B.E, III Semester, Electronics & Communication Engineering

Semester: III		
Transforms, and Numerical Methods		
Course Code:	MVJ21MA31D	CIE Marks: 50
Credits:	L: T:P: 3:2:0	SEE Marks: 50
Hours:	30L+20T	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Solve the linear differential equations using Laplace transforms	
2	Apprehend and apply Fourier transform	
3	Realize and use of Z-Transforms	
4	Use of numerical methods to solve ordinary differential equation	
5	Use of statistical methods in curve fitting applications.	

UNIT-I	
Laplace Transforms: Definition, Transforms of elementary functions, Properties, Periodic function, Unit step function. **Inverse Laplace Transforms:** Inverse Laplace Transforms, Convolution theorem to find inverse Laplace transform. Solution of linear differential equations using Laplace transforms **Self-study:** Solution of simultaneous first order differential equations. **Applications:** Analysis of electrical and electronic circuits, used in Signal processing and in control systems. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-II	
Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse. Fourier sine and cosine transforms, Convolution theorem **Self-study:** Complex form of Fourier series. **Applications:** Fourier transforms used in image **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-III	
Z-Transforms: Definition, standard Z-transforms, properties of Z-transforms- Shifting property, Reversal property, Multiplication by n,	8 Hrs

initial value and final value theorems. Inverse Z- transform, convolution theorem (proof and problems) Application of Z-transforms to solve difference equations. **Self-study:** Damping rule and problems on them. **Applications:** Fourier transforms used in image processing and Z-transforms in Digital signal processing. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	
UNIT-IV	
Numerical solution of ordinary differential equations: Numerical solution of first order and first degree; Taylor's series method, modified Euler's method, Runge-Kutta method of fourth-order. Milne's and Quadratic Spline Method. **Self-study:** Adams Bash-Method . **Applications:** To solve initial value problems **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-V	
Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression –problems. **Curve Fitting:** Curve fitting by the method of least squares, fitting of linear, quadratic and geometric curve. **Self-study:** A study of rank correlation. **Applications:** Applications of Correlation in Signal Processing and application of regression analysis in business **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Learn to solve linear differential equations using Laplace transforms
CO2	Demonstrate Fourier Transform as a tool for solving Integral equations
CO3	Learn to evaluate Z-transform to solve difference equations.
CO4	Learn to solve algebraic, transcendental and ordinary differential equations numerically.

CO5	Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data

Reference Books	
1.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 44th Edition, 2013.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition, 2014.
3.	Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17
4.	Ramana B. V., "Higher Engineering Mathematics", Tata McGraw-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	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

Semester: III		
NETWORK ANALYSIS		
Course Code:	MVJ21EC32	CIE Marks: 50
Credits:	L: T:P: 3:2:0	SEE Marks: 50
Hours:	30L+20T	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 and AC 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 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	**8 Hrs**
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 and AC excitations, Applications of Laplace Transforms in circuit analysis: Application to circuits. **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. **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	**8 Hrs**

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 AC 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.

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: III		
ELECTROMAGNETIC WAVES AND TRANSMISSION LINES (Theory)		
Course Code:	MVJ21EC33	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-I	
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-II	
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 4. https://youtu.be/hp9Jito4vPE	**8 Hrs**
UNIT-III	
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,	**8 Hrs**

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 **Video link / Additional online information :** 1. https://youtu.be/ebGM_q19gY0 2. https://youtu.be/uXQbYJVzlQ0 3. https://youtu.be/aYRBXI63Oqk	
UNIT-IV	
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-V	
Transmission line: Introduction, Transmission line parameters, Transmission line equations, input impedance, standing wave ratio and power, Smith Chart, 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.	**8 Hrs**

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 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: III		
Analog Electronic Circuits (Theory and Practice)		
Course Code:	MVJ21EC34	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	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.	

UNIT-I	
Prerequisites: *Transistor Biasing* **Transistor at Low Frequencies:** BJT transistor modeling, CE Fixed bias configuration, Voltage divider bias, Emitter follower, Analysis of circuits re model; **FET Amplifiers:** JFET small signal model, Fixed bias configuration, Self-bias onfiguration, Voltage divider configuration, Common Gate configuration, Source-Follower Configuration. **Laboratory Sessions/ Experimental learning:** 1. Plot the transfer and drain characteristics of a JFET and calculate its drain 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	8Hrs
UNIT-II	
Prerequisites: *Feedback Amplifier, Oscillators*	8Hrs

Feedback Amplifier: The Four Basic Feedback Topologies, The series-shunt, series-series, shunt-shunt and shunt-series amplifiers. **Oscillators:** Oscillator operation, FET based Phase shift oscillator, Wien bridge oscillator, LC and Crystal Oscillators. **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	
UNIT-III	
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. **Voltage Regulators:** Discrete transistor voltage regulation -Series and Shunt Voltage regulators. **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	8Hrs
UNIT-IV	
OP-Amps as DC Amplifiers : Direct coupled voltage followers, Non-inverting amplifiers, 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, Comparators, Zero Crossing Detector, Schmitt trigger. **Laboratory Sessions/ Experimental learning:**	8 Hrs

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	
UNIT-V	
Op-Amp Circuits: DAC - Weighted resistor and R-2R ladder, ADC- Successive approximation type, Small Signal half wave rectifier, 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 chip 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	
1. Design and set up the RC coupled Single stage BJT amplifier and determine the gain-frequency response, input and output impedances 2. Design and set up BJT Darlington Emitter follower without bootstrapping and determine the gain, input and output impedances. 3. Design and set-up BJT i) Colpitts Oscillator, and ii) Crystal Oscillator. 4. Design active second order Butterworth low pass and high pass filters. 5. Design Adder, Integrator and Differentiator circuits using Op-Amp 6. Test a comparator circuit and design a Schmitt trigger for the given UTP and LTP values and obtain the hysteresis. 7. Design 4 bit R – 2R Op-Amp Digital to Analog Converter (i) using 4 bit binary input from toggle switches and (ii) by generating digital inputs using mod-16 counter. 8. Design Monostable and Astable Multivibrator using 555 Timer. **Simulation using PSpice Software**	

9. RC Phase shift oscillator and Hartley oscillator
10. Precision Half and Full wave Rectifier
11. JFET Amplifier
12. Monostable and Astable Multivibrator using 555 Timer

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyse the frequency response of BJT Amplifier and FET amplifier
CO2	Design various Feedback amplifiers and oscillators using BJT/FET
CO3	Understand the classes of amplifiers and Voltage regulator
CO4	Describe DC amplifier, AC Amplifiers and 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

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Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the 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		
DIGITAL SYSTEM DESIGN WITH VERILOG (Theory and Practice)		
Course Code:	MVJ21EC35	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	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	Familiarize with Modern EDA tool such as Verilog.	
4	Acquire knowledge on different types of description in Verilog.	
5	Know the importance of Synthesis & 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, Karnaugh maps-3, 4 variables, 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 Pspice, a simulation tool. **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 Adder and Subtractor, Look ahead carry Adder, Binary comparators, Decoders & Multiplexers as minterm/maxterm Generator. **Introduction to Verilog** : Structure of verilog Module, Operators, Data types, Units and ports, Verilog constructs. **Laboratory Sessions/ Experimental learning:** 1. Design a full adder using two half adders in Pspice tool. 2. Design an Adder cum Subtractor circuit which adds when input bit operation=1 or subtract if 0, using Pspice. 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, https://www.youtube.com/watch?v=397DDnkBm8A	8 Hrs
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. **Verilog Concepts** : Verilog statements- assign, if-else, case, loops, always. **Laboratory Sessions/ Experimental learning:** 1. Develop the Verilog code for the following flip-flops SR, D, JK &T. 2. Design a 6-bit Register using D-Flipflop using Verilog which stores every bit for each clock cycle.	8 Hrs

Applications: Frequency divider circuit, frequency counter. **Video link / Additional online information:** https://www.youtube.com/watch?v=Nxpei7Kp4Vs	
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. **Programmable Logic Devices:** PLA, PAL, FPGA. **Laboratory Sessions/ Experimental learning:** 1. Design a Synchronous Counter for a given sequence- 0, 2, 4, 6, 0 using Verilog. 2. Design a 4-bit Asynchronous up/down counter using Pspice tool (D,T,JK,SR flipflops) 3. Design a 4-bit binary Synchronous up/down counter using Pspice tool. (D,T, JK, SR flipflops) 4. Implement ALU operations on FPGA **Applications:** Data synchronizer, Counter. **Video link / Additional online information:** https://www.youtube.com/watch?v=O3If0Nr9to0	**8 Hrs**
UNIT-V	
Synthesis Basics : Introduction, Synthesis information from Entity and Module, Mapping Process and Always in the Hardware Domain. **Laboratory Sessions/ Experimental learning:** 1. Verilog code for weather forecast Entity. 2. Mapping logic operators. **Applications:** Timing verification, test documentation. **Video link / Additional online information:** https://nptel.ac.in/courses/117108040/	**8 Hrs**
LABORATORY EXPERIMENTS	
1. Verify (a) Demorgan's Theorem for 2 variables. (b) The sum-of product and product-of-sum expressions using universal	

gates.

2.Design and implement

(a) Full Adder using basic logic gates.

(b) Full subtractor using basic logic gates.

3. Design and implement

(i) 4-bitParallelAdder/ Subtractor using IC 7483.

(ii) BCD to Excess-3 code conversion and vice-versa.

Realize

(i) Adder & Subtractors using IC 74153

(ii) 4-variable function using IC 74151(8:1MUX)

4. Realize the following flip-flops using NAND Gates.

(a) Clocked SR Flip-Flop

(b) JK Flip-Flop

(c) D-Flip-Flop

5. Realize the following shift registers using IC7474

(a)SISO (b) SIPO (c) PISO (d) PIPO (e) Ring Counter (f) Johnson Counter.

6. Realize

(i) Design Mod – N Synchronous Up Counter & Down Counter using 7476 JK Flip-flop

(ii) Mod-N Counter using IC7490 / 7476.

Simulate the following using Verilog Code and Implement on FPGA

7. Write a Verilog program for the following combinational designs a) 2 to 4 decoder b) 8 to 3 (encoder without priority & with priority) c). 8 to 1 multiplexer d) 4 bit binary to gray converter e) Multiplexer, De-multiplexer, Comparator.

8. Design 4 bit binary, BCD counters with Synchronous reset and asynchronous reset and "any sequence" counters using Verilog code.

9. Write HDL code to display messages on alpha numeric LCD display.

10. Write a HDL code to control speed, direction of DC and Stepper motor

11.Write HDL code to interface Hex key pad and display the key code on seven segment display.

12. Write a HDL code to accept Analog signal, Temperature sensor and display the data on LCD or Seven Segment Display.

Virtual Lab Links: http://vlabs.iitkgp.ernet.in/dec/ Any 12 experiments to be conducted

Course outcomes:	
CO1	Illustrate simplification of Algebraic equations using K-map & Quine-McCluskey Technique.
CO2	Use the modern engineering tools such as verilog, necessary for engineering practice.
CO3	Analyse& design different applications of Combinational & Sequential Circuits to meet desired need within realistic constraints.
CO4	Write code & verify the functionality of digital circuit/system using test benches to solve engineering problems in digital circuits.
CO5	Know the importance of Synthesis & 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.	NazeihM.Botros- "HDL Programming (VHDL and Verilog)"- John Weily India Pvt. Ltd. 2008
4.	Samir Palnitkar "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second 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.

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

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

High-3, Medium-2, Low-1

Semester: III/IV		
CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (Theory)		
Course Code:	MVJ21EC36	CIE Marks: 50
Credits:	L:T:P: 1:0:0	SEE Marks: 50
Hours:	15L	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.	
2	To provide overall legal literacy to the young technocrats to manage complex societal issues in the present scenario.	
3	To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.	

UNIT 1	
Introduction to Indian Constitution : The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.	3Hrs.
UNIT II	
Union Executive and State Executive: Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.	3Hrs.
UNIT III	

Elections, Amendments and Emergency Provisions: Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements). Emergency Provisions, types of Emergencies and its consequences. **Constitutional Special Provisions:** Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.	3Hrs.
UNIT IV	
Professional / Engineering Ethics: Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	3Hrs.
UNIT V	
Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.	3Hrs.

Course Outcomes: On completion of this course, students will be able to	
CO1	Have constitutional knowledge and legal literacy

CO2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO3	Understand the cybercrimes and cyber laws for cyber safety measure.

Reference Books:	
1.	Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher
2.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20th Edn., (Latest Edition) or 2008.
3.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.
4	M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. Ltd. New Delhi, 2004.
5.	M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
6.	Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi.

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.

Semester: III		
Additional Mathematics-I (Common to all branches)		
Course Code:	MVJ21MATDIP1	CIE Marks:50
Credits:	L:T:P: 1:2:0	SEE Marks: 50
Hours:	40L	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 in 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. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	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. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-III	
Vector Differentiation: Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. **Vector identities** - $div(\phi\vec{A}), curl(\phi\vec{A}), curl(grad(\phi)), div(curl\vec{A})$. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8Hrs
UNIT-IV	

Probability: Basic terminology, Sample space and events. Axioms of probability. Conditional probability – illustrative examples. Bayes theorem-examples. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	**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. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	**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	
1.	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2013, .
2.	G. B. Gururajachar, Calculus and Linear Algebra, Academic Excellent Serie Publication, 2018-19
3.	Chandrashekar K. S, Engineering Mathematics-I, Sudha Publications, 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 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	1	1
CO2	3	3	0	2	0	0	0	0	0	0	1	1
CO3	3	3	0	3	0	0	0	0	0	0	1	1
CO4	2	2	0	3	0	0	0	0	0	0	1	1
CO5	2	2	0	2	0	0	0	0	0	0	0	1

B.E, IV Semester, Electronics & Communication Engineering

Semester: IV		
Probability Theory, Complex variables and Optimization		
Course Code:	MVJ21MA41D	CIE Marks: 50
Credits:	L: T:P:2:2:0	SEE Marks: 50
Hours:	20L+20T	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	Learn the mathematical formulation of linear programming problem	
3	Learn the mathematical formulation of transportation problem.	
4	Understand the concepts of Complex variables and transformation for solving Engineering Problems.	
5	Learn the solutions of partial differential equations numerically	

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. **Self-study:** Discrete and continuous probability problems **Applications:** Discrete and continuous probability distributions help in analysing the probability models arising in engineering field. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-II	
Optimization: Linear Programming, mathematical formulation of linear programming problem (LPP), Types of solutions, Graphical Method, simplex method, big-M method, Dual – simplex method. **Self-study:** Two phase simplex method **Applications:** Applications of transportation Problems **Video Link** :	8 Hrs

1. http://nptel.ac.in/courses.php?disciplineID=111	
UNIT-III	
The transportation problem: Initial Basic Feasible Solution (IBFS) by Least Cost Method, North West Corner Rule method, Vogel's Approximation Method, MODI method (Optimal Solution), Salesman problem, Assignment problem. **Self-Study Topic** : Matrix Minima Method **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	**8 Hrs**
UNIT-IV	
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. **Self-study:** Unique Expression Method **Applications:** Application to flow problems **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	**8 Hrs**
UNIT-V	
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. **Self-study:** Crank Nicolson method – problems. **Applications:** To solve boundary value problems **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply discrete and continuous probability distributions in analysing the probability models arising in engineering field.
CO2	Learn the mathematical formulation of linear programming problem
CO3	Solve the applications of transport problems
CO4	Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
CO5	Learn the numerical solutions of partial differential 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.	Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17
4.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th 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	3	0	0	0	0	0	0	1	1
CO2	3	3	0	3	0	0	0	0	0	0	1	0
CO3	3	2	0	2	0	0	0	0	0	0	0	0
CO4	3	3	0	3	0	0	0	0	0	0	0	1
CO5	3	3	0	3	0	0	0	0	0	0	1	0

High-3, Medium-2, Low-1

Semester: IV		
Basic Signal Processing (Theory)		
Course Code:	MVJ21EC42	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	Analyse the mathematical description of continuous and discrete time signals and systems.	
2	Analyse the signals in time domain using convolution sum and Integral.	
3	Determine the response of the LTI system to any input signal.	
4	Analyse 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: Probability **Random Variables:** Random Variables, Several Random Variables, Statistical Averages (Mean, Moment, Central Moment, Mean Square Value, Characteristic Function, Joint Moments). **Random Processes:** Random Processes, Stationary, Mean, Correlation, Covariance functions, Autocorrelation and its properties, Cross correlation and its properties, Ergodicity, Power Spectral Density and its properties. **Laboratory Sessions/ Experimental learning:** To find the basis and properties of statistical averages and correlation. **Applications** : **Video link / Additional online information :** 1. https://nptel.ac.in/courses/108/104/108104100/ 2. https://www.youtube.com/watch?v=ZK3O402wf1c&list=PL49CF3715CB9EF31D&index=1	8Hrs.
UNIT 2	
Introduction and Classification of signals : Definition of signal and systems with examples, Elementary signals/Functions: Exponential, sinusoidal, step, impulse and ramp functions Basic Operations on signals: Amplitude scaling, addition, multiplication, time scaling, time shift and time reversal. Expression of triangular, rectangular and other waveforms in terms of elementary signals.	8Hrs.

System Classification and properties: Linear-nonlinear, Time variant -invariant, causal-noncausal, static-dynamic, stable-unstable, invertible. **Laboratory Sessions/ Experimental learning:** To define eigen values and eigen vectors using MATLAB **Applications:** Communication systems, car stereo systems **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117105134/ http://www.digimat.in/nptel/courses/video/108108109/L63.html	
UNIT 3	
Time domain representation of LTI System: Impulse response, convolution sum. Computation of convolution sum using graphical method for unit step and unit step, unit step and exponential, exponential and exponential, unit step and rectangular, and rectangular and rectangular. LTI system Properties in terms of impulse response: System interconnection, Memory less, Causal, Stable, Invertible and Deconvolution and step response **Laboratory Sessions/ Experimental learning:** 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. **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://nptel.ac.in/courses/111106046/ 2. https://nptel.ac.in/courses/111106111/	8Hrs.
UNIT 4	
Fourier Representation of aperiodic Signals: Introduction to Fourier Transform & DTFT, 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. To analyze the spectrum of the signal with Fourier transform using MATLAB. **Applications:** Image analysis, image filtering, image reconstruction and image compression.	8Hrs.

Video link / Additional online information: 1. https://nptel.ac.in/courses/117104074	
UNIT 5	
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 by partial fraction, 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**: To 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://nptel.ac.in/courses/108104100/	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the basics of Linear Algebra.
CO2	Develop input output relationship for linear time invariant system and understand the convolution operator for continuous and discrete time system.
CO3	Analyse the properties of discrete time signals & systems.
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.	Simon Haykins and Barry Van Veen,"Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.

2.	Ganesh Rao and SatishTunga, "Signals and Systems", Pearson/Sanguine,First Edition,2017.
3	Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, 4th Edition, 2006, I 97809802327
4.	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab,"Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	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		
CONTROL SYSTEM (Theory)		
Course Code:	MVJ21EC43	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	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 3. https://youtu.be/tDXgiStzbcY	8Hrs.
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 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 2. https://youtu.be/YuZ3iwA-47I	**8Hrs.**
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	**8Hrs.**
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:**	**8Hrs.**

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 **Video link / Additional online information:** 1. https://youtu.be/QzTCRk4nkDg 2. https://youtu.be/Wi6xt7IyjA0	
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. **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	**8Hrs.**

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

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

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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		
DATA STRUCTURES AND ALGORITHMS USING PYTHON (Theory and Practical)		
Course Code:	MVJ21EC44	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	Understand the 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*	8Hrs.

Linked Lists: Definition, Linked list operations: Traversing, Searching, Insertion, and 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:** 1. 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:** 2. Towers of Hanoi. 3. 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.	8Hrs.

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:** 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/ 2. 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/ 3. https://nptel.ac.in/courses/106/102/106102064/	**8Hrs.**

Laboratory Sessions	
Sl No	**Experiment Name**
1	Write a Python program for implementing the following searching techniques. i. Linear Search ii. Binary Search
2	Write a Python program for implementing the following sorting techniques. i. Bubble Sort ii. Selection Sort iii. Insertion Sort
3	Write a Python program for implementing the following sorting techniques.

	i. Quick Sort ii. Merge Sort
4	Write a Python program to design and implement Linked List and its operations.
5	Write a Python program to design and implement Circular Linked List and its operations.
6	Write a Python program to i. Design and implement Stack and its operations using List. ii. Design and implement Queue and its operations using List.
7	Write a Python program for the following stack applications: i. Infix to postfix conversion ii. Tower of Hanoi
8	Write a Python program to implement the following: i. Create a Binary Search Tree ii. Tree Traversals: Inorder, Preorder, Postorder. iii. Determine the height of the tree. iv. Count the number of elements of tree.
9	Write a Python program to implement the following graph traversal algorithms: i. BFS ii. DFS

Course outcomes:	
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 Sons.
2.	Michael T. Goodrich, R. Tamassia and Michael H Goldwasser "Data structures Algorithms in python", Wiley student edition, John Wiley and Sons.
3	Narasimha Karumanchi "Data Structures and Algorithmic Thinking with Python", Career Monk 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.

Laboratory- 50 Marks

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

Semester End Examination (SEE):
Total marks: 50+50=100
SEE for 50 marks are executed by means of an examination.

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: IV		
COMMUNICATION SYSTEMS (Theory and Lab)		
Course Code:	MVJ21EC45	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	Understand the 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. Coherent detection 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 :** 1. https://nptel.ac.in/courses/117/105/117105143/	8Hrs.

2. https://youtu.be/00ZbuhPruJw 3. https://youtu.be/rt08yTGv_z4 4. https://youtu.be/S8Jod9AtpN4 5. https://youtu.be/SxSPdjwXDQk	
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 – locked loop, Linear model of the phase – locked loop, Nonlinear effects in FM systems. **Noise:** Introduction, Types of noise, Noise Figure, Equivalent noise temperature, Noise in AM receivers, Noise in FM receivers, Pre-emphasis and De-emphasis in FM. **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-borns 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/ 2. https://youtu.be/gsUaHawPy-w 3. https://youtu.be/jqJpbPseX2c 4. https://youtu.be/PmuZnJfheK4 5. https://youtu.be/QEubAxBfqKU	8Hrs.
UNIT 3	
NOISE: Shot Noise, Thermal noise, White Noise, 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,	8Hrs.

Capture effect, FM threshold effect, FM threshold reduction, Preemphasis 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/ 3. https://youtu.be/s6vlXP3mYXk 4. https://youtu.be/HlGJ6xxbz8s	
UNIT 4	
Intersymbol 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/	8Hrs.
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.	8Hrs.

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. Analyse 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 :** 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	

Laboratory Sessions	
Sl No	**Experiment Name**
Hardware Experiments	
1	Amplitude Modulation and Demodulation using transistor.
2	DSB SC Modulation.
3	Frequency modulation and FSK using IC 8038/2206,.
4	Pre-emphasis & de-emphasis
5	Demonstrate sampling and reconstruction
6	Pulse Amplitude Modulation and Detection.
7	Generation of PWM/PPM signal
8	Generation and detection of ASK Waveform.
9	FSK Generation and detection.
10	TDM of two band limited signals.
Simulation Experiments using SCILAB/MATLAB/Simulink/LabVIEW	

11	Amplitude Modulation using Pspice
12	Simulate NRZ, RZ for polar signaling.
13	Simulate NRZ, RZ for bipolar signaling.
14	Generation of eye diagram.

OPEN ENDED PROJECT:

1. Design and make a simple FM Radio.
2. Design simple circuit for Mobile phone jammer.

Course outcomes:	
CO1	Examine the concepts of analog modulation techniques such as amplitude, modulations and its 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 preemphasis 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.

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Theory for 50 Marks

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

High-3, Medium-2, Low-1

Semester: III/IV		
SAMSKRUTHIKA KANNADA (Theory)		
Course Code:	MVJ21EC46	CIE Marks: 50
Credits:	L:T:P: 1:0:0	SEE Marks: 50
Hours:	15L	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Samskruthika Kannada –Parichaya (Introduction to Adalithakannada)	
2	Kannada Kavyagalaparichaya (Kannada D Ra Bendre, Siddalingaiha)	
3	Adalithdalli Kannada Padagalu (Kannada KagunithaBalake, Patra Lekhana, Prabhandha)	
4	Kannada Computer Gnyana (Kannada ShabdhaSangraha, Computer Paribashikapadagalu)	
5	Activities in Kannada.	

UNIT 1	
1. ಕನ್ನಡ ಭಾಷೆ–ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ. 2. ಭಾಷಾ ಪ್ರಯೋಗಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ	3 Hrs
UNIT 2	
1. ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ 2. ಪತ್ರ ವ್ಯವಹಾರ.	3 Hrs
UNIT 3	
1. ಆಡಳಿತ ಪತ್ರಗಳು. 2. ಸರ್ಕಾರದಆದೇಶ ಪತ್ರಗಳು	3 Hrs
UNIT 4	
1. ಸಂಕೀಪ್ತ ಪ್ರಬಂಧರಚನೆ, ಪ್ರಬಂಧ ಮತ್ತು ಭಾಷಾಂತರ 2. ಕನ್ನಡ ಶಬ್ದಸಂಗ್ರಹ	3 Hrs
UNIT 5	
1. ಕಂಪ್ಯೂಟರ್ ಹಾಗೂ ಮಾಹಿತಿತಂತ್ರಜ್ಞಾನ 2. ಪಾರಿಭಾಷಿಕ ಆಡಳಿತ ಕನ್ನಡ ಪದಗಳು ಮತ್ತುತಾಂತ್ರಿಕ/ಕಂಪ್ಯೂಟರ್ ಪಾರಿಭಾಷಿಕ ಪದಗಳು.	3 Hrs

Scheme of Evaluation:		
Details		**Marks**
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks Obtained in each test) / 3	CIE(50)	30
Assignment / Case Studies / Quiz		20
Semester End Examination	SEE (50)	50
Total		100

Textbooks:	
1.	Adalitha Kannada – Dr. L Thimmesh, Prof. V Keshav Murthy

Semester: III/IV		
BALAKE KANNADA		
Course Code:	**MVJ21EC46**	**CIE Marks: 50**
Credits:	**L:T:P: 1:0:0**	**SEE Marks: 50**
Hours:	**15L**	**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
1	Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada)	
2	Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation	
3	Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).	
4	Kannada Grammer in Conversations (Sambhasaneyalli Kannada Vyakarana)	
5	Activities in Kannada.	

Course Title	BALAKE KANNADA	Semester	III/IV
Module - 1			
Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada)			
Module - 2			

Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation		
Module - 3		
Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).		
Module - 4		
Kannada Grammar in Conversations (Sambhasaneyalli Kannada Vyakarana)		
Module - 5		
Activities in Kannada		
Scheme of Evaluation:		
Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks Obtained in each test) / 3	CIE(50)	30
Assignment / Case Studies / Quiz		20
Semester End Examination	SEE (50)	50
Total		100

Semester: III/IV		
SUMMER INTERNSHIP-I		
Course Code:	MVJ21INT48	CIE Marks: 50
Credits:	2	SEE Marks: 50
Hours:	Industrial Oriented	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To get the field exposure and experience.	
2	To apply the theoretical concept in field application	
3	To prepare the comparison statement of difference activities	

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

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

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

Scheme of Evaluation:

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

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

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

High-3, Medium-2, Low-1

Semester: IV		
Additional Mathematics-II (Common to all branches)		
Course Code:	MVJ21MATDIP2	CIE Marks:50
Credits:	L:T:P:S: 1:2:0	SEE Marks: 50
Hours:	40L	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. **Self study** : Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	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. **Self study** : Curve tracing. **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	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. Self -Study: Volume Tetrahedron **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	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. **Self study** : Method of variation of parameters **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-V	
Partial differential equation: Introduction- Classification of partial differential 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. **Self study:** One dimensional heat and wave equations and solutions by the method of separable of variable **Video Link** : 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs

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	
1.	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2013, .
2.	G. B. Gururajachar, Calculus and Linear Algebra, Academic Excellent Serie Publication, 2018-19
3.	Chandrashekar K. S, Engineering Mathematics-I, Sudha Publications, 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 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	1	1
CO2	3	3	0	2	0	0	0	0	0	0	1	1
CO3	3	3	0	3	0	0	0	0	0	0	0	1
CO4	2	2	0	3	0	0	0	0	0	0	1	1
CO5	2	2	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

B.E, V Semester, Electronics & Communication Engineering

Semester: V		
TECHNICAL MANAGEMENT &ENTREPRENEURSHIP		
Course Code:	MVJ21EC51	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/ 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. **Directing and Controlling:** Meaning and nature of directing Leadership styles, Motivation Theories, Communication: Meaning and importance, Leadership: Meaning, Characteristics, Behavioral Approach of Leadership; Coordination: Meaning, importance and Techniques of Coordination. Meaning and steps in Controlling, Essentials of a sound control system and Methods of establishing control system. **Laboratory session/Experiment:** 1. Document the job responsibilities of a manager level employee of an organization. **Applications:** IT sectors, Banking sectors and Institutional Research sectors. **Video link / Additional online information:** https://nptel.ac.in/courses/110/107/110107151/	8Hrs.
UNIT 3	
Entrepreneur: Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneurs, Entrepreneur - an emerging. Classification of Entrepreneurs, Concept of Entrepreneurship, Evolution of Entrepreneurship, Development of Entrepreneurship, Stages in entrepreneurial process, Role of Entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship- its Barriers. **Laboratory session/Experiment:** 1. Find, Fill and Document the application forms which are all need to start an enterprise. **Applications:** Core Industrial sectors, New Enterprises sectors. **Video link / Additional online information:** https://nptel.ac.in/courses/110/106/110106141/	8Hrs.
UNIT 4	

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

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

CO1	Explain about the management and planning.
CO2	Apply the knowledge on organizing, staffing, directing, and controlling.
CO3	Analyse the concept of Entrepreneurship.

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

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

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	3	-	-	1	-	3	3	2	2	1
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 ORGANIZATION & ARCHITECTURE		
Course Code:	MVJ21EC52	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*	**8Hrs.**

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

2. https://www.youtube.com/watch?v=NhyIUpOj5V8#action=share 3. https://www.youtube.com/watch?v=xXk3WiPGux8#action=share 4. https://www.youtube.com/watch?v=aeDyDIo-G44#action=share	
UNIT 5	
Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hardwired Control, Micro programmed Control ,Pipelining ,Basic concepts, Role of Cache memory, Pipeline Performance **Laboratory Sessions/ Experimental learning:** Evaluate the possible control sequence for implementing a multiplication instruction using registers for a single bus organization **Applications:** Microprocessor **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=R41DfN3NpIM#action=share 2. 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: V		
DIGITAL SIGNAL PROCESSING		
Course Code:	MVJ21EC53	CIE Marks:50+50
Credits:	L:T:P: 2:2:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	Understand the frequency domain sampling and reconstruction of discrete time signals.	
2	Study the properties and the development of efficient algorithms for the computation of DFT.	
3	Learn the procedures to design IIR filters from the analog filters using impulse invariance and bilinear transformation.	
4	Study the different windows used in the design of FIR filters and design appropriate filters based on the specifications.	
5	Learn DSP Processor Architecture and study the real time applications of DSP	

UNIT 1	
Prerequisites: *DTFT and its properties.* **Discrete Fourier Transforms (DFT):** Frequency domain sampling and reconstruction of discrete time signals, DFT as a linear transformation, its relationship with other transforms, Properties of DFT. **Laboratory Sessions/ Experimental learning:** 1. DFT computation of square pulse and Sinc function using MATLAB. **Applications:** Spectral Analysis of Signals, Frequency Response of Systems, Convolution via the Frequency Domain. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105134/ 2. https://youtu.be/gpv4h2fcKdA 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/3fVu__fCSg0	
UNIT 3	
Prerequisites: *L- Hospital rule, Sinc function* **Design of FIR Filters:** Symmetric and Antisymmetric FIR filters, Design of Linear-phase FIR filters using windows - Rectangular, Hamming, Hanning, Bartlett windows. Design of FIR filters using frequency sampling method.Structure for FIR Systems: Direct form, Cascade form and Lattice structures. **Laboratory Sessions/ Experimental learning:** 1. Design and implementation of Low pass FIR filter to meet the desired specifications (using different window techniques) and test the filter with an audio file. Plot the spectrum of audio signal before and after filtering. **Applications:** Noise suppression, Enhancement of selected frequency ranges, Removal or attenuation of selected frequencies **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/102/117102060/ 2. https://nptel.ac.in/courses/108/105/108105055/ 3. https://www.youtube.com/watch?v=nsK7mmRSTDY	**8Hrs.**
UNIT 4	
Prerequisites: *Types of filters* **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.	**8Hrs.**

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.

Laboratory Sessions	
Sl No	Experiment Name
Programming using Matlab	
1	Verification of sampling theorem.
2	Linear and circular convolution of two given sequences, Commutative, distributive and associative property of convolution.
3	Auto and cross correlation of two sequences and verification of their properties Solving a given difference equation.

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

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

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

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

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.

Laboratory- 50 Marks

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

Semester End Examination (SEE):
Total marks: 50+50=100
SEE for 50 marks are executed by means of an examination.

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

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

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

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

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

Laboratory Sessions

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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.

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

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

High-3, Medium-2, Low-1

Semester: V		
ENVIRONMENTAL STUDIES (Theory)		
Course Code:	MVJ21ENV56	CIE Marks: 50
Credits:	L:T:P: 1:0:0	SEE Marks: 50
Hours:	15 L	SEE Duration: 02 Hrs.
Course Learning Objectives: The students will be able to		
1	Relate interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes	
2	Study drinking water quality standards and to illustrate qualitative analysis of water.	
3	Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability.	

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

Waste Management & Public Health Aspects: Bio-medical Waste, Solid waste, Hazardous waste and E-waste. Video link: • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/105/103/105103205/ • https://nptel.ac.in/courses/120/108/120108005/ • https://nptel.ac.in/courses/105/105/105105160/	
UNIT-IV	
Global Environmental Concerns (Concept, policies, and case-studies): Global Warming, Climate Change, Acid Rain, Ozone Depletion and Fluoride problem in drinking water. Video link: • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/120108004/ • https://onlinecourses.nptel.ac.in/noc19_ge23/preview	**3 Hrs**
UNIT-V	
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems. Video link: • https://nptel.ac.in/courses/105/102/105102015/ • https://nptel.ac.in/courses/120/108/120108004/	**3 Hrs**

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

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

Total marks: 50+50=100

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

Semester: V		
RESEARCH METHODOLOGY AND IPR		
Course Code:	MVJ21RMI57	CIE Marks:50
Credits:	L:T:P: 1:2:0	SEE Marks: 50
Hours:	30	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. *Ethics in Engineering Research:* Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.	6 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.	6 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, 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.	6 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, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	6 Hrs
UNIT-V	
Introduction to Intellectual Property Rights: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights. **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.	6 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	formulate the research problem and follow research ethics.
CO2	carry to carrying 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, 2 nd 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: V		
UNIVERSAL HUMAN VALUES		
Course Code:	MVJ21UHV58	CIE Marks: 50
Credits:	L:T:P: 2:0:0	SEE Marks: 50
Hours:	30 L	SEE Duration: 02 Hrs.
Course Learning Objectives: The students will be able to		
1	Appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.	
2	Facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.	
3	Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.	

UNIT-I	
Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations. **Practical Sessions**: (1) Sharing about Oneself (2) Exploring Human Consciousness (3) Exploring Natural Acceptance. Video link: 1. https://www.youtube.com/watch?v=85XCw8SU084 2. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3p Z3yA7g_OAQz 3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs
UNIT-II	
Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health. **Practical Sessions**: (4) Exploring the difference of Needs of Self and Body (5) Exploring Sources of Imagination in the Self (6) Exploring Harmony of Self with the Body	6 Hrs

Video link: 1. https://www.youtube.com/watch?v=GpuZo495F24 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	
UNIT-III	
Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order. **Practical Sessions** : (7) Exploring the Feeling of Trust (8) Exploring the Feeling of Respect (9) Exploring Systems to fulfill Human Goal Video link: 1. https://www.youtube.com/watch?v=F2KVW4WNnS 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs
UNIT-IV	
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence. **Practical Sessions** : (10) Exploring the Four Orders of Nature (11) Exploring Co-existence in Existence Video link: 3. https://www.youtube.com/watch?v=1HR-QB2mCF0 4. https://www.youtube.com/watch?v=lfN8q0xUSpw 5. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs
UNIT-V	
Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession **Practical Sessions** : (12) Exploring Ethical Human Conduct (13) Exploring Humanistic Models in Education (14) Exploring Steps of Transition towards Universal Human Order Video link: 1. https://www.youtube.com/watch?v=BikdYub6RY0 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	6 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore themselves, get comfortable with each other and with the teacher

CO2	Enlist their desires and the desires are not vague.
CO3	Restate that the natural acceptance (intention) is always for living in harmony, only competence is lacking
CO4	Differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them
CO5	Present sustainable solutions to the problems in society and nature

Reference Books	
3.	AICTE SIP UHV-I Teaching Material, https://fdp-si.aicte india.org/ AicteSipUHV _download.php
4.	A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
3.	Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
4.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Continuous Internal Evaluation (CIE):

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

Semester End Examination (SEE):

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

Total marks: 50+50=100

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

Professional Elective-I

Semester: V		
MACHINE LEARNING DESIGN & APPLICATIONS		
Course Code:	MVJ21EC551	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 basic theory of machine learning.	
2	To formulate machine learning problems related to different applications.	
3	To describe the range of machine learning algorithms along with their hypothesis.	
4	To apply the algorithms to real time applications and optimize the results by applying the models.	

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

in Decision tree. Neural Network Representation, Perceptron's, Multilayer Networks and Back Propagation Algorithms. **Laboratory Sessions/ Experimental learning:** 1. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample. **Applications:** Email Spam and Malware Filtering, ID3 algorithm, Self-driving cars **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106198/ 2.https://www.youtube.com/watch?v=fPLxFXiS9fU	
UNIT 3	
Bayesian and Computational Learning: Introduction, Analyze Bayes theorem, Bayes theorem demonstration and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm **Laboratory Sessions/ Experimental learning:** 1. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets. **Applications:** Artificial Neural Network, Virtual Personal Assistant, Online Fraud Detection. **Video link / Additional online information:** https://nptel.ac.in/courses/106/105/106105215/	8Hrs.
UNIT 4	
Instant Based Learning and Learning set of rules: Demonstrate K- Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning and Develop Sequential Covering Algorithms. Reinforcement Learning: Introduction, Evaluate Learning Task, Q Learning Laboratory Sessions/ Experimental learning: **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.	8Hrs.

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

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

Reference Books:	
1.	Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.
2	Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

3	T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st edition, 2001.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: V		
OPERATING SYSTEM		
Course Code:	MVJ21EC552	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 3. https://www.youtube.com/watch?v=29JPq5JuKj8	8Hrs.
UNIT 2	

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

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

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

CO5	Describe message passing, deadlock detection and prevention methods.

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

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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: V		
MEMS & SENSOR DESIGN		
Course Code:	MVJ21EC553	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 overview of Microsystems and their applications.	
2	Acquire the knowledge of various Microsystems Fabrication Processes.	
3	Study the working principles of Micro sensors and Micro Actuators.	
4	Illustrate the Microsystems Design consideration.	
5	Know the basics of NEMS and its applications.	

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

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

1. Study the process involved in LIGA micromanufacturing **Applications:** Hybrid integrated circuits, integrated passive devices & sensors. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. https://nptel.ac.in/courses/108/108/108108113/ 3. https://nptel.ac.in/courses/108/108/108108147/ 4. http://www.nptelvideos.in/2012/12/mems-microsystems.html	
UNIT 5	
Microsystems Design: Introduction, Design Considerations, Process Design, Mechanical Design, Computer Aided Design. **Introduction to NEMS:** Micro and Nanoscale Technologies, General Principle of Nanofabrication, Nanoproducts, Applications of Nanoproducts. **Laboratory Sessions/ Experimental learning:** 1. Design Capacitive Pressure Sensor using COMSOL Multiphysics. **Applications:** To measure blood pressure within the body, detect ions, to perform biological tests, displays, tunable Lasers, smart phones, mobile infrastructure, IoT and defence. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. http://www.nptelvideos.in/2012/12/mems-microsystems.html	**8Hrs.**

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

CO-PO Mapping												
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CO3	3	2	1	1	-	2	1	-	1	-	-	1
CO4	3	3	2	2	-	2	1	-	1	-	-	1
CO5	3	3	3	2	2	2	1	-	1	-	-	1

High-3, Medium-2, Low-1

Semester: V		
APPLICATIONS WITH MATLABPROGRAMMING & SIMULINK		
Course Code:	MVJ21EC554	CIE Marks: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 foundation in programming for engineering problem solving using the MATLAB software package.	
2	Break a complex task up into smaller, simpler tasks with some of the terminology in this very new field and relate it to the basic engineering process of design.	
3	To introduce the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.	
4	To develop the skills to analyze and break down an engineering program and solve it algorithmically using MATLAB	

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

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

UNIT 5	
Information Entropy: Introduction, Histogram function, Entropy, Entropy filtration, Entropy thresholding and segmentation, Point Information Gain. **Laboratory session/Experiment:** 1. Design process and analysis of the color images through entropy. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=-dkib4Ei1Wg 2. https://www.youtube.com/watch?v=RPNxSG9LD78	8Hrs.

Course outcomes:	
CO1	Students should be able to apply computer methods for solving a wide range of engineering problems.
CO2	Students should be able to use computer engineering software to solve and present problem solutions in a technical format.
CO3	Students should be able to utilize computer skills to enhance learning and performance in other engineering and science courses.
CO4	Understand how signals, images, and data are represented and manipulated in MATLAB
CO5	Students should be able understand the various programming constructs and how they can be used to solve a computational problem.
Textbooks:	
1.	John O. Attia "ELECTRONICS and CIRCUIT ANALYSIS using MATLAB", Department of Electrical Engineering, Prairie View A&M University
2.	MATLAB and SIMULINK for Engineers by Kumar Tyagi Agam, OUP India, 9780198072447, 9780198072447,2011
3.	Jan Valdman, "Applications from Engineering with MATLAB Concepts", Published by Intech Janeza Trdine 9, 51000 Rijeka, Croatia.
Reference Books:	
1.	Modelling, Analysis and Design of Control Systems in MATLAB and Simulink, Dingyü Xue, YangQuan Chen, World Scientific Publishing Co., 2015

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

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

High-3, Medium-2, Low-1

VI SEMESTER

Course Title	**WIRELESS NETWORK MANAGEMENT**	**Semester**	VI
Course Code	MVJ21EC61	**CIE**	50
Total No. of Contact Hours	40	**SEE**	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	**Total**	100
Credits	3	**Exam. Duration**	3 Hours

Course objective is to:

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

Module-1	
Introduction to Cellular Mobile Systems: The Cellular concept, System design, Capacity improvement in cellular systems, Co-channel interference reduction. Intelligent cell concept and applications, technical Challenges. **Laboratory Sessions/ Experimental learning:** 1. Understand how pulse shaping is realized using MATLAB® functions **Applications:** 1. Transmission of music, news, road conditions, weather reports, and other broadcast information are received via digital audio broadcasting (DAB) with 1.5Mbit/s. 2. A universal mobile telecommunications system (UMTS) phone might be available offering voice and data connectivity with 384kbit/s. **Video link / Additional online information:**	**8Hrs.**

1. https://www.coursera.org/lecture/wireless-communications/1-1-cellular-communication-KpitQ **2.** https://nptel.ac.in/courses/117/102/117102062/	
Module-2	**8Hrs.**
Mobile radio propagation: Reflection, Diffraction, Fading, Multipath Propagation, Channel modelling, Diversity Schemes and Combining Techniques. The cellular fundamentals: cellular communication and frequency reuse, general architecture of a cellular system, channel assignment strategies, hand-off in a cellular system. Interference and cellular system capacity: co-channel interference and adjacent channel interference, power control. **Laboratory Sessions/ Experimental learning:** 1. Compute the power of the noise and the original signal. Find signal to noise ratio (SNR), compare it with the desired value and see if they are the same using MATLAB **Applications:** **1.** International broadcasting, long distance aircraft and ship communication, citizen band (CB) radios. **2.** Diffraction and reflection give rise to propagation beyond the horizon. Propagation at large distance propagates well within buildings. **Video link / Additional online information:** 1. https://freevideolectures.com/course/2329/wireless-communication/14 **2.** https://nptel.ac.in/courses/108/108/108108148/	
Module-3	**8Hrs.**
Signal propagation in mobile communication: Design parameters at the base station, Practical link budget design using path loss models. propagation path loss, outdoor propagation models (Okumura model & Hata model), indoor propagation models, power delay profile, channel parameters (delay spread, doppler spread, coherence bandwidth, coherence time, Smart antenna systems, Beam forming. MIMO Systems. RAKE receiver. **Laboratory Sessions/ Experimental learning:** 1. Performance of Baseband QAM/QPSK Under AWGN Channel **Applications:** 1. Antennas mounted on these structures pump out wireless communications signals to devices in the field via electromagnetic waves.	

2. Wireless signal propagation is the movement of these radio waves (which move at the speed of light) to and from these sites and devices. **Video link / Additional online information:** 1. https://freevideolectures.com/course/2329/wireless-communication 2. https://web.stanford.edu/class/ee359/lectures.html **3.** https://nptel.ac.in/courses/117/105/117105084/	
Module-4	
Multiuser Systems: CDMA- Principle, Network design, Link capacity, Power control, WCDMA-Network planning, MC-CDMA, OFDM, Cellular mobile communication beyond 3G. Wireless Personal Area Networks (Bluetooth, UWB and ZigBee), Wireless Local Area Networks (IEEE 802.11, network architecture, medium access methods, WLAN standards), Wireless Metropolitan Area Networks (WiMAX), Ad-hoc Wireless Networks. **Laboratory Sessions/ Experimental learning:** 1. Develop a detector and calculate BER with MATLAB Simulation **Applications:** Radio and TV Broad casting **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/104/108104157/ 2. https://nptel.ac.in/courses/106/105/106105173/ **3.** https://nptel.ac.in/courses/111/102/111102130/	**8Hrs.**
Module-5	
5G Radio Access Technologies: Access Design Principles for Multi-user Communications – Multi-carrier with Filtering – Non orthogonal Schemes for Efficient Multiple Access – Radio Access for Dense Deployments – Radio Access for V2X Communication – Radio Access for Massive Machine-type Communication. **Laboratory Sessions/ Experimental learning:** 1. Implementation of channel estimation for multipath environment **Applications:** Television remote control, Wi-Fi, Cell phones, wireless power transfer, computer interface devices **Video link / Additional online information:** 1. https://www.technologyreview.com/collection/wireless-technology-innovations-lead-the-way-to-a-smartly-connected-future/	**8Hrs.**

2. https://in.mathworks.com/videos/5g-new-radio-fundamentals-understanding-the-next-generation-of-wireless-technology-1561301737915.html **3.** https://nptel.ac.in/courses/117/104/117104099/	

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

Text Books:	
1.	T.S Rapaport, "Wireless Communications" 2 nd edition, Pearson Education, Noida, India.
2.	A.F.Molisch, Wireless Communications, Wiley, 2005.
Reference Books:	
1.	A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.
2.	Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
3.	Jonathan Rodriquez, "Fundamentals of 5G Mobile Networks", Wiley, 2015

CIE Assessment:

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

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

SEE Assessment:

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

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

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

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

High-3, Medium-2, Low-1

Semester: VI		
MICROWAVE & ANTENNA		
Course Code:	**MVJ21EC62**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50 +50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03+03 Hours**

Course objective is to:

• Describe the microwave properties and the transmission media. • Describe microwave devices for several applications. • Understand the concept behind microwave systems. • Understand the basics of antenna theory. • Different antennas for specific applications	
Module-1	**8Hrs.**
Prerequisites: *Electromagnetics, Wave propagation, Waveguides* **Introduction to Microwaves:** History of Microwaves, Microwave Frequency bands, General Applications of Microwaves, Advantages of Microwaves **Analysis of Microwave Transmission Lines**: Transmission line equations & solutions, Smith Chart Basics, problems on smith chart, impedance matching using stub line, Introduction to strip lines, Micro strip lines, parallel strip lines, coplanar strip lines, shielded strip lines, Rectangular and circular waveguides-theory and analysis. **Laboratory Sessions/ Experimental learning:** 1. Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench. **Applications:** Power transmission line, Telephone lines, Traces on Printed Circuit Boards, Traces on Multi-Chip Modules, Traces on Integrated Circuit Packages. **Video link / Additional online information:** **1.** https://lake.videoken.com/nptel/category/933/	
Module-2	**8Hrs.**
Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, Wave-guide Corners, Bends, Twists, Attenuator, Circulator, Isolator and Resonator. **Microwave Active components:** Tunnel diode, Varactor diodes, Step recovery diodes, Schottky Barrier diodes, PIN diodes, Gunn Diodes, IMPATT and TRAPATT diodes, Parametric Amplifiers, Microwave Transistors, Microwave oscillators and Mixers. Microwave tubes: Klystron, TWT, Magnetron. **Laboratory Sessions/ Experimental learning:** 1. Study of the characteristics of Klystron tube and to determine its electronic tuning range.	

Applications: Oscillators and mixers, power sources. **Video link / Additional online information:** 1. https://lake.videoken.com/nptel/category/933/ **2.** https://www.daenotes.com/electronics/microwave-radar/microwave-tube-devices	
Module-3	
Microwave Systems: Wireless Communications system, Radar Systems, Radiometer Systems, Satellite Communication, Remote sensing, Microwave Propagation (Introduction and Block diagrams only) **Antenna Basics:** Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain, Antenna Apertures, Effective Height, Bandwidth, Friis Transmission Equation, Antenna Field Zones & Polarization. **Laboratory Sessions/ Experimental learning:** 1. To perform PC to PC Communication using Microwave test bench **Applications:** Satellite communications, remote sensing, RADAR systems. **Video link / Additional online information:** 1. https://lake.videoken.com/nptel/category/933/ 2. https://lake.videoken.com/nptel/category/1052/	**8Hrs.**
Module-4	
Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing, Phased Arrays. **Electric Dipoles:** Introduction, Short Electric Dipole, Fields of a Short Dipole (General and Far Field Analyses), Radiation Resistance of a Short Dipole, Thin Linear Antenna (Field Analyses), Radiation Resistances of Lambda/2 Antenna. **Laboratory Sessions/ Experimental learning:** 1. Simulation of antenna patterns using FEKO software.	**8Hrs.**

Applications: Two-way radio communications links, to broadcasting broadcast reception, general radio reception. **Video link / Additional online information:** **1.** https://lake.videoken.com/nptel/category/1052/	
Module-5	**8Hrs.**
Antenna Types: Introduction to Loop Antenna, Small loop, Comparison of Far fields of Small Loop and Short Dipole, The Loop Antenna General Case, Far field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Microwave antennas, Horn antennas, Helical Antenna, Yagi-Uda array, Parabolic reflectors, Log periodic array, Plasma antenna, Antenna for GPR. **Laboratory Sessions/ Experimental learning:** 1. Measurement of directivity and gain of Helical, Loop, Horn and Yagi antennas 2. Case study on 3-element printed Yagi-Uda antenna **Applications:** wave propagation and communications **Video link / Additional online information:** **1.** https://lake.videoken.com/nptel/category/1052/	

LABORATORY SESSIONS:	
PART A: Hardware Experiments	
Sl No	**Experiment Name**
1.	Measurement of directivity and gain of microstrip Yagi antennas.
2.	Determination of Coupling and isolation characteristics of microstrip directional coupler.
3.	Determination of Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate.
4.	Power division and isolation of microstrip power divider.
5.	Measurement of frequency, guide wavelength, power, VSWR, and attenuation of the microwave test bench.
6.	Study of Isolator. Extraction of S- parameters.
7.	Study of Circulator. Extraction of S- parameters.
8.	Study the I-V Characteristics of Gunn Diode.
9.	Modelling of different planar microstrip patch antennas (square patch, circular patch, triangular patch etc.). Investigation of parametric requirements for simulation.

10.	Simulation of planar microstrip square (or circular, or triangular etc.) patch (or monopole) antenna and plotting the return loss bandwidth.
11.	Simulation of planar microstrip square (or circular, or triangular, or complementary etc.) patch (or monopole) antenna and investigating the gain and radiation patterns.
12.	Design of planar microstrip square (or circular, or triangular etc.) patch (or monopole) antenna, incorporation of fractal design and plotting the return loss bandwidth, investigation of surface current patterns.

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

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.

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Semester: VI		
COMPUTER NETWORKS		
Course Code:	**MVJ21EC63**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50 +50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03+03 Hours**

Course objective is to:

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

Module-1	
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	**8Hrs.**
Module-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.	**8Hrs.**

Wired LANs: Ethernet: Ethernet Protocol: IEEE802, Ethernet Evolution, Standard Ethernet: Characteristics, Addressing, Access Method, Efficiency, and Implementation. **Wireless LANs:** Introduction: Architectural Comparison, Characteristics, Access control **Laboratory Sessions/ Experimental learning**: 1. Study and analyse packet transfer using CSMA/CD and CSMA/CA using NetSim. **Applications:** Collision detection and avoidance in wired and wireless network. **Video link / Additional online information:** https://nptel.ac.in/courses/106/105/106105183/	
Module-3	**8Hrs.**
Wireless LANs: Introduction: Architectural Comparison, Characteristics, IEEE 802.11: Architecture, MAC Sublayer, Addressing Mechanism, Physical Layer, Bluetooth: Architecture, Layers. **Connecting Devices:** Hubs, Switches. **Virtual LANs:** Membership, Configuration, Communication between Switches and Routers, Advantages. **Network Layer:** Introduction, Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses, Address Space, Classful Addressing, Classless Addressing, DHCP. **Laboratory Sessions/ Experimental learning**: 1. Study of different types of connecting devices. **Applications:** Bluetooth, WiFi, WiMax **Video link / Additional online information:** **1.** https://nptel.ac.in/courses/117/102/117102062/	
Module-4	**8Hrs.**
Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-Back-N Protocol, Selective repeat protocol. **Transport-Layer Protocols in the Internet:** User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, Flow control, Error control, TCP congestion control. **Laboratory Sessions/ Experimental learning**: 1. Study of IP addressing, subnet mask and subnetting.	

Applications: Routing and forwarding packets. **Video link / Additional online information:** **1.** https://nptel.ac.in/content/storage2/courses/106105080/pdf/M6L2.pdf	
Module-5	**8Hrs.**
Application Layer: Introduction: providing services, Application- layer paradigms, Standard Client - Server Protocols: World wide web, Hyper Text Transfer Protocol, FTP: Two connections, Control Connection, Data Connection, Electronic Mail: Architecture, Wed Based Mail, Telnet: Local versus remote logging.Domain Name system: Name space, DNS in internet, Resolution, DNS Messages, Registrars, DDNS, security of DNS. **Laboratory Sessions/ Experimental learning**: 1. Transport analysis using TCP/UDP using NetSim. **Applications:** MS Teams, Zoom, Cisco webex **Video link / Additional online information:** 1. http://www.digimat.in/nptel/courses/video/106105183/L11.html **2.** http://www.digimat.in/nptel/courses/video/106105183/L06.html	

Laboratory Sessions	
Sl No	**Experiment Name**
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.

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

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

High-3, Medium-2, Low-1

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.

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Semester: VI		
3D Printing		
Course Code:	**MVJ21ECA66**	**CIE Marks:50**
Credits:	**L:T:P: 2:0:0**	**SEE Marks: 50**
Hours:	**20L**	**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	To develop CAD models for 3D printing.
2	To import and export CAD data and generate. STL file
3	To select a specific material for the given application
4	To select a 3D printing process for an application
5	To produce a product using 3D printing or Additive Manufacturing (AM).

UNIT 1	
Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications	**4Hrs.**
UNIT 2	
CAD Data formats, Data translation, Data loss, STL format. **Practical: i. Creation of a Simple Box** **ii. Design of basic Hex nut** **iii. Design of a Text**	**4Hrs.**
UNIT 3	
Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains	**4Hrs.**
UNIT 4	

Polymers, Metals, Non-Metals, Ceramics. Various forms of raw material – Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials	**4Hrs.**
UNIT 5	
Process equipment- design and process parameters Governing bonding mechanism Common faults and troubleshooting Process design Post processing: requirement and techniques Product quality Inspection and testing Defects and their causes	**4Hrs.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop CAD models for 3D printing.
CO2	Import and Export CAD data and generate STL file.
CO3	Select a specific material for the given application.
CO4	Select a 3D printing process for an application.
CO5	Produce a product using 3D Printing or Additive Manufacturing (AM)

Reference Books:	
1.	Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1
2.	Ian Gibson, David W. Rosen and Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126
3.	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of tests (T) and assignments. Test portion is evaluated for 50 marks. 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 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 consists of objective type questions for 50 marks covering the entire syllabus. Each question will carry 1 mark.

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

Course Title	**SUMMER INTERNSHIP-II**	**Semester**	V
Course Code	MVJ21INT68	**CIE**	50
Total No. of Contact Hours	Industrial Oriented	**SEE**	50
No. of Contact Hours/week	-	**Total**	100
Credits	2	**Exam. Duration**	3 Hours

Course Objective:

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

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

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

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

Scheme of Evaluation :

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

VII SEMESTER

Semester: VII		
VLSI SYSTEM DESIGN		
Course Code:	MVJ21EC71	CIE Marks:50+50
Credits:	L:T:P: 3:0:1	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours

Course objective is to:

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

Module-1	
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	8Hrs.
Module-2	
Basic Electrical Properties of MOS Circuits : Drain-to-Source current vs. voltage relationships, aspects of MOS transistor threshold voltage, MOS transistor	**8Hrs.**

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	
Module-3	**8Hrs.**
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/	
Module-4	**8Hrs.**
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, 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/ 3. https://nptel.ac.in/courses/117101058/	
Module-5	**10Hrs.**
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) https://youtu.be/NGoRLtDkPwU (Sequential Circuit Testing and Scan Chains &BIST)	

Laboratory Sessions	
Sl No	**Experiment Name**
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.
Analog Design	
8	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
9	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
10	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
11	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
12	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	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.
CO2	Utilize the knowledge of physical design aspects to draw the basic gates using stick and layout diagrams.
CO3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements.
CO4	Interpret Memory elements along with timing considerations.
CO5	Summarize testing and testability issues in VLSI Design.
Text Books:	

1.	Sung Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design" - Third Edition, Tata McGraw-Hill.
2.	Neil H. E. Weste, and David Money Harris, "CMOS VLSI Design- A Circuits and Systems Perspective"- 4th Edition, Pearson Education.
3.	Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition, Oxford University Press, International Version, 2009.
Reference Books:	
1.	Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition – 1994).
2.	https://link.springer.com/chapter/10.1007%2F978-981-33-4642-0_2

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

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.

Laboratory- 50 Marks

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

innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):
Total marks: 50+50=100
SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the 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.

Professional Elective II

Course Title	Medical Electronics	Semester	VII
Course Code	MVJ21EC721	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L: T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course Objectives

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

Module-1	
Prerequisites: *Basics of Transducer* **Fundamentals of Physiology and Transducer:** **Types of Bioelectric Potentials:** Introduction to different types of bioelectric potentials, Action and resting potentials, Propagation of action potentials. **Biological Systems:** Nervous system and its fundamentals, Basic components of a biomedical system, Cardiovascular systems, Respiratory systems **Electrodes and Transducers in Medical systems:** Different type of electrodes, sensors used in biomedicine. Physiological signals and transducers, Piezoelectric Transducers, ultrasonic transducers, Temperature measurement, Fibre optic temperature sensors. Selection criteria for transducer and electrodes. **Laboratory Sessions/ Experimental learning:** 1. Practical applications of electrodes in medical field. **Applications:** Ultrasonic scanning devices, Measures skin and body temperature, Measures Respiratory rate**Video link / Additional online information :** 1. https://nptel.ac.in/courses/102/104/102104043/	**8Hrs.**

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

Telemetry: Introduction to telemetry systems, Different types of biotelemetry systems, Retinal Imaging, Imaging application in Biometric systems. **Safety in Medical Environment:** Electrical safety in medical environment, shock hazards, leakage current, Instruments for checking safety parameters of biomedical equipment **Laboratory Sessions/ Experimental learning:** 1. Practical applications of telemetry in medical systems. **Applications:** In the branch of Ophthalmology **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=0UPoSdBFD48 2. https://www.youtube.com/watch?v=8SPHA_1tTw4	
Module-5	
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
Reference Books:	
1.	S.K. Guha, "Principles of Medical Electronics and biomedical Instrumentation" - ISBN-13: 978-8173712579.
2.	J.G.Webster(Wiley India), "Medical instrumentation Application and Design", ISBN-13: 978-0471676003.
3	Joseph D. Bronzino, "The Biomedical Engineering Handbook", Third Edition, CRC Press-2006.

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	SATELLITE & RADAR COMMUNICATION	Semester	VII

Course Code	MVJ21EC722	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
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 https://youtu.be/oYRMYSIVj1o	8Hrs.
Module-2	
Satellite sub-systems: Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system, Space craft antennas, Multiple access techniques, comparison of FDMA, TDMA, and CDMA. Earth station equipment, tracking systems. **Satellite Link Design** : Basic transmission theory, System noise temperature and G/T Ratio, Noise figure and noise temperature, Calculation of system noise	8Hrs.

temperature, G/T ratio for earth stations, Link budgets - Uplink and downlink budget calculations, Error control for digital satellite links, Prediction of rain attenuation and propagation impairment counter measures. **Laboratory Sessions/ Experimental learning:** 1. Study and analyze the parameters of RF-link satellite simulation using Matlab **Applications:** Mobile Communication, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://www.youtube.com/watch?v=FTHt-c8hWKw	
Module-3	**8Hrs.**
Communication Satellites: Introduction, C band and Ku band Home satellite TV, Digital DBS TV, DBS TV System Design, Installation of DBS TV Antenna, Satellite Radio Broadcasting. **Navigation Satellite** s: Introduction, Radio and Satellite Navigation, GPS Position Location Principle, Satellite Signal Acquisition, GOS Navigation Message, GPS Signal Levels, GOS Receiver Operation. **VSAT Systems:** Introduction, Overview, Network Architectures. **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	
Module-4	**8Hrs.**
Introduction to Radar: Radar block diagram and operation, Radar frequencies, Applications of radar, Prediction of range performance, Minimum detectable signal, Receiver noise, Probability density function, SNR, Integration of radar pulses, Radar cross-section of targets, PRF and range ambiguities, Transmitter power, System losses.	

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/	
Module-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:	
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 oftargets and clutter.

CO5	Calculate and simulate receiver noise and losses.

Text Books:	
1.	T. Pratt, C.W. Boastian and Jeremy Allnutt, "Satellite Communication", 2013, 2nd edition, John Wiley and Sons, Bangalore, India.
2.	Merril. I. Skolnik, "Introduction to Radar Systems", 2/e, MGH, 1981.
Reference Books:	
1.	Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006
2.	Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd Edition, Wiley India Pvt. Ltd , 2017, ISBN: 978-81-265-0833-4

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

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

High-3, Medium-2, Low-1

Course Title	REAL TIME OPERATING SYSTEMS	Semester	VII
Course Code	MVJ21EC723	CIE	50
Total No. of Contact Hours	40	SEE	50

No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Prerequisites: *Basic Concepts of Operating systems and basics of task management and task scheduling.* **Real Time Systems:** Introduction, issues in real time computing, Structure of a real time system, task classes, performance measures for real time systems, task assignment and scheduling algorithms, mode changes, Fault tolerant scheduling, Real Time Models. **Laboratory Sessions/ Experimental learning:** 1. Create an application that creates two tasks that wait on a timer whilst the main task loops. 2. Create an application that creates tasks and scheduling tasks. **Applications:** Kiel RTOS for ARM (Keil RTX - ARM) **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105036/ 2. https://nptel.ac.in/courses/106/105/106105172/	8Hrs.
Module-2	**8Hrs.**

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

Laboratory Sessions/ Experimental learning: 1. Write an application that display two different messages in LCD display in two lines. **Applications:** Smart Mobile Phone operating system development process demonstration. **Video link / Additional online information:** 1. http://1.https//nptel.ac.in/courses/11706087/ 2. https://nptel.ac.in/courses/106/106/106106198/	
Module-5	**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, Board support 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 kernels and Embedded Drivers.

Text Books:	
1.	Krishna C.M., Kang G. Shin, "Real Time Systems", Tata McGraw-Hill international Edition, 2010.

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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

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

High-3, Medium-2, Low-1

Course Title	CRYPTOGRAPHY & NETWORK SECURITY	Semester	VII

Course Code	MVJ21EC724	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Introduction: Services, Mechanisms, Mechanism Attacks, The OSI Security Architecture, A Model for Network Security, Cyber Attacks, Defence Strategies and Techniques, Guiding Principles **Mathematical Background of Cryptography:** Integer Arithmetic, Modular Arithmetic, Matrices, The Greatest Comma Divisor, Useful Algebraic Structures, Chinese Remainder Theorem **Applications:** Time Stamping, Electronic Money, Secure Network Communication **Laboratory Sessions/ Experimental learning:** 1. Breaking the Shift Cipher **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117103063/ 2. https://nptel.ac.in/courses/117107095/ 3. http://nptelvideos.com/video.php?id=2441 http://www.nptelvideos.com/video.php?id=429	8Hrs.
Module-2	
Basics of Cryptography: Preliminaries, Elementary Substitution Ciphers, Elementary Transport Ciphers, Other Cipher Properties.	8Hrs.

Symmetric Ciphers: Symmetric Ciphers model, Substitution Techniques, Transposition Techniques, Simplified DES, Data encryption Standard (DES), The strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and modes of operation, Evaluation Criteria for Advanced Encryption standard, The AES Cipher. **Laboratory Sessions/ Experimental learning:** 1. 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 https://nptel.ac.in/courses/108102095/	
Module-3	8Hrs.
Public Key Cryptography: Principles of public key Cryptosystem, The RSA algorithms, Key management, Diffie – Hellman key exchange, PRNG. **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. Diffie-Hellman Key Establishment **Applications:** Random number generator, permutation generator **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=m4sjTt7rhow 2. https://nptel.ac.in/courses/117101106/ 3. https://nptel.ac.in/courses/108108114/	
Module-4	8Hrs.
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: 1. Digital Signatures Scheme 2. Cryptographic Hash Functions and Applications (HMAC) **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/	
Module-5	
Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH) **IP Security:** IP Security Overview, IP Security Policy, ESP, Combining Security Associations. **Laboratory Sessions/ Experimental learning:** 1. Program for SSL operation. **Applications:** Encryption , message authentication and integrity, and replay attack protection **Video link / Additional online information:** https://nptel.ac.in/courses/117102052/	**8Hrs.**

Course outcomes:	
CO1	Analyse the importance of security attacks, service mechanism, basic network security model and its applications.
CO2	Design and develop simple cryptography algorithms and Explain basic structure of DES and AES
CO3	Apply the concepts of Primes, Testing, Factorization, Chinese remainder theorem and RSA Cryptosystem.
CO4	Illustrate the concept public key cryptography & apply digital signatures in email. Processing and Explain usages of email-security, IP security and web security.
CO5	Describe different techniques used in key exchange protocols.
Text 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.

Reference Books:

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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Professional Elective-III

Course Title	DIGITAL IMAGE PROCESSING	Semester	VII
Course Code	MVJ21EC731	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Prerequisites: *Discrete Fourier Transform, MATLAB Basics* **Introduction to Digital Image Processing:** What is Digital Image Processing? Origin of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. **Applications of Image Processing:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Laboratory Sessions/ Experimental learning:**	8Hrs.

1. Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB **Applications:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
Module-2	**8Hrs.**
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain:** Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image, Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications:** Image Enhancement, Image Analysis **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
Module-3	**8Hrs.**
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant	

Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. **Laboratory Sessions/ Experimental learning:** 1. Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications:** Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
Module-4	
Segmentation: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds. **Representation and Description:** Representation, Boundary descriptors. **Laboratory Sessions/ Experimental learning:** 1. Develop and implement a matlab code for Image segmentation using thresholding technique. **Applications:** Object tracking, Pattern recognition **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2 .https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
Module-5	**8Hrs.**

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. Four morphological principles, Skeletons and object marking. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of multimodal image fusion using MATLAB. **Applications:** Color conversion, Object marking **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	

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

Text Books:	
1.	Rafel C Gonzalez and Richard E. Woods, "Digital Image Processing"-, PHI 3rd Edition, 2010.

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

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

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

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

High-3, Medium-2, Low-1

Course Title	IOT & WIRELESS SENSOR NETWORK	Semester	VII
Course Code	MVJ21EC732	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 2 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
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.
Module-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	**8Hrs.**

Analytics), Analytics vs Control, Data vs Network Analytics IoT Data Management and Compute Stack. **Laboratory Sessions/ Experimental learning:** 1. Implement an IoT architecture to design an application of your own. **Video link / Additional online information:** 2. https://nptel.ac.in/courses/108/108/108108147/ 3. https://onlinecourses.nptel.ac.in/noc20_cs69/unit?unit=17&lesson=18	
Module-3	**8Hrs.**
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	
Module-4	**8Hrs.**
Overview of Wireless Sensor Networks: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. **Architectures:** Single-Node Architecture, Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture, Sensor Network Scenarios, Optimization Goals and Figures	

of Merit, Design principles for WSNs, Service interfaces of WSNs Gateway Concepts. **Laboratory Sessions/ Experimental learning:** 1. Do a case study on total energy conservation opportunities in Solar Power **Applications:** Health care monitoring, Area monitoring, Industrial monitoring, Threat detection. **Video link / Additional online information :** https://nptel.ac.in/courses/106/105/106105166/ https://nptel.ac.in/courses/106/105/106105160/	
Module-5	8Hrs.
Communication Protocols: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Contention based protocols(CSMA,PAMAS), Schedule based protocols (LEACH) Address and Name Management in WSNs, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Hierarchical networks by clustering. **Laboratory Sessions/ Experimental learning:** 1. Design an energy efficient system for a WSN using the routing protocols using NetSim or NS2. **Applications:** Environmental/Earth sensing, Air pollution monitoring, Forest fire detection, Landslide detection, Water quality monitoring **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105160/ 2. https://nptel.ac.in/courses/106/105/106105195/	

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

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

Textbooks:	
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.
Reference Books:	
1.	Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor NetworksTechnology, Protocols, And Applications", John Wiley, 2007.
2.	Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
3.	Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547

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

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

High-3, Medium-2, Low-1

Course Title	OPTICAL COMMUNICATION	Semester	VII
Course Code	MVJ21EC733	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

- Learn the basic principles of optical fibre communication with different modes of light propagation.
- Study of optical sources, detectors, and receivers.
- Understand the transmission characteristics and losses in optical fibre and study optical components.
- Know the concept of WDM and system design.
- Learn the network standards in optical fibre and understand the network architectures along with its functionalities.

Module-1	
Optical fiber Communications: Historical development, General system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index, Fiber Materials, Photonic crystal fibers. **Laboratory Sessions/ Experimental learning:** 1. Measurement of numerical aperture of an optical fiber. **Applications:** Networking, Telecommunication **Video link / Additional online information:** 1. https://youtu.be/9seDKvbaoHU 2. https://youtu.be/BGUhTDWkwx8	8Hrs.
Module-2	8Hrs.
Pre-requisite: *Knowledge of Semiconductor Devices*	

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

https://youtu.be/BGUhTDWkwx8	
Module-4	
WDM Concepts and Components: Overview of WDM: Operational Principles of WDM, WDM standards, Passive Optical couplers, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings. **Optical System Design** : Point-to- Point Links, System Considerations, Link Power Budget Rise Time Budget, Short-Wavelength Band, Attenuation-Limited Distances for Single-Mode Links. **Laboratory Sessions/ Experimental learning:** 1. Determine the wavelength of light from a monochromatic source using Interferometer and calculate the refractive index of a thin film. **Applications:** Networking, Telecommunication **Video link / Additional online information:** 1. https://youtu.be/t8a25L58-m8 2. https://vlab.amrita.edu/index.php?sub=1&brch=189	**8Hrs.**
Module-5	**8Hrs.**
Optical Networks: Optical network evolution and concepts: Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, public telecommunication network overview. Optical network transmission modes, layers, and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching, Optical burst switching networks. **Laboratory Sessions/ Experimental learning:** 1. Analog and Digital (with TDM) communication link using optical fiber. **Applications:** Networking, Telecommunication **Video link / Additional online information:** 1. http://ofcvlab.vesit.ves.ac.in/page2/honeycomb.html	

https://www.youtube.com/embed/f5EmFoXlYyQ	

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

Text Books:	
1.	Gerd Keiser, Optical Fiber Communication, 5th Edition, McGraw Hill Education(India) Private Limited, 2015. ISBN:1-25-900687-5.
2.	John M Senior, Optical Fiber Communications, Principles and Practice, 3rd Edition, Pearson Education, 2010, ISBN:978-81-317-3266-3
Reference Books:	
1.	Joseph C Palais, Fiber Optic Communication, Pearson Education, 2005, ISBN:0130085103
2.	Ramaswami, Sivarajan and Sasaki "Optical Networks", Morgan Kaufmann, 2009.
3.	Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.
4.	John F. Read, 'Industrial Applications of Lasers', Academic Press, 1978.

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

- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	ARTIFICIAL INTELLIGENCE & DATA SCIENCE	Semester	VII
Course Code	MVJ21EC734	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Prerequisites: *Machine Learning* **Artificial Intelligence:** What is Artificial Intelligence? AI Technique, Level of the Model, Problem Spaces, and Search: Defining the Problem as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics, and issues in the Design of Search Programs. Heuristic Search Techniques: Generate-and Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends. **Laboratory Sessions/ Experimental learning:** 1. Write a program to solve 8 queens problem using PROLOG **Applications:** Astronomy, Health care, Finance, Gaming, Data security **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/102/106102220/ 2. https://www.simplilearn.com/artificial-intelligence-introduction-for-beginners-training-course	8Hrs.
Module-2	8Hrs.

Analysis, Knowledge Representation: Representations and Mappings, Approaches to Knowledge Representation, Using Predicate Logic: Representing Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution, Natural Deduction. Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning. **Laboratory Sessions/ Experimental learning:** 1. Program to replace an integer from the list using PROLOG **Applications:** Computer database **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105077/ 2. https://www.youtube.com/watch?v=xUIqkAmfi8A	
Module-3	**8Hrs.**
Reasoning: Symbolic Reasoning Under Uncertainty, Statistical Reasoning, Weak Slot and Filler, Structure, Semantic nets, Frames, Strong Slot and Filler Structure, Conceptual Dependency, Scripts, CYC. **Natural Language Processing:** Natural Language Processing, Syntactic processing, semantic analysis, Parallel and Distributed AI, Psychological modelling- parallelism and distributed in reasoning systems, Learning, Connectionist Models, Hopfield networks, neural networks. Expert Systems. **Laboratory Sessions/ Experimental learning:** 1. Solve Robot (traversal) problem using means End Analysis using PROLOG **Applications:** Search Autocorrect and Autocomplete, Language Translator, Social Media Monitoring. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/101/106101007/ 2. https://www.youtube.com/watch?v=WHCo4m2VOws&vl=en 3. https://www.youtube.com/watch?v=dw6kp0jfi5w	
Module-4	**8Hrs.**

Prerequisites: *Mathematical and Statistical concepts, Programming skills like C or C++* **Data Visualization:** Introduction, Causality and Experiments - Data Pre-processing: Knowing data, Data cleaning, Data reduction, Data transformation, Data discretization -Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of Exploratory Data Analysis (EDA). Exploring Univariate Data - Histograms -Stem-and Leaf Quantile Based Plots - Continuous Distributions - Quantile Plots- QQ Plot- Box Plots **Laboratory Sessions/ Experimental learning:** R as CALCULATOR APPLICATION 1. Using with and without R objects on console 2. Using mathematical functions on console 3. Write an R script, to create R objects for calculator application and save in a specified location in disk. **Applications:** Fraud and Risk Detection, Website Recommendations, Advanced Image Recognition, Airline Route Planning **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106179/ 2. https://nptel.ac.in/courses/106/107/106107220/	
Module-5	**8Hrs.**
Prerequisites: *Probability theory* **Big Data Analytics:** Hadoop Distributed File System Basics, Running Example Programs and Benchmarks, Hadoop Map Reduce Framework, Map Reduce Programming **Applications:** Customer Relationship management, Health care, Education, Retail, Banking, Financial services, Insurance, Manufacturing, Telecom, Public Sector **Laboratory Sessions/ Experimental learning:** 1. Word Count Map Reduce program to understand Map Reduce Paradigm Installing and configuring Hadoop **Applications:** Communication, Healthcare	

Video link / Additional online information: 1. https://nptel.ac.in/courses/106/104/106104189/ 2. https://www.digimat.in/nptel/courses/video/106104189/L06.html	

Course outcomes:	
CO1	Identify the AI based problems
CO2	Apply techniques to solve the AI problems.
CO3	Demonstrate learning and various learning techniques
CO4	Apply pre-processing techniques to convert raw data so as to enable further analysis
CO5	Analyze the probability density function of transformations of random variables and use these techniques to generate data from various distributions

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

5.	Anil Maheshwari, "Data Analytics", 1st Edition, McGraw Hill Education, 2017. ISBN-13: 978-9352604180

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	PROJECT PHASE – I	Semester	VII
Course Code	MVJ21ECP75	CIE	50
Total No. of Contact Hours	-	SEE	-
No. of Contact Hours/week	3 (L : T : P :: 0 : 0 : 3)	Total	50
Credits	5	Exam. Duration	-

Course Objective:

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

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

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

CO1	Describe the project and be able to defend it.
CO2	Learn to use modern tools and techniques.
CO3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.

CO5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation:

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

VIII SEMESTER

Course Title	**PROJECT PHASE – II**	**Semester**	VIII
Course Code	MVJ21ECP81	**CIE**	50
Total No. of Contact Hours	-	**SEE**	50
No. of Contact Hours/week	-	**Total**	100
Credits	10	**Exam. Duration**	3 Hours

Course Objective:

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

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

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

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

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

Scheme of Evaluation :

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**SUMMER INTERNSHIP-II**	**Semester**	V
Course Code	MVJ21INT82	**CIE**	50
Total No. of Contact Hours	Industrial Oriented	**SEE**	50
No. of Contact Hours/week	-	**Total**	100
Credits	5	**Exam. Duration**	3 Hours

Course Objective:

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

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

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

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

Scheme of Evaluation :

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	TECHNICAL SEMINAR	Semester	VII
Course Code	MVJ21ECS83	CIE	100
Total No. of Contact Hours	-	SEE	-
No. of Contact Hours/week	L : T : P :: 1 : 0 : 0	Total	100
Credits	1	Exam. Duration	3 Hours

Course Objective:

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

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

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

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

CO1	Develop knowledge in the field of Electronics and Communication Engineering and other disciplines through independent learning and collaborative study.

CO2	Identify and discuss the current, real-time issues and challenges in engineering & technology. Develop written and oral communication skills.
CO3	Explore concepts in larger diverse social and academic contexts.
CO4	Apply principles of ethics and respect in interaction with others.
CO5	Develop the skills to enable life-long learning.

Scheme of Evaluation :

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Open Elective offered by ECE department

Open Elective I

Course Title	PRINCIPLES OF COMMUNICATION	Semester	VI
Course Code	MVJ21EC641	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

- Understand and analyze the concepts of Analog Modulation schemes viz; AM, FM.
- Learn the concepts of digitization of signals viz; sampling, quantizing and encoding.
- Realize the basic concepts of various digital modulation techniques
- Study the principles behind information theory and coding
- Understand the basics of spread spectrum modulation.

Module-1	
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	
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	8Hrs.
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	8Hrs.

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 **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/	

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

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

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

High-3, Medium-2, Low-1

Course Title	DIGITAL IMAGE PROCESSING	Semester	VI
Course Code	MVJ21EC642	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Prerequisites: *Discrete Fourier Transform, MATLAB Basics* **Introduction to Digital Image Processing:** What is Digital Image Processing? Origin of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. **Applications of Image Processing:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Laboratory Sessions/ Experimental learning:** **1.** Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB **Applications:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/	**8Hrs.**

2. https://www.tutorialspoint.com/dip/index.htm	
Module-2	
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain:** Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image, Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications:** Image Enhancement, Image Analysis **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ https://www.tutorialspoint.com/dip/index.htm	8Hrs.
Module-3	8Hrs.
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error(Wiener) Filtering, Constrained Least Squares Filtering. **Laboratory Sessions/ Experimental learning:** 1. Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications:** Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
Module-4	8Hrs.

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

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

CO5	Conduct independent study and analyze various Morphological Image Processing techniques.
Text Books:	
1.	Rafel C Gonzalez and Richard E. Woods , "Digital Image Processing"-, PHI 3rdEdition 2010.
2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, –"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, 2013, ISBN: 978-81-315-1883-0
Reference Books:	
1.	S.Jayaraman, S Esakkirajan, T.Veerakumar, "Digital Image Processing", Tata McGraw Hill, 2011
4.	S.Jayaraman, S.Esakkirajan, T.Veerakumar, "Digital Image Processing"- Tata McGraw Hill 2014.
5.	A. K. Jain, "Fundamentals of Digital Image Processing"- Pearson 2004.

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

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

High-3, Medium-2, Low-1

Course Title	SENSOR TECHNOLOGY	Semester	VI
Course Code	MVJ21EC643	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Prerequisite: Basic Electronics, Knowledge on physical quantities **Sensors Fundamentals and Characteristics:** General Concepts and Terminology, Sensor Classification, Static Characteristics, Dynamic Characteristics, Materials for Sensors, Microsensor Technology. **Laboratory Sessions/ Experimental learning:** 1. Study on applications of sensors **Applications:** Biological, Chemical, Electric, magnetic, or electromagnetic wave, Heat, temperature, Mechanical displacement or wave, Radioactivity, radiation and other. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105064/ 2. https://nptel.ac.in/courses/108/108/108108147/	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.	8Hrs.

Resistive Sensors: Resistive Temperature Detectors (RTDs),Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas sensors. **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/ 2. 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:** 1. 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.

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	INTRODUCTION TO MATLAB & SIMULINK	Semester	VI
Course Code	MVJ21EC644	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Introduction to Matlab, Creating Variables, Some Useful MATLAB Functions Data Types creating simple and multiple data set in single plot, Matrix generation, Array operations and Linear equations Introduction to programming in MATLAB, Visualization and Programming ,Control flow and operators **Laboratory Sessions/ Experimental learning:** 1. Write MATLAB commands to analyze arithmetic, logical and Boolean operations. 2. Write MATLAB commands to analyze vector operations and magic matrixes. 3. Write a MATLAB program to demonstrate if and else if statement for comparing Two numbers. **Video link / Additional online information :** 1. https://in.mathworks.com/videos/writing-a-matlab-program-69023.html 2. https://youtu.be/ygGF3RR1NyM https://www.halvorsen.blog/documents/programming/matlab/matlab_basics.php	8Hrs.

Module-2	
Solving Equations, Curve Fitting, and Numerical Techniques :Linear Algebra, Polynomials, Optimization, Differentiation/Integration, Differential Equations **Advanced Methods** : Probability and Statistics, Data Structures, Images, File I/O **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=14H4UFoxZjs 2. https://www.youtube.com/watch?v=fqS873TnMDs	8Hrs.
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 2. https://in.mathworks.com/videos/app-designer-overview-1510748719083.html	
Module-4	
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=iOmqgewj5XI 2. https://in.mathworks.com/learn/tutorials/simulink-onramp.html 3. https://www.halvorsen.blog/documents/teaching/courses/matlab/matlab3.php	**8Hrs.**
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 2. 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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

Open Elective II

Course Title	LABVIEW	Semester	VII
Course Code	MVJ21EC741	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	8Hrs.

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

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

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

Laboratory Sessions/Experimental Learning:

1. Perform basic arithmetic & Boolean Operations using LabView

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

Video link/ Additional online information:

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

Module-2	
MODULAR PROGRAMMING: Modular Programming In Labview, Build A VI Front Panel and Block Diagram, Creating an Icon, Building a Connector Pane, Creating, Opening And Editing SUBVIs, **REPETITION AND LOOPS:** For Loops, While Loops, Structure Tunnels, Terminals Inside Or Outside Loops, Shift Registers, Feedback Nodes, Control Timing, Communicating Among Multiple Loops, Local & Global Variables. **ARRAYS:** Creating 1-D, 2-D And Multidimensional Arrays, Deleting, Inserting, Replacing, Elements, Array Functions, Matrix Operations with Arrays, Polymorphism. **Laboratory Sessions/ Experimental learning:** 1. Find the sum of 'n' numbers using FOR loop using LabView 2. To perform the factorial of a given number using WHILE loop 3. To sort even numbers using WHILE loop in an array 4. To find the maximum and minimum variable from an array. **Applications:** Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI. **Video link/ Additional online information:** 1. https://www.youtube.com/watch?v=WKvRDIuUNNs	**8Hrs.**
Module-3	
PLOTTING DATA: Types of Waveforms, Graphs, Charts, Data Type, XY Graphs, Intensity Graphs And Charts, Digital Waveform Graphs, 3D Graphs, Customizing Graphs And Charts, Customizing Graphs, Customizing 3D Graphs, and Displaying Special Planes on the XY Graph. **STRUCTURES, STRINGS AND FILE I/O:** Case, Sequence, Customizing Structures, Timed Structures, Formula Nodes, Event Structure, String Functions, Formatting Strings, Basics of File Input/Output, File I/O VIs, and Creating a Relative Path. **Laboratory Sessions/ Experimental learning:** 1. To bundle and unbundle a cluster. 2. To perform functions using flat and stacked sequence.	**8Hrs.**

3. To create a sine wave using formula node. **Applications:** Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI. **Video link/ Additional online information:** 1. https://www.youtube.com/watch?v=kdPyGcJNQbM 2. https://www.youtube.com/watch?v=c6hLkFsQ-VU	
Module-4	**8Hrs.**
DATA ACQUISITION: Transducers, Signals And Signal Conditioning, DAQ Hardware Configuration, Analog Inputs & Outputs, Counters, DAG Software Architecture, Assistant, Selecting and Configuring a Data Acquisition Device, Components of Computer Based Measurement System. **Laboratory Sessions/ Experimental learning:** 1. Temperature sensor using LabView and NI myDAQ. 2. To apply filtering technique for a given input signal 3. To perform discrete cosine transform on the given signal **Applications:** Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI. **Video link/ Additional online information:** 1. https://www.youtube.com/watch?v=fIy6XT3CdPQ	
Module-5	**8Hrs.**
IMAQ VISION: Vision Basics, Image Processing and Analysis, Particle Analysis, Machine Vision, Machine Vision Hardware and Software. **Laboratory Sessions/ Experimental learning:** 1. Build a complete machine vision system. 2. Acquire and Display images with NI-IMAQ driver software. **Applications:** Instrumentation, Control Systems, Embedded Systems, Speech Signal Processing, Image Processing, Robotics & VLSI. **Video link/ Additional online information:** https://www.youtube.com/watch?v=4vDS4CRGhL0&list=PL3qqtKcHarV1yCaDZBQHXunX6MAwhXny1	

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

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

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

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	MEMS & SENSOR DESIGN	Semester	VII
Course Code	MVJ21EC742	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L : T : P :: 3 : 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

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

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

1. Study the process involved in LIGA micromanufacturing **Applications:** Hybrid integrated circuits, integrated passive devices & sensors. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. https://nptel.ac.in/courses/108/108/108108113/ 3. https://nptel.ac.in/courses/108/108/108108147/ 4. http://www.nptelvideos.in/2012/12/mems-microsystems.html	
Module-5	**8Hrs.**
Microsystems Design: Introduction, Design Considerations, Process Design, Mechanical Design, Computer Aided Design. **Introduction to NEMS:** Micro and Nanoscale Technologies, General Principle of Nanofabrication, Nanoproducts, Applications of Nanoproducts. **Laboratory Sessions/ Experimental learning:** 1. Design Capacitive Pressure Sensor using Comsol Multiphysics. **Applications:** To measure blood pressure within the body, detect ions, to perform biological tests, displays, tunable Lasers, smart phones, mobile infrastructure, IoT and defense. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105082/ 2. http://www.nptelvideos.in/2012/12/mems-microsystems.html	

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

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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

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

High-3, Medium-2, Low-1

Course Title	Medical Electronics	Semester	VII
Course Code	MVJ21EC743	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L: T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course Objectives

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

Module-1	
Prerequisites: *Basics of Transducer* **Fundamentals of Physiology and Transducer:** **Types of Bioelectric Potentials:** Introduction to different types of bioelectric potentials, Action and resting potentials, Propagation of action potentials. **Biological Systems:** Nervous system and its fundamentals, Basic components of a biomedical system, Cardiovascular systems, Respiratory systems **Electrodes and Transducers in Medical systems:** Different type of electrodes, sensors used in biomedicine. Physiological signals and transducers, Piezoelectric Transducers, ultrasonic transducers, Temperature measurement, Fibre optic temperature sensors. Selection criteria for transducer and electrodes. **Laboratory Sessions/ Experimental learning:** 1. Practical applications of electrodes in medical field. **Applications:** Ultrasonic scanning devices, Measures skin and body temperature, Measures Respiratory rate**Video link / Additional online information :** 1. https://nptel.ac.in/courses/102/104/102104043/	**8Hrs.**

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

Telemetry: Introduction to telemetry systems, Different types of biotelemetry systems, Retinal Imaging, Imaging application in Biometric systems. **Safety in Medical Environment:** Electrical safety in medical environment, shock hazards, leakage current, Instruments for checking safety parameters of biomedical equipment **Laboratory Sessions/ Experimental learning:** 1. Practical applications of telemetry in medical systems. **Applications:** In the branch of Ophthalmology **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=0UPoSdBFD48 2. https://www.youtube.com/watch?v=8SPHA_1tTw4	
Module-5	
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
Reference Books:	
1.	S.K. Guha, "Principles of Medical Electronics and biomedical Instrumentation" - ISBN-13: 978-8173712579.
2.	J.G.Webster(Wiley India), "Medical instrumentation Application and Design", ISBN-13: 978-0471676003.
3	Joseph D. Bronzino, "The Biomedical Engineering Handbook", Third Edition, CRC Press-2006.

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	INDUSTRIAL IOT	Semester	VII
Course Code	MVJ21EC744	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	3 (L: T : P :: 3: 0 : 0)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

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

Module-1	
Prerequisites : *Basic Knowledge about C or C++* **Introduction to IoT** : IoT Vs. IIoT, History of IIoT, Components of IIoT: Sensors, Interface, Networks, People &Process, Hype cycle, IoT Market, Trends& future Real life examples, Key terms: IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining &Manipulation; Role of IIoT in Manufacturing Processes Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges & Benefits in implementing IIoT **Video link / Additional online information (related to module if any):** 1. http://www.theinternetofthings.eu/what-is-the-internet-of-things. 2. https://www.engineersgarage.com/article_page/sensors-different-types-of-sensors/ 3. https://www.educba.com/applications-of-sensors/	**8Hrs.**
Module-2	
Architectures: Overview of IoT components ,Various Architectures of IoT and IIoT, Advantages & disadvantages, Industrial Internet, Reference Architecture; IIoT System components: Sensors, Gateways, Routers,	**8Hrs.**

Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT. **Applications:** IoT Protocol Applications **Video link / Additional online information (related to module if any):** 1. https://inductiveautomation.com/resources/article/what-is-scada 2. https://iotbytes.wordpress.com/application-protocols-for-iot/ 3. https://data-flair.training/blogs/iot-protocols/	
Module-3	
Sensor and Interfacing: Introduction to sensors, Transducers, Classification, Roles of sensors in IIoT , Various types of sensors , Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet , Current, M2M etc **Video link / Additional online information (related to module if any):** 1. https://www.digiteum.com/rfid-technology-internet-of-things 2. https://www.uio.no/studier/emner/matnat/ifi/INF5910CPS/h10/undervisningsmateriale/RFID-IoT.pdf	**8Hrs.**
Module-4	
Protocols and Cloud: Need of protocols, Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI , I2C, IIoT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ IIoT cloud platforms : Overview of cloud platforms, predix, thingworks, azure etc. Data analytics, cloud services, Business models: Saas, Paas, Iaas. **Video link / Additional online information (related to module if any):** 1. https://www.simform.com/home-automation-using-internet-of-things/ 2. https://iot5.net/iot-applications/smart-home-iot-applications/ 3. https://maker.pro/raspberry-pi/tutorial/how-to-connect-and-interface-raspberry-pi-with-arduino# 4. https://create.arduino.cc/projecthub/ruchir1674/how-to-interface-arduino-with-raspberrypi-504b06	**8Hrs.**

Module-5	
IoT Analytics and Applications: IoT Analytics, Role of Analytics in IoT, Data visualization Techniques, Introduction to R Programming, Statistical Methods. Internet of Things Applications: Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIoT in Manufacturing Sector **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/	8Hrs.

Course outcomes:	
CO1	Describe IoT and IIoT
CO2	Analyse various IoT Layers and their relative importance
CO3	Design and develop the real life IoT applications using off the shelf hardware software
CO4	Realize the importance of Data Analytics in IoT
CO5	Apply the concepts of Design Thinking

Text Books:	
1.	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications 2.Bernd Scholz-Reiter, Florian
2.	Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743
3.	Raj Kamal,"Internet of Things-Architecture and design principles", McGraw Hill Education.

Reference Books:	
1.	Honbo Zhou, "The Internet of Things in the Cloud:A Middleware Perspective" -C Press-2012
2.	Dieter Uckelmann, Mark Harrison, "Architecting the Internet of Things", Springer201
3.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things (A Hands-On-Approach)", V 2014.

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

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CO3	3	3	3	2	1	1	_	_	1	_	1	1
CO4	3	3	3	2	1	1	_	_	1	_	1	1
CO5	3	3	3	2	1	1	_	_	1	_	1	1

High-3, Medium-2, Low-1