Lists: list operations, slices, methods and parameters; **Tuples:** tuple assignment, tuple as return value; **Dictionaries:** operations and methods. **Arduino with Python:** Introduction to Arduino programming History; Why Arduino; Arduino variants; Comments; Variables; Constants; Data types; Conversions; Functions and statements; setup function; loop function; pin Mode function; Working with pins; Statements **Laboratory Sessions/ Experimental learning:** How to apply the Firmata Protocol and to connect the Arduino board for python programming execution. **Applications:** Implementation of modules in Aurdino board **Video link / Additional online information :** https://www.electronicshub.org/arduino-rf-transmitter-receiver-module/	**8 Hrs**
UNIT-V	
Data Science and Python: Considering the emergence of data science; Outlining the core competencies of a data scientist; Linking data science and big	**8 Hrs**

data ;Understanding the role of programming ; Creating the Data Science Pipeline ; Understanding Python's Role in Data Science; Considering the shifting profile of data scientists; Working with a multipurpose, simple, and efficient language; Learning to Use Python Fast. **Laboratory Sessions/ Experimental learning:** How to Load, Train and View a simple model using python programming. **Applications:** Machine Learning Project in Python **Video link / Additional online information:** https://data-flair.training/blogs/train-test-set-in-python-ml/	

1. Print all the Disarium numbers between 1 and 100.
2. Encrypt the text using Caesar Cipher technique. Display the encrypted text. Prompt the user for input and the shift pattern.
3. Perform Jump Search for a given key and report success or failure. Prompt the user to enter the key and a list of numbers.
4. The celebrity problem is the problem of finding the celebrity among n people. A celebrity is someone who does not know anyone (including themselves) but is known by everyone. Write a Python program to solve the celebrity problem.
5. Construct a linked list. Prompt the user for input. Remove any duplicate numbers from the linked list.
6. Traverse a path and display all the files and subdirectories in each level till the deepest level for a given path. Also, display the total number of files and subdirectories
7. How to create a menu drive with a dictionary for words and their meanings. How to add the Write functions to add a new entry (word: meaning), search for a particular word and retrieve meaning, given meaning find words with the same meaning, remove an entry, display all words sorted alphabetically.
8. Identify a word with a sequence of one upper case letter followed by lower case letters.

Plot the Line chart in MS Excel Sheet using Xlsx Writer module to display the annual net income of the companies.Design of Thickener

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Basics of Python Programming
CO2	Implement the expression, conditional executions in Python flow.
CO3	Understand the iterations and functions in Python Programming.
CO4	Implement the Python Programming in Arduino.
CO5	Demonstrate python proficiency in handling Data Science.

Text Books:

1.	Fundamentals of Python Programming, Richard L. Halterman, Southern Adventist University, Year: 2019
2.	Python Programming for Arduino, Pratik Desai ,Packt Publishing Ltd, 2015.
3.	Python for Data Science by Luca Massaron and John Paul MuellerPublished by: John Wiley & Sons, Inc., 2015.
Reference Books:	
1.	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)

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 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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

High-3, Medium-2, Low-1

Semester: VII		
Artificial Intelligence		
Course Code:	**MVJ22IO72**	**CIE Marks:50**
Credits:	**L: T:P: 3:0:2**	**SEE Marks: 50**
Hours:	**40L+26L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Describe the basic principles, techniques, and applications of Artificial Intelligence	
2	Analyze and explain different AI learning methods.	
3	Compare and contrast different AI techniques available.	
4	Understanding the minimax algorithm.	
5	Apply the concept of NLP algorithms	

UNIT 1	
INTRODUCTION: What Is AI? The Foundations of Artificial Intelligence ,The History of Artificial Intelligence, The State of the Art . Intelligent Agents : Agents and Environments ,Good Behaviour: The Concept of Rationality ,The Nature of Environments, The Structure of Agents. Knowledge Representation Issues, Using Predicate Logic, Representing knowledge using Rules. **Experimental Learning:** Implementation of Relational and Inheritable Knowledge **Video Links** • https://www.youtube.com/watch?v=3MW3ICnkQ9k	8 Hrs.
UNIT 2	
The natural Language of Artificial Intelligence: Introduction, Converting English to Prolog Facts and Rules, Goals, Prolog Terminology, Variables, Control Structures, Arithmetic operators, Matching in Prolog, Backtracking, Cuts, Recursion, Lists, Dynamic databases, Input/Output and Streams **Using Predicate Logic:** Representing simple facts in logic, representing instance and ISA relationships, Computable Functions and Predicates, Resolution, Natural Deduction. **Experimental Learning:** Implementing programs in PROLOG to solve problems of Predicate Logic **Video Links:** • https://www.youtube.com/watch?v=pzUBrJLIESU • https://www.youtube.com/watch?v=2juspgYR7as • https://www.youtube.com/watch?v=h9jLWM2lFr0 https://www.youtube.com/watch?v=-v1K9AnkAeM	8 Hrs.
UNIT 3	
Heuristic search techniques: Generate and test, Hill Climbing, Best First Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis.	8 Hrs.

Weak Slot- and- Filler Structures: Semantic Nets,Frames. **Strong slot-and Filler Structures-** Conceptual Dependency, Scripts. **Experimental Learning**: Program to implement Best first Search, A*, AO* algorithm **Video Links:** • https://www.youtube.com/watch?v=ieZr_TpRwnQ https://www.youtube.com/watch?v=lCrHYT_EhDs	
UNIT 4	
Game Playing : Overview, Minimax Search Procedure, Adding alpha beta cut off, Additional Refinements, Iterative Deepening, References on Specific games. **Learning:** What is learning?, Forms of learning, Rote learning, learning by taking advice, Learning in problem solving, Induction leaning, Explanation based learning, Discovery, Analogy, Formal learning Theory, Neural Network Learning. **Experimental Learning** : Real time problem solving using Game Playing **Video Links**: • https://www.youtube.com/watch?v=_i-lZcbWkps https://www.youtube.com/watch?v=l-hh51ncgDI	8 Hrs.
UNIT 5	
Natural Language Processing: Syntactic Processing, Semantic Analysis, Discourse and Pragmatic processing, Statistical Natural language processing and Spell checking. **Genetic Algorithms**: A peek into the biological world, Genetic Algorithms (GAs), Significance of genetic operators, termination parameters, niching and speciation, evolving neural network, theoretical grounding. **Experimental Learning**: Program to implement spell checking problem **Video Links**: • https://www.youtube.com/watch?v=zG8AJhVy5NY https://www.youtube.com/watch?v=Z_8MpZeMdD4	8 Hrs.

LABORATORY SESSIONS:
1. Implement and Demonstrate Depth First Search Algorithm on Water Jug Problem 2. Implement and Demonstrate Best First Search Algorithm on any AI problem 3. Implement AO* Search algorithm. 4. Solve 8-Queens Problem with suitable assumptions 5. Implementation of TSP using heuristic approach

6. Implementation of the problem-solving strategies: either using Forward Chaining or Backward Chaining
7. Implement resolution principle on FOPL related problems
8. Implement any Game and demonstrate the Game playing strategies
9. Aim: Illustrate and Demonstrate the working model and principle of Find-S algorithm. Program: For a given set of training data examples stored in a .CSV file, implement and demonstrate the Find-S algorithm to output a description of the set of all hypotheses consistent with the training examples.
10. Aim: Demonstrate the working model and principle of candidate elimination algorithm. Program: For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
11. Aim: To construct the Decision tree using the training data sets under supervised learning concept. Program: 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.
12. Aim: To understand the working principle of Artificial Neural network with feed forward and feed backward principle. Program: Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
13. Aim: Demonstrate the text classifier using Naïve bayes classifier algorithm. Program: Write a program to implement the naive Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

Any 12 experiments to be conducted

Course Outcomes:

CO1	Identify AI based problems and understand Intelligent agents
CO2	Apply predicate logic and heuristic techniques to solve AI problems.
CO3	Understand the different representation of knowledge.
CO4	Understand the concepts of learning and Natural Language Processing.
CO5	Understand Genetic Algorithms and solve AI problems using PROLOG.

Text Books	
1.	Artificial Intelligence: A Modern Approach, Stuart Rusell, Peter Norving, Pearson Education 2nd Edition.
2.	E. Rich , K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.
3.	Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems – Prentice Hal of India.
Reference Books	
1	G. Luger, “Artificial Intelligence: Structures and Strategies for complex problem Solving”, Fourth Edition, Pearson Education, 2002.
2	N.P. Padhy “Artificial Intelligence and Intelligent Systems” , Oxford University Press-2015

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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO/PSO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	2	-	-	-	-	-	-	-	2	1	-
CO2	3	3	2	3	1	-	-	-	-	-	-	2	2	2
CO3	3	3	2	3	1	-	-	-	-	-	-	2	3	-
CO4	3	3	2	3	2	-	-	-	-	-	-	2	3	-
CO5	3	3	2	3	2	-	-	-	-	-	-	2	3	1

High-3, Medium-2, Low-1

Semester: VII		
Wireless Cellular and LTE 4G Broadband		
Course Code:	**MVJ22IO73**	**CIE Marks:50**
Credits:	**L:T:P:4:0:0**	**SEE Marks: 50**
Hours:	**50T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the basics of LTE standardization phases and specifications.	
2	Explain the system architecture of LTE and E-UTRAN, the layer of LTE, based on the use of OFDMA and SC-FDMA principles.	
3	Analyze the role of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer, for transferring the EPS bearer.	
4	Analyze the main factors affecting LTE performance including mobile speed and transmission bandwidth.	

UNIT 1	
Key Enablers for LTE features: OFDM, Single carrier FDMA, Single carrier FDE, Channel Dependent Multiuser Resource Scheduling, Multi antenna Techniques, IP based Flat network Architecture, LTE Network Architecture. **Wireless Fundamentals:** Cellular concept, Broadband wireless channel (BWC), Fading in BWC, Modeling BWC – Empirical and Statistical models, Mitigation of Narrow band and Broadband Fading. **Video link / Additional online information:** https://archive.nptel.ac.in/courses/117/102/117102062/	**10Hrs.**
UNIT 2	
Multicarrier Modulation: OFDM basics, OFDM in LTE, Timing and Frequency Synchronization, PAR, SC-FDE . **OFDMA and SC-FDMA:** OFDM with FDMA,TDMA,CDMA, OFDMA, SC-FDMA, OFDMA and SC-FDMA in LTE . **Multiple Antenna Transmission and Reception:** Spatial Diversity overview, Receive Diversity, Transmit Diversity, Interference cancellation and signal enhancement, Spatial Multiplexing, Choice between Diversity, Interference suppression and Spatial Multiplexing. **Video link / Additional online information:** https://archive.nptel.ac.in/courses/117/102/117102062/	**10Hrs.**

UNIT 3	
Overview and Channel Structure of LTE: Introduction to LTE, Channel Structure of LTE, Downlink OFDMA Radio Resource, Uplink L1, L2 146 SC-FDMA Radio Resource. **Downlink Transport Channel Processing:** Overview, Downlink shared channels, Downlink Control Channels, Broadcast channels, Multicast channels, Downlink physical channels, H-ARQ on Downlink. **Video link / Additional online information:** https://archive.nptel.ac.in/courses/117/102/117102062/	**10Hrs.**
UNIT 4	
Uplink Channel Transport Processing: Overview, Uplink shared channels, Uplink Control Information, Uplink Reference signals, Random Access Channels, H-ARQ on uplink. **Physical Layer Procedures:** Hybrid – ARQ procedures, Channel Quality Indicator CQI feedback, Precoder for closed loop MIMO Operations, Uplink channel sounding, Buffer status Reporting in uplink, Scheduling and Resource Allocation, Cell Search, Random Access Procedures, Power Control in uplink. **Video link / Additional online information:** https://archive.nptel.ac.in/courses/117/102/117102062/	**10Hrs.**
UNIT 5	
Radio Resource Management and Mobility Management: PDCP overview, MAC/RLC overview, RRC overview, Mobility Management, Inter-cell Interference Coordination **Video link / Additional online information:** https://archive.nptel.ac.in/courses/117/102/117102062/	**10Hrs.**

Course outcomes:	
CO1	Understand the system architecture and the functional standard specified in LTE 4G.
CO2	Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.
CO3	Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.

CO4	Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Text Books:	
1.	Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, 'Fundamentals of LTE', Prentice Hall, Communications Engg. and Emerging Technologies.
2.	LTE for UMTS Evolution to LTE-Advanced' Harri Holma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.
3.	'EVOLVED PACKET SYSTEM (EPS) ; THE LTE AND SAE EVOLUTION OF 3G UMTS' by Pierre Lescuyer and Thierry Lucidarme, 2008, John Wiley & Sons, Ltd. Print ISBN:978-0-470-05976-0.
4.	'LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, Issam Toufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

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

High-3, Medium-2, Low-1

Professional Elective Course:

Semester: VII		
WIRELESS SENSOR NETWORKS		
Course Code:	**MVJ22IO741**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To provide a basic understanding of the important aspects of Wireless sensor networks	
2	To provide a basic understanding of wireless sensor and transmission technology	
3	Understand about middleware, performance and traffic management.	
4	Understand communication protocols to be used for wireless sensor networks	
5	Apply the applications of WSN in various fields	

UNIT 1	
Wireless Sensor Networks: Introduction, applications of sensor networks, basic overview of the technology, basic sensor network architectural elements, present day sensor network research, challenges and hurdles, examples of Category 2 WSN applications, examples of Category 1 WSN applications. **Laboratory Sessions/ Experimental learning:** 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/	**8Hrs.**
UNIT 2	
Wireless sensor technology: Introduction, sensor node technology – overview, hardware and software, sensor taxonomy, WN operating environment, WN trends. **Wireless Transmission technology and systems:** Introduction, Campus applications, MAN/WAN applications. **Laboratory Sessions/ Experimental learning:** Assess real-world wireless network performance and metrics on maps using indoor and outdoor propagation scenarios and channel models using matlab	**8Hrs.**

Applications: Mobile communications through cell phones and satellites, Internet of Things (IoT) connecting various devices, wireless sensor networks for traffic management **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105160/	
UNIT 3	
Middleware for WSNs: Introduction, principles, architecture, data related functions Performance and traffic management: background, WSN Design issues, performance modelling of WSNs. **Laboratory Sessions/ Experimental learning:** To simulate a Wireless sensor networks using NS2 **Applications**: industrial process monitoring and control, machine health monitoring **Video link / Additional online information:** https://cse.iitkgp.ac.in/~smisra/course/wasn.html	**8Hrs.**
UNIT 4	
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:** 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/	**8Hrs.**
UNIT 5	
APPLICATIONS OF WSN WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military	**8Hrs.**

Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications **Laboratory Sessions/ Experimental learning:** Model a communication architecture of a sensor **Applications:** Military, Building automation **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=GUSrkWJ_Z2g	

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss the overview of the Wireless sensor networks characteristics and applications
CO2	Present the sensor, transmission technology and systems associated with WSN.
CO3	Understand the concepts of middleware, performance evaluation and traffic management in WSN.
CO4	Apply the knowledge to identify appropriate physical and MAC layer protocol
CO5	Understand the applications of WSN in various fields

Reference Books:	
1.	'Wireless Sensor Networks', Kazem Sohraby, Daniel Minoli and Taieb Znati, Wiley, 2015.
2.	Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 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**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
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: VII		
5G FUNDAMENTAL'S AND ARCHITECTURE		
Course Code:	**MVJ22IO742**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40 L**	**SEE Duration: 03 Hours**
Course Learning Objectives: The students will be able to		
1	Understand the essential principles of 5G communications	
2	Describe the 5G architecture and 5G Internet.	
3	Analyze the cognitive radio networks for 5G.	
4	Analyze the 5G spectrum crunch and security issues	

UNIT-I	
History of 5G: Historical background, 5G use cases, and system concept: Use case requirements, 5G system concept. **The 5G Architecture:** Introduction, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Physical architecture and 5G deployment	**8 Hrs**
UNIT-II	
Machine-type communications: Introduction, Fundamental techniques for MTC, Massive MTC, Massive MTC, Summary of uMTC features. **Device to Device (D2D) communications:** From 4G to 5G, Radio resource management for mobile broadband D2D, Multi-hop D2D communications for proximity and emergency services, Multi operator D2D communication	**8 Hrs**
UNIT-III	
The 5G radio-access technologies: Access design principles for multi-user communications, Multi-carrier with filtering: a new waveform, Non-orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication.	**8 Hrs**
UNIT-IV	
Relaying and wireless network coding: The role of relaying and network coding in 5G wireless networks, Multi-flow wireless backhauling, Highly flexible multi-flow relaying,Buffer-aided relaying.	**8 Hrs**

UNIT-V	
Mobility management in 5G, Dynamic network reconfiguration in 5G **Spectrum:** Introduction, 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies, Value of spectrum for 5G: a techno-economic perspective .	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the concepts of 5G networks and its architecture.
CO2	Analyze the spectrum optimization using cognitive radio in 5G network.
CO3	Analyze the white space spectrum opportunities and challenges.
CO4	Analyze the security issues and challenges in 5G communication systems.
CO5	Describe the concepts of 5G networks and its architecture.

Reference Books	
1.	5G Mobile and Wireless Communication Technology, AfifOsseran, Jose F Monserrat, Patrick Marsch, Cambridge University Press, 2016.
2.	Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, John Wiley & Sons 2015, ISBN: 9781118867525.
3.	5G Core Networks Powering Digitization, Stephen Rommer, Academic Press,2019 ISBN: 978-0-08-1030009-7.

Continuous Internal Evaluation (CIE):

Theory for 100 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 100 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**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

Semester: VII		
Optical Communication		
Course Code:	**MVJ22IO743**	**CIE Marks:50**
Credits:	**L:T:P:3:0:0**	**SEE Marks: 50**
Hours:	**40T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	The functionality of each of the components that comprise a fiber-optic communication system.	
2	The properties of optical fibre and the principles of single and multi-mode optical fibres and their characteristics.	
3	The operation of LEDs, laser diodes, and PIN photo detectors (spectral properties, bandwidth, and circuits) and apply in optical systems.	
4	The concept of power launch to Optical analog and digital receiver	
5.	The concepts of optical system design and WDM	

UNIT 1	
Overview of optical fiber communication - Historical development, The general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection, Acceptance angle, Numerical Aperture, Skew rays, Cylindrical fibers- Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index, Related problems.	**8Hrs.**
UNIT 2	
FIBER MATERIALS: Glass, Halide, Active glass, Chalgenide glass, Plastic optical fibers. Signal distortion in optical fibers-Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay.	**8Hrs.**
UNIT 3	
OPTICAL FIBER CONNECTORS-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints. **OPTICAL SOURCES AND DETECTORS:**	**8Hrs.**

Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED&ILD, Optical detectors-Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors, Related problems.	
UNIT 4	
Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling, Optical receiver operation-Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit, Analog receivers.	**8Hrs.**
UNIT 5	
Optical system design - Point-to- point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links, WDM, Necessity, Principles, Measurement of Attenuation and Dispersion, Eye pattern.	**8Hrs.**

Course outcomes:	
CO1	Understand the system architecture and the functional standard specified in LTE 4G.
CO2	Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.
CO3	Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
CO4	Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Text Books:	
1.	Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, 'Fundamentals of LTE', Prentice Hall, Communications Engg. and Emerging Technologies.
2.	LTE for UMTS Evolution to LTE-Advanced' Harri Holma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.

3.	'EVOLVED PACKET SYSTEM (EPS) ; THE LTE AND SAE EVOLUTION OF 3G UMTS' by Pierre Lescuyer and Thierry Lucidarme, 2008, John Wiley & Sons, Ltd. Print ISBN:978-0-470-05976-0.
4.	'LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, Issam Toufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

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.

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

High-3, Medium-2, Low-1

Semester: VII		
Soft Computing Techniques		
Course Code:	**MVJ22IO744**	**CIE Marks: 50**
Credits:	**L: T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40T**	**SEE Duration: 3 Hrs.**
Course Learning Objectives:		
1	Learn soft computing techniques and their applications.	
2	To introduce the concepts of fuzzy sets and fuzzy logic	
3	To make students familiar with neural networks	
4	Analyze various neural network architectures	
5	Apply soft computing techniques to solve problems	

UNIT-I	
Introduction to Soft Computing – Neural networks, Fuzzy logic, Gnetic algorithms, Hybrid systems and its applications, Fundamental concept of ANN, Evolution basic Model of ANN, Terminologies used in ANN, MP model, Hebb model. **Video Link**: https://nptel.ac.in/courses/106/105/106105173/	**8 Hrs**
UNIT-II	
Perception Network: Adaptive linear neuron, Multiple adaptive linear neurons, Back propagation Network (Theory, Architecture for training, learning factors, testing and applications of all the above NN models). **Video Link**: https://www.youtube.com/watch?v=xbYgKoG4x2g	**8 Hrs**
UNIT-III	
Introduction to Classical sets and Fuzzy sets: Classical relations and fuzzy relations, Membership functions – Fuzzy rules and Fuzzy Reasoning, Fuzzy Interference Systems, Fuzzy Expert Systems, Fuzzy Decision Making **Video Link:** https://nptel.ac.in/courses/108/104/108104157/	**8 Hrs**
UNIT-IV	
Defuzzification: Fuzzy decision making and applications. **Video Link:**	**8 Hrs**

https://nptel.ac.in/courses/127/105/127105006/	
UNIT-V	
Genetic Algorithms: Introduction, Basic operations, Traditional algorithms, Simple GA General genetic algorithms, The Schema theorem, Genetic programming, applications. Video Link: https://www.youtube.com/watch?v=Z_8MpZeMdD4	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Implement machine learning through neural networks
CO2	Understand Artificial neural networks and its applications
CO3	Develop a Fuzzy expert system
CO4	Model Neuro Fuzzy system for clustering and classification
CO5	Design Genetic Algorithm to solve the optimization problem

Reference Books	
1.	S.N.Sivanandam & S.N.Deepa "Principles of Soft Computing" Wiley India Pvt. Ltd., 2007 B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 44th Edition, 2013.
2.	J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI,2004, Pearson Education 2004.
3.	N. K. Sinha and M. M. Gupta, Soft Computing & Intelligent Systems: Theory & Applications-Academic Press /Elsevier. 2009
4.	R. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/Elsevier, 200

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

Open Elective Course

Semester: VII		
Medical Electronics		
Course Code:	**MVJ22IO751**	**CIE Marks:50**
Credits:	**L:T:P:3:0:0**	**SEE Marks: 50**
Hours:	**40T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Explain physiological parameters such as electrical, non-electrical and the recording methods.	
2	Learn the methods used for recording and measuring the biological signals.	
3	Illustrate the various Medical Imaging devices used in the hospitals.	
4	Explain the telemetry systems and know the safety aspects required in medical equipment.	
5.	Understand the various Therapeutic Devices and know about recent trends in medical system.	

UNIT 1	
Prerequisites: Basics of Transducer **Fundamentals of Physiology and Transducer:** Types of Bioelectric Potentials: Introduction to different types of bioelectric potentials, Action and resting potentials, Propagation of action potentials. Biological Systems: Nervous system and its fundamentals, Basic components of a biomedical system, Cardiovascular systems, Respiratory systems **Electrodes and Transducers in Medical systems:** Different type of electrodes, sensors used in biomedicine. Physiological signals and transducers, Piezoelectric Transducers, ultrasonic transducers, Temperature measurement, Fibre optic temperature sensors. Selection criteria for transducer and electrodes. **Laboratory Sessions/ Experimental learning:** 1. Practical applications of electrodes in medical field. Applications: Ultrasonic scanning devices, Measures skin and body temperature, Measures Respiratory rate	**8Hrs.**

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

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

Course outcomes:	
CO1	Analyse the operation and characteristics of Electronic devices and use of them in applications.
CO2	Evaluate the performance of electronic circuits.

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

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

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.

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

Semester: VII		
IoT and Wireless Sensor Networks		
Course Code:	**MVJ22IO752**	**CIE Marks:50**
Credits:	**L:T:P:3:0:0**	**SEE Marks: 50**
Hours:	**40T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Provide knowledge about IoT and M2M architecture.	
2	Understand various layers of IoT and their functionality.	
3	Describe Cloud computing and design principles of IoT	
4	Understand the architecture and design principles of WSNs.	
5.	Provide knowledge about MAC and routing protocols in WSN	

UNIT 1	
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/	**8Hrs.**
UNIT 2	
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	**8Hrs.**

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	
UNIT 3	
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	**8Hrs.**
UNIT 4	
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.	**8Hrs.**

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/	
UNIT 5	
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/	**8Hrs.**

Course outcomes:	
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.

Text Books:	
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.
4	Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor NetworksTechnology, Protocols, And Applications", John Wiley, 2007.
5	Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
6	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

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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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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

Semester: VII		
Digital Image Processing		
Course Code:	**MVJ22IO753**	**CIE Marks:50**
Credits:	**L:T:P:3:0:0**	**SEE Marks: 50**
Hours:	**40T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Learn the fundamentals of digital image processing	
2	Understand the image transforms and other image enhancement techniques used in digital image processing.	
3	Study the image restoration techniques and methods used in digital image processing	
4	Understand region-based segmentation and segmentation using morphological watersheds.	
5.	Know the color fundamentals and various morphological image processing techniques.	

UNIT 1	
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, **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB Applications: Medical imaging, Robot vision, Character recognition, Remote Sensing. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 2	
Spatial Domain: Some Basic Relationships Between Pixels, Linear and Nonlinear Operations, Some Basic Intensity Transformation Functions, Histogram Processing,	**8Hrs.**

Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain:** Filtering in the Frequency Domain, Image, Smoothing and Image Sharpening Using Frequency Domain Filters. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications:** Image Enhancement, Image Analysis **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ https://www.tutorialspoint.com/dip/index.htm	
UNIT 3	
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error(Wiener) Filtering. **Laboratory Sessions/ Experimental learning:** 1. Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications:** Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 4	
Segmentation: Point, Line, and Edge Detection: Detection of Isolated Points, Line Detection, Edge Models, Basic Edge Detection, Advanced Technique for Edge Detection, Thresholding: Optimum Global Thresholding Using Otsu's Method, Region-Based Segmentation: Region growing, Region splitting and merging **Laboratory Sessions/ Experimental learning:**	**8Hrs.**

Develop and implement a matlab code for Image segmentation using thresholding technique. **Applications:** Object tracking, Pattern recognition **Video link / Additional online information :** 1.https://nptel.ac.in/courses/117/105/117105079/ 2.https://www.tutorialspoint.com/dip/index.htm	
UNIT 5	
Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing. **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of multimodal image fusion using MATLAB. **Applications:** Color conversion, Object marking **Video link / Additional online information:** 1.https://nptel.ac.in/courses/117/105/117105079/ 2.https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**

Course outcomes:	
CO1	Analyze image processing algorithms used for sampling and quantization.
CO2	Apply and analyze image processing techniques in both the spatial and frequency (Fourier) domains.
CO3	Implement and analyse various image restoration algorithms
CO4	Design image analysis techniques for image segmentation and evaluate the methodologies for segmentation.
CO5	Conduct independent study and analyze various Morphological Image Processing techniques.

Text Books:	
1.	Rafel C Gonzalez and Richard E. Woods , “Digital Image Processing”-, PHI 3rdEdition 2010.

2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, –"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, 2013, ISBN: 978-81-315-1883-0
3.	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.

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**	**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

Semester: VII		
Robotics and Automation		
Course Code:	**MVJ22IO754**	**CIE Marks:50**
Credits:	**L:T:P:3:0:0**	**SEE Marks: 50**
Hours:	**40T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Study the history, concept development and key components of robotics technologies.	
2	Know the concept of interfacing actuators and other components	
3	Understand basic mathematics manipulations of spatial coordinate representation and transformation.	
4	Learn basic robot forward and inverse kinematic problems	
5.	Analyze basic robotic dynamics, path planning and control problems	

UNIT 1	
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/	**8Hrs.**
UNIT 2	
Robot drivers, Sensors and Vision : Vision Introduction to techniques, Image acquisition and processing, Different types of grippers- Mechanical, Magnetics ,vacuum, Adhesive, Gripper force Analysis & Gripper Design , overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors,	**8Hrs.**

DC motors and servomotors. **Laboratory Sessions/ Experimental learning:** 1. Interface motors using various Motor drivers. **Applications:** Industrial application, agriculture robots, surgical robots **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	
UNIT 3	
Robot Kinematics and Dynamics: 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. **Laboratory Sessions/ Experimental learning:** 1. Interface servo motors to form gripper. **Applications:** Pick and Place, Excavators, Robotic ARM. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	**8Hrs.**
UNIT 4	
Robot Kinematics: 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. **Laboratory Sessions/ Experimental learning:** 1. Design algorithm for Maze solving robot. **Applications:** Defence, Survillience, Autonomous Vehicle. **Video link / Additional online information:**	**8Hrs.**

1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	
UNIT 5	
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 Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot. Laboratory Sessions/ Experimental learning: 1. Robots in material handling and assembly. Human Robot Interaction **Applications:** Humanoid, Robotic Arms. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	**8Hrs.**

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 HilL
3	Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall India.

4	Robotics Technology and Flexible Automation by S.R.Deb, S. Deb, Tata McGraw Hill.
5	Robot Motion and Control (Recent Developments) by M.Thoma& M. Morari.

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**	**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

VII SEMESTER		
PROJECT PHASE – II		
Course Code:	**MVJ22IOP76**	**CIE Marks:100**
Credits:	**L:T:P:0:0:12**	**SEE Marks: 100**
Hours:	**-**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To support independent learning.	
2	To develop interactive, communication, organization, time management, and presentation skills.	
3	To impart flexibility and adaptability.	
4	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.	
5	To inspire independent and team working.	

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