Semester: III		
Engineering Mathematics for EEE (Theory)		
Course Code:	**MVJ22EE31**	**CIE Marks:50**
Credits:	**L: T:P: 2:2:0**	**SEE Marks: 50**
Hours:	**40L + 10P**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Acquaintthestudentswithdifferentialequationsandtheirapplicationsinelectricalengineering	
2	Findtheassociationbetweenattributesandthe correlationbetweentwovariables	
3	Learn to use Fourier series to represent periodical physical phenomena in engineeringanalysisand toenablethestudenttoexpressnonperiodicfunctionstoperiodicfunctionusingFourier series andFourier transforms.	
4	Learn thebasic ideas ofthe theoryofprobabilityand randomsignals.	

UNIT-I	
OrdinaryDifferentialEquationsofHigherOrder: **Importanceofhigher-orderordinarydifferentialequationsinElectrical&ElectronicsEngineeringapplications.** Higher-orderlinearODEswithconstantcoefficients-Inversedifferentialoperator,problems. LineardifferentialequationswithvariableCoefficients- Cauchy'sandLegendre'sdifferentialequations -Problems. **Applications:** Applicationoflineardifferential equationsto L-Ccircuitand L-C-Rcircuit. **Self-Study:** Finding the solution by the method of undetermined coefficients and method ofvariationofparameters.	**8Hrs**
UNIT-II	
Curvefitting,Correlationandregressions: Principlesof least squares,Curvefittingbythemethod of least squaresin theform $y=a+bx$,$y=a+bx+cx^2$,and$y=ax^b$.Correlation,Co-efficientofcorrelation,Linesofregression,Angle betweenregressionlines, standarderrorofestimate,rankcorrelation. **Self-study:** Fittingofcurvesinthe form$y=ae^{bx}$	**8Hrs**
UNIT-III	

Fourierseries: Periodic functions, Dirchlet's condition, conditions for a Fourier series expansion,Fourier seriesof functions with period $2\pi$and with arbitrary period. Half rang Fourier series.Practicalharmonicanalysis. **Applicationtovariationof periodiccurrent.** **Self-study:**Typicalwaveforms,complex formofFourierseries	**8Hrs**
UNIT-IV	
FouriertransformsandZ-transforms: **Infinite Fourier transforms**: Definition, Fourier sine, and cosine transform. Inverse FouriertransformsInverse Fourier cosine and sinetransforms. Problems. **Z-transforms:**Definition,Standardz-transforms,Damping,andshiftingrules,Problems.Inversez-transform andapplications to solvedifferenceequations. **Self-study**:ConvolutiontheoremsofFourier and z-transforms	**8Hrs**
UNIT-V	
Probabilitydistributions: Reviewofbasicprobabilitytheory,Randomvariables-discreteandcontinuousProbabilitydistribution function, cumulative distribution function, Mathematical Expectation, mean andvariance, Binomial, Poisson,Exponential and Normal distribution (without proofs for mean andSD)–Problems. **Sampling Theory:** Introduction to sampling distributions, standard error, Type-I and Type-IIerrors.Student'st-distribution, Chi-squaredistributionas a testof goodness offit. **Self-study:**Testofhypothesisformeans,singleproportionsonly.	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C201.1	Understandthatphysicalsystemscanbedescribedbydifferentialequationsandsolvesuchequations
C201.2	Makeuseofcorrelationandregressionanalysistofitasuitablemathematicalmodelforstatistical data
C201.3	DemonstratetheFourierseriestostudythebehaviorofperiodicfunctionsandtheirapplicationsinsystemcommunications,digitalsignalprocessing,andfieldtheory.
C201.4	TouseFouriertransformstoanalyzeproblemsinvolvingcontinuous-timesignalsandtoapplyZ-Transform techniques to solvedifferenceequations
C201.5	Applydiscreteandcontinuousprobabilitydistributionsinanalyzingtheprobability

Textbooks/ Reference Books	
1.	**B. S. Grewal**: ‘‘Higher EngineeringMathematics’’, KhannaPublishers, 44thEd., 2021.
2.	**E. Kreyszig**: ‘‘Advanced EngineeringMathematics’’, John Wiley&Sons, 10thEd., 2018.
3.	**V.Ramana:**‘‘HigherEngineeringMathematics’’McGraw-Hill Education, 11thEd., 2017
4.	**SrimantaPal &SubodhC.Bhunia**: ‘‘EngineeringMathematics’’Oxford UniversityPress, 3rdEd., 2016.

Semester: III		
Electric Circuit Analysis (Theory)		
Course Code:	**MVJ22EE32**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50+50**
Hours:	**40L + 10P**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Solve the electrical circuits using different network reduction methods.	
2	Apply various network theorems to solve complex electric circuits.	
3	Analyze resonance and transient response of electric circuits.	
4	Apply the Laplace transform to basic waveforms.	
5	Analyze power consumed by three phase balanced and unbalanced load, different network topology and two-port networks.	

UNIT-I	
Basic circuit concepts: Active and passive elements, Concept of ideal and practical sources. Source transformation. Analysis of networks by (i) Network reduction method (star-to-delta and delta-to-star transformation) (ii) Mesh and Node voltage methods for DC circuits with independent and dependent sources. Concept of Super-Mesh and Super node analysis. **Applications**: Analysis of electric circuits by reducing their complexity. **Video link**: https://nptel.ac.in/courses/108104139/	**8Hrs**
UNIT-II	
Network Theorems: Thevenin's theorem, Norton's theorem, Millman's theorem, Super Position theorem and Maximum power transfer theorem. Analysis of networks (Problems with independent AC and DC sources). **Applications**: Analysis of complex electric circuits by reducing the complexity. **Video link**: http://www.digimat.in/nptel/courses/video/108105112/L20.html	**8Hrs**
UNIT-III	
Laplace Transformation (LT): Laplace transformation (LT). Initial and Final value theorems.Solution of electrical circuits using LT. **Applications**: Application of waveform synthesis in communication, speech processing, medical science **Video link:** https://nptel.ac.in/courses/108102097/	**8Hrs**
UNIT-IV	
Resonant Circuits: Analysis of simple series RLC and parallel RLC circuits under resonances. Problems on Resonant frequency, Bandwidth and Quality factor at resonance **Transient Analysis:** Behavior of circuit elements under switching action, Evaluation of initial and final conditions. Transient analysis of RL and RC circuits under DC excitations. **Applications**: Analysis of resonant circuits and transient behavior of RL, RC and RLC circuits in communication engineering **Video link**: https://nptel.ac.in/courses/108102097/	**8Hrs**

UNIT-V	
Unbalanced Three Phase Systems: Analysis of three phase systems (3-wire and 4 wire system), calculation of real and reactive Powers. **Two Port networks:** Definition, Open circuit impedance, Short circuit admittance and Transmission parameters and their evaluation for simple circuits. **Applications**: Model of voltage, current characteristics of complex electrical networks, Modeling of the transmission line. Video link: https://nptel.ac.in/courses/108104139	**8Hrs**

Practice (Laboratory) Part	
Sl..No	**Experiments (to be carried out using discrete components)**
1	Study of the effect of open and short circuits in simple circuits.
2	Determination of resonant frequency, bandwidth, and Q of a series circuit.
3	Determination of resonant frequency, bandwidth, and Q of a parallel circuit.
4	Verification of Thevenin's theorem.
5	Verification of Norton's theorem.
6	Verification of Superposition theorem.
7	Verification of maximum Power transfer theorem.
8	Power factor correction.
Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.	
9	Measurement of time constant of an RC circuit.
10	Measurement of power in three phase Circuits using two watt meter method.

Course Outcomes: After completing the course, the students will be able to	
C202.1	Solve the complex electrical circuits using different network reduction and Mesh and Node voltage methods for dependent and independent source.
C202.2	Apply various network theorems to solve complex electric circuits.
C202.3	Analyze the resonance and transient behavior of RL, RC and RLC circuits.
C202.4	Analyze the basic waveforms and waveform synthesis.
C202.5	Analyze star-delta connected balanced and unbalanced three phase loads, complex circuits using network topology and two-port networks**.**

Reference Books	
1	"Fundamentals of Electric Circuits", Charles Alexander, Matthew Sadik, Seventh, 2021, McGraw-Hill Education, ISBN: 978-1-260-57079-3
2	"Network Analysis", M. E. Van Valkenburg, T.S. Rathore, Third, 2019, Pearson Education, ISBN: 978-9353433123.
3	"Circuit theory analysis and synthesis", A Chakrabarti, 2018, Dhanpat Rai Publishing Co Pvt Ltd, ISBN: 9788177000009
4	"Engineering Circuit Analysis" Hayt, Kemmerly and Durbin, 2005, Tata McGraw Hill Education, ISBN: 978-0070611054

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 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):

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C202.1	3	3	1	1	1	-	-	-	1	-	-	2	-	-
C202.2	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C202.3	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C202.4	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C202.5	3	2	1	2	1	-	-	-	1	-	-	2	-	-

ANALOG ELECTRONIC CIRCUITS (Theory and Practice)		
Course Code:	**MVJ22EE33**	**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	Analyze transistor biasing and thermal stability circuits.	
2	Explain the working of transistor at low frequencies.	
3	Understand the working of multistage amplifiers.	
4	Analyze feedback amplifiers.	
5	Develop skills to design power amplifiers and oscillators.	

UNIT-I	
Diode Circuits: Diode clipping (series, shunt and double ended clippers) and clamping circuits (Positive and negative clamping) **Transistor Biasing:** The operating point, load line analysis, DC analysis and design of fixed bias circuit, emitter stabilized bias circuit, collector to base bias circuit, voltage divider bias circuit, modified DC bias with voltage feedback, Transistor switching circuits (only CE mode). **Laboratory Sessions / Experimental learning:** Formation of different waveforms by using clipper and clamper circuits in PSpice. **Applications:**Analysis of composite picture signals **Video link:**https://www.youtube.com/watch?v=x-5HcKU1gH8	**8Hrs**
UNIT-II	
Transistor at Low Frequencies: Hybrid model, h-parameters for CE mode, mid-band analysis of single stage amplifier, simplified hybrid model, analysis for CE (emitter voltage follower circuit) modes. **Transistor frequency response**: General frequency considerations, effect of various capacitors on frequency response, Miller effect capacitance, **Laboratory Sessions/ Experimental learning:** Static Transistor characteristics for CE modes and determination of h parameters. **Applications:** Amplifying and switching apparatuses.	**8Hrs**

Video link: https://www.youtube.com/watch?v=in6ElwzGOkE	
UNIT-III	
Multistage amplifiers: Cascade connection, analysis for CE-CC mode, CE-CE mode, CASCODE stage-unbypassed and bypassed emitter resistance modes, Darlington connection using h-parameter model. **Laboratory Sessions/ Experimental learning:** BJT Darlington emitter follower with and without bootstrapping. **Applications:** Voltage regulators, Servo drives **Video link:https://www.youtube.com/watch?v=m4sjTt7rhow**	**8 Hrs**
UNIT-IV	
Feedback Amplifiers: Classification of feedback amplifiers, concept of feedback, general characteristics of negative feedback amplifiers, Input and output resistance with feedback of various feedback amplifiers, analysis of different practical feedback amplifier circuits. **Laboratory Sessions/ Experimental learning:**Design of Voltage series feedback amplifier. **Applications:**Regulated power supplies. **Video link:**https://www.youtube.com/watch?v=F-wUTfOT8ZQ	**8 Hrs**
UNIT-V	
Power Amplifiers: Classification of power amplifiers, Analysis of class A, Class B, class C and Class AB amplifiers. **Oscillators:** Concept of positive feedback, frequency of oscillation for RC phase oscillator, Wien Bridge oscillator, crystal oscillator and its types**.** **Laboratory Sessions/ Experimental learning:**Design and testing of BJT -RC phase shift oscillator for given frequency of oscillation in PSpice. **Applications:**Analysis of different pulses. **Video link:**https://www.youtube.com/watch?v=SVQutMsLKfQ	**8 Hrs**
LABORATORY EXPERIMENTS	
1. Experiments on series, shunt, and double ended clippers. 2. Experiments on positive and negative clampers. 3. Static Transistor characteristics for CE modes and determination of h parameters. 4. Frequency response of single stage BJT RC coupled amplifier and determination of half power points, bandwidth, input, and output impedances. 5. Design and testing of Class A and Class B power amplifier and to determine conversion efficiency. 6. Design and testing of BJT-RC phase shift oscillator for given frequency of oscillation.	

7. Design and testing of Wien bridge oscillator for given frequency of oscillation using EDA software PSpice.
8. Design and testing of crystal oscillator for given frequency of 2MHz and compare with the theoretical frequency using EDA software PSpice.

Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.

1. Design of voltage series feedback amplifier.
2. Simulate Wien Bridge oscillator using PSpice and determine the frequency of oscillation.

Course Outcomes: After completing the course, the students will be able to	
C203.1	Analyze transistor biasing and thermal stability circuits.
C203.2	Analyze transistor at low frequencies.
C203.3	Understand the working of multistage amplifiers.
C203.4	Understand the working of feedback amplifiers.
C203.5	Design power amplifiers and different oscillators.

Reference Books	
1	Electronic Devices and Circuit Theory, Robert L Boylestad Louis Nashelsky, Pearson, 11th Edition, 2015.
2	Electronic Devices and Circuits, S.Salivahanan&N.Suresh, McGraw Hill, 3rd Edition, 2013
3	Electronic Devices and Circuits, David A bell, 5E. Fifth Edition - 30 April 2008. ISBN-13: 978-0195693409 ISBN-10: 019569340X.
4	Analog Electronics, J.B. Gupta,S.K. Kataria & Sons; Edition : 2nd 2014; Reprint : 2022;

CO-PO Mapping

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C203.1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
C203.2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
C203.3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
C203.4	3	3	1	1	2	-	-	-	-	-	-	1	-	-
C203.5	3	3	1	1	2	-	-	-	-	-	-	1	-	-

Semester: III		
Transformers and Generators (Theory)		
Course Code:	**MVJ22EE34**	**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 concept of single-phase transformers and their analysis.	
2	Explain the methods of testing of transformer and auto-transformer tap changing mechanism.	
3	Understand the requirement for the parallel operation of transformers	
4	Analyze the performance of Synchronous Generators	
5	Discuss the types and operating mechanism of salient and non-salient generators and wind power generators.	

UNIT-I	
Single phase Transformers: Necessity of transformer, principle of operation, Types and construction, EMF equation, Losses and efficiency, condition for maximum efficiency, Operation of practical transformer under no-load and on-load with phasor diagrams. Equivalent circuit. **Laboratory Sessions/ Experimental learning:** Plotting B-H curve/hysteresis loop of different core material specimen for comparative study. **Applications:** R&D in transformer core manufacture **Video link / Additional online information:** https://nptel.ac.in/courses/108106071	**8 Hrs**
UNIT-II	
Testing of transformer: Open circuit and Short circuit tests, calculation of equivalent circuit parameters. Predetermination of efficiency, voltage regulation and its significance. Numerical. **Auto-transformer and tap changing transformer:** Introduction to autotransformer-equivalent circuit, no load and on load tap changing transformers. Numerical. **Laboratory Sessions/ Experimental learning:** Computer simulation of plotting efficiency and regulation curves of a single-phase transformer using OC and SC test data.	**8 Hrs**

Applications: Counter check for manufacturer's load test data **Video link / Additional online information**: https://nptel.ac.in/courses/108/105/108105017/	
UNIT-III	
Three-phase Transformers: Introduction, Constructional features of three-phase transformers. Transformer connection for three phase operation– star/star, delta/delta and star/delta, scott connection. **Parallel Operation of Transformers:** Necessity of Parallel operation, conditions for parallel operation– Single phase and three phase. Load sharing in case of similar and dissimilar transformers. Numerical. **Laboratory Sessions/ Experimental learning:** Computer simulation of parallel operation of 3 phase transformer and load sharing of similar transformers. **Applications:** load sharing concepts of similar transformers in distribution system. **Video link / Additional online information:** https://archive.nptel.ac.in/courses/108/105/108105017/	**8 Hrs**
UNIT-IV	
Synchronous Generators: Construction, Types of rotor, Armature windings, winding factors, EMF equation.Harmonics–causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit. **Synchronous Generators Analysis:**Voltage regulation. Voltage regulation by EMF, MMF and ZPF methods. Excitation control for constant terminal voltage. Numerical. **Laboratory Sessions/ Experimental learning:** Computer simulation of plotting efficiency and regulation curves of aSynchronous Generators by EMF, MMF and ZPF methods data. **Applications:** Counter check for manufacturer's regulation and efficiency test data. **Video link / Additional online information:** https://archive.nptel.ac.in/courses/108/105/108105131/	**8 Hrs**
UNIT-V	
Synchronous Generators (Salient Pole): Effects of saliency, two-reaction theory, Parallel operation of generators and load sharing. Methods of	**8 Hrs**

Synchronization. **Performance of Synchronous Generators:** Power angle characteristic (salient and non-salient pole), power angle diagram, reluctance power, Hunting and damper windings. Numerical. **Wind power Generator** –Basic components of wind energy conversion system, types of wind generators. **Laboratory Sessions/ Experimental learning:**Assembling of induction generator. **Applications:**Understanding the detailed operation of wind power generators Video link / Additional online information: **Video link**: https://nptel.ac.in/courses/103103206	

Course Outcomes: After completing the course, the students will be able to	
C204.1	Explain the construction, working of single phase Transformer.
C204.2	Understand the testing and tap changing mechanism of transformers
C204.3	Analyze the performance and parallel operation of three phase Transformer.
C204.4	Analyze the regulation of Synchronous Generator by using various methods
C204.5	Discuss the type and operating principle of salient pole and non-salient pole generator and wind power generators.

Textbooks/ Reference Books	
1	Electric Machines, D. P. Kothari, et al, 4th Edition, 2011.
2	Principals of Electrical Machines, V.K Mehta, Rohit Mehta, S Chand, 2nd edition, 2009
3.	Non-conventional Energy sources by G D Rai Khanna Publishers, 6th edition,2017
4.	Ramana B. V., "Higher Engineering Mathematics", Tata McGraw-Hill, 2006.

CO-PO Mapping														
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C204.1	3	2	1	2	-	-	-	-	1	-	-	-	-	-
C204.2	3	2	-	1	-	-	-	-	1	-	-	-	-	-
C204.3	2	2	1	2	-	-	-	-	1	-	-	-	-	-
C204.4	3	2	-	1	-	-	-	-	1	-	-	-	-	-
C204.5	3	2	-	2	-	-	-	-	1	-	-	-	2	1

Semester: III		
Transformers & Generators Laboratory (Practical)		
Course Code:	**MVJ22EEL35**	**CIE Marks:50**
Credits:	**L: T:P: 0:0:2**	**SEE Marks: 50**
Hours:	**50L**	**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
1	Along with prescribed hours of teaching –learning process, provide opportunity to perform the experiments at their own time, at their own pace, at any place as per their convenience and repeat any number of times to understand the concept.	
2	Provide unhindered access to perform whenever the students wish.	
3	Vary different parameters to study the behaviour of the circuit without the risk of damaging equipment/device or injuring themselves.	

SL No	**LABORATORY EXPERIMENTS**
1	Open Circuit and Short circuit tests on single-phase step up or step down transformer and predetermination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency
3	Parallel operation of two similar single-phase transformers of different kVA and determination of load sharing and analytical verification given the Short circuit test data.
4	Separation of no load losses in single phase transformer
5	Voltage regulation of an alternator by EMF method.
6	Voltage regulation of an alternator by MMF method.
7	Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.
8	Load test on single phase transformer - Find the efficiency of a single-phase transformer under various load conditions
Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.	
9	Voltage regulation of an alternator by ASA method.
10	Voltage regulation of an alternator by ZPF method.

Course Outcomes: After completing the course, the students will be able to	
C205.1	Calculate equivalent circuit parameters of single-phase transformer.
C205.2	Apply various methods to do the experiments on transformers and analyze the results.
C205.3	Analyze the performance of Transformer by doing OC and SC test.
C205.4	Apply various methods to find regulation of an alternator.
C205.5	Analyze the performance of synchronous generator by conducting slip test

CO-PO Mapping														
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
C205.1	3	2	-	2	1	-	-	-	1	-	-	1	-	1
C205.2	3	2	-	1	1	-	-	-	2	-	-	1	-	-
C205.3	3	2	-	1	1	-	-	-	2	-	-	1	-	2
C205.4	3	2	-	2	1	-	-	-	2	-	-	1	-	2
C205.5	3	2	-	1	1	-	-	-	1	-	-	1	-	-

DIGITAL LOGIC CIRCUITS (Theory and Practice)		
Course Code:	**MVJ22EE36**	**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	Illustrate simplification of algebraic equations using Karnaugh Maps and Quine-McClusky methods.	
2	Design decoders, encoders, digital multiplexer, adders, subtractors and binary comparators.	
3	Explain latches and flip-flops, registers, and counters.	
4	Develop state diagrams for synchronous sequential circuits and analyze Melay ad Moore Models.	
5	Understand the applications of sequential circuits.	

UNIT- 1	
Principles of Combinational Logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, incompletely specified functions (Don‘t care terms) Simplifying Max term equations, Quine-McCluskey minimization technique, Quine-McCluskey using don‘t care terms, Reduced prime implicants Tables. **Laboratory Sessions/ Experimental learning:**Design and implementation of code converters using logic gates (i) BCD to excess-3 code and vice versa (ii) Binary to gray and vice-versa. **Applications**: Traffic Signals **Video link**: https://nptel.ac.in/courses/108105113	**8Hrs**
UNIT- 2	
Analysis and Design of Combinational logic: General approach to combinational logic design, Decoders, BCD decoders, Encoders, digital multiplexers, Using multiplexers as Boolean function generators, Adders and subtractors, Cascading full adders, Look ahead carry, Binary comparators. **Laboratory Sessions/ Experimental learning: -** Realization of half/full adder and half/full subtractor using (a) X-OR and basic gates. (b) only NAND gates. **Applications:** Microcontrollers for arithmetic subtraction **Video link:** https://www.youtube.com/watch?v=85XxQZqBNlg	**8Hrs**
UNIT-3	
Flip-Flops: Basic Bistable elements, Latches, Timing considerations, The master-slave flip-flops (pulse triggered flip-flops): SR flip-flops, JK flip-flops, Edge triggered flip-flops, Characteristic equations.	**8Hrs**

Laboratory Sessions/ Experimental learning: Truthtable verification of Flip-Flops: (i) JK Master Slave (ii) D- Type (iii) T- Type. **Applications:** Data Transfer, Counters **Video link:** 1. https://www.youtube.com/watch?v=EAhtV0H6z0Y 2. https://www.youtube.com/watch?v=j_NrUIwj1gc	
UNIT-4	
Flip-Flops Applications: Registers, binary ripple counters, synchronous binary counters, Counters based on shift registers, Design of a synchronous counter, Design of a synchronous mod-n counter using clocked T, JK, D and SR flip-flops. **Laboratory Sessions/ Experimental learning**: Realization of 3-bit counters as a sequential circuit **Applications**: Data storage, Frequency Dividers. **Video link**: 1.https://www.youtube.com/watch?v=Iecj9xmIfXM 2.https://www.youtube.com/watch?v=aGHpADG8Yo4	**8 Hrs**
UNIT-5	
Sequential Circuit Design: Mealy and Moore models, State machine notation, Synchronous Sequential circuit analysis, Construction of state diagrams, counter design. **Memories:** Read only and Read/Write Memories, Programmable ROM, EPROM, Flash memory. **Laboratory Sessions/ Experimental learning**:Realization of MOD – N counter design using 7476, 7490, 74193. **Applications**: Video processor **Video link**: https://www.youtube.com/watch?v=2aRwFWhLk0o0	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
C206.1	Explain the concept of combinational and sequential logic circuits.
C206.2	Analyze and design combinational circuits.
C206.3	Describe and characterize flip flops and its applications.
C206.4	Design the sequential circuits using SR, JK, D and T flip-flops and Melay and Moore applications.
C206.5	Analyze the applications of sequential circuits.

Reference Books	
1	John M Yarbrough , Digital logic applications and design, Thomson Learning, 2001.
2	Morris Mano, Digital Design, PHI, 3rd edition
3	D.P.Kothari and J S Dhillon, -Digital circuits and design, Pearson, 2016

4	Donald D Givone, Digital Principles and design, MC Graw Hill 2002

CO-PO Mapping														
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C206.1	3	3	2	3	2	-	-	-	2	-	-	1	-	-
C206.2	3	3	2	3	3	-	-	-	2	-	-	1	-	-
C206.3	3	3	3	3	3	-	-	-	2	-	-	1	-	-
C206.4	3	3	3	3	3	-	-	-	2	-	-	1	-	-
C206.5	3	3	3	2	3	-	-	-	2	-	-	1	-	-

Semester-IV		
ELECTRIC MOTORS (Theory)		
Course Code:	**MVJ22EE41**	**CIE Marks:50**
Credits:	**L:T:P:: 3:0:0**	**SEE Marks: 50**
Hours:	**40 L**	**SEE Duration: 03 Hours**
Course Learning Objectives: The students will be able to		
1	Study the constructional features of Motors and select a suitable drive for specific aapplication.	
2	Study the constructional features of Three Phase and Single-phase induction Motors.	
3	Understand different test to be conducted for the assessment of the performance. characteristics of motors.	
4	Study the speed control of motor by different methods.	
5	Explain the construction and operation of Synchronous motor and special motors.	

UNIT-I	
DC Motors: Construction and working principle. Back E.M.F and its significance, Torque equation, Classification, Characteristics of shunt, series & compound motors, Speed control ofshunt motor, Application of motors. **Losses and Efficiency**- Losses in DC motors, power flow diagram,efficiency, condition for maximum efficiency. **Testing of DC Motors**: Direct & indirect methods of testing of DC motors- Swinburne's test, Field's test, merits and demerits of tests. (Only theory). **Laboratory Sessions/ Experimental learning:** Testing DC machines using any indirect method of testing. **Applications:** Understand the construction and operation of a DC motor. **Video link / Additional online information:** **1. https://youtu.be/kOj8dA9cKXo**	**8 Hrs**
UNIT-II	
Three Phase Induction Motors: Concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring. Slip and its significance, Torque equation, torque-slip characteristic	**8Hrs**

covering motoring, generating and braking regions of operation, Maximum torque (numerical as applicable). **Laboratory Sessions/ Experimental learning:**Construction of model of rotors used in three phase induction motors. **Applications:** Selection of appropriate motors according to the requirements. **Video link / Additional online information**: **1. https://youtu.be/dZyO5gcWP-o** **2. https://youtu.be/BPfIvcxM-Fo**	
UNIT-III	
Performance of Three-Phase Induction Motor: Phasor diagram of induction motor on no-load and on load, equivalent circuit, losses, efficiency, No-load and blocked rotor tests. Performance of the motor from the equivalent circuit. Cogging and crawling. (numerical as applicable) **Laboratory Sessions/ Experimental learning:** Determine the efficiency of a three phase induction motor using load test. **Applications**: Countercheck for manufacturer's load test data **Web Link and Video Lectures:** **1. https://youtu.be/eMq9j0KY2Ak**	**8Hrs**
UNIT-IV	
Starting and Speed Control of Three-Phase Induction Motors: Necessity of starter. Direct on line, Star-Delta, and autotransformer starting. Rotor resistance starting, speed control by V/f method. **Single-Phase Induction Motor:** Construction and operation of single phase induction motor, Double revolving field theory. Types: Split-phase,Capacitor start Induction run, Capacitor start capacitor run and Shaded pole motors. **Laboratory Sessions/ Experimental learning:** Speed control of three phase slip ring induction motor using stator voltage control. **Applications:**Speed control of three-phase induction motors **Web Link and Video Lectures:** **1. https://www.youtube.com/watch?v=ze8LY4yq9Wk** **2. https://www.digimat.in/nptel/courses/video/108105131/L72.html**	**8Hrs**
UNIT-V	
Synchronous Motor: Principle of operation, methods of starting, phasor diagrams, torque and torque angle, effect of change in excitation. V and inverted V curves.Synchronous condenser, **Other Motors:** Construction and operation of Universal motor, AC servomotor, Linear induction motor, PMSM, SRM and BLDC **Laboratory Sessions/ Experimental learning:** V and Inverted V-curves of a three-phase synchronous motor. **Applications**: Operation and use of special electric motors for different	**8Hrs**

applications. **Web Link and Video Lectures:** 1. **https://youtu.be/eMq9j0KY2Ak** 2. **https://www.youtube.com/watch?v=o4qJMMBRSJw**	

Course Outcomes: After completing the course, the students will be able to	
C210.1	Understand the construction and operation, characteristics, Testing of DC Motors and determine losses and efficiency.
C210.2	Understand the construction and operation, classification and types of Three phase Induction motors.
C210.3	Describe the performance characteristics and applications of three phase Induction motors
C210.4	Demonstrate and explain Speed Control methods of three phase induction motor and types of single phase induction motors.
C210.5	Construction and operation of Synchronous motors, universal motor, AC servomotor, Linear induction motor, PMSM, SRM and BLDC motors.

Reference Books	
1.	"Alexander Langsdorf" Theory of Alternating Current Machines,McGraw Hill, 2nd Edition, 2001.
2.	" B.LTheraja " Electrical Technology, , Volume2, S. Chand, 22nd Edition."
3.	"R Krishnan" Permanent magnet synchronous and brushless DC motor drives, CRC Press, 2010.
4.	"E G Janardanan" Special Electrical Machines, Prentice-Hall of India Pvt.Ltd

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C210.1	2	3	1	1	-	-	1	-	2	2	1	2	-	-
C210.2	1	1	2	1	-	-	1	-	2	2	1	2	-	-
C210.3	3	2	2	2	-	-	-	-	2	2	-	2	-	-
C210.4	-	2	2	1	-	-	-	-	2	2	-	2	-	-
C210.5	3	3	-	1	2	-	-	-	2	2	-	2	-	-

Semester: IV		
TRANSMISSION AND DISTRIBUTION (Theory)		
Course Code:	**MVJ22EE42**	**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 concepts of various supporting structures used for transmission of power.	
2	Calculate the parameters of a transmission line like inductance and capacitance.	
3	Understand the different classification of transmission lines and representation by suitable equivalent circuits	
4	Understand the various factors and parameters that affect the performance of the transmission line.	
5	Understand design considerations in DC and AC distribution systems.	

UNIT-I	
Introduction to Power System: Feeders, distributors, Advantages of higher voltage transmission: HVAC, EHVAC, UHVAC and HVDC. **Overhead Transmission Lines: I**ntroduction to types of supporting structures and line conductors-Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All – aluminium alloy conductor (AAAC) and All –aluminium conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI), Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR). **Laboratory Sessions/ Experimental learning:** Visit nearby power station to get practical knowledge on various type of insulators used for power transmission. **Applications:** To transmit required amount of power based on insulator installed on lines. **Video link / Additional online information:** **1.** https://archive.nptel.ac.in/courses/108/102/108102047/ 2.https://onlinecourses.nptel.ac.in/noc22_ee98/preview	**8 Hrs**
UNIT-II	
Transmission Line Parameters: Bundled and Stranded Conductors- Resistance for Solid Conductors – Skin Effect- Calculation of Inductance for Single Phase and Three Phase, Single and Double Circuit Lines, Concept of GMR & GMD, Symmetrical Conductor Configuration with and without Transposition, Numerical Problems, Capacitance- Calculations for Symmetrical Single and Three Phase, Single and Double Circuit Lines, Effect of Ground on Capacitance, Numerical Problems. **Laboratory Sessions/ Experimental learning:**Calculation of inductance and capacitance of transmission line using MAT LAB -Simulink software.	**8Hrs**

Applications: Transmission line parameters are used for the analysis of an electrical network. **Video link :** https://archive.nptel.ac.in/courses/108/102/108102047/	
UNIT-III	
Performance of Transmission Lines: Classification of Transmission Lines, Short, Medium and Long Lines and Their Exact Equivalent Circuits, Nominal-T, Nominal-Π, Mathematical Solutions to Estimate Regulation and Efficiency of All Types of Lines. Long Transmission Line, Rigorous Solution, Evaluation of A, B, C, D Constants, Interpretation of the Long Line Equations, Surge Impedance and Surge Impedance Loading, Ferranti Effect, Numerical Problems. **Laboratory Sessions/ Experimental learning:** Calculation of efficiency and regulation of various transmission lines using MAT LAB -Simulink software. **Applications**: Design of transmission line for different voltages levels and distance. **Web Link and Video Lectures:** https://archive.nptel.ac.in/courses/108/102/108102047/	**8Hrs**
UNIT-IV	
Corona: Phenomenon, Disruptive and visual critical voltages, Corona Loss. Advantages and disadvantages of corona. Methods of reducing corona. **Sag and Tension Calculations**: Sag and Tension Calculations with Equal and Unequal Heights of Towers, Effect of Wind and Ice on Weight of Conductor, Numerical Problems. **Underground Cable:** Types of cables, constructional features, insulation resistance, thermal rating, charging current, grading of cables. **Laboratory Sessions/ Experimental learning:** Calculation of inductance and capacitance of transmission line using MAT LAB -Simulink software. **Applications:**Design of transmission line parameters considering the effect of various factors for different voltages. **Web Link and Video Lectures:** https://archive.nptel.ac.in/courses/108/102/108102047/	**8Hrs**
UNIT-V	
A.C Distribution System: Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation. Voltage Drop Calculations (Numerical Problems) in A.C, Ring and radial main systems, introduction to HVAC systems and EHVAC systems. **D.C Distribution System:** Introduction to D.C distribution system, Comparison of DC vs. AC, and Under-Ground vs. Over- Head Distribution Systems. - Requirements and Design features of Distribution Systems, Introduction HVDC systems. **Reliability of Distribution System**: Definition of reliability, failure, probability concepts, limitation of distribution systems. **Laboratory Sessions/ Experimental learning:** Visit near AC power distribution substation to get practical knowledge on working of power substation equipment installed in system. Applications: Distribution of power for domestic and industrial applications **Video link :**	**8Hrs**

https://archive.nptel.ac.in/courses/108/107/108107112/	

Course Outcomes: After completing the course, the students will be able to	
C211.1	Explain transmission and distribution scheme, identify the importance of different transmission systems and types of insulators.
C211.2	Analyze and compute the parameters of the transmission line for different configurations.
C211.3	Assess the performance of overhead lines efficiency and regulation.
C211.4	Interpret corona and sag calculations explain the use of underground cables.
C211.5	Analyse A.C. and D.C. distribution systems for different loads and can perform voltage drop calculations.

Reference Books	
1	M.L. Soni, P.V. Gupta, U.S. Bhatnagar, A. Chakrabarthy, -A Text Book on Power System Engineering, Dhanpat Rai & Co Pvt. Ltd. 1999.
2	C.L. Wadhwa –Electrical Power Systems, Fifth Edition, New Age International, 2009
3	V.K Mehta & Rohith Mehta- Principles of Power system, Revised Edition, S Chand.
4	Electric Power Distribution, A.S. Pabla, Tata Mc Graw Hill (India) Pvt. Ltd., 6th Edition, 2011.

CO-PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C211.1	2	1	2	2	2	-	2	-	-	-	-	-	2	-
C211.2	2	1	2	3	2	-	-	-	-	-	-	-	1	-
C211.3	2	1	2	1	2	-	-	-	-	-	-	-	1	1
C211.4	3	2	2	2	2	-	-	-	-	-	-	-	2	1
C211.5	2	2	2	1	2	-	-	-	-	-	-	-	1	1

Semester: IV		
Microcontrollers (Theory)		
Course Code:	**MVJ22EE43**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50+50**
Hours:	**40L+26P**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Explain the working of different microcontrollers and internal organization of 8051.	
2	Understand the various instructions to write assembly language program for different applications	
3	Understand C data types to develop 8051 timer, counter programs.	
4	Understand the various interrupts and serial port programs.	
5	Explain the interfacing of parallel peripheral devices to 8051.	

UNIT-I	
8051 Microcontroller Basics: Review of numbering systems, Architecture and pin configuration of 8051, PSW and Flag Bits, 8051 Register Banks, Stack, Stack pointer, Program counter, Data pointer, Internal Memory Organization of 8051, Special Function Registers, Addressing Modes **Laboratory Sessions/ Experimental learning**: Conduct a review on different types of microcontrollers available in market. **Applications**: Selection of different microcontrollers for various applications/projects. **Video link**: https://youtube.videoken.com/embed/SUusup7FfJo https://youtube.videoken.com/embed/AdMxMBH393Q https://youtube.videoken.com/embed/-YYpIdk4_W8 https://youtube.videoken.com/embed/3hltHQXAQm8	**8 Hrs**
UNIT-II	
Assembly programming and instructions of 8051 Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. **Introduction to the ARM**: Instruction set Introduction, Data processing instructions, Load - Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, Conditional Execution. ALP programming. **Laboratory Sessions/ Experimental learning**: 1. Simulate a program using Keil to find number of zeroes and ones in a given number.	**8Hrs**

2. Simulate a program to find whether a number is odd or even using Keil. **Applications**: Generating assembly language algorithms for various applications **Video link :https://youtube.videoken.com/embed/oRPluYsxF28**	
UNIT-III	
8051 Programming in C: I/O programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C. **8051 Timer Programming in Assembly and C**: Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C. **Laboratory Sessions/ Experimental learning**: Generate a Program for reading and manipulating port data. **Applications**: Generation of creating delay for generation of any waveform. **Video link** : https://youtube.videoken.com/embed/2AVOxLPKjeA https://youtube.videoken.com/embed/NhurqshD0HA	**8Hrs**
UNIT-IV	
8051 Serial Port Programming in Assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C. **8051/52 Interrupt Programming in Assembly and C**: 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C **Laboratory Sessions/ Experimental learning**: Simulate a program using Keil to generate a square wave of frequency 100KHz on pin P2.3.Use timer 1 in mode 1. Take crystal frequency of 22MHz. **Applications**: Interfacing of external devices to microcontrollers. **Video link:** https://youtube.videoken.com/embed/DpMxQzHhyyc https://youtube.videoken.com/embed/MqhxeOi8R1Q	**8Hrs**
UNIT-V	
Interfacing: LCD interfacing, Keyboard interfacing. ADC, DAC and Sensor Interfacing: ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning. **Motor Control**: Relay, PWM, DC and Stepper Motor: Relays and opt isolators, stepper motor interfacing, DC motor interfacing and PWM. 8051 Interfacing with 8255: Programming the 8255, 8255 interfacing, C programming for 8255. **Laboratory Sessions/ Experimental learning:** 1. Develop any simple project on toggling the bits in LED display sing Microcontroller. 2. Virtual lab experiment: Interface DAC and LCD to 8051. **Applications**: Interfacing of external devices to microcontrollers.	**8Hrs**

Video link: https://youtube.videoken.com/embed/MqhxeOi8R1Q	

Course Outcomes: After completing the course, the students will be able to	
C212.1	Select microcontrollers for different applications and explain the functional units of 8051.
C212.2	Develop algorithm and formulate assembly language program for a given task.
C212.3	Develop program for timers and serial port using C.
C212.4	To explain writing assembly language programs using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
C212.5	Design interfacing circuitry to interface various peripheral devices to microcontroller.

Reference Books	
1	8051 Microcontroller and Embedded Systems– using assembly and C by Muhammad Ali Mazidi, Janice Gillespie Mazidi, Rollin D. McKinlay, Pearson Education, 2nd Edition.
2	ARM Systems Developers Guide by Andrew.N. Sloss, Elsevier Publications, 2008.
3	Embedded Systems: Architecture, Programming and Design by Rajkamal , Tata McGraw-Hill, 7th Edition, 2006.
4	The 8051 Microcontroller Architecture Programming &Applications by Kenneth J. Ayala, Penram International, 1996.

CO-PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C212.1	3	3	2	2	1	-	-	-	3	-	-	3	-	-
C212.2	3	3	3	3	3	-	-	-	-	-	-	3	-	-
C212.3	3	3	3	3	3	-	-	-	-	-	-	3	-	-
C212.4	3	3	3	3	3	-	-	-	-	-	-	3	-	-
C212.5	3	3	2	3	3	-	-	-	3	-	-	3	-	-

Semester: IV		
Electric Motors Laboratory (Practical)		
Course Code:	**MVJ22EEL44**	**CIE Marks:50**
Credits:	**L:T:P: 0:0:2**	**SEE Marks: 50**
Hours:	**20**	**SEE Duration: 3 Hrs**
Course Learning Objectives: Enables students to get practical experience in testing and performance evaluation of DC Generators, DC Motors and transformers.		

Sl No	Experiment Name	RBT Level	Hours
1	Swinburne's test on a DC shunt motor and speed control of DC shunt motor.	L3	2
2	Load test on DC shunt motor.	L3	2
3	Field test on DC series machines.	L3	2
4	Brake test on three phase Induction Motor.	L3	2
5	No-load & Blocked rotor test on three phase Induction motor	L3	2
6	Equivalent circuit of a single-phase induction motor.	L3	2
7	Load test on three-phase induction motor.	L3	2
8	Load test on single-phase induction motor.	L3	2
Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.			
1	Brake test on single-phase induction motor.	L3	2
2	Speed-control of three-phase slip-ring induction motor-rotor resistance control.	L3	2
3	Determination of Xd and Xq of a salient pole synchronous machine.	L3	2

Course outcomes:	
C213.1	Predetermine the efficiency of DC shunt motor/ DC series machine by conducting necessary tests..
C213.2	Determine the performance curves of DC shunt motor by conducting load test
C213.3	Draw the equivalent circuit of a single phase and a three-phase induction motor.
C213.4	Determine the performance curves of three phase and single-phase induction motor by conducting load test
C213.5	Assess the performance of Induction machines using different testing methods

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C213.1	2	3	3	2				1	3	3		2
C213.2	2	3	3	2				1	3	3		2
C213.3	2	3	3	2				1	3	3		2
C213.4	2	3	3	2				1	3	3		2
C213.5	2	3	3	2				1	3	3		2

OPAMPSANDLIC (Theory)		
Course Code:	**MVJ22EE45**	**CIE Marks:50**
Credits:	**L: T: P: 3:0:0**	**SEE Marks: 50**
Hours:	**40 L**	**SEE Duration: 03 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.
2	Learn the designing of various circuits using linear ICs.
3	Use these linear ICs for specific applications.
4	Understand the concept and various types of converters.
5	Use these ICs, in Hardware projects.

UNIT-I	
Operationalamplifiers: Introduction,Blockdiagramrepresentationofatypical Op-amp,schematic symbol,characteristicsofanOp-amp,idealop-amp,equivalentcircuit,idealvoltagetransfer curve, open loop configuration, differential amplifier, inverting & non –inverting amplifier,Op-amp with negative feedback. **GeneralLinearApplications**:D.C.&A.Camplifiers,peakingamplifier,summing,scaling& averagingamplifier,invertingandnon-invertingconfiguration,differentialconfiguration,instrumentationamplifier **Laboratory Sessions / Experimental learning:**Analysis of inverting and non-inverting op-amp circuits **Applications:**Analysis of audio mixer to add different signals with equal gains **Video link:**https://youtu.be/clTA0pONnMs	**8Hrs**
UNIT-II	
Active Filters: Types of active filter- First & Second order high pass & low pass Butterworth filters (derivation), Band pass filters, Band reject filters & all pass filters (Explaination). DC Voltage Regulators: voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators. **Laboratory Sessions/ Experimental learning:**Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c)band pass filters for a given cut off frequency/frequencies to verify the frequency response Characteristic. **Applications:**Analysis of constant power supply **Video link:** https://www.youtube.com/watch?v=LL3U-Gp-qGk	**8Hrs**
UNIT-III	

Signal generators: Working and derivation of frequency of oscillation for Phase shift oscillator, crystal oscillator, square wave generator, sawtooth wave generator, triangular wave generator, rectangular wave generator. **Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-Inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter. **Laboratory Sessions/ Experimental learning:**Design and realize Schmitt trigger circuit using an op – amp. (Virtual Lab) **Applications:** Study of different ways to remove noise from signals used in digital circuits. **Video link:**https://www.youtube.com/watch?v=7FepL3KO-LI	**8 Hrs**
UNIT-IV	
Signal processing circuits: Precision half wave & full wave rectifiers limiting circuits, clamping circuits, peak detectors, sample & hold circuits. **A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, flash ADC, linear ramp ADC, dual slope ADC. **Laboratory Sessions/ Experimental learning:**Design and verify output of R–2R D/A Converter **Applications:** A/D and D/A conversion **Video link:** https://www.youtube.com/watch?v=kMGap-0XwGs	**8 Hrs**
UNIT-V	
Phase Locked Loop (PLL): Basic PLL, components, performance factors, applications of PLL IC-phase shift and frequency, applications. **555. Timer:** Internal architecture of 555 timer, Mono stable, Astable-multivibrators and applications. **Laboratory Sessions/ Experimental learning:** Design and verify an IC 555 timer-based pulse generator for the specified pulse. **Applications:** Application on 555 timer in pulse width modulation **Video link:** https://www.youtube.com/watch?v=WFsPI8_ZKbc	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
C214.1	Explain the basics of linear ICs.

C214.2	Design circuits using linear ICs.
C214.3	Demonstrate the application of Linear ICs.
C214.4	Explain the different types of A/D and D/A converters.
C214.5	Use ICs in the electronic projects.

Reference Books	
1	Operational Amplifiers and Linear ICs, David A. Bell ,Oxford, 3rd Edition 2011
2	Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, Pearson, 4th Edition, 2015
3	Linear Integrated Circuits , S. Salivahanan, et al, Wiley India , 2013
4	Op-Amps and Linear Integrated Circuits, Concept and Application,James M Fiore, Cengage, 2009.

	CO-PO Mapping													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	**PSO1**	PSO2
C214.1	2	1	-	-	-	-	-	-	-	-	-	-		
C214.2	3	2	3	2	2	-	-	-	-	-	-	2		
C214.3	3	2	3	2	2	-	-	-	-	-	-	2		
C214.4	3	2	3	2	2	-	-	-	-	-	-	2		
C214.5	2	2	2	2	-	-	-	-	-	-	-	2		

Semester: V		
BIOLOGY FOR ENGINEERS (Theory)		
Course Code:	**MVJ22BI47**	**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 familiarize the students with the basic biological concepts and their engineering applications.	
2	To enable the students with an understanding of biodesign principles to create novel devices and structures	
3	To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.	
4	To motivate the students to develop interdisciplinary vision of biological engineering.	
5	To familiarize the students with the basic biological concepts and their engineering applications.	

UNIT-I	
CELL BASIC UNIT OF LIFE Introduction. Structure and functions of a cell. Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules:Properties and functions of enzymes, vitamins and hormones.	**08 Hrs**
UNIT-II	
P APPLICATION OF BIOMOLECULES Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication, food processing, detergent formulation and textile processing.	**08 Hrs**
UNIT-III	
ADAPTATION OF ANATOMICAL PRINCIPLES FOR **BIOENGINEERING DESIGN** Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as purification system. Kidney as a filtration system.	**08 Hrs**
UNIT-IV	
NATURE-BIOINSPIRED MATERIALS AND MECHANISMS: Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).	**08 Hrs**

UNIT-V	
TRENDS IN BIOENGINEERING: Muscular and Skeletal Systems as scaffolds, scaffolds and tissue engineering, Bioprinting techniques and materials. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Bioconcrete. Bioremediation. Biomining.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
215.1	Elucidate the basic biological concepts via relevant industrial applications and case studies.
215.2	Evaluate the principles of design and development, for exploring novel bioengineering projects.
215.3	Corroborate the concepts of biomimetics for specific requirements.
215.4	Think critically towards exploring innovative biobased solutions for socially relevant problems.

Reference Books	
1.	Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
2.	Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
3.	Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4.	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011

Semester: IV		
UNIVERSALHUMANVALUES		
Course Code:	MVJ22UHV48	**CIE Marks: 50**
Credits:	**L: T:P: 1:0:0**	**SEE Marks: 50**
Hours:	**15L**	**SEE Duration: 2Hrs.**
Course Learning Objectives: The students will be able to		
1	Appreciatetheessentialcomplementarybetween'VALUES'and'SKILLS'toensure sustainedhappinessandprosperitywhicharethecoreaspirationsofallhuman- beings.	
2	FacilitatethedevelopmentofaHolisticperspectiveamongstudentstowardslifeand profession as well as towards happiness and prosperity based on a correct understandingoftheHumanrealityandtherestofexistence.Suchaholistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.	
3	HighlightplausibleimplicationsofsuchaHolisticunderstandingintermsofethical humanconduct,trustfulandmutuallyfulfillinghumanbehaviorandmutually. 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, andProsperity–CurrentScenario,MethodtoFulfillthe Basic Human Aspirations. PracticalSessions:(1)SharingaboutOneself(2)ExploringHumanConsciousness (3)ExploringNaturalAcceptance. Videolink: 1. https://www.youtube.com/watch?v=85XCw8SU084 2. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt 6jqzA3p Z3yA7g_OAQz https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**8Hrs**
UNIT-II	
Harmony in the Human Being: Understanding Human being as the Co-existence oftheSelfand the Body, distinguishing between the Needs ofthe Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in theSelf,HarmonyoftheSelfwiththeBody,Programtoensureself-regulation and Health.	**8Hrs**

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. Videolink: 1. https://www.youtube.com/watch?v=GpuZo495F24 https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	
UNIT-III	
HarmonyintheFamilyandSociety: HarmonyintheFamily– theBasicUnit ofHumanInteraction,'Trust'–theFoundationalValueinRelationship,'Respect' –as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society,Vision for theUniversal Human Order. Practical Sessions: (7) Exploring the Feeling of Trust (8) Exploring the Feeling of Respect (9) Exploring Systems to fulfill Human Goal Videolink: 1. https://www.youtube.com/watch?v=F2KVW4WNnS https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**8Hrs**
UNIT-IV	
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness,self-regulationandMutualFulfillmentamongtheFourOrders 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. Videolink: 3. https://www.youtube.com/watch?v=1HR-QB2mCF0 4. https://www.youtube.com/watch?v=lfN8q0xUSpw https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**8Hrs**
UNIT-V	
Implications of the Holistic Understanding – a Look at Professional Ethics: NaturalAcceptanceofHumanValues,Definitivenessof(Ethical)HumanConduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production SystemsandManagementModels-TypicalCaseStudies,StrategiesforTransition towards Value-based Life and ProfessionPracticalSessions:(12)ExploringEthicalHumanConduct(13)ExploringHumanistic Models in Education (14) Exploring Steps of Transition towards Universal Human Order	**8Hrs**

Videolink: 1. https://www.youtube.com/watch?v=BikdYub6RY0 https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	

Course Outcomes: After completing the course, the students will be able to	
C216.1	Explorethemselves,getcomfortablewitheachotherandwiththeteacher
C216.2	Enlisttheirdesiresandthedesiresarenotvague.
C216.3	Restatethatthenaturalacceptance(intention)isalwaysforlivingin harmony, only competence is lacking
C216.4	Differentiatebetweenthecharacteristicsandactivitiesofdifferentorders. and study the mutual fulfillment among them
C216.5	Presentsustainablesolutionsto theproblemsinsocietyandnature

Reference Books	
1.	AICTESIPUHV-ITeachingMaterial,https://fdp-si.aicteindia.org/AICTESipUHV _download.php
2.	AFoundationCoursein HumanValuesandProfessional Ethics,RRGaur,RAsthana, GPBagaria,2ndRevisedEdition,ExcelBooks,NewDelhi,2019.ISBN978-93-87034- 47-1
3.	Teachers'ManualforAFoundationCourseinHumanValuesandProfessionalEthics, RRGaur,RAsthana,GPBagaria,2ndRevisedEdition,ExcelBooks,NewDelhi,2019. ISBN 978-93-87034-53-2
4.	HumanValuesandProfessionalEthicsbyRRGaur,RSangal,GPBagaria,Excel Books, New Delhi, 2010

Semester: V		
Engineering Management and Entrepreneurship (Theory)		
Course Code:	**MVJ22EE51**	**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	Introduce the field of management, the task of the manager, the importance of planning and types of planning, staff recruitment, and the selection process.	
2	Understand the staff recruitment and selection process and explain the need for coordination between the manager and staff.	
3	Explain the social responsibility of business, and the role, and importance of the entrepreneur in economic development.	
4	Discuss the importance of Small-Scale Industries and the related terms and problems involved	
5	Explain the project feasibility study and project appraisal and discuss project financing.	

UNIT-I	
Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management &Administration, Management as a Science, Art & Profession**.** **Planning:** Nature, Importance and Purpose of Planning, Types of Plans, Steps in Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making. **Laboratory Sessions/ Experimental learning:** Case study on decision making process in a corporate. **Applications**: Planning in engineering field. **Web Link and Video Lectures:** 1.https://nptel.ac.in/courses/110/105/110105146/ 2.https://nptel.ac.in/courses/122/108/122108038/	**8Hrs**
UNIT-II	
Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees –meaning, Types of Committees, Centralization Vs Decentralization of Authority and Responsibility, Span of Control, Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling:** Meaning and Nature of Directing-Leadership Styles, Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination, controlling – Meaning and Steps in Controlling. **Laboratory Sessions/ Experimental learning:** Case study of steel plant departmentalization. **Applications:** Effective communication in a corporate.	**8Hrs**

Web Link and Video Lectures: 1.https://nptel.ac.in/content/storage2/courses/122106031/slides/3_2s.pdf 2.https://www.slideshare.net/100005130728571/27-nature-of-directing	
UNIT-III	
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Problems faced by Entrepreneurs and capacity building for Entrepreneurship. **Laboratory Sessions/ Experimental learning:** Case study of a startup. **Application:** Social auditing in electrical industry **Web Link and Video Lectures:** 1.https://nptel.ac.in/courses/110/106/110106141/ 2.https://nptel.ac.in/courses/127/105/127105007/	**8Hrs**
UNIT-IV	
Modern Small Business Enterprises: Role of Small-Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small-Scale sector in India, Sickness in SSI sector, Problems faced by Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs. **Institutional Support for Business Enterprises:** Introduction, Policies and Schemes of Central–Level Institutions, State-Level Institutions. **Laboratory Sessions/ Experimental learning**: Case study on the growth of small-scale industries. **Application:** Setting up and functioning of Small-Scale Industries **Web Link and Video Lectures:** 1. https://www.slideshare.net/syedmubarak15/institutional-support-for-business-enterprises 2. https://www.wto.org/english/docs_e/legal_e/gatt47_01_e.htm	**8Hrs**
UNIT-V	
Electrical Project Management Process: Meaning of Project Management, Electrical project management process, Project Objectives and Characteristics; Project Life Cycle, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Prerequisites for Successful Project Implementation. **New Control Techniques:** PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM**.** **Laboratory Sessions/ Experimental learning: Preparation of detailed project report (DPR).** **Application:** Preparation of reports for specific project.	**8Hrs**

Web Link and Video Lectures: 1.**https://www.projectmanager.com/project-scheduling** 2.https://kissflow.com/project/basics-of-project-scheduling/	

Course Outcomes: After completing the course, the students will be able to	
C301.1	Understand the concept of management
C301.2	Understand the staffing process
C301.3	Explain the social responsibilities of business towards different groups
C301.4	Explain the role of small-scale industries
C301.5	Interpret the project objectives

Textbooks/ Reference Books	
3.	"Entrepreneurship Development and Small Business Enterprises", Poornima M.Charanthimath, , 2nd Edition,2014,Pearson.
4.	"Principles of Management", Tripathy PC & Reddy PN Tata McGraw Hill, 1999.
3.	"Fundamentals of Management", Stephen A. Robbins & David A. Decenzo & Mary Coulter, , , 7th Edition, 2011, Pearson Education.
4.	"Management", Stephen P. Robbins & Mary Coulter,., 10th Edition, 2009, Prentice Hall (India) Pvt. Ltd.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Total marks: 50+50=100

CO-PO Mapping													PSO	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C301.1	-	2	-	1	-	-		3	3	3	3	3	-	-
C301.2	-	1	-	3	-	-		3	3	3	3	3	-	-
C301.3	-	2	-	2	-	3		3	3	2	3	3	-	-
C301.4	-	2	-	2	-	2		3	3	3	3	3	-	-
C301.5	-	2	-	2	-	2		3	3	3	3	3	-	-

Semester: V		
Signals and DSP (Theory)		
Course Code:	**MVJ22EE52**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50+50**
Hours:	**40L + 26P**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Explain basic operations on signals and properties of systems.	
2	Apply continuous Fourier representation to periodic and aperiodic signals.	
3	Compute DFT for a given time domain signal.	
4	Design IIR filter by applying appropriate transformation techniques.	
5	Design FIR filter by applying appropriate transformation techniques.	

UNIT-I	
Signals Introduction: Definitions of signals and a system, Classification of signals, Basic operations on signals, Elementary signals viewed as interconnections of operations. Relation between the elementary signals, specific systems, Properties of systems. **Laboratory Sessions/ Experimental learning:** Verification of Sampling Theorem both in time and frequency domains by using MATLAB. **Application:** Speech recognition. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=879pXoml0XI	**8Hrs**
UNIT-II	
Impulse response of an LTI system, convolution integral, graphical convolution, solution of differential and difference equations, block diagram representation system. **Laboratory Sessions/ Experimental learning:** Evaluate impulse response of a system using MATLAB. **Application:** Digital Speedometer. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=U8riFeiiu3s	**8Hrs**
UNIT-III	
Z Transform: Introduction Z-transform, Properties of ROC, Properties of z transform. Basic elements of digital signal processing, Advantages of digital signal processing over analog signal processing. **Discrete Fourier Transform:**Properties of DFT, DFT as a linear transformation, circular convolution, Use of DFT in linear filtering. **Laboratory Sessions/ Experimental learning:** Computation of N point DFT and to plot the magnitude and phase spectrum. **Application:** Image processing. **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=gkC7cXa8ewk 2. https://www.youtube.com/watch?v=6spPyJH6dkQ	**8Hrs**

UNIT-IV	
Design of IIR Filters from Analog Filters: IIR Filter design by impulse invariance, Bilinear transformation. Characteristics of analog filters - Butterworth and Chebyshev, frequency transformation in analog domain **Laboratory Sessions/ Experimental learning:** Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) by using MATLAB. **Application:** High-speed telecommunication. **Web Link and Video Lectures:** **1.** https://www.youtube.com/watch?v=3QWvi8EC_DI https://youtu.be/ryfaCpTHVtQ	**8Hrs**
UNIT-V	
Design of FIR Filters: Introduction to filters, Design of linear phase FIR Filters using rectangular, Hamming and Hanning windows, FIR filter design by frequency sampling method. **Laboratory Sessions/ Experimental learning:** Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique in MATLAB **Application:** Radio Astronomy. **Web Link and Video Lectures:** **1.** https://www.youtube.com/watch?v=nsK7mmRSTDY 2.https://www.youtube.com/watch?v=Xl5bJgOkCGU	**8Hrs**

Practice (Laboratory) Part

Sl..No	**Experiments** **(to be carried out using discrete components)**
1	Computation of N – point DFT and to plot the magnitude and phase spectrum.
2	Verification of Sampling Theorem both in time and frequency domains
3	Evaluation of impulse response of a system
4	Linear and circular convolution by DFT and IDFT method.
5	Solution of a given difference equation. Calculation of DFT and IDFT by FFT
6	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)
7	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions
8	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.
9	Realization of IIR and FIR filters
Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.	
10	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.
11	Computation of N – point DFT and to plot the magnitude and phase spectrum

Course Outcomes: After completing the course, the students will be able to	
C302.1	Explain the generation of signals, behaviour of system and the basic operations that can be performed on signals and properties of systems.
C302.2	Apply convolution in both continuous and discrete domain for the analysis of systems given impulse response of a system.
C302.3	Introduction to Z transform. Perform Fourier analysis for continuous and discrete time, linear time invariant systems.
C302.4	Develop a digital IIR filter by direct, cascade, parallel, ladder methods of realization.
C302.5	Design FIR filters by use of window function and frequency sampling method.

Reference Books	
1	Simon Haykin, Barry Van Veen, "Signals and Systems", John Wiley & Sons,2nd edition 2002
2	Jhon G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing –Principles, Algorithms, and Applications", Pearson, 4th Edition, 2007.
3	A .Nagoor Kani, "Digital Signal Processing", McGraw Hill Education; 2nd edition, 2017
4	Oppenheim, Willsky and Nawab,"Signals and Systems", Phi Learning, 2nd Edition, 1997.

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

Total marks: 50+50=100

CO-PO Mapping													PSO	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C302.1	3	3	1	1	1	-	-	-	1	-	-	2	-	-
C302.2	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C302.3	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C302.4	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C302.5	3	2	1	2	1	-	-	-	1	-	-	2	-	-

Semester: V		
Power Electronics (Theory)		
Course Code:	**MVJ22EE53**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the working of power diodes and power transistor.	
2	Understand the operation, characteristics, and performance parameters of thyristor.	
3	Explain the working of controlled rectifier for different loads.	
4	Explain the working of AC voltage controller for different loads.	
5	Design chopper and pulse width modulated inverter for different applications.	

UNIT-I	
Introduction: Power electronic systems, Application of power electronics, Advantage and disadvantage of power electronics, Types of power electronic converter. **Power Transistors:** Introduction, Power MOSFETs (Enhancement and depletion type): Steady State Characteristics, Switching Characteristics, Gate Drive, IGBT (Construction and Working), Gan, Isolation of Gate Drives. **Laboratory Sessions/ Experimental learning**: Build a circuit for controlling a load by using MOSFET/IGBT in MATLAB. **Applications:** Mobile charging unit, switch mode power supply, induction heating, and traction motor control. **Web Link and Video Lectures:** 1. https://gansystems.com/design-center/application-notes/ 2. https://youtu.be/Z2CORFayCv0 3. https://youtu.be/tNp39_L_HtU	**8Hrs**
UNIT-II	
Thyristors: Introduction, Static Characteristics, switching characteristics, turn on methods, Two-Transistor Model, Bidirectional Triode Thyristors, Protection Circuits. **Laboratory Sessions/ Experimental learning:** Realize the static characteristics of SCR in MATLAB. **Application**s: AC voltage stabilizers, light dimmer, AC power control with solid relay. **Web Link and Video Lectures:** 1. https://youtu.be/no1hld5JcCw 2. https://www.electrical4u.com/thyristor-silicon-controlled-rectifier-scr/	**8Hrs**
UNIT-III	

Controlled Rectifiers: Introduction, Performance Parameters, Single-Phase half wave Converters with R and RL load, Single-Phase Full wave Bridge Converters with R, RL and RLE load (continuous current conduction operation only), Single phase symmetrical semi converter, Single-Phase Dual Converters, Three-Phase Full wave Converters with R and RL Load. **Laboratory Sessions/ Experimental learning:** Simulation of single phase and three phase full wave rectifier for R, RL and RLE load in MATLAB **Applications:** Paper mills, textile mills using DC motor drives and DC motor control in steel mills, AC fed traction system using a DC traction motor, High voltage DC transmission, UPS. **Web Link and Video Lectures:** 1. https://youtu.be/EpTKSp9611I 2. https://youtu.be/OuyyVgkzKT8 3. https://youtu.be/Q5Yw4Z_Oydc	**8Hrs**
UNIT-IV	
AC Voltage Controllers: Introduction, Single phase half-wave controller with R and RL load, Single-Phase Full-Wave Controllers with R and RL Loads, Three-Phase Full-Wave Controllers with R load. **Cycloconverters:** **Laboratory Sessions/ Experimental learning:** MATLAB simulation of AC voltage controller**.** **Applications:** Adjustable speed drives, Light dimming, industrial heating **Web Link and Video Lectures:** https://youtu.be/6NCml4kY9Jo	**8Hrs**
UNIT-V	
DC-DC Converters: Introduction, Buck, Boost, Buck Boost regulator, Applications. **DC-AC converters:** Introduction, principle of operation single phase bridge inverters with RL Load, three phase bridge inverters, Current source inverters, PWM techniques -SPWM technique. **Laboratory Sessions/ Experimental learning:** Build a circuit to step up PV output voltage in MATLAB **Applications:** Two stage solar power conversion, Solar PV integration to grid. **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=rfChSvb8FX0 2. https://www.youtube.com/watch?v=Q7cTuZIH8IA 3. https://www.electrical4u.com/boost-converter-step-up-chopper/ 4. https://www.youtube.com/watch?v=QnUhjnbZ0T8 5. https://www.youtube.com/watch?v=zNfbbPobtus	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C303.1	Explain types of power diodes and power transistors
C303.2	Explain the operation, characteristics, and performance parameters of thyristor.
C303.3	Explain steady state, switching characteristics and gate control requirements of controlled rectifiers

C303.4	Discuss the principle of operation of AC voltage controllers.
C303.5	Design DC – DC and DC –AC converters for different application.

Textbooks/ Reference Books	
5.	Power Electronics: Circuits Devices and Applications Mohammad H Rashid, Pearson 4th Edition, 2014.
6.	Power Electronics, Dr. P S Bimbhra, Khanna Publishers, 7th Edition, 2022.
3.	Power Electronics: Converters, Applications and Design Ned Mohan et al Wiley 3rd Edition, 2014
4.	Power Electronics Daniel W Hart McGraw Hill 1st Edition, 2011

Continuous Internal Evaluation (CIE):
Theory for 50 Marks
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C303.1	3	1	1	1	2	3	-	-	3	2	-	3	-	-
C303.2	3	1	1	1	2	3	-	-	3	2	-	3	-	-
C303.3	3	3	2	1	2	3	-	-	3	2	-	3	-	-
C303.4	3	3	2	3	3	3	-	-	3	2	-	3	-	-
C303.5	3	3	2	3	3	3	-	-	3	2	-	3	-	-

Semester: V		
Power Electronics Laboratory (Practical)		
Course Code:	**MVJ22EEL54**	**CIE Marks:50**
Credits:	**L: T:P: 0:0:2**	**SEE Marks: 50**
Hours:	**20L**	**SEE Duration: 3 Hrs.**

Course Learning Objectives: The students will be able to	
1	Conduct experiments on semiconductor devices to obtain their static characteristics.
2	Demonstrate the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
3	Control the speed of a DC motor and universal motor.
4	Demonstrate the working of single phase full bridge inverter connected to resistive load.

SL No	**LABORATORY EXPERIMENTS**
1	Static Characteristics of SCR
2	Static Characteristics of MOSFET and IGBT
3	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode.
4	AC voltage controller with R and RL loads.
5	Speed control of universal motor using ac voltage regulator.
6	Speed control of DC motor using single semi converter.
7	Speed control of a separately excited D.C. Motor using chopper.
8	Single phase MOSFET/IGBT based PWM inverter.
Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.	
9	Speed control of stepper motor
10	Study of charging and discharging of capacitor in snubber circuit.
11	SCR digital triggering circuit for a single-phase controlled rectifier and ac voltage regulator.

Course Outcomes: After completing the course, the students will be able to	
C304.1	Obtain static characteristics of semiconductor devices to discuss their performance.
C304.2	Verify the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
C304.3	Illustrate the speed control of a DC motor and universal motor
C304.4	Verify the performance of single-phase full bridge inverter connected to resistive load.

CO-PO Mapping													PSO	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C304.1	3	1	1	1	2	3	-	-	3	2	-	3	-	-
C304.2	3	1	1	1	2	3	-	-	3	2	-	3	-	-
C304.3	3	3	2	1	2	3	-	-	3	2	-	3	-	-
C304.4	3	3	2	3	3	3	-	-	3	2	-	3	-	-
C304.5	3	3	2	3	3	3	-	-	3	2	-	3	-	-

Semester: V		
Non-Conventional Energy Systems (Theory)		
Course Code:	**MVJ22EE551**	**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 energy resources and availability of renewable energy.	
2	Examine types of solar collectors, their configurations, solar cell system, their characteristics, and their applications.	
3	Discuss generation of energy from hydrogen, wind, and geothermal system.	
4	Discuss production of energy from biomass, biogas and tidal.	
5	Discuss sea wave energy and OTEC.	

UNIT-I	
Renewable Energy sources: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications. **Laboratory Sessions/ Experimental learning:** Survey and data collection of different renewable energy sources available. **Applications:** Get awareness about available RES. **Web Link and Video Lectures**: https://youtu.be/e0nkkKDjY50	**8Hrs**
UNIT-II	
Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish –Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooling, Solar Cookers, Solar Pond. Solar Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic Panels, Applications of Solar Cell Systems. **Laboratory Sessions/ Experimental learning:** Design of solar torch **Applications:** solar thermal applications for water and room heating. **Web Link and Video Lectures**: https://youtu.be/Dd20RQNBwGY	**8Hrs**
UNIT-III	

Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy. **Wind Energy:** Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. **Geothermal Energy**: Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects **Solid waste and Agricultural Refuse**: Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics. **Laboratory Sessions/ Experimental learning:** Visit a nearby Wind mill. **Applications**: Extract power from wind and geothermal energy. **Web Link and Video Lectures**: https://youtu.be/3JXWrKzlkZQ	**8Hrs**
UNIT-IV	
Biomass Energy: Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers. Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics. **Tidal Energy:** Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy. **Laboratory Sessions/ Experimental learning:** Visit a biogas plant nearby. **Applications**: Produce bio-fuel for cooking. **Web Link and Video Lectures**: https://youtu.be/_OQtT4yhhWc	**8Hrs**
UNIT-V	
Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. **Ocean Thermal Energy**: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion Sea plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC. **Laboratory Sessions/ Experimental learning:** Visit near RES plant and get practical knowledge on working of OTEC. **Applications:** Power generation **Web Link and Video Lectures**: https://youtu.be/_iz8ZkjD7z8	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C305.1.1	Understand energy resources and availability of renewable energy
C305.1.2	Examine types of solar collectors, their configurations, solar cell system, its characteristics and their applications
C305.1.3	Discuss generation of energy from hydrogen, wind and geothermal system
C305.1.4	Discuss production of energy from biomass, biogas and tidal.
C305.1.5	Discuss sea wave energy and OTEC.

Textbooks/ Reference Books	
1	Nonconventional Energy Resources ShobhNath Singh Pearson 1 st Edition, 2015.
2	Nonconventional Energy Resources B.H. Khan McGraw Hill 3 rd edition.
3	Renewable Energy; Power for a sustainable Future Godfrey Boyle Oxford 3rd Edition, 2012.
4	Renewable Energy Sources: Their Impact on global Warming and Pollution Tasneem Abbasi S.A. Abbasi PHI.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C305.1.1	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
C305.1.2	**3**	**3**	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**2**	**2**	**3**	**-**	**-**
C305.1.3	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**1**	**3**	**-**	**-**
C305.1.4	**3**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
C305.1.5	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Semester: V		
Introduction to Semiconductor devices		
Course Code:	**MVJ22EE552**	**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	Learn the fundamental physics of semiconductor material.
2	Understand the structure, characteristics and applications of semiconductor devices
3	Study the working and applications fundamentals of Field effect tansistors
4	Gain knowledege in optoelectronic devices and applications
5	Learn about the fabrication process of semiconductor devices

UNIT-I	
Electrical Conductivity in an Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – Band gap determination- extrinsic semiconductors (Qualitative)- Hall effect - determination of Hall co-efficient - Applications of Hall effect. **Laboratory Sessions/ Experimental learning:** Determine band gap and hall coefficient of a semiconductor material **Applications:** Semiconductor devices **Video link:** https://nptel.ac.in/courses/108108122	**08 Hrs**
UNIT-II	
P-N junction formation -Forward bias- Reverse bias -Ohmic contact **Special Diodes** -Zener Diode - VI Characteristics – Zener diode as peak clipper, Tunneling Effect-Tunnel diode, Varactor Diode, –Point Contact Diode-Shcottkey Diode, PIN Diode. **Laboratory Sessions/ Experimental learning:** Study characteristics of PN junction diode, Zener diode & Tunnel diode **Applications:** Clippers, clampers and voltage regulators **Video link:** https://archive.nptel.ac.in/courses/122/106/122106025/	**08 Hrs**
UNIT-III	
Field Effect Transistor(FET)- Construction of JFET, idea of channel formation, pinch- off voltage, Transfer and output characteristics. MOSFET: MOS Diode, Basic construction of MOSFET and working, I-V characteristics, enhancement and depletion modes, Complimentary MOS (CMOS) **Laboratory Sessions/ Experimental learning:** Transfer and Output Characteristics of JFET**,** IV characteristics of MOSFET **Applications:** SMPS,Audio amplifiers **Video link:** https://archive.nptel.ac.in/courses/115/102/115102014/	**08 Hrs**
UNIT-IV	
Opto Electronic materials and devices – carrier generation and recombination processes – Absorption, emission and scattering of light in metals, insulators and semiconductors (concepts only) – Photo electric effect-Photo current in a P-N diode – Photo transistor-solar cell - LED – Organic LED- Non Linear Optical materials-properties and applications **Laboratory Sessions/ Experimental learning:** Characteristics of Photo diode	**08 Hrs**

and Solar cell **Applications:** Solar power generation **Video link:** https://archive.nptel.ac.in/courses/113/104/113104012/	
UNIT-V	
Semiconductor devices fabrication: Semiconductor device fabrication process: Oxidation, Diffusion, Ion implantation, Lithography, Thin film deposition technique, Epitaxy, Examples: P-N junction device fabrication. **Laboratory Sessions/ Experimental learning:** Design of PN junction diode using Ansys **Applications:** Semiconductor design and fabrication **Video link:** https://archive.nptel.ac.in/courses/113/106/113106062/	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
C305.2.1	Understand the physics of semiconductor materials.
C305.2.2	Understand semiconductor devices
C305.2.3	Explain about the fundamentals of Field effect tansistors
C305.2.4	Develop appplications using optoelectronic devices
C305.2.5	Understand semiconductor fabrication process.

Reference Books	
1.	"Semiconductor Device Fundamentals", Robert F. Pierret, Pearson education, 2006
2.	"Principles of Electronic Materials and Devices", S.O. Kasap. McGraw Hill Education (Indian Edition), 2020.
3.	"Semiconductor Optoelectronics: Physics and Technology",Jasprit Singh, , McGraw-Hill Education (Indian Edition), 2019.
4.	"Electrical Properties of Materials", Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., Oxford Univ. Press (Indian Edition) 2015.
5.	"VLSI Technology", S.M.Sze(2nd Edition) McGraw Hill Companies Inc.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):
Total marks: 50+50=100

SEE for 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three subdivisions. 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**
C305.2.1	-	2	-	1	-	-		3	3	3	3	3
C305.2.2	-	1	-	3	-	-		3	3	3	3	3
C305.2.3	-	2	-	2	-	3		3	3	2	3	3
C305.2.4	-	2	-	2	-	2		3	3	3	3	3
C305.2.5	-	2	-	2	-	2		3	3	3	3	3

Semester: V		
Introducyion to Embedded System Design (Theory)		
Course Code:	**MVJ22EE553**	**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 concepts of embedded system design such as ROM variants, RAM.	
2	Learn the technological aspects of embedded system such as signal conditioning, Sample &Hold.	
3	Understand the design trade-offs.	
4	Explain the software aspects of embedded system.	
5	Understand the subsystem interfacing.	

UNIT-I	
Concept of Embedded System Design: Components, classification, skills required. Embedded Microcontroller cores: Architecture of 6808 and 6811, Embedded Memories ROM variants, RAM. **Laboratory Sessions/ Experimental learning**: Assembly Language Program for addition of 8-bit numbers stored in an array. **Applications**:Digital electronics. **Video link**: https://nptel.ac.in/courses/106/105/106105193/	**8Hrs**
UNIT-II	
Technological Aspects of Embedded System: Applications of embedded system: Examples of Embedded systems SOC for bar code scanner. Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Sample & hold, Multiplexer interface Internal ADC interfacing (excluding 6805 & 6812). **Laboratory Sessions/ Experimental learning**: 1. Interfacing of 8-bit ADC 0809 with 8051 Microcontroller. 2. Interfacing of 8-bit DAC 0800 with 8051 Microcontroller and Waveform generation using DAC. **Applications**: Telecommunications. **Video link**: https://nptel.ac.in/courses/108/102/108102169/	**8Hrs**
UNIT-III	
Design Trade Offs Due to Process Incompatibility, Thermal Considerations: Data Acquisition System and Signal conditioning using DSP. Issues in embedded system design. Design challenge, design technology, trade-offs. Thermal considerations. **Laboratory Sessions/ Experimental learning:** 1.Temperature control interfacing with 8051 microcontrollers. 2.Implementation of Digital FIR filters on 8051 microcontrollers. **Applications**: Computer networks **Video link:** https://nptel.ac.in/courses/106/103/106103182/	**8Hrs**
UNIT-IV	

Software aspects of Embedded Systems: Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, function queue-scheduling architecture. **Laboratory Sessions/ Experimental learning:** Implementation of Hopfield network in C to recognize a simple ASCII character. **Applications**: Systems with artificial intelligence and robotics. **Video link:**https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee98/	**8Hrs**
UNIT-V	
Subsystem interfacing: With external systems user interfacing, Serial I/O devices, Parallel portInterfaces: Input switches, Keyboards and Memory interfacing. **Laboratory Sessions/ Experimental learning:** 1. Implementation of Serial Communication by using 8051 serial ports. 2. Simple test program using Arm 9 mini 2440 kit (Interfacing LED with ARM 9 mini-2440 kit). **Applications:** Militarydefence systems. **Video link:**https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee98/	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C305.3.1	Identify the Embedded system components.
C305.3.2	Apply technological aspects to various interfacing with devices.
C305.3.3	Elaborate various design trade-offs.
C305.3.4	Apply software aspects and programming concepts to the design of Embedded System.
C305.3.5	Explain how to interface subsystems with external systems.

Textbooks/ Reference Books	
1	"Introduction to Embedded Systems",Shibu K V, Second Edition,2017, McGraw Hill Education India Private Limited,9789339219680 .
2	"Embedded System, Architecture, Programming and Design Operational Amplifiers",Raj Kamal, , 2nd Edition, 2008,McGraw Hill Education, 9780070667648
3	Embedded Microcomputer systems: Real time interfacing Valvano, 2nd edition, 2011, J.W Cengage Learning India Private Limited,978-111142625.
4	Embedded System Design: A Unified Hardware / Software Introduction, Wiley, Student edition, 2006,978-8126508372.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C305.3.1	2	1	2	1	2	-	-	-	-	-	-	3	-	-
C305.3.2	2	1	2	2	2	-	-	-	-	-	-	3	-	-
C305.3.3	2	2	2	1	1	-	-	-	-	-	-	3	-	-
C305.3.4	2	3	3	2	3	-	-	-	-	-	-	2	-	-
C305.3.5	2	2	2	2	3	-	-	-	-	-	-	3	-	-

Semester: V		
Fundamentals of Electric Vehicles (Theory)		
Course Code:	**MVJ22EE554**	**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 fundamental laws and vehicle mechanics.	
2	Understand working of Electric Vehicles and recent trends.	
3	Analyze different energy storage systems used in electric vehicles.	
4	Develop the electric propulsion unit and its control for application of electric vehicles	
5	Develop and design major components of Electric and Hybrid Electric Vehicles	

UNIT-I	
Vehicle Mechanics: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradability, Velocity and Acceleration, Constant FTR, Level Road, Velocity Profile, Distance Traversed, Tractive Power, Energy Required, Non-constant FTR, General Acceleration, Propulsion Systems. **Laboratory Sessions/ Experimental learning:** Simulation of an EV **Applications**: Designing an Electric Vehicle **Web Link and Video Lectures:** https://www.youtube.com/watch?v=LZ82iANWBL0	**8Hrs**
UNIT-II	
Electric and Hybrid Electric Vehicles: Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving. **Concept of Hybrid Electric Drive Trains**, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains **Laboratory Sessions/ Experimental learning:** Industrial Visit **Applications:** Selection of appropriate motors for Electric vehicles **Web Link and Video Lectures:** https://www.youtube.com/watch?v=q6BYr5-fq5U	**8Hrs**
UNIT-III	
Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Supercapacitors **Laboratory Sessions/ Experimental learning:** **Application:** Selection of the most efficient energy storage system for an EV. **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=IgxY_Xz4OMA https://www.youtube.com/watch?v=y0Pa35ftnOI	**8Hrs**
UNIT-IV	

Electric Propulsion: EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives. **Laboratory Sessions/ Experimental learning:** Simulation of an EV drive with MATLAB/SIMULINK **Application:** Electric Vehicles **Web Link and Video Lectures:** **1.** https://www.youtube.com/watch?v=9JFSJmD3m1E https://www.youtube.com/watch?v=OhiZH7geedQ	**8Hrs**
UNIT-V	
Design of Electric and Hybrid Electric Vehicles: **Series Hybrid Electric Drive Train Design**: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator. **Design of Parallel Hybrid Electric Drive Train Design**: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design. **Laboratory Sessions/ Experimental learning: :** Develop an electric propulsion unit and its control for application in electric vehicles **Application**: Design of power transmission system in an electric vehicle **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=zzpOtJA-Rqw https://www.youtube.com/watch?v=GgtesA-8tKs	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C305.4.1	Explain the roadway fundamentals, laws of motion, vehicle mechanics and propulsion system design.
C305.4.2	Explain the working of electric vehicles and hybrid electric vehicles in recent trends.
C305.4.3	Model batteries, Fuel cells, PEMFC and super capacitors
C305.4.4	Develop the electric propulsion unit and its control for application of electric vehicles.
C305.4.5	Develop and design major components of Electric and Hybrid Electric Vehicles

Textbooks/ Reference Books	
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, M. Ehsani, Y. Gao, S.Gay and Ali Emadi,1 Edition,2005, CRC Press, ISBN:.978-0849331541.
2	Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, 1 Edition, 2013, Springer, ISBN:**1493955233**
3	Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau,4 Edition,2001,Oxford University press, ISBN: 9780198504160

4	Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 1 Edition,2003, CRC Press,ISBN: **084931466.**

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C305.4.1	2	3	1	1	-	-	-	-	-	-	-	-	-	-
C305.4.2	2	3	1	2	-	-	-	-	-	-	-	-	-	-
C305.4.3	2	3	1	2	-	-	-	-	-	-	-	-	-	-
C305.4.4	2	3	1	2	-	-	-	-	-	-	-	-	-	-
C305.4.5	2	3	1	3	-	-	-	-	-	-	-	-	-	-

Semester: V		
Sensors Technologies (Theory)		
Course Code:	**MVJ22EE555**	**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 working of different types of sensors.	
2	Discuss recent trends in sensor technology and their selection.	
3	Explain basics of smart sensors	
4	Discuss need of transducers, their classification, advantages and disadvantages.	
5	Explain basics of signal conditioning and signal conditioning equipment.	

UNIT-I	
Introduction to sensors: Capacitance, magnetism, Induction, Resistance, Piezoelectric Effect, Hall effect, Thermoelectric effect, Sound waves, Temperature and thermal properties of materials. Different types of sensors- Displacement and Level Sensors: Inductive, Magnetic and Optical Acceleration: Accelerometers, Seismic Sensors. Force and Strain: Strain Gauge, Pressure sensors. **Laboratory Sessions/ Experimental learning:** Measurement of level in a tank using capacitive type level probe in virtual lab **Applications:** Automation. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=onNkjSbcSWc	**8Hrs**
UNIT-II	
Acoustic sensor: Resistive and Fiber-optic microphones, Humidity and Moisture sensor: capacitive, resistive and thermal conductivity, Light Detectors: Photodiode, Phototransistor, Photo resistor, Radiation Detectors: Scintillating Detectors and Ionization Detectors **Temperature sensor:** Pyroelectric Effect, Coupling with object, Static & Dynamic heat exchange, RTD, Thermistors, Thermocouple circuits, proximity sensors-inductive, optical, capacitive, magnetic and ultrasonic, Hall effect sensors **Gas sensors**: Optical gas sensor, Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor, Polymer gas sensor, Nano-structured based gas sensors **Laboratory Sessions/ Experimental learning:** Characteristics the temperature sensor (RTD) in virtual lab **Applications:** Medical applications, temperature control, position control. **Web Link and Video Lectures:** https://nptel.ac.in/courses/108/108/108108147/	**8Hrs**

UNIT-III	
Basics of smart sensors: Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, types of smart sensors, overview of smart sensing and control systems. Interfacing sensors with microprocessors and micro controllers, Emerging fields of sensor technologies **Laboratory Sessions/ Experimental learning:** Interfacing of sensors through micro controller. **Application:** Sensor array **Web Link and Video Lectures:** https://www.youtube.com/watch?v=q8UuRkOQ9A0	**8Hrs**
UNIT-IV	
Introduction to Transducers: Introduction, Different types of transducers Resistive transducers: Potentiometers, metal, and semiconductor strain gauges. Strain gauge applications: Load and torque measurement. Self and mutual inductive transducers- capacitive transducers, eddy current transducers, tacho generators and stroboscope. Piezoelectric transducers, photoelectric transducers, Magneto strictive transducers, Basics of Gyroscope. **Laboratory Sessions/ Experimental learning:** Strain gauge characteristics using virtual lab. **Application:** Torque measurement, vibration measurement, velocity measurement. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=1uPTyjxZzyo	**8Hrs**
UNIT-V	
Signal Conditioning: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronicAmplifiers. **Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion. **Laboratory Sessions/ Experimental learning:** Signal amplification. **Application:** Automation. **WebLinkandVideoLectures:** https://www.youtube.com/watch?v=MGC2LWeNKSI	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C305.5.1	Explain working of different types of transducers and sensors.
C305.5.2	Describe different type of sensors and its application.
C305.5.3	Explain basics of smart sensors
C305.5.4	Identify need of transducers, their classification, advantages and disadvantages.
C305.5.5	Discuss basics of signal conditioning and signal conditioning equipment

Textbooks/ Reference Books

1	R.K Rajput, "Electrical and Electronic Measurements and instrumentation", S. Chand, 3rdEdition, 2013.
2	Daniel E. Suarez, "Smart Sensors and Sensing Technology", Nova Science Publishers, 2011
3	Murthy D. V. S, "Transducers and Instrumentation", Prentice Hall, New Delhi, 2nd Edition, 2008.
4	Patranabis, "Sensors and Transducers", Prentice Hall India Pvt. Ltd, 2nd Edition, 2003.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C305.5.1	3	3	3	1	1	-	-	-	-	-	-	3	-	-
C305.5.2	3	3	3	3	3	-	-	-	-	-	-	3	-	-
C305.5.3	3	3	3	3	3	-	-	-	-	-	-	3	-	-
C305.5.4	3	3	3	3	3	-	-	-	-	-	-	3	-	-
C305.5.5	3	3	3	3	3	-	-	-	-	-	-	3	-	-

Semester: VI		
Power System Analysis I (Theory)		
Course Code:	**MVJ22EE61**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50+50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand per unit quantities, network models and bus admittance matrix	
2	Compute steady state load flow analysis with numerical iterative techniques	
3	Compute short circuit faults occurring in power systems	
4	Explain numerical solution of swing equation for multi-machine stability	
5	Illustrate problems of unit commitment and economic load dispatch	

UNIT-I	
Per Unit Representation and Topology: Per-Unit representation of Power system elements - Per-Unit equivalent reactance network of a three phase Power System. Graph Theory: Definitions, Formation of element node incidence and Bus Incidence Matrices, Y bus formation by Direct and Singular Transformation Methods, Numerical Problems **Laboratory Sessions/ Experimental learning**: Preparation of graph for a simple power system. **Applications**: Analysis of power system by reducing the complexity. **Video link:** https://www.youtube.com/watch?v=dmNlW2q-tbI	**8Hrs**
UNIT-II	
Power flow analysis: Bus classification, Formulation of Power Flow problems, Power flow solution using Gauss Seidel method, Handling of Voltage controlled buses, Power Flow Solution by Newton Raphson method, Fast Decoupled Power Flow Solution. **Laboratory Sessions/ Experimental learning**: Write a MATLAB program to solve any simple equation using iterative methods. **Applications:** Power system planning and operation **Video link:** https://www.youtube.com/watch?v=rEyE3NxK8vE	**8Hrs**
UNIT-III	
Short Circuit Analysis: Symmetrical short circuit on Synchronous Machine, Bus Impedance matrix building algorithm, Symmetrical fault analysis through bus impedance matrix, Symmetrical components, Sequence impedance, Sequence networks, Analysis of unsymmetrical fault at generator terminals, use of bus impedance matrix for analyzing unsymmetrical fault occurring at any point in a power system. **Laboratory Sessions/ Experimental learning**: Evaluation of sequence components of phase currents and voltages for a LG fault in simple 4 bus system using MATLAB programming. **Applications**: Selection of appropriate protective devices	**8Hrs**

Video link: https://www.youtube.com/watch?v=HcMh7ahJxfo	
UNIT-IV	
Power System Stability: Introduction, Dynamic and Transient Stabilities. Derivation of Swing Equation, Power Angle Curve and Determination of Steady State Stability. Determination of Transient Stability by Equal Area Criterion and its application, Critical Clearing Angle Calculation. Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers **Laboratory Sessions/ Experimental learning**: Determination of Power Angle curves using MATLAB. **Applications:** To determine nature of the relaying system needed, critical clearing time of circuit breakers, voltage level of and transfer capability between systems **Video link:** https://www.youtube.com/watch?v=-NkoZx8gdqM	**8Hrs**
UNIT-V	
Economic Operation of Power System: Introduction and Performance curves, Economic load dispatch of hydro-thermal scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. **Unit Commitment:** Introduction, Constraints and unit commitment solution by prior list method andDynamic forward DP approach (Flow chart and Algorithm only). **Laboratory Sessions/ Experimental learning:** Optimal generation scheduling for thermal power plants using Mi-power. **Applications:** To minimize the total cost of system production, yet maintain all the requirements such as loads, operating restrictions **Video link:** https://nptel.ac.in/courses/108/104/108104052/	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C310.1	Prepare per unit reactance diagram and formulate network matrices and models for solving load flow problems.
C310.2	Perform steady state power flow analysis of power systems using numerical iterative techniques
C310.3	Analyze short circuit faults in power system.
C310.4	Analyse steady state and transient stability in power systems.
C310.5	Solve economic load dispatch and unit commitment problems.

Textbooks/ Reference Books	
1	D. P. Kothari , "Modern Power System "McGraw Hill , 4th Edition, 2011 .
2	John.J.Grainger, William D. Stevenson, "Power System Analysis", Tata Mc Graw Hill Publishing company, New Delhi, 2003.
3	J.Duncan Glover et al, " Power System Analysis and Design" , Cengage, 4th Edition, 2008

4	Hadi Sadat, " Power System Analysis", McGraw Hill , 1st Edition, 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 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C310.1	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C310.2	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C310.3	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C310.4	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C310.5	3	2	2	1	-	-	3	-	-	-	-	2	-	-

Semester: VI		
Control Systems (Theory)		
Course Code:	**MVJ22EE62**	**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	Obtain mathematical modeling of control systems.
2	Obtain transfer function of systems using various techniques and discuss time response of the systems.
3	Determine the stability of LTI systems in time domain
4	Determine the stability of LTI systems in frequency domain and discuss different controllers used in control systems.
5	Explain different compensators used in control systems

UNIT-I	
Introduction: Open loop and closed loop systems – Examples, Control system components. Transfer function of physical systems: Mechanical systems - Translational and Rotational systems, Electrical network, Transfer function of DC servomotor, AC servomotor. **Laboratory Sessions/ Experimental learning**: Obtain the transfer function of Servomotor by using MATLAB. **Applications**: Modeling of Physical systems helps in Mathematical analysis. **Video link**: https://nptel.ac.in/courses/108101037	**8Hrs**
UNIT-II	
Block diagram - Reduction techniques. Signal flow graphs – Mason's gain formula, Construction of block diagram from signal flow graph, Construction of signal flow graph from block diagram. **Laboratory Sessions/ Experimental learning**: Experiment to obtain the time response of RLC circuit and determine the time domain specification. **Applications**: Performance analysis of second order system in time domain. **Video link**:https://nptel.ac.in/courses/108106098	**8Hrs**
UNIT-III	
Time domain Analysis: Standard Test signals –Time response of first and second order system, Time domain specifications, Type of systems, Steady state error constants, generalized error coefficients. **Laboratory Sessions/ Experimental learning**: Obtain the root locus for the given open loop transfer function and analyze the stability using MATLAB software. **Applications**: Stability Analysis of a given system **Video link**:https://nptel.ac.in/courses/108102044	**8Hrs**
UNIT-IV	
Stability Analysis: Concept of stability, Effect of location of poles on stability, R H criterion, applications of RH criterion with limitations.	**8Hrs**

Root locus technique: Introduction to root locus concepts, Construction rules, Analysis of stability by root locus plot. **Laboratory Sessions/ Experimental learning**: Write a MATLAB program to obtain the Bode plot and analyze the stability of the system in frequency domain. **Applications**: Performance analysis of second order system in frequency domain **Video link:** http://www.ni.com/tutorial/6450/en/	
UNIT-V	
Frequency Domain Analysis: Frequency domain specification, Bode plots, GM and PM, Relative stability. **Basic Control Actions and Controller:** Introduction, elements of industrial automatic controller, classification of controllers, P, I, D, PI, PD, and PID controllers (only block diagram). **Introduction to compensators**: Introduction, types of compensators, transfer function of lead, Lag, Lag-Lead Compensators. **Laboratory Sessions/ Experimental learning**: Simulation of compensator by using MATLAB. **Applications**: Analysis of system for accuracy and stability improvement. **Video link:**https://www.digimat.in/nptel/courses/video/108107115/L01.html	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C311.1	Obtain the mathematical model of physical systems.
C311.2	Obtain transfer function of systems using various techniques and discuss time response of the systems
C311.3	Determine the stability of LTI systems in time domain
C311.4	Determine the stability of LTI systems in frequency domain and differentiate the various controllers used in control systems
C311.5	Explain different compensators used in control systems.

Textbooks/ Reference Books	
1	"Control Systems Engineering", I. J. Nagrath, M. Gopal, 7th Edition, New Delhi, 2017.New Age International Publishers.
2	"Modern Control Engineering", Ogata K; 5th edition2013Pearson
3	"Automatic Control Systems (with MATLAB programs)" S. Hasan Saeed, KATSON Books, 8th Edition, New Delhi, 2016.
4	"Control systems", A. Anand Kumar, 2nd edition, PHI, 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 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C311.1	3	3	1	2	2	-	-	-	3	2	-	3	-	-
C311.2	3	3	1	3	2	-	-	-	3	2	-	3	-	-
C311.3	3	3	1	3	2	-	-	-	3	2	-	3	-	-
C311.4	3	3	2	3	2	-	-	-	3	2	-	3	-	-
C311.5	3	3	2	3	2	-	-	-	3	2	-	3	-	-

Semester: VI		
Solar PV Technologies (Theory)		
Course Code:	**MVJ22EE631**	**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	Acquire knowledge on world energy scenario and PN junction diode
2	Understand the design of a solar cell.
3	Explain different emerging solar cell technologies
4	Explain balance of solar PV systems.
5	Explain various photovoltaic systems and their lifecycle costing.

UNIT-I	
Introduction to Solar Photovoltaic energy source: Need for sustainable energy, solar PV as a renewable energy source, current status of renewable energy sources in India. **Introduction to Solar Cell:** Introduction to PN junction equilibrium condition, non-equilibriumcondition, PN junction under illumination. **Applications:** Help in better understanding of the solar cell **Video Link:** https://www.youtube.com/watch?v=bdnHTkrKWfc	**8Hrs**
UNIT-II	
Solar Cell Design: Upper limits of cell parameters, losses in solar cells, solar cell design, design for high I_{sc}, design for high V_{oc}, design for high FF, analytical techniques **Applications:** Analyse and design a cell for various requirements **Video Link:**https://www.youtube.com/watch?v=KlHdlVrVj8o	**8Hrs**
UNIT-III	
Solar Cell Technologies: Production of Si, Si wafer based solar cell technology, thin film solar cell technologies, emerging solar cell technologies and concepts. **Applications:** Selection of appropriate solar panel for different applications. **Video Link:** https://www.youtube.com/watch?v=9LGLbcjXxqI https://www.youtube.com/watch?v=8uGZMyjFugg	**8Hrs**
UNIT-IV	
Solar Photovoltaic: Solar radiation, solar photovoltaic modules, balance of solar PV systems. **Applications:** Helps in better understanding of solar PV systems **Video Link:** https://www.youtube.com/watch?v=1yvaZZJ5IMc	**8Hrs**
UNIT-V	
Photovoltaic System Design and Applications: Introduction to solar PV systems, standalone PV systems configurations, design	**8Hrs**

methodology of PV systems, wire sizing in PV systems, hybrid PV systems, grid connected PV systems, lifecycle costing. **Applications:** Installation of solar PV systems **Video Link:** https://www.youtube.com/watch?v=jZs37m3IXJU https://www.youtube.com/watch?v=mi2BzuEbj9o&t=1275s	

Course Outcomes: After completing the course, the students will be able to	
C312.1.1	Acquire knowledge on world energy scenario and PN junction diode
C312.1.2	Understand the design of a solar cell.
C312.1.3	Explain different emerging solar cell technologies
C312.1.4	Explain balance of solar PV systems.
C312.1.5	Explain various photovoltaic systems and their lifecycle costing.

Textbooks/ Reference Books	
1	Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki, 3rd Edition, PHI Learning PVT Ltd., 2015.
2	Renewable Energy: Theory & Practice, Rathore N.S., Kurchania A.K., Panwar N.L. , First edition,2006, Himanshu Publications, New Delhi.
3	Solar Photo-voltaic Products, Derrick, Francis and Bookalders, Second edition,1991, ITDG Publishing, UK.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/P	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO1**	**PSO**	**PSO**

O	1	2	3	4	5	6	7	8	9	0	1	2	1	2
C312.1.1	3	3	3	3	-	2	2	-	-	1	3	3	-	-
C312.1.2	3	3	3	3	2	3	2	-	-	1	3	3	-	-
C312.1.3	3	3	3	3	2	3	2	-	-	1	3	3	-	-
C312.1.4	3	3	3	3	2	3	2	-	-	1	3	3	-	-
C312.1.5	3	3	3	1	-	3	2	-	-	1	3	3	-	-

Semester: VI		
PWM Techniques for Power Electronics Converters (Theory)		
Course Code:	**MVJ22EE632**	**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 impart knowledge of PWM techniques in controlling the converter operation.	
2	To impart knowledge of designing and analyzing DC – DC PWM converters and control modules.	
3	To impart knowledge of designing and analyzing DC – AC converters.	
4	To impart knowledge of AC –DC converters and multilevel controllers..	
5	To impart knowledge of analyzing different types of resonant converters and their control	

UNIT-I	
PWM DC/DC Converters: PWM control-basic principle, types--basic equation- continuous and discontinuous mode-funcions of DC –DC converters with PWM-voltage control mode, -Boost converter-modes of operation-buck converter-modes of operation-Buck boost –modes of operation-application, **Laboratory Sessions/ Experimental learning**: Build a circuit for controlling a load by using PWM DC-DC converter MATLAB. **Applications**: Mobile charging unit, switch mode power supply, induction heating, and traction motor control. **Web Link and Video Lectures:** 1.https://archive.nptel.ac.in/courses/108/108/108108035/ 2. https://en.wikipedia.org/wiki/Boost_converter	**8Hrs**
UNIT-II	
Control Modules: Basic Principles and Characteristics of PWM Control Modules - Circuit Analysis, Simple PWM, Voltage-Controlled PWM, Current-Controlled PWM- Compensated PWM, IC Control Modules - Control Module TL494, Control Module SG1524/2524/3524, Control Module TDA 1060. **Laboratory Sessions/ Experimental learning:** Realize the control circuit using MATLAB **Applications:** Effective control of voltage and current in appliances. **Web Link and Video Lectures:** 1. https://archive.nptel.ac.in/courses/108/105/108105180/ 2. https://archive.nptel.ac.in/courses/108/105/108105186/	**8Hrs**
UNIT-III	
DC/AC Converters – Inverters:	**8Hrs**

Single-Phase Voltage Inverters - Pulse-Controlled Output Voltage, Pulse-Width Modulated Inverters - Unipolar PWM, Three-Phase Inverters-Over modulation (ma > 1), Asynchronous PWM, Space Vector Modulation - Space Vector Modulation: Basic Principles, Application of Space Vector Modulation Technique, Direct and Inverse Sequencing, Real Drive Influence. **Laboratory Sessions/ Experimental learning:** . MATLAB simulation of DC/AC converter**.** **Application:** Social auditing in electrical industry **Web Link and Video Lectures:** 1. https://archive.nptel.ac.in/courses/108/108/108108035/ 2. https://www.youtube.com/watch?v=Dg5AIy0bY1A	
UNIT-IV	
AC/DC Converters – Rectifiers: PWM Rectifiers - Advanced Control Techniques of PWM Rectifiers, PWM Rectifier with Current Output, PWM Rectifiers in Active Filters, Some Topologies of PWM Rectifiers, Applications of PWM Rectifiers. **Laboratory Sessions/ Experimental learning**: Simulation of single phase and three phase full wave rectifier for R, RL and RLE load in MATLAB **Application:** Paper mills, textile mills using DC motor drives and DC motor control in steel mills, AC fed traction system using a DC traction motor, High voltage DC transmission, UPS. **Web Link and Video Lectures:** 3. https://archive.nptel.ac.in/courses/108/102/108102145/ https://www.daenotes.com/electronics/basic-electronics/ac-dc-converters-rectifiers	**8Hrs**
UNIT-V	
Resonant Converters: Resonant Circuits - Resonant Converters of Class D, Series Resonant Converters, Parallel Resonant Converters, Series – Parallel Resonant Converter, Soft Switching PWM DC/DC Converters -Phase Shift Bridge Converters, Resonant Transitions PWM Converters, Control Circuits of Resonant Converters. **Laboratory Sessions/ Experimental learning: Design the resonant converter using MATLAB** **Application:** application in renewable energy conversion system **Web Link and Video Lectures:** **1.https://www.youtube.com/watch?v=xpAqoKBEfoI** 2.https://nptel.ac.in/courses/108108036	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C312.2.1	Understand the concept of PWM techniques in controlling the converter operation
C312.2.2	Understand the concept of DC – DC PWM converters and control modules
C312.2.3	Analyze DC – AC converters with PWM.

C312.2.4	Explain the role of AC –DC converters and multilevel controllers..
C312.2.5	Design different types of resonant converters and their control

Textbooks/ Reference Books	
1	"Power Electronics Converters and Regulators", Branko L. Doki and Branko Blanu, Springer (International Publishing, Switzerland) , 3 rd Edition, 2015
2	"Power Electronics Converters, Applications, and Design", Ned Mohan at el, Wiley, 3 rd Edition,2014

Continuous Internal Evaluation (CIE):
Theory for 50 Marks
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	2	2	-	1	-	-	-	**1**	**2**	**1**	**1**	**1**	2	2
C312.2.1	**2**	1	-	2	-	-	-	-	**1**	-	-	-	**2**	1
C312.2.2	2	2	-	2	-	1	-	-	1	-	-	-	2	2
C312.2.3	2	2	-	1	-	-	-	**1**	-	**1**	**1**	**1**	2	2
C312.2.4	2	2	-	1	-	-	-	**1**		-	-	**1**	2	2
C312.2.5	2	2	-	1	-	-	-	**1**	**2**	**1**	**1**	**1**	2	2

Semester: VI		
Design of analog and mixed mode VLSI circuits (Theory)		
Course Code:	**MVJ22EE633**	**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 characteristics of CMOS circuit construction	
2	Introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).	
3	Design CMOS combinational and sequential logic at the transistor level, with mask layout.	
4	Design for higher performance or lower area using alternative circuit families	
5	Testing and Verification of VLSI Design	

UNIT-I	
Introduction: A Brief History, MOS Transistors, MOS Transistor Switches, CMOS Logic, Circuit and System Representations, MOS Transistor Theory, Ideal I-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics, Review of MOS electrical properties, Expression for threshold voltage and drain current, Secondary effects of MOSFET, review of CMOS and bipolar technologies. **Laboratory Sessions/ Experimental learning**: Design and demonstrate the MOS transistor connected as a diode using any CAD tool. **Applications**: integrated circuit (IC) chips, including microprocessors, microcontrollers, memory chips. **Video link**:https://nptel.ac.in/courses/117/101/117101058/	**8Hrs**
UNIT-II	
MOS and Bi-CMOS Circuit Design Processes: MOS Layers, Stick Diagrams, Design Rules and Layout.Bi-CMOS processes, Integration and Isolation considerations, Integrated Analog/Digital CMOS Process. **Basic inverter** - Inverter Device sizing, Enhancement load and Depletion load inverters, CMOS inverter, CMOS inverter logic levels, Inverter device sizing, combinational logic implementation using NMOS and CMOS inverters. **Laboratory Sessions/ Experimental learning**: Draw layout of inverter using Cadence Tool. **Applications**: Design of CMOS inverter circuit with different scaling functions. **Video link**: 1. https://nptel.ac.in/courses/117106093/ 2. https://nptel.ac.in/courses/117106092/	**8Hrs**
UNIT-III	
Scaling of MOS Circuits: Scaling Models & Scaling Factors for Device Parameters. **Subsystem Design Processes:** Some General considerations, An illustration of	**8Hrs**

Design Processes, Illustration of the Design Processes- Regularity, Design of an ALU Subsystem, The Manchester Carry-chain and Adder Enhancement Techniques, Semiconductor memories, memory chip organization, RAM Cells, dynamic memory cell. **Laboratory Sessions/ Experimental learning**: 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**: 1. https://www.youtube.com/watch?v=eqnMAaYU4OY 2.. https://www.youtube.com/watch?v=zNqmohJHDwc	
UNIT-IV	
Subsystem Design: Some Architectural Issues, Switch Logic, Gate(restoring) Logic, Parity Generators, Multiplexers, The Programmable Logic Array (PLA), CMOS Logic Gate Design, Basic Physical Design of Simple Gate, CMOS Logic Structures, Clocking Strategies, I/O Structures, Low Power Design. **Laboratory Sessions/ Experimental learning**: Design Manchester Carry-chain using CMOS transistors using any CAD tool. **Applications**: Designing of PLA and PLD **Video link**: https://nptel.ac.in/courses/117106093/	**8Hrs**
UNIT-V	
Memory, Registers and Aspects of system Timing- System Timing Considerations, Some commonly used Storage/Memory elements. **Testing and Verification:** Introduction, Logic Verification, Logic Verification Principles, Manufacturing Test Principles, Design for testability, Chip Level Test Techniques, System Level Test Techniques, Layout Design for Improved Testability. **Laboratory Sessions/ Experimental learning**: Perform a survey on Prime-Time CAD tool from Synopsis for timing Analysis. **Applications**:Testing of Imperfections in chip fabrication. **Video link:** 1. https://youtu.be/V-GL-oQSa14 (Fault design & Testability) 2. https://youtu.be/P7AQJn7K8Os (Combinational Circuit Test Pattern Generation-ATPG)	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C312.3.1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.
C312.3.2	Draw the basic gates using the stick and layout diagrams with the knowledge ofphysical design aspects
C312.3.3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements
C312.3.4	Interpret Memory elements along with timing considerations
C312.3.5	Interpret testing and testability issues in VLSI Design

Textbooks/ Reference Books

1	"CMOS Digital Integrated Circuits: Analysis and Design" - Sung Mo Kang & Yosuf Leblebici, Third Edition, Tata McGraw-Hill.
2	"CMOS VLSI Design- A Circuits and Systems Perspective"- Neil H. E. Weste, and David Money Harris4th 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.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C312.3.1	2	1	2	2	2	-	-	-	-	-	-	3	-	-
C312.3.2	2	2	2	2	2	-	-	-	-	-	-	3	-	-
C312.3.3	2	2	2	1	2	-	-	-	-	-	-	3	-	-
C312.3.4	3	3	2	2	2	-	-	-	-	-	-	3	-	-
C312.3.5	2	3	2	1	2	-	-	-	-	-	-	3	-	-

Semester: VI		
Battery Management Systems (Theory)		
Course Code:	**MVJ22EE634**	**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 types of batteries and principle of operation.
2	Understand about the modeling of battery.
3	Explain about the Battery Management System Architecture.
4	Understandbattery safety and protection for Electric Vehicle battery.
5	Explain Battery Management System integration to various application.

UNIT-I	
Introduction to Batteries Types of batteries (e.g., lithium-ion, lead-acid, nickel-cadmium), Basic principles of battery operation, Importance of battery management. **Laboratory Sessions/ Experimental learning**: Identify the specifications and parameters of different types of batteries used in EV. **Applications**: Electric vehicles **Video link:** https://youtu.be/A3fHQsIkYeU?si=tkdTvyQdXpjaW7Yx	**8Hrs**
UNIT-II	
Battery Modeling Mathematical modeling of battery behavior, Equivalent circuit models, State of Charge (SoC) and State of Health (SoH) estimation (Extended Kalman Filter based method) **Laboratory Sessions/ Experimental learning:** Using MATLAB estimate SoC and SoH using EKF. **Applications:** Design and develop SoC and SoHestimation for battery used in Electric Vehicles. **Video link:**https://youtu.be/pPzj-YBCadg?si=YdLjjiL2Mxg5z-Ao	**8Hrs**
UNIT-III	
Battery Management System Architecture Overview of BMS components, Functions of each component (e.g., cell balancing, voltage monitoring, temperature monitoring) ,Communication protocols (e.g., CAN bus) for BMS integration **Laboratory Sessions/ Experimental learning:**Monitor the temperature of the battery using CAN bus interface. **Application:** Develop Battery management system for Electric Vehicles. **Web Link and Video Lectures:**https://youtu.be/zmO3nHkH8Ak?si=dZGPxgF8UyQ3Yffd	**8Hrs**
UNIT-IV	
Battery Safety and Protection Overcharge protection, Over-discharge protection, Overcurrent protection, Thermal management and temperature monitoring	**8Hrs**

Laboratory Sessions/ Experimental learning: Design protection circuits for Overcharge and Overcurrent protection and Temperature monitoring. **Application:** Design of safety and protection system for battery. **Web Link and Video Lectures:**https://youtu.be/9M_DO-xe5h0?si=gFYHY_LpFmpRtGXL	
UNIT-V	
BMS Integration in Applications Automotive BMS, Renewable energy storage systems, Portable electronics, Medical devices **Applications:** Electric vehicles **Video link:** https://youtu.be/-ua6MNFn9EE?si=U849g36dWZyjwSUa	

Course Outcomes: After completing the course, the students will be able to	
C312.4.1	Understand principle of operation of battery and Importance of Battery management.
C312.4.2	Understand about Equivalent-circuit based modeling of battery.
C312.4.3	Explain about battery management system architectures and communication protocols.
C312.4.4	Understandcontrol circuit for battery safety and protection for Electric Vehicle battery.
C312.4.5	Explain Battery Management System integration to automobile.

Textbooks/ Reference Books	
1	Gregory L. Plett, "Battery Management Systems: Vol. II Equivalent-Circuit Methods", Artech House, London, 2016.
2	Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs", Artech House, London, 2010.
3	Phillip Weicker, "A Systems Approach to Lithium-Ion Battery Management", Artech House, London, 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 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C312.4.1	2	1	2	2	2	-	-	-	-	-	-	3	-	-
C312.4.2	2	2	2	2	2	-	-	-	-	-	-	3	-	-
C312.4.3	2	2	2	1	2	-	-	-	-	-	-	3	-	-
C312.4.4	3	3	2	2	2	-	-	-	-	-	-	3	-	-
C312.4.5	2	3	2	1	2	-	-	-	-	-	-	3	-	-

Semester: VI		
Industrial Insrumentation (Theory)		
Course Code:	**MVJ22EE635**	**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 basics in measurement techniques of force, torque and speed and	
2	Learn about methods of measurement of acceleration, Vibration and density	
3	Gain knowledge on basics of transmitter and types of transmitters.	
4	Understand micro electromechanical systems.	
5	Understand the digital data acquisition system and control.	

UNIT-I	
Measurement of force, torque and speed Different types of load cells - Hydraulic, Pneumatic, strain gauge. Magneto elastic and Piezoelectric load cells - Different methods of torque measurement Strain gauge-Relative angular twist-Speed measurement-Capacitive tacho-Drag cup type tacho-D.C and A.C tacho generators - Stroboscope. **Laboratory Sessions/ Experimental learning:** Speed measurement of machines. **Applications**: Electrical and mechanical engineering **Web Link and Video Lectures:** 1.https://youtu.be/EakRe6ICM-Q 2. https://www.watelectrical.com/electric-drive-working-and-its-applications/	**8Hrs**
UNIT-II	
Measurement of acceleration, vibration and density - Accelerometers - LVDT, Piezoelectric, Strain gauge and Variable reluctance type accelerometers - Mechanical type vibration instruments - Seismic instruments as accelerometer - Vibration sensor - Calibration of vibration pickups - Units of density and specific gravity - Baume scale and API scale - Pressure type densitometers - Float type densitometers - Ultrasonic densitometer - gas densitometer. **Laboratory Sessions/ Experimental learning:**LVDT experiment for measurement of displacement. **Applications:** Manufacture industries **Web Link and Video Lectures:** 1.https://youtu.be/EakRe6ICM-Q 2.https://nptel.ac.in/content/storage2/courses/108105066/PDF/L13(DK)(PE)%20((EE)NPTEL)%20.pdf	**8Hrs**
UNIT-III	
TRANSMITTER: Pneumatic transmitter: Operation – Electronic transmitter: Study of 2wire and 4 wire transmitters –Operation of Electronics and Smart transmitters – Principle of operation of flow, level, temperature and pressure transmitters – Installation and Calibration of smart and conventional transmitters **Laboratory Sessions/ Experimental learning**: Demonstration of Different types of transmitters	**8Hrs**

Application: Communication sectors **Web Link and Video Lectures:** 1. https://freevideolectures.com/course/4600/nptel-energy-conservation-waste-heat-recovery/52 2. https://youtu.be/E76q-9q7ZDg	
UNIT-IV	
Micro Electromechanical system (MEMS): Advantages and Applications, MEMS micro sensors and actuators, Manufacturing process: Bulk micro machining and surface micromachining, MEMS accelerometers Virtual instrumentation system: architecture of virtual instruments – Virtual instruments and traditional instruments – concepts of graphical programming. **Laboratory Sessions/ Experimental learning:** Case study on Virtual instrumentation system. **Application:** automation industries **Web Link and Video Lectures:** 1.https://nptel.ac.in/content/storage2/courses/108103009/download/M7.pdf 2. https://youtu.be/l46GUVBisUo	**8Hrs**
UNIT-V	
Digital Data Acquisition systems & control: Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition. Instrumentation systems. Types of Instrumentation systems. Components of an analog Instrumentation Data – Acquisition system. Multiplexing systems. Uses of Data Acquisition systems. Use of Recorders in Digital systems. Digital Recording systems. Modern Digital Data Acquisition system. Analog Multiplexed operation, operation of sample Hold circuits. **Laboratory Sessions/ Experimental learning:** working of A/D & D/A in circuit. **Application:**signal transmission and microprocessor applications **Web Link and Video Lectures:** **1.** https://www.youtube.com/watch?v=_LAuDTNW5dw **2. https://new.siemens.com/global/en/products/buildings/fire-safety/applications/li-ion-battery-storage-system.html**	

Course Outcomes: After completing the course, the students will be able to	
C312.5.1	Describe the different types of measurement techniques to measure force, torque and speed.
C312.5.2	Describe the techniques of acceleration, Vibration and density
C312.5.3	Describe the basics of transmitter and its types.
C312.5.4	Describe the basics of micro electromechanical system
C312.5.5	Describe the digital data acquisition systems & control.

Textbooks/ Reference Books	
1	S.K. Singh, 'Industrial Instrumentation and Control', Tata McGraw Hill, 2003. 7. D.P. Eckman', Industrial Instrumentation', Wiley Eastern Ltd
2	R.K. Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, New Delhi,1999.

3	D. Patranabis, 'Principles of Industrial Instrumentation', Tata McGraw Hill Publishing Company Ltd, 1996.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C312.5.1	3	1	-	2	-	-	-	-	-	-	-	2	3	1
C312.5.2	3	1	-	2	-	-	-	-	-	-	-	2	3	1
C312.5.3	3	2	-	2	-	-	-	-	-	-	-	2	3	2
C312.5.4	3	2	-	2	-	-	-	-	-	-	-	2	3	2
C312.5.5	3	2	-	2	-	-	-	-	-	-	-	2	3	2

Semester: VI		
Renewable Energy Sources (Theory)		
Course Code:	**MVJ22EE641**	**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 energy resources and availability of renewable energy
2	Examine types of solar collectors, their configurations, solar cell system, their characteristics, and their applications.
3	Discuss generation of energy from hydrogen, wind, and geothermal system
4	Discuss production of energy from biomass, biogas and tidal.
5	Discuss sea wave energy and OTEC.

UNIT-I	
Renewable Energy sources: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications. **Laboratory Sessions/ Experimental learning:** Survey and data collection of different RES available. **Applications:** Get awareness about available RES. **Web Link and Video Lectures**:https://youtu.be/e0nkkKDjY50	**8Hrs**
UNIT-II	
Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish –Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooling, Solar Cookers, Solar pond. Solar Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic Panels, Applications of Solar Cell Systems. **Laboratory Sessions/ Experimental learning:** Design of solar torch **Applications:** solar thermal applications for water and room heating. **Web Link and Video Lectures**: https://youtu.be/Dd20RQNBwGY	**8Hrs**
UNIT-III	
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen	**8Hrs**

Energy. **Wind Energy:** Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. **Geothermal Energy**: Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects **Solid waste and Agricultural Refuse**: Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics. **Laboratory Sessions/ Experimental learning:** Visit a nearby Wind mill. **Applications**: Extract power from wind and geothermal energy. **Web Link and Video Lectures**: https://youtu.be/3JXWrKzlkZQ	
UNIT-IV	
Biomass Energy: Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers. Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics. **Tidal Energy:** Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy. **Laboratory Sessions/ Experimental learning:** Visit a biogas plant nearby. **Applications**: Produce bio-fuel for cooking. **Web Link and Video Lectures**:https://youtu.be/_OQtT4yhhWc	**8Hrs**
UNIT-V	
Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. **Ocean Thermal Energy**: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion Sea plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC. **Laboratory Sessions/ Experimental learning:** Visit near RES plant and get practical knowledge on working of OTEC. **Applications:** Power generation **Web Link and Video Lectures**: https://youtu.be/_iz8ZkjD7z8	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C313.1.1	Understand energy resources and availability of renewable energy
C313.1.2	Examine types of solar collectors, their configurations, solar cell system, its characteristics and their applications
C313.1.3	Discuss generation of energy from hydrogen, wind and geothermal system
C313.1.4	Discuss production of energy from biomass, biogas and tidal.
C313.1.5	Discuss sea wave energy and OTEC.

Textbooks/ Reference Books	
1	Nonconventional Energy Resources ShobhNath Singh Pearson 1 st Edition, 2015
2	Nonconventional Energy Resources B.H. Khan McGraw Hill 3 rd edition
3	Renewable Energy; Power for a sustainable Future Godfrey Boyle Oxford 3 rd Edition, 2012
4	Renewable Energy Sources: Their Impact on global Warming and Pollution Tasneem Abbasi S.A. Abbasi PHI.

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

Total marks: 50+50=100

CO-PO Mapping													PSO	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313.1.1	2	1	2	2	2	-	-	-	-	-	-	3	-	-
C313.1.2	2	2	2	2	2	-	-	-	-	-	-	3	-	-
C313.1.3	2	2	2	1	2	-	-	-	-	-	-	3	-	-
C313.1.4	3	3	2	2	2	-	-	-	-	-	-	3	-	-
C313.1.5	2	3	2	1	2	-	-	-	-	-	-	3	-	-

Semester: VI		
Smart Sensors and Systems (Theory)		
Course Code:	**MVJ22EE642**	**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 different types of sensors and smart sensors.	
2	Learn the principles and operations of active sensors.	
3	Understand the concepts of smart sensors.	
4	Study the conceptual approach of various Passive Sensors.	
5	Learn the fundamentals of signal conditioning, data acquisition and communication systemsused in mechatronics system development.	

UNIT-I	
Introduction to Smart Sensor: Introduction, definition of sensors, smart sensors, integrated smart sensors and integrated smart sensor systems, Classification of sensors, Third and fourth industrial revolution, Smart Sensors applications for Automated homes and vehicles. **Laboratory Sessions/ Experimental learning:** Automated system using smart sensors. **Applications:** Automation **Video link:** 1. https://archive.nptel.ac.in/courses/108/108/108108147/ 2. https://youtu.be/n1XcDq-Ynv0 **3.** https://youtu.be/fhp61CepgUg	**8Hrs**
UNIT-II	
Motion, Proximity and Ranging Sensors: Motion Sensors, Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR). **Laboratory Sessions/ Experimental learning:** Measuring analog variations in physical variables by using appropriate resistive sensors in an RC-circuit and measuring the time to charge/discharge the capacitor **Applications:**Smart systems essentials for physical measurements Video link: 1. https://onlinecourses.nptel.ac.in/noc22_ee36/preview 2.https://youtu.be/sIBHVsoRgLs 3. https://nptel.ac.in/courses/112108092	**8Hrs**
UNIT-III	
Force, Magnetic and Heading Sensors: Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement, and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers. **Laboratory Sessions/ Experimental learning:** Display the distance the object is placed from the sensor using Arduino. **Applications:** Integrated smart system design **Video link: 1.** https://nptel.ac.in/courses/112104251	**8Hrs**

2. https://archive.nptel.ac.in/courses/112/107/112107298/	
UNIT-IV	
Smart Sensors: Optical sensors based on photon detection- introduction, Photon absorption in silicon- detection limit- photon detectors with gain, physical chemosensory-physical chemosensing-energy domains, Thermal sensors- heat transfer mechanisms, different temperature sensing elements. **Laboratory Sessions/ Experimental learning**: To display the temperature in a room by using thermal sensor. **Applications:** Smart Sensors **Video link:** 1.https://archive.nptel.ac.in/courses/115/107/115107122/ 2. https://www.youtube.com/watch?v=oRydUfgMdgA	**8Hrs**
UNIT-V	
Signal Conditioning and DAQ Systems: Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring. **Laboratory Sessions/ Experimental learning:** Interfacing Data Acquisition system hardware with computer. **Applications:** LabVIEW programming techniques. **Video link:** 1. https://nptel.ac.in/courses/108105062 2. https://youtu.be/I_9Pwyxhe40	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C313.2.1	Expertise in various types for sensors and smart sensors.
C313.2.2	Acquire knowledge on different sensors and transducers.
C313.2.3	Apply the various smart sensors in the Automotive and Mechatronics applications.
C313.2.4	Study the basic principles of various smart sensors
C313.2.5	Implement the DAQ systems with different sensors for real time applications

Textbooks/ Reference Books	
1	"Measurement Systems – Applications and Design", Ernest O Doebelin, Tata McGraw-Hill, 2009.
2	"A Course in Mechanical Measurements and Instrumentation and Control", Sawney A K and Puneet Sawney, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.
3	"Sensors and Transducers", Patranabis D, 2nd Edition, PHI, New Delhi, 2010.
4	"Instrumentation for Engineers and Scientists", John Turner and Martyn Hill, Oxford Science Publications, 1999.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C313.2.1	3	2	2	2	2	1	1	-	1	2	-	2	-	-
C313.2.2	3	3	3	2	3	2	2	-	2	3	2	3	-	-
C313.2.3	3	3	3	2	3	2	2	-	2	3	2	3	-	-
C313.2.4	3	3	3	2	3	2	2	-	2	3	2	3	-	-
C313.2.5	3	3	3	3	3	3	3	-	3	3	3	3	-	-

Semester: VI		
Aircraft Power System (Theory)		
Course Code:	**MVJ22EE643**	**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 electrical and electronics components of aircraft system.	
2	Explain electrical machines and power units in aircraft system.	
3	Explain power distribution in aircraft systems.	
4	Explain different controls, transducers and lighting used in aircraft system.	
5	Explain the fuel management and engine system in aircraft.	

UNIT-I	
Electrical and Electronic fundamentals for aircraft systems: Electrostatics and Capacitors, Direct Current, Current, Voltage and Resistance, Power and Energy, Electromagnetism, and Inductors, Alternating Current and Transformers, Safety, Semiconductor Theory, Diodes, Transistors, Integrated Circuits. **Digital fundamentals for aircraft systems:** Logic Gates, Combinational Logic Systems, Monostable and Bistable Devices, Encoders and Decoders, Multiplexers, Bus Systems and Computers **Applications**: Concepts can be used to understand basics of power components of any aircraft system. **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=BzBhHKLQO3k https://www.youtube.com/watch?v=d5sXmNplQHw	**8Hrs**
UNIT-II	
Generators and motors: Working Principle, AC Generators, 3 Phase Generation and Distribution, AC Motors, Practical Aircraft Generating Systems. **Power supplies:** Regulators, External Power, Inverters, Transformer Rectifier Units, Auxiliary Power Unit, Emergency Power. **Applications**: Concepts can be used to understand the different power sources available for aircraft system. **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=b0qaO_1mmOw https://www.youtube.com/watch?v=ObHw148t6ss	**8Hrs**

UNIT-III	
Wiring and Circuit Protection: Overview, Construction and Materials, Specifications, Shielding/ Screening, Circuit Protection. **Distribution of Power Supplies:** Single Engine/General Aviation, Twin Engine General Aviation Aircraft, Large Aircraft Systems, Split Bus System, Parallel Bus System, Battery Charging, Control and Protection, Load Shedding **Laboratory Sessions/ Experimental learning:** Wiring of aircraft model. **Applications**: Power Distribution in Aircraft. **Web Link and Video Lectures:** **1.** https://www.youtube.com/watch?v=DTe8mrw7pko https://www.youtube.com/watch?v=5uaebpWwz0A	**8Hrs**
UNIT-IV	
Lights: Lighting Technologies, Flight Compartment Lights, Passenger Cabin Lights, Exterior Lights. **Controls and Transducers:** Switches, Relays and Contactors, Variable Resistors, Linear Displacement Transducers, Fluid Pressure Transducers, Temperature Transducers, Strain Transducers, Rotary Position Transducers, electronic flight instrument system **Applications**: Concept can be used to design lighting **Web Link and Video Lectures:** 1. https://www.youtube.com/watch?v=3WxhYtkADKs **2.** https://www.youtube.com/watch?v=WhQ8Ai4fa_Q https://www.youtube.com/watch?v=FSl8iIpeHEk	**8Hrs**
UNIT-V	
Engine system: Starting and Ignition, Indicating Systems Overview, Primary Indicating Systems, Secondary Indicating Systems, Electronic Indicating Systems. **Fuel Management:** introduction, storage overview, Fuel Quantity Measurement and Indication, Fuel Feed and Distribution, Fuel Transfer. **Web Link and Video Lectures:** **1.** https://www.youtube.com/watch?v=gIdXLMVP6VU https://www.youtube.com/watch?v=R0_Hn3WeOCI	

Course Outcomes: After completing the course, the students will be able to	
C313.3.1	Understand the electrical and electronic components of the aircraft system.
C313.3.2	Understand the electrical and electronic components of the aircraft system.
C313.3.3	Describe power distribution in aircraft systems.

C313.3.4	Explain different controls, transducers, and lighting used in aircraft systems.
C313.3.5	Explain the fuel management and engine system in aircraft.

Textbooks/ Reference Books	
1	Aircraft electrical and Electronics systems, Mike Tooley and David Wyatt, Elsevier Book Aid International
2	Aircraft Electrical System by EHJ Pallett, 3rd edition Pearson
3	Aircraft Electricity and Electronics by Thomas K Eismin, Sixth edition MC. Graw Hill

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313.3.1	3	1	-	-	-	1	-	-	-	-	2	2	-	-
C313.3.2	3	1	-	-	-	1	-	-	-	-	2	2	-	-
C313.3.3	3	2	-	-	-	1	-	-	-	-	2	2	-	-
C313.3.4	3	2	-	-	-	1	-	-	-	-	2	2	-	-
C313.3.5	3	2	-	-	-	1	-	-	-	-	2	2	-	-

Semester: VI		
Industrial ServoControl Systems (Theory)		
Course Code:	**MVJ22EE644**	**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 evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques	
2	Discuss system analogs, vectors and transfer functions of differential equations.	
3	Represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.	
4	Determine the frequency response techniques for proper servo compensation.	
5	Explain perform indices and performance criteria for servo systems and discuss the mechanical considerations of servo systems.	

UNIT-I	
Servos Introduction, Benefits of Servo Systems, Types of Servos - Evolution of Servo Drives, Classification of Drives, Components of Servos - Hydraulic/Electric Circuit Equations, Actuators- Electric, Actuators-Hydraulic,Amplifiers-Electric,Amplifiers-Hydraulic,Transducers (Feedback). **Laboratory Sessions/ Experimental learning**: Identification of components for Electric/Hydraulic actuators **Applications**: servo motors are used to control speed in automobiles **Video link:** https://youtu.be/Sv3YYwfWR60?si=ka-mQMOAv6viPBYC	**8Hrs**
UNIT-II	
Machine Servo Drives Types of Drives, Feed Drive Performance. **Application of Industrial Servo Drives** Introduction, Physical System Analogs, Quantities and Vectors, Differential Equations for Physical Systems, Electric Servo Motor Transfer Functions and Time Constants, Transport Lag Transfer Function, Hydraulic Servo Motor Characteristics, General Transfer Characteristics. **Laboratory Sessions/ Experimental learning:** Using MATLAB simulate the hydraulic servo system and find its characteristics **Applications:** Application in mobile hydraulics **Video link:**https://youtu.be/6DctdwlDKhc?si=jFhiZBK-4LdV2co-	**8Hrs**
UNIT-III	
Generalized Control Theory Servo Block Diagrams, Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts, Nichols Charts, Servo Analysis Techniques, Servo Compensation.	**8Hrs**

Indexes of Performance Definition of Indexes of Performance for Servo Drives, Indexes of Performance for Electric and Hydraulic Drives. **Laboratory Sessions/ Experimental learning:**Frequency analysis of servo systems using MATLAB. **Application:** Used to find the performance of the servo drives. **Web Link and Video Lectures:**https://youtu.be/1AT1yuQ9awM?si=hSwoXx5-y8Ki8bpD	
UNIT-IV	
Performance Criteria: Percent Regulation, Servo System Responses. **Servo Plant Compensation Techniques** Dead-Zone Nonlinearity, Change-in-Gain Nonlinearity, Structural Resonances, Frequency Selective Feedback, Feed forward Control. **Machine Considerations** Machine feed drive Considerations, Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives. **Laboratory Sessions/ Experimental learning:** Connect the servo motor with ball screw arrangement for position control using PLC **Application:** Implementation of servo systems for ball screw arrangement **Web Link and Video Lectures:**https://youtu.be/agjdqWZOen8?si=9tA7loVzDJAs7Ukf	**8Hrs**
UNIT-V	
Machine Considerations Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque And Friction Considerations, Drive Duty Cycles. **Applications:** Appropriate selection of servo system based on the machine considerations **Video link:** https://youtu.be/agjdqWZOen8?si=w7V8ER_1gWljtzNb	

Course Outcomes: After completing the course, the students will be able to	
C313.4.1	Explain the evolution and classification of servos, with descriptions of servo drive actuators, performance, and troubleshooting techniques
C313.4.2	Analyze the transfer functions of servo systems
C313.4.3	Understand servo drive components by their transfer function.
C313.4.4	Analyze the frequency response of servo compensation.
C313.4.5	Explain perform indices and performance criteria for servo systems.

Textbooks/ Reference Books	
1	George W. Younkin Marcel Dekker, "Industrial Servo Control Systems Fundamentals and Applications",1st Edition, 2003.

2	RiazollahFiroozian, "Servo Motors and Industrial Control Theory", Springer 2nd Edition, 2014.
3	Stephen M. Tobin, "DC SERVOS Application and Design with MATLAB", CRC", 1st Edition, 2011.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C313.4.1	2	2	-	-	2	2	3	-	2	2	-	3	2	2
C313.4.2	2	3	-	-	1	2	3	-	2	2	-	3	2	3
C313.4.3	2	3	-	-	1	2	3	-	2	2	-	3	2	3
C313.4.4	2	3	2	3	2	2	3	-	2	2	-	3	2	3
C313.4.5	2	2	3	3	2	2	3	-	2	2	-	3	2	2

Semester: VI		
Disater Management (Theory)		
Course Code:	**MVJ22EE645**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Discuss disaster management, its planning, occurrence of cyclones and their hazard potential.	
2	Discuss the role of IMD, cyclone warning system in India and cyclone disaster management plan.	
3	Discuss the role of different institutions, defence, and other services in natural disaster management.	
4	Discuss the role of Central Water Commission in river water sharing, Draught, its assessment, and drought management plan.	
5	Discuss reasons for the occurrence of earthquake, Tsunamis, and thunderstorms.	

UNIT-I	
Disaster Management Plan (DMP): - General introduction. **Cyclones and their Hazard Potential:** Classification of Low-Pressure Systems, Movement of Cyclones in Indian Seas, Storm Surges. Hazard Potential of Cyclonic Storms, Cyclone Prediction and Dissemination of Warnings, Dissemination of Cyclone Warnings. **Case study:** A study on Hazard Risks and Vulnerabilities in Regions Requiring Special Attention. **Applications: R**educe vulnerability to hazards & cope with disaster. **Web Link and Video Lectures:** • https://www.youtube.com/watch?v=TB97oX7ANGo https://nptel.ac.in/courses/105104183	**8Hrs**
UNIT-II	
India Meteorological Department and Cyclone Warnings in India: Cyclone Warnings through INSAT, Port Warnings with Day and Night hoisting Signals. **Cyclones Disaster Management – Plan:** Hazard Potentials Associated with Cyclones, Vulnerability Reduction, Early Warning. **Action Plan for Cyclone Disaster Management.** **Case study:** A study on cyclones and its impact on India. **Applications:** helps removing people and property from a threatened location by facilitating timely and effective rescue, relief, and rehabilitation. **Web Link and Video Lectures:** • https://nptel.ac.in/courses/105104183 https://archive.nptel.ac.in/courses/105/104/105104183/	**8Hrs**

UNIT-III	
Role of Different Institutions in Natural Disaster Management: Role of Zilla Parishad, Role of PRA Groups in Disaster Management, Role of NGOs, Self Help Groups in Disaster Management, Role of Red Cross in Disaster Management. **The Role of Defence and other Services in Disaster Management:** Role of Air Force in DisasterManagement, Role of Medical and Health Department in Cyclone disaster management, National Disaster Response Force (NDRF), Role of Remote Sensing in Disaster Management, Role of Broadcast, Educational Media in disaster management. **Case study:** Role of NGOs during Covid 19 pandemic. **Applications:** helps to provide effective rescue, relief, and rehabilitation. **Web Link and Video Lectures:** • https://www.youtube.com/watch?v=F6expVc06PI https://egyankosh.ac.in/bitstream/123456789/25512/1/Unit-3.pdf	**8Hrs**
UNIT-IV	
Floods: Definition of Flood, Role of Central Water Commission, Flood Warning Signals and Precautionary Actions, Water Purification Technologies in Flood Affected Areas. **Drought:** Drought Management Plan, Drought Assessment, Drought Parameters, Role of Banking, Insurance, Microfinance in drought mitigation, Drought Monitoring, Drought Research Unit (IMD), Rainwater harvesting. **Case study:** A study on impact of floods and drought on India. **Applications:** helps to provide effective rescue, relief, and rehabilitation. **Web Link and Video Lectures:** • https://nptel.ac.in/courses/105104183 https://archive.nptel.ac.in/courses/105/104/105104183/	**8Hrs**
UNIT-V	
Earthquakes: Plate Tectonics, Seismicity of India, Earthquake Forecast and disaster management, Tsunamis, Landslides and Avalanches, Volcanoes. **Hazards associated with Convective Clouds:** Lightning, Some Effects of Electric Shock, Favours and Frowning's of Thunderstorms, Hailstorms, Tornadoes, Waterspouts, Dust-Devils, Nowcasting, Summer Thunderstorms over India, Cold Waves and Heat Waves in India. **Case study:** Case study on Gorkha Earthquake **Applications:** helps removing people and property from a threatened location by facilitating timely and effective rescue, relief, and rehabilitation. **Web Link and Video Lectures:** • https://archive.nptel.ac.in/courses/105/104/105104183/ • https://nptel.ac.in/courses/105104183 https://nptel.ac.in/courses/105104183	
Course Outcomes: After completing the course, the students will be able to	

C313.5.1	Discuss disaster management plan, cyclones, and their hazard potential.
C313.5.2	Understand the role of IMD and cyclone prediction and cyclone warning system in India.
C313.5.3	Understand the role of different institutions defense and other services in natural disaster management.
C313.5.4	Understand the role of Central Water Commission in river water sharing, Draught, its assessment, and draught management plan.
C313.5.5	Understand occurrence of earthquake, Tsunamis, and thunderstorms.

Textbooks/ Reference Books	
1	''Earth and Atmospheric Disaster Management Natural and Man-made'' Navale Pandharinath, C. K. Rajan, BS Publications 2009
2	''National Disaster Management Plan'' by National Disaster Management Authority Revised Edition - November, 2019

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

Total marks: 50+50=100

CO-PO Mapping													PSO	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313.5.1	3	3	1	1	1	-	-	-	1	-	-	2	-	-
C313.5.2	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C313.5.3	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C313.5.4	3	3	1	2	1	-	-	-	1	-	-	2	-	-
C312.5.5	3	2	1	2	1	-	-	-	1	-	-	2	-	-

Semester: VII		
PROJECT PHASE – I		
Course Code:	**MVJ22EEP65**	**CIE Marks: 50**
Credits:	**L:T:P: 0:0:4**	**SEE Marks: 50**
Hours:		**SEE Duration:**

Course Learning Objectives: The students will be able to	
1	Develop interactive, communication, organization, time management, and presentation skills.
2	Impart flexibility and adaptability.
3	Inspire independent and team working.
4	Expand intellectual capacity, credibility, judgment, intuition.
5	Adhere to punctuality, setting and meeting deadlines.
6	Instill responsibilities to oneself and others.
7	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 theproject report as per the norms avoiding plagiarism.

Course Outcomes: After completing the course, the students will be able to	
314.1	Describe the project and be able to defend it. Develop critical thinking and problem-solving skills.
314.2	Learn to use modern tools and techniques. Communicate effectively and to present ideas clearly and coherently both in written and oral forms.
314.3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
314.4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
314.5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation:

Continuous Internal Evaluation: The CIE (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**
314.1	2	2	2	3	3	2	1	1	2	1	1	2
314.2	2	2	2	3	3	2	1	1	2	1	2	2
314.3	2	2	2	3	3	2	1	1	2	1	2	2
314.4	2	2	2	3	3	2	1	1	2	1	2	2
314.5	2	2	2	3	3	2	1	1	2	1	2	2

Semester: VI		
Control System Laboratory (Practical)		
Course Code:	**MVJ22EEL66**	**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 performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair.
2	Design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
3	Determine the time and frequency domain responses of a given second order system using software package or discrete components.
4	Study the DC position and feedback control system and the effect of P, PI, PD and PID controller on the step response of the system.
5	Determine effect of addition of poles and zeros and pole location on stability of a system.

List of Experiments

1. Speed torque characteristics of (i) AC servo motor (ii) DC servo motor.
2. Synchro pair characteristics
3. Determine frequency response of a second order system.
4. Frequency response of a passive RC lead compensating network for the given specifications.
5. Frequency response of a passive RC lag compensating network for the given specifications.
6. Frequency response characteristics of the lag – lead compensating network for the given specifications.
7. (a) Simulate a typical second order system and determine step response and evaluate time response specifications.

(b)Evaluate the effect of adding poles and zeros on time response of second ordersystem.

8. Study a second order system and verify the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.

Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.

9. Determine the stability of system using root locus plot in MATLAB.
10. Determination of specific cake and medium resistance using Plate and frame filter press.
11. Simulate a D.C. Position control system and obtain its step response.
12. Simulate a DC Servomotor and study its stability

Course Outcomes: After completing the course, the students will be able to	
315.1	Determine the performance characteristics of AC and DC servomotors and synchro-transmitter receiver pair used in control systems.
315.2	Design, analyse and simulate Lead, Lag and Lag – Lead compensators for given

	specifications.
315.3	Utilize software package and discrete components in assessing the time and frequency domain response of a given second order system.
315.4	Simulate the DC position and feedback control system and study the effect of P, PI, PD and PID controller on the step response of the system.
315.5	Determine effect of addition of poles and zeros and pole location on stability of a system.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
315.1	2	1	2	2	2	-	-	-	-	-	-	3	-	-
315.2	2	2	2	2	2	-	-	-	-	-	-	3	-	-
315.3	2	2	2	1	2	-	-	-	-	-	-	3	-	-
315.4	3	3	2	2	2	-	-	-	-	-	-	3	-	-
315.5	2	3	2	1	2	-	-	-	-	-	-	3	-	-

Semester: VII		
Switchgear and Protection (Theory)		
Course Code:	**MVJ22EE71**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50+50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Discuss performance of protective relays, components of protection scheme and relay terminology.	
2	Explain Overcurrent protection using electromagnetic relays and Overcurrent protective schemes.	
3	Explain construction, operating principles of various distance relays for distance protection.	
4	Discuss construction, operating principles of static and numerical relays for Numerical protection.	
5	Explain the principle of circuit interruption and different types of circuit breakers	

UNIT-I	
Protective Relays: Introduction, Need for power system protection, evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, basic relay terminology. **Operating Principles and Relay Construction:** Electromagnetic relays, thermal relays, static relays. **Laboratory Sessions/ Experimental learning:** Field visit to show placing and operation of relays in substation. **Applications**: Selection of relays for protection of system components. **Web Link and Video Lectures:** 1. https://nptel.ac.in/courses/108/101/108101039/ 2. https://youtu.be/NEXWcOgqZOI	**8Hrs**
UNIT-II	
Over-Current Protection: Time-current characteristics, current setting, over current protective schemes, directional relay,Protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme. **Distance Protection**: Impedance relay, reactance relay, MHO relay, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays. **Laboratory Sessions/ Experimental learning:** Design of protection system for distribution system. **Applications:** Protection of transmission line and selection of distance relays. **Web Link and Video Lectures:** 1. https://nptel.ac.in/courses/108/101/108101039/	**8Hrs**

2. https://youtu.be/XdE149Hk_h0	
UNIT-III	
Differential protection–Introduction, differential relays, differential protection scheme, Wire Pilot protection (Transley scheme), Carrier current protection. **AC Machines and Bus Zone Protection:** Protection of Generators, Protection of transformers, Protection of induction motors, Protection of Bus zone protection **Laboratory Sessions/ Experimental learning:** Study the gas actuated Buchholz relay for oil filled transformer (virtual lab). **Application:** Protection of machines from internal and external faults. **Web Link and Video Lectures:** **1.** https://nptel.ac.in/courses/108/101/108101039/ **2.** https://youtu.be/ZXyq-xxRLnQ	**8Hrs**
UNIT-IV	
Numerical Protection Static Relays: Amplitude and Phase comparators, Static amplitude comparator, static over current relays, static directional relay, and static distance relays. **Microprocessor Based Relays:** Over current relays, directional relays, distance relays. **Laboratory Sessions/ Experimental learning:** Industrial visit **Application:** Numerical protection is used in smart grid. **Web Link and Video Lectures:** 1. https://nptel.ac.in/courses/108/101/108101039/ https://youtu.be/NEXWcOgqZOI	**8Hrs**
UNIT-V	
FUSES: Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination **Circuit Breakers:** Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast Circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, ratings of circuit breakers, testing of circuit breakers. **Laboratory Sessions/ Experimental learning:** **1.** Circuit Breaker Status Indication from field input(virtual lab) **2.** Substation Visit **Application:** MCB & Fuses are used for protection of all electrical machines. **Web Link and Video Lectures:** **1.** https://nptel.ac.in/courses/108/101/108101039/ https://youtu.be/JRv2RVyYMtM	**8Hrs**
Practice (Laboratory) Part	
Sl..No	**Experiments** **(to be carried out using discrete components)**
1	12. IDMT non-directional characteristics and calculation of error in operating time for Over current Relay (Electro mechanical type). **Along with mandatory experiments students are advised to complete two**

	open ended experiments. The following are some suggestions for open ended experiments.
2	Operating characteristics of Over voltage & Under voltage Relay (Electro mechanical type)
3	Operating characteristics of Microprocessor – based (numeric) Over / Under voltage Relay.
4	Operating Characteristics of Microprocessor Based (Numeric) Over Current Relay.
5	Motor protection scheme Studies.
6	Spark over characteristics of air insulation subjected to High Voltage AC – with Spark over voltage corrected to STP.
7	Breakdown strength of transformer oil using oil test kit.
8	Generator Protection Scheme
Along with mandatory experiments students are advised to complete two open ended experiments. The following are some suggestions for open ended experiments.	
9	Field mapping using electrolytic tank for capacitor model
10	Generation of standard lightning impulse voltage. Spark over characteristics of air insulation subjected to High Voltage DC.

Course Outcomes: After completing the course, the students will be able to	
C401.1	Compare and contrast electromagnetic, static and microprocessor-based relays
C401.2	Select relay settings of over current and distance relays.
C401.3	Analyze different protective schemes for bus-bars, generators, induction motors and transformers
C401.4	Apply technology to protect power system components.
C401.5	Analyze quenching mechanisms used in air, oil and vacuum circuit breakers

Textbooks/ Reference Books	
7.	Power System Protection and Switchgear, Badriram and D.N. Vishwakarma, 2ND Edition, TMH 2011.
8.	Fundamentals of Switchgear and Protection, J B Gupta, Technical Publications, 1st Edition, 2001.
3.	Fundamentals of Power system protection, Y.G.Paithankar and S.R.Bhide,2nd Edition, PHI private limited,NewDelhi,2010
4.	Switch Gear and Protection, Sunil S Rao, Khanna Publication, 1999

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C401.1	3	3	2	2	3	1	2	1	2	3	1	2	-	-
C401.2	3	3	2	2	3	1	2	1	2	3	1	2	-	-
C401.3	3	3	2	2	3	1	2	1	2	3	1	2	-	-
C401.4	3	3	2	2	3	1	2	1	2	3	1	2	-	-
C401.5	3	3	2	2	3	1	2	1	2	3	1	2	-	-

Semester: VII		
Industrial Drives and Applications (Theory)		
Course Code:	**MVJ22EE72**	**CIE Marks:50**
Credits:	**L:T:P: 4:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the electric drive	
2	Explain dynamics and modes of operation of electric drives.	
3	Explain selection of motor power ratings and control of dc motor using rectifiers.	
4	Analyze the performance of induction motor drives under different conditions	
5	Explain the control of induction motor, synchronous motor and stepper motor drives.	

UNIT-I	
Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives,Choice of Electrical Drives, Status of dc and ac Drives. **Dynamics of Electrical Drives:** Fundamental Torque Equations, Speed TorqueConventions andMultiquadrant Operation. Equivalent Values of DriveParameters, Components of Load Torques,Nature and Classification of LoadTorques, Calculation of Time and Energy Loss in TransientOperations, SteadyState Stability, Load Equalization. **Control of Electrical Drives:**Modes of Operation, Speed Control and Drive Classifications. **Laboratory Sessions/ Experimental learning:** MATLAB Simulation of closed loop control of drives. **Applications**: AC Drives on hotel air conditioning fans **Web Link and Video Lectures:** 1. https://www.electrical4u.com/classification-of-electrical-drives/ https://www.watelectrical.com/electric-drive-working-and-its-applications/	**8Hrs**
UNIT-II	
Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes ofMotor Duty, Determination of Motor Rating. **Direct Current Motor Drives:**Controlled Rectifier Fed dc Drives, Single Phase Fully ControlledRectifier Control of dc Separately Excited Motor,SinglePhase Half Controlled Rectifier Control of dcSeparately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited motor. **Four Quadrant Operations of DC Drives** Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic, and Regenerative Braking	**8Hrs**

operations. Closed-loop operation of DC motor (Block Diagram Only) **Laboratory Sessions/ Experimental learning:** Demonstration of the operation of controlled rectifier fed dc drives. **Applications:** Hybrid electric vehicles **Web Link and Video Lectures:** 1.https://nptel.ac.in/content/storage2/courses/108105066/PDF/L-10(DK)(PE)%20((EE)NPTEL).pdf 2.https://nptel.ac.in/content/storage2/courses/108105066/PDF/L13(DK)(PE)%20((EE)NPTEL)%20.pdf	
UNIT-III	
Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operationwith Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of induction motor fed from the non-sinusoidal voltage supply, Starting- star-delta starter, Auto-transformer starter, Rotor resistance starter, Braking-Regenerative braking, Plugging, AC dynamic braking. **Speed Control Techniques-**Stator Voltage Control by semiconductor voltage controller, Variable Frequency Control of Induction Motor, Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source Inverter (CSI) Control, current regulated voltage source inverter control. **Laboratory Sessions/ Experimental learning:** MATLAB simulation of induction motor fed from the non-sinusoidal voltage supply **Application:**Conveyors, pumps, winders **Web Link and Video Lectures:** 1. https://www.electrical4u.com/squirrel-cage-induction-motor/ https://instrumentationtools.com/squirrel-cage-induction-motor-vs-slip-ring-induction-motor/	**8Hrs**
UNIT-IV	
Synchronous Motor Drives Operation from fixed frequency supply-starting, synchronous motor,Self-controlled synchronous motor drive employing loadcommutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC)Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Laboratory Sessions/ Experimental learning:** Simulation of Synchronous Motor Drives using MATLAB simulation **Application:**Robot actuators **Web Link and Video Lectures:**https://nptel.ac.in/content/storage2/courses/108103009/download/M7.pdf	**8Hrs**

UNIT-V	
Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of StepperMotors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:**Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools. **Laboratory Sessions/ Experimental learning:** Simulation of stepper motor drives using MATLABsimulation **Application:**CNC milling machines. **Web Link and Video Lectures:** 1. https://nptel.ac.in/courses/112/106/112106153/ https://nptel.ac.in/courses/108/102/108102156/	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C402.1	Explain the electric drives and its advantages
C402.2	Understand the multi-quadrant operation of dc Separately Excited Motor
C403.3	Explain the various speed control techniques
C404.4	Interpret the self-controlled synchronous motor drive
C405.5	Understand the applications of drives in various industries

Textbooks/ Reference Books	
1.	Gopal K Dubey, Fundamentals of electrical drives, Narosa publishing house, 2014.
2.	Nagrath .I.J. and Kothari .D.P, Electrical Machines, Tata McGraw-Hill, 2006
3.	Vedam Subrahmaniam, Electric Drives (Concepts and Applications), Tata McGraw-Hill, 2010
4.	Pillai.S.K , A First Course on Electric Drives, Wiley Eastern Limited, 2012

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 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from

each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C402.1	-	2	-	1	-	-		3	3	3	3	3	-	-
C402.2	-	1	-	3	-	-		3	3	3	3	3	-	-
C403.3	-	2	-	2	-	3		3	3	2	3	3	-	-
C404.4	-	2	-	2	-	2		3	3	3	3	3	-	-
C405.5	-	2	-	2	-	2		3	3	3	3	3	-	-

Semester: VII		
Power System Analysis II (Theory)		
Course Code:	**MVJ22EE73**	**CIE Marks:50+50**
Credits:	**L:T:P: 3:0:2**	**SEE Marks: 50+50**
Hours:	**40L +10P**	**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand per unit quantities, network models and bus admittance matrix
2	Compute steady state load flow analysis with numerical iterative techniques
3	Compute short circuit faults occurring in power systems
4	Explain numerical solution of swing equation for multi-machine stability
5	Illustrate problems of unit commitment and economic load dispatch

UNIT-I	
Per Unit Representation and Topology: Per-Unit representation of Power system elements - Per-Unit equivalent reactance network of a three phase Power System. Graph Theory: Definitions, Formation of element node incidence and Bus Incidence Matrices, Y bus formation by Direct and Singular Transformation Methods, Numerical Problems **Laboratory Sessions/ Experimental learning**: Preparation of graph for a simple power system. **Applications**: Analysis of power system by reducing the complexity. **Video link:** https://www.youtube.com/watch?v=dmNlW2q-tbI	**8Hrs**
UNIT-II	
Power flow analysis: Bus classification, Formulation of Power Flow problems, Power flow solution using Gauss Seidel method, Handling of Voltage controlled buses, Power Flow Solution by Newton Raphson method, Fast Decoupled Power Flow Solution. **Laboratory Sessions/ Experimental learning**: Write a MATLAB program to solve any simple equation using iterative methods. **Applications:** Power system planning and operation **Video link:** https://www.youtube.com/watch?v=rEyE3NxK8vE	**8Hrs**
UNIT-III	
Short Circuit Analysis: Symmetrical short circuit on Synchronous Machine, Bus Impedance matrix building algorithm, Symmetrical fault analysis through bus impedance matrix, Symmetrical components, Sequence impedance, Sequence networks, Analysis of unsymmetrical fault at generator terminals, use of bus impedance matrix for analyzing unsymmetrical fault occurring at any point in a power system. **Laboratory Sessions/ Experimental learning**: Evaluation of sequence components of phase currents and voltages for a LG fault in simple 4 bus system using MATLAB programming. **Applications**: Selection of appropriate protective devices **Video link:** https://www.youtube.com/watch?v=HcMh7ahJxfo	**8Hrs**
UNIT-IV	

Power System Stability: Introduction, Dynamic and Transient Stabilities. Derivation of Swing Equation, Power Angle Curve and Determination of Steady State Stability. Determination of Transient Stability by Equal Area Criterion and its application, Critical Clearing Angle Calculation. Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers **Laboratory Sessions/ Experimental learning**: Determination of Power Angle curves using MATLAB. **Applications:** To determine nature of the relaying system needed, critical clearing time of circuit breakers, voltage level of and transfer capability between systems **Video link:** https://www.youtube.com/watch?v=-NkoZx8gdqM	**8Hrs**
UNIT-V	
Economic Operation of Power System: Introduction and Performance curves, Economic load dispatch of hydro-thermal scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. **Unit Commitment:** Introduction, Constraints and unit commitment solution by prior list method andDynamic forward DP approach (Flow chart and Algorithm only). **Laboratory Sessions/ Experimental learning:** Optimal generation scheduling for thermal power plants using Mi-power. **Applications:** To minimize the total cost of system production, yet maintain all the requirements such as loads, operating restrictions **Video link:** https://nptel.ac.in/courses/108/104/108104052/	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C403.1	Prepare per unit reactance diagram and formulate network matrices and models for solving load flow problems.
C403.2	Perform steady state power flow analysis of power systems using numerical iterative techniques
C403.3	Analyze short circuit faults in power system.
C403.4	Analyse steady state and transient stability in power systems.
C403.5	Solve economic load dispatch and unit commitment problems.

Textbooks/ Reference Books	
1.	D. P. Kothari , "Modern Power System "McGraw Hill , 4th Edition, 2011 .
2.	John.J.Grainger, William D. Stevenson, "Power System Analysis", Tata Mc Graw Hill Publishing company, New Delhi, 2003.
3.	J.Duncan Glover et al, " Power System Analysis and Design" , Cengage, 4th Edition, 2008
4.	Hadi Sadat, " Power System Analysis", McGraw Hill , 1st Edition, 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 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C403.1	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C403.2	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C403.3	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C403.4	3	2	2	1	-	-	3	-	-	-	-	2	-	-
C403.5	3	2	2	1	-	-	3	-	-	-	-	2	-	-

Semester: VII		
DC Microgrid and Control System (Theory)		
Course Code:	**MVJ22EE741**	**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	Understanding the basics of AC and DC microgrid	
2	Analyze the different modelling of microgrid Power system.	
3	Understand various controlling techniques of Microgrid	
4	Understand various operation modes and architecture	
5	Analyze stability systems in DC Micro-grids	

UNIT-I	
INTRODUCTION : Conventional power generation: advantages and disadvantages, Energy crises, Non- conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. **BASICS OF A MICROGRID**:Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids **Laboratory Sessions/ Experimental learning**: NA **Web Link and Video Lectures:** 1.https://online.vtu.ac.in/course-details/dc-microgrid-and-control-systems	**8Hrs**
UNIT-II	
Modelling of microgrid Power system: DC-AC converter, AC-DC converter, DC-DC converter, Modelling of Renewable energy source: Wind energy, Photovoltaic energy , Energy storage system. **Laboratory Sessions/ Experimental learning: NA** **Web Link and Video Lectures:** 1.https://online.vtu.ac.in/course-details/dc-microgrid-and-control-systems	**8Hrs**
UNIT-III	
CONTROL AND OPERATION OF MICROGRID: Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communicationbased techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids. **Laboratory Sessions/ Experimental learning**: NA **Applications**:	**8Hrs**

Web Link and Video Lectures: https://online.vtu.ac.in/course-details/dc-microgrid-and-control-systems	
UNIT-IV	
Operation Modes and Architecture: Microgrid dynamic and modelling, operation modes and standards, microgrid control architecture. DC microgrid system architecture and AC interface **Laboratory Sessions/ Experimental learning:** NA **Web Link and Video Lectures:** 1. https://online.vtu.ac.in/course-details/dc-microgrid-and-control-systems	**8Hrs**
UNIT-V	
Stability in Microgrid: Introduction, Stability analysis of DC microgrid, DC Stabilization strategies (passive damping method), Non linear techniques **Laboratory Sessions/ Experimental learning:NA** **Web Link and Video Lectures:** https://online.vtu.ac.in/course-details/dc-microgrid-and-control-systems	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C404.1.1	Understand the basic concepts of Microgrid and types of it
C404.1.2	Design the various models for different converters.
C404.1.3	Analyze different control methods for Microgrid
C404.1.4	Design the architecture for Microgrid
C404.1.5	Understand the Stability analysis of Microgrid

Textbooks/ Reference Books	
1.	AmirnaserYezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2010
2.	DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006
3.	F. Katiraei, M.R. Iravani, "Transients of a Micro-Grid System with Multiple Distributed Energy Resources" International Conference on Power Systems Transients (IPST-05) in Montreal, Canada on June 19-23, 2005.
4.	Z.Ye R. Walling, N.Miller, P.Du.K.Nelson,"FacilityMicrogrids, General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C404.1.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**
C404.1.2	**2**	**-**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
C404.1.3	**2**	**-**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**2**	**1**	**2**	**-**
C404.1.4	**2**	**-**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**2**	**1**	**2**	**-**
C404.1.5	**2**	**-**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**2**	**1**	**2**	**-**

Semester: VII		
High Power Multilevel Converters (Theory)		
Course Code:	**MVJ22EE742**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To understand multilevel, symmetrical and unsymmetrical topologies.	
2	To understand the operation of Diode clamped multilevel inverter	
3	To analyze the function of Flying capacitor multilevel converter	
4	To characterize the Cascade asymmetric multilevel converter	
5	To impart knowledge of analyzing Modular multilevel converter	

UNIT-I	
Converters: Introduction, medium voltage power converters, multilevel converters, Applications. **Multilevel Topologies:** Introduction, generalized topologies with common DC bus, converters derived from the generalized topology, symmetric topologies without common DC link, summary of symmetric topologies, Asymmetric topologies. **Laboratory Sessions/ Experimental learning:** Simulation the multilevel converter in MATLAB. **Applications**: inverter circuit, industrial, switch mode power supply, traction motor control. **Web Link and Video Lectures:** 1. https://archive.nptel.ac.in/courses/108/102/108102157/ https://www.elprocus.com/multilevel-inverter-types-advantages/	**8Hrs**
UNIT-II	
Diode clamped multilevel inverter Introduction-structure and functional description, modulation of multilevel converter, voltage balance control, effectiveness, boundary of voltage balancing, Applications. **Laboratory Sessions/ Experimental learning:** Realize the DCMLI circuit using MATLAB **Applications:** Effective speed control of induction motors. **Web Link and Video Lectures:** 1.https://archive.nptel.ac.in/courses/108/102/108102157/ 2.https://www.youtube.com/watch?v=lYPArniBlzc	**8Hrs**
UNIT-III	
Flying capacitor multilevel converter Introduction, flying capacitor topology, modulation scheme for the flying capacitor multilevel converter, dynamic voltage balance of the flying capacitor multilevel converter. **Cascade asymmetric multilevel converter:** Introduction, general characteristics of CAMC, comparison of five level topologies **Laboratory Sessions/ Experimental learning:** MATLAB simulation of FCMC. **Application:** electrified aircraft **Web Link and Video Lectures:**	**8Hrs**

1.http://acl.digimat.in/nptel/courses/video/108102157/lec42.pdf 2.https://www.slideshare.net/slideshow/flying-capacitor-multi-level-inverter-190707471/190707471 3.https://web.iitd.ac.in/~anandarup/nptel_high_power_conv/15_other_converter_topologies.pdf	
UNIT-IV	
Modular multilevel converter Basic principle-topology and operation, arm and cell voltage rating, arm current, Different circuit topology, PWM technique and capacitor voltage balancing, fault tolerant operation. **Laboratory Sessions/ Experimental learning**: Simulation of single phase and three phase modular multilevel converter **Application:** High voltage DC transmission, STATCOM. **Web Link and Video Lectures:** 1. https://encyclopedia.pub/entry/5863 2. https://assets.new.siemens.com/siemens/assets/api/uuid:852447ab-debe-4199-843b-4e256a22ddf7/%20GH150M2CWhitePaper.pdf 3. https://archive.nptel.ac.in/courses/108/102/108102157/	**8Hrs**
UNIT-V	
DSTATCOM build with Cascade asymmetric multilevel converter: Introduction, compensation principles, CAM model, reactive power and harmonics compensation. **Laboratory Sessions/ Experimental learning:** Design CAMC using MATLAB **Application:** eliminate the bulky transformer required in case of conventional multi phase inverters, Power system Transmission and control. **Web Link and Video Lectures:** 1 https://nptel.ac.in/courses/108102157 2 https://www.mdpi.com/2079-9292/4/2/311	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C404.2.1	Understand the concept of multilevel, symmetrical and unsymmetrical topologies
C404.2.2	Understand the operation of Diode clamped multilevel inverter
C404.2.3	Analyze the function of Flying capacitor multilevel converter
C404.2.4	Characterize the Cascade asymmetric multilevel converter
C404.2.5	Design and analyzing Modular multilevel converter

Textbooks/ Reference Books	
1.	"Multilevel converters for industrial applications", Sergio Alberta Gonzalez CRC press,2014
2.	"Power Electronics Converters and Regulators", Branko L. Doki and Branko Blanu, Springer (International Publishing, Switzerland) , 3 rd Edition, 2015

3.	"Power Electronics Converters, Applications, and Design", Ned Mohan at el, Wiley, 3 rd Edition,2014

Continuous Internal Evaluation (CIE):
Theory for 50 Marks
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C404.2.1	2	2	-	1	-	-	-	**1**	**1**	**1**	**1**	**1**	2	2
C404.2.2	**2**	1	-	1	-	-	-	-		-	-	-	**2**	1
C404.2.3	2	1	-		-	1	-	-	1	-	-	-	2	1
C404.2.4	2	2	-	1	-	-	-	**1**	-	**1**	**1**	-	2	2
C404.2.5	2	2	-		-	-	-	**1**	-	-	-	**1**	2	2

Semester: VII		
CMOS Digital VLSI Design (Theory)		
Course Code:	**MVJ22EE743**	**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 characteristics of CMOS circuit construction.	
2	Introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).	
3	Design CMOS combinational and sequential logic at the transistor level, with mask layout.	
4	Design for higher performance or lower area using alternative circuit families	
5	Testing and Verification of VLSI Design	

UNIT-I	
Introduction: A Brief History, MOS Transistors, MOS Transistor Switches, CMOS Logic, Circuit and System Representations, MOS Transistor Theory, Ideal I-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics, Review of MOS electrical properties, Expression for threshold voltage and drain current, Secondary effects of MOSFET, review of CMOS and bipolar technologies. **Laboratory Sessions/ Experimental learning**: Design and demonstrate the MOS transistor connected as a diode using any CAD tool. **Applications**: integrated circuit (IC) chips, including microprocessors, microcontrollers, memory chips. **Video link**:https://nptel.ac.in/courses/117/101/117101058/	**8Hrs**
UNIT-II	
MOS and Bi-CMOS Circuit Design Processes: MOS Layers, Stick Diagrams, Design Rules and Layout.Bi-CMOS processes, Integration and Isolation considerations, Integrated Analog/Digital CMOS Process. **Basic inverter** - Inverter Device sizing, Enhancement load and Depletion load inverters, CMOS inverter, CMOS inverter logic levels, Inverter device sizing, combinational logic implementation using NMOS and CMOS inverters. **Laboratory Sessions/ Experimental learning**: Draw layout of inverter using Cadence Tool. **Applications**: Design of CMOS inverter circuit with different scaling functions. **Video link**: 1. https://nptel.ac.in/courses/117106093/ 2. https://nptel.ac.in/courses/117106092/	**8Hrs**
UNIT-III	
Scaling of MOS Circuits: Scaling Models & Scaling Factors for Device Parameters. **Subsystem Design Processes:** Some General considerations, An illustration of	**8Hrs**

Design Processes, Illustration of the Design Processes- Regularity, Design of an ALU Subsystem, The Manchester Carry-chain and Adder Enhancement Techniques, Semiconductor memories, memory chip organization, RAM Cells, dynamic memory cell. **Laboratory Sessions/ Experimental learning**: 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**: 1. https://www.youtube.com/watch?v=eqnMAaYU4OY 2. https://www.youtube.com/watch?v=zNqmohJHDwc	
UNIT-IV	
Subsystem Design: Some Architectural Issues, Switch Logic, Gate(restoring) Logic, Parity Generators, Multiplexers, The Programmable Logic Array (PLA), CMOS Logic Gate Design, Basic Physical Design of Simple Gate, CMOS Logic Structures, Clocking Strategies, I/O Structures, Low Power Design. **Laboratory Sessions/ Experimental learning**: Design Manchester Carry-chain using CMOS transistors using any CAD tool. **Applications**: Designing of PLA and PLD **Video link**: https://nptel.ac.in/courses/117106093/	**8Hrs**
UNIT-V	
Memory, Registers and Aspects of system Timing- System Timing Considerations, Some commonly used Storage/Memory elements. **Testing and Verification:** Introduction, Logic Verification, Logic Verification Principles, Manufacturing Test Principles, Design for testability, Chip Level Test Techniques, System Level Test Techniques, Layout Design for Improved Testability. **Laboratory Sessions/ Experimental learning**: Perform a survey on Prime-Time CAD tool from Synopsis for timing Analysis. **Applications**:Testing of Imperfections in chip fabrication. **Video link:** 3. https://youtu.be/V-GL-oQSa14 (Fault design & Testability) 4. https://youtu.be/P7AQJn7K8Os (Combinational Circuit Test Pattern Generation-ATPG)	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C404.3.1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.
C404.3.2	Draw the basic gates using the stick and layout diagrams with the knowledge ofphysical design aspects
C404.3.3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements
C404.3.4	Interpret Memory elements along with timing considerations
C404.3.5	Interpret testing and testability issues in VLSI Design

Textbooks/ Reference Books	
1.	"CMOS Digital Integrated Circuits: Analysis and Design" - Sung Mo Kang & Yosuf Leblebici, Third Edition, Tata McGraw-Hill.
2.	"CMOS VLSI Design- A Circuits and Systems Perspective"- Neil H. E. Weste, and David Money Harris4th Edition, Pearson Education.
3.	Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition,Oxford University Press, International Version, 2009.
4.	Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition – 1994).

Continuous Internal Evaluation (CIE):
Theory for 50 Marks
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C404.3.1	2	1	2	2	2	-	-	-	-	-	-	3	-	-
C404.3.2	2	2	2	2	2	-	-	-	-	-	-	3	-	-
C404.3.3	2	2	2	1	2	-	-	-	-	-	-	3	-	-
C404.3.4	3	3	2	2	2	-	-	-	-	-	-	3	-	-
C404.3.5	2	3	2	1	2	-	-	-	-	-	-	3	-	-

Semester: VII		
Energy Storage and Management System (Theory)		
Course Code:	**MVJ22EE744**	**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 needs for energy storage.	
2	Understand the types of electrical energy storage Systems.	
3	Understand the various technologies availableand their applications.	
4	Explain various devices used for the energy storage systems.	

UNIT-I	
Needs for Electrical Energy Storage: Emerging needs for EES, Smart Grid uses, The roles of electrical energy storage technologies, The rolesfrom the viewpoint of a utility, consumers and generators of renewable energy, Classification of EES systems. **Laboratory Sessions/ Experimental learning**: Case study on the need of energy storage. **Applications**: Uninterrupted power supply. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=EakRe6ICM-Q	**8Hrs**
UNIT-II	
Mechanical Energy Storage Systems: Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES). **ElectricalEnergy Storage Systems:**Electrical Energy storage-super-capacitors, Magnetic EnergyStorage-Superconducting systems, **Laboratory Sessions/ Experimental learning:** Demonstration of energy storage using capacitor. **Applications:** Power grids **Web Link and Video Lectures:**https://nptel.ac.in/courses/108/106/108106182/	**8Hrs**
UNIT-III	
Chemical Energy Storage Systems: Chemical-Hydrogen production and storage, Principle of direct energy conversion using fuel cells,thermodynamics of fuel cells, Types of fuel cells, AFC, PEMFC, MCFC, SOFC, Microbial fuel cell, Fuel cellperformance, **Laboratory Sessions/ Experimental learning:** Demonstration of Fuel cell **Application:**Domestic, commercial and transport	**8Hrs**

Web Link and Video Lectures:https://nptel.ac.in/courses/108/106/108106182/	
UNIT-IV	
Electrochemical Energy Storage: Battery, primary, secondary and flow batteries. **Thermal Energy Storage systems:**Thermal Energy storage, sensible and latent heat, phase change materials, Energyand energy analysis of thermal energy storage. **Laboratory Sessions/ Experimental learning:** Demonstration of Battery. **Application:** Electrical vehicles and RES **Web Link and Video Lectures:**https://www.youtube.com/watch?v=HUlQ09x6Tmo	**8Hrs**
UNIT-V	
Design and Applications of Energy Storage: Renewable energy storage-Battery sizing and stand-aloneapplications, stationary (Power Grid application), Small scale application-Portable storage systems andmedical devices, Mobile storage Applications-Electric vehicles (EVs), types of EVs, batteries and fuel cells, future technologies, hybrid systems for energy storage. **Laboratory Sessions/ Experimental learning:** Battery energy management in electric vehicles **Application:**RES, Smart grid. **Web Link and Video Lectures:**https://nptel.ac.in/courses/108/106/108106182/	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C404.4.1	Explain needs for Electrical Energy Storage.
C404.4.2	Analyse the characteristics of energy from various sources.
C404.4.3	Classify various types of energy storage systems and various devices used for the purpose
C404.4.4	Understand the types of electrical energy storage Systems.
C404.4.5	Identify various real time applications.

Textbooks/ Reference Books	
1.	"James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004
2.	"Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.
3.	Pillai.S.K A First Course on Electric Drives, Wiley Eastern Limited, 2012
4.	Singh. M.D., K.B.Khanchandani, Power Electronics, 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 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):
SEEfor 50 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C404.4.1	1	1	1	-	2	2	2	-	3	1	1	3	1	1
C404.4.2	1	1	1	-	2	2	2	-	2	2	1	3	1	1
C404.4.3	1	1	1	-	2	2	1	-	3	1	1	1	1	1
C404.4.4	1	1	1	-	1	2	2	-	2	1	1	2	1	1
C404.4.5	1	1	1	-	3	2	1	-	2	1	1	2	1	1

Semester: VII		
Industrial Automation and Control (Theory)		
Course Code:	**MVJ22EE745**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Discuss architecture of industrial automation system and draw block diagram of industrial automation & control system.	
2	Describe the basic and application of PLC for automation.	
3	Discuss the fundamentals of PLC Wiring Diagram and Ladder Logic Program**.**	
4	Discuss different program control instruction in PLC	
5	Discuss the fundamentals of SCADA and HMI.	

UNIT-I	
Introduction to automation: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, different automation components, Introduction of PLC and supervisory control and data acquisition (SCADA). **Industrial bus systems**: modbus & profibus **Laboratory Sessions/ Experimental learning:** Study hardware and software used in PLC **Applications:** Industrial and commercial applications. **Web Link and Video Lectures:**https://nptel.ac.in/courses/108/105/108105088/	**8Hrs**
UNIT-II	
Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries. **Laboratory Sessions/ Experimental learning:** Implementation Logic Gates and verification of truth table in virtual lab or Logix Pro 500. **Applications:**Industrial and commercial applications **Web Link and Video Lectures:**http://www.digimat.in/nptel/courses/video/108105088/L31.html	**8Hrs**
UNIT-III	

Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: converting Relay Schematics into PLC LadderPrograms, writing a Ladder Logic Program TimerInstructions, On/offDelay Timer Instruction, Retentive Timer, Cascading TimersProgramming Counter Instructions, Up-Counter,Down-Counter, CascadingCounters, Incremental Encoder, Combining Counter and Timer Functions for different applications. **Laboratory Sessions/ Experimental learning:** Implementation of On-Delay Timer and Off-Delay Timer in Virtual lab. **Application:**Counter and timer applications **Web Link and Video Lectures:**https://www.youtube.com/watch?v=qD1WGwe0AQ0	**8Hrs**
UNIT-IV	
Program Control Instructions: Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction. **Laboratory Sessions/ Experimental learning:**Implementation of arithmetic instruction using Virtual lab **Application:** Conveyor belt control in industries. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=grr-3XhBSuY	**8Hrs**
UNIT-V	
SCADA Fundamentals: Introduction, Open system: Need and advantages, building blocks of SCADA systems, Remote terminal unit (RTU): Evolution of RTUs, Components of RTU, Communication subsystem, Logic subsystem, Termination subsystem, Testing and human-machine interface (HMI) subsystem, Power supplies, Advanced RTU functionalities, Intelligent electronic devices (IEDs), Data concentrators and merging units, SCADA communication systems. **Laboratory Sessions/ Experimental learning:** Study of key concepts within SCADA systems **Application:** Temperature control using PLC and SCADA **Web Link and Video Lectures:**https://youtu.be/X0U8-4ZPcro	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C404.5.1	Explain the architecture of industrial automation system and draw a block diagram of industrial automation & control system
C404.5.2	Explain basic concepts and Application of PLC to process control industries.

C404.5.3	Develop the fundamental PLC Wiring Diagrams and Ladder Logic Programsfor different applications.
C404.5.4	Develop the ladder diagram using different program control instructions.
C404.5.5	Explain the fundamentals of SCADA and HMI.

Textbooks/ Reference Books	
1.	Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S.Sen and A.K. Deb, Jaico Publishing House, 2013
2.	Programmable Logic controllers, Frank D Petruzella, The McGraw Hill ,4th edition.
3.	Process Control Instrumentation Technology By. C.D. Johnson, PHI
4.	Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C404.5.1	3	2		2		-	-	-	-	-	-	3	3	2
C404.5.2	3	2	2	2	2	-	-	-	-	-	-	3	3	2
C404.5.3	3	3	3	2	2	-	-	-	-	-	-	3	3	3

C404.5.4	3	2	2	2	1	-	-	-	-	-	-	2	3	2
C404.5.5	3	2		2		-	-	-	-	-	-	2	3	2

Semester: VII		
Fundamentals of Electric Vehicle (Theory)		
Course Code:	**MVJ22EE751**	**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 fundamental laws and vehicle mechanics.	
2	Understand upcoming technology of hybrid electric vehicles.	
3	Ability to develop the electric propulsion unit for EVs	
4	Understand about drives and control of EVs.	
5	Ability to analyze different power converter topologies used for EVs application	

UNIT-I	
Vehicle Mechanics: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of VehicleMotion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradeability, Velocity and Acceleration,Constant FTR, Level Road, Velocity Profile, Distance Traversed, Tractive Power, Energy Required, Non-constantFTR, General Acceleration, Propulsion System Design. **Laboratory Sessions/ Experimental learning**: Simulation of a vehicle to understand the different forces acting on vehicle. **Applications**: Stability check and mechanical design of EVs. **Video link:** **1.** https://youtu.be/wypbLRe9xUg https://nptel.ac.in/courses/108/102/108102121/	**8Hrs**
UNIT-II	
Introduction to Electric Vehicles: Introduction, conventional vehicles, and Electric vehicles, vehicle fundamentals, Types, performanceand configuration of EVs, Traction motor characteristics. **Hybrid Electric Vehicles:** Energy consumption concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains. **Laboratory Sessions/ Experimental learning**: Case study on different EVs **Applications**: Electric vehicles **Video link:** https://youtu.be/T5P9b0_Fv6w	**8Hrs**
UNIT-III	
Electric Propulsion System: Electric propulsion unit,EV consideration, Configuration and speed control: DC motor drives, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Sizing of Electric Machine for EVs and HEVs, Drive System Efficiency **Laboratory Sessions/ Experimental learning**: Analysis of Speed control of different types of motor in EVs using Simulink **Applications**: Electric vehicles	**8Hrs**

Video link:https://nptel.ac.in/courses/108/102/108102121/	
UNIT-IV	
Design of Electric and Hybrid Electric Vehicles: **Series Hybrid Electric Drive Train Design:** Operatingpatterns, control strategies, Sizing of major components, power rating of traction motor, power rating ofengine/generator, design of PPS **Parallel Hybrid Electric Drive Train Design:** Control strategies of parallel hybriddrive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energystorage design. **Laboratory Sessions/ Experimental learning:** Case study on different energy management strategies. **Applications:** Electric vehicles **Video link:** https://nptel.ac.in/courses/108/102/108102121/	**8Hrs**
UNIT-V	
Power Electronic Converter for Battery Charging: Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, High-frequency transformer basedisolated charger topology, Transformer less topology. E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Laboratory Sessions/ Experimental learning: Modeling of Electric Vehicles using MATLAB & Simulink. **Applications:** Electric vehicles **Video link:** https://youtu.be/yCjtiCFTFbk	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C405.1.1	Explain roadway fundamental, laws of motion and vehicle mechanics
C405.1.2	Acquire fundamental concepts and principles of hybrid electric vehicles (HEV)
C405.1.3	Develop the electric propulsion unit for application of EVs.
C405.1.4	Analyze and apply electric drives in vehicles / traction
C405.1.5	Design converters for battery charging and explain transformer less topologies.

Textbooks/ Reference Books	
1.	Modern Electric, Hybrid Electric, andFuel Cell Vehicles: Fundamentals,Theory, an Design, M. Ehsani, Y. Gao, S.Gay and Ali Emadi, CRC Press, 2005
2.	Modern Electric Vehicle Technology C.C. Chan and K.T.Chau, OxfordUniversity, 2001
3.	Husain, I. “Electric and Hybrid Vehicles” Boca Raton, CRC Press, 2010
4.	Larminie, James, and John Lowry, “Electric Vehicle Technology Explained” John Wiley and Sons, 2012

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C405.1.1	2	3	1	1	-	-	-	-	-	-	-	-	-	-
C405.1.2	2	3	1	2	-	-	-	-	-	-	-	-	-	-
C405.1.3	2	3	1	2	-	-	-	-	-	-	-	-	-	-
C405.1.4	2	3	1	2	-	-	-	-	-	-	-	-	-	-
C405.1.5	2	3	1	3	-	-	-	-	-	-	-	-	-	-

Semester: VII		
PLC and SCADA (Theory)		
Course Code:	**MVJ22EE752**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Discuss architecture of industrial automation system and draw block diagram of industrial automation & control system.	
2	Describe the basic and application of PLC for automation.	
3	Discuss the fundamentals of PLC Wiring Diagram and Ladder Logic Program**.**	
4	Discuss different program control instruction in PLC	
5	Discuss the fundamentals of SCADA and HMI.	

UNIT-I	
Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types. **Basics of PLC Programming:** Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Modes of Operation. **Laboratory Sessions/ Experimental learning:** Study hardware and software used in PLC **Applications:** Industrial and commercial applications. **Video Link:** https://nptel.ac.in/courses/108/105/108105088/	**8Hrs**
UNIT-II	
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic ControlRelays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors,Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC LadderPrograms,Writinga LadderLogicProgramDirectlyfroma Narrative Description. **Laboratory Sessions/ Experimental learning:** Implementation Logic Gates and verification of truth table in virtual lab or Logix Pro 500. **Applications:** Industrial and commercial applications **Video Link:**http://www.digimat.in/nptel/courses/video/108105088/L31.html	**8Hrs**
UNIT-III	
Programming Timers and counters: Timer Instructions, On/offDelay Timer Instruction, Retentive Timer, Cascading Timers,Programming Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental	**8Hrs**

Encoder, Combining Counter and Timer Functions for different applications. **Laboratory Sessions/ Experimental learning:** Implementation of On-Delay Timer and Off-Delay Timer in Virtual lab. **Application:** Counter and timer applications **Video Link:** https://www.youtube.com/watch?v=qD1WGwe0AQ0	
UNIT-IV	
Program Control Instructions: Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction. **Laboratory Sessions/ Experimental learning:** Implementation of arithmetic instruction using Virtual lab **Application:** Conveyor belt control in industries. **Video Link:**https://www.youtube.com/watch?v=grr-3XhBSuY	**8Hrs**
UNIT-V	
SCADA Fundamentals: Introduction, Open system: Need and advantages, building blocks of SCADA systems, Remote terminal unit (RTU), Evolution of RTUs, Components of RTU, and human-machine interface (HMI) subsystem, Power supplies, Advanced RTU functionalities, Intelligent electronic devices (IEDs), SCADA communication systems. **Laboratory Sessions/ Experimental learning:** Study of key concepts within SCADA systems **Application:** Temperature control using PLC and SCADA **Video Link:**https://youtu.be/X0U8-4ZPcro	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C405.2.1	Explain the architecture of industrial automation system and draw a block diagram of industrial automation & control system
C405.2.2	Explain basic concepts and Application of PLC to process control industries.
C405.2.3	Develop the fundamental PLC Wiring Diagrams and Ladder Logic Programsfor different applications.
C405.2.4	Develop the ladder diagram using different program control instructions.
C405.2.5	Explain the fundamentals of SCADA and HMI.

Textbooks/ Reference Books	
1.	Programmable Logic controllers, Frank D Petruzella, The McGraw Hill ,4th edition.
2.	Introduction Programmable Logic Controllers, Gary Dunning, Cengage 3rd Edition, 2006.
3.	Process Control Instrumentation Technology By. C.D. Johnson, PHI
4.	Industrial Instrumentation and Control By. S.K. Singh the McGraw Hill Companies

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
C405.2.1	3	2	-	2	-	-	-	-	-	-	-	3	-	-
C405.2.2	3	2	2	2	2	-	-	-	-	-	-	3	-	-
C405.2.3	3	3	3	2	2	-	-	-	-	-	-	3	-	-
C405.2.4	3	2	2	2	1	-	-	-	-	-	-	2	-	-
C405.2.5	3	2	-	2	-	-	-	-	-	-	-	2	-	-

Semester: VII		
Smart System Automation (Theory)		
Course Code:	**MVJ22EE753**	**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 conceptual approach of various smart sensors	
2	Explain different operations of sensors with microcontrollers	
3	Understandconcept of IoT for remote monitoring	
4	Understand concepts ofcloud computing based data monitoring	
5	Gain knowledege about different applications of Automation	

UNIT-I	
Basics of Smart Sensors: Introduction- Sensor Vs Transducer, Various sensing technologies-capacitive, Inductive, piezo electric, Hall effect, Digital output sensors.Smart Sensors, Components of Smart Sensors, General Architecture of Smart Sensors, Smart temperature sensor, Smart wind sensor and Smart Hall sensor, Calibration of smart sensors. **Laboratory Sessions/ Experimental learning:** Voltage and Current Detection Circuitry **Applications:** Pressure control of Boilers **Video link:** https://archive.nptel.ac.in/courses/108/108/108108147/	**8Hrs**
UNIT-II	
Sensor Interfacing with Microcontroller: MCU Control, MCUs for Sensor Interface, Techniques and Systems Considerations- Sensor Integration. **Laboratory Sessions/ Experimental learning:** Control of Water flow and Level detection Circuitry. **Applications:** Microcontroller based Temperature control of furnaces. **Video link:** 1. https://nptel.ac.in/courses/112104251 2. https://archive.nptel.ac.in/courses/112/107/112107298/	**8Hrs**
UNIT-III	
Implementation systems for IIoT: Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems. **Laboratory Sessions/ Experimental learning:** Measurement of Industrial parameters using microcontroller	**8Hrs**

Applications: Automatic water bottling plant **Video link:** https://archive.nptel.ac.in/courses/106/105/106105166/	
UNIT-IV	
IIoT Data Monitoring & Control: IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology. **Laboratory Sessions/ Experimental learning:** C*ollect data from different sensors/devices and transfer it to cloud* **Applications:** Remote Health monitoring **Video link:** https://onlinecourses.nptel.ac.in/noc19_cs65/preview	**8Hrs**
UNIT-V	
Smart Applications and Fundamental concepts in Robotics: Automated consumer products- Smart Car, Smart Home, Smart Domestic Appliances, Smart Toys. Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV. **Laboratory Sessions/ Experimental learning:** Smart home **Applications:** Smart Dustbin **Video link:** https://nptel.ac.in/courses/107106090	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C405.3.1	Explain the working of different sensors.
C405.3.2	Understand interfacing smart sensors with microcontrollers
C405.3.3	Gain knowledge of theory and practice related to Industrial IoT Systems.
C405.3.4	Identify, formulate and solve engineering problems by using Industrial IoT
C405.3.5	Gain knowledge on real word problems and their solutions through automation

Textbooks/ Reference Books	
1.	"Sensors and Transducers", Patranabis D, 2nd Edition, PHI, New Delhi, 2010.
2.	"Instrumentation for Engineers and Scientists", John Turner and Martyn Hill, Oxford Science Publications, 1999.
3.	Gerard Meijer, Michiel Pertijs, Kofi Makinwa,"Smart Sensor SystemsEmerging Technologies and Applications",Wiley (2014)
4.	Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C405.3.1	-	2	-	1	-	-		3	3	3	3	3	-	-
C405.3.2	-	1	-	3	-	-		3	3	3	3	3	-	-
C405.3.3	-	2	-	2	-	3		3	3	2	3	3	-	-
C405.3.4	-	2	-	2	-	2		3	3	3	3	3	-	-
C405.3.5	-	2	-	2	-	2		3	3	3	3	3	-	-

Semester: VII		
Energy Conservation and Audit (Theory)		
Course Code:	**MVJ22EE754**	**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 current energy scenario and importance of energy conservation.	
2	Understand the methods of improving energy efficiency in different electrical systems.	
3	Realize energy auditing methods for energy saving.	
4	Explain about various pillars of electricity market design and design of good lighting system.	
5	Explain the scope of demand side management, its concept and implementation issues and strategies	

UNIT-I	
Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector. Laboratory Sessions/ Experimental learning:Modeling & Simulation of Home Energy Management System Using Matlab Simulink. **Applications**: World energy Scenario. **Video link: https://youtu.be/IMGudx8i1q4**	**8Hrs**
UNIT-II	
Energy Efficiency in Electrical Systems: Electricity billing- Electrical load management and maximum demand Control-Maximum demand controllers; Energy Efficient Motors, Factors Affecting Efficiency, Constructional Details, Characteristics - Variable Speed- Variable Duty Cycle Systems, RMS Hp-Voltage Variation-Voltage Unbalance- Over Motoring- Motor Energy Audit. Power Factor – Methods of Improvement. Laboratory Sessions/ Experimental learning:Modelling of energy efficient motor using MATLAB. Applications: Integrated energy management - The Future of Smart Buildings. **Video link:** https://youtu.be/2zWt-pBCU2I https://youtu.be/EFUzw_nNvKg	**8Hrs**
UNIT-III	
Energy auditing: Introduction, Elements of energy audits, different types of audits, energy use profiles, measurements in energy audits, presentation of energy audit results. Laboratory Sessions/ Experimental learning: Basics of BCI Experimentation: Signal Acquisition using MATLAB. Applications: Energy monitoring, auditing and targeting	**8Hrs**

Video link: https://youtu.be/yyr2x3KbiKg	
UNIT-IV	
Electricity and Other Commodities: Distinguishing features of electricity as a commodity, Four pillars of market design: Imbalance, Scheduling and Dispatch. Lighting and Energy Instruments for Audit: Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit -Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tong Testers. Laboratory Sessions/ Experimental learning: practicing lighting methods for smart building to save energy. Applications: Economic Dispatch and Load Scheduling. **Video link:** https://youtu.be/7wAvBzMc7QI https://youtu.be/PSbbsZnxWEQ	**8Hrs**
UNIT-V	
Demand side Management: Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM –Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs. Laboratory Sessions/ Experimental learning: Design of DSM programs using MATLAB/SIMULINK. Applications: Demand-side management in Grid-Connected Energy Storage System. **Video link:** https://youtu.be/vs3H-IPQCsE	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C405.4.1	Analyse about energy scenario nationwide and worldwide, also outline Energy Conservation Act and its features.
C405.4.2	Discuss load management techniques and energy efficient motors.
C405.4.3	Understand the need of energy audit and energy audit methodology.
C405.4.4	Understand various pillars of electricity market design and lighting system design.
C405.4.5	Conduct energy audit of electrical systems, buildings, understanding of demand side management and energy conservation.

Textbooks/ Reference Books	
1.	Energy Management Handbook, W.C. Turner, Third Edition, 1942, John Wiley and Sons, ISBN 0-88173-361-x.
2.	Energy Management, W. R. Murphy, G. Mckay, Second Edition, 2009, Butterworth-Heinemann Ltd, Gurgaon Haryana, ISBN- 978-81-312-0738-3.
3.	Energy Conservation, Dr. Parag Diwan & Dr. Prasoom Dwivedi (Eds.)Pra, Second Edition, 2009, Pentagon Press, ISBN- 9788182743502.

4.	Energy Efficient Electric Motors and Applications, H.E. Jordan, Second Edition, 2013, Plenum Pub. Corp, ISBN-13- 9781489914675.

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C405.4.1	3	3	3	1	1	2	2	1	1	2	2	2	-	-
C405.4.2	3	3	3	2	1	2	2	1	1	2	2	2	-	-
C405.4.3	3	3	3	2	1	2	2	1	1	2	2	2	-	-
C405.4.4	3	3	3	2	1	2	2	1	1	2	2	2	-	-
C405.4.5	3	2	3	2	1	2	2	1	1	2	2	2	-	-

Semester: VII		
Utilization of Electric Power (Theory)		
Course Code:	**MVJ22EE755**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Discuss electric heating, air-conditioning and electric welding.	
2	Explain the terminology of illumination, laws of illumination, construction and working of electric lamps.	
3	Discuss systems of electric traction, speed time curves and mechanics of train movement.	
4	Discuss braking of electric motors, traction systems and power supply and other traction systems.	

UNIT-I	
Heating and welding: Electric Heating, Resistance ovens, Radiant Heating, Induction Heating, Highfrequency Eddy Current Heating, Dielectric Heating, The Arc Furnace, Heating of Buildings, Air-Conditioning, Electric Welding and Modern Welding Techniques. **Electrolytic Process:**Ionization, Faraday's Laws of Electrolysis, Definitions, Extraction of Metals, Refining of Metals, Electro Deposition. **Laboratory Sessions/ Experimental learning:** Demonstration of welding **Applications**: Impure metal refining. **Web Link and Video Lectures:** 1.https://nptel.ac.in/content/storage2/courses/113104058/mme_pdf/Lecture38.pdf 2. https://nptel.ac.in/content/storage2/courses/103103027/module9/lec3/2.html	**8Hrs**
UNIT-II	
Illumination: Introduction, Radiant Energy, Definitions, Laws of Illumination, Polar Curves,Photometry, Measurement of Mean Spherical Candle Power by Integrating Sphere, IlluminationPhotometer, Energy Radiation and luminous Efficiency, electric Lamps, Cold Cathode Lamp,Lighting Fittings, Illumination for Different Purposes, Requirements of Good Lighting. **Laboratory Sessions/ Experimental learning:** Measurement of candle power of a lamp **Applications:** Street lighting **Web Link and Video Lectures:** 1.https://nptel.ac.in/content/storage2/courses/108105061/Illumination%20%20Engineering/Lesson-06/pdf/L-6(NKK)(IE)%20((EE)NPTEL).pdf 2. https://nptel.ac.in/courses/108/105/108105060/	**8Hrs**
UNIT-III	
Electric Traction: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for TrainMovement,Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient ofAdhesion. **Motors for Electric traction:**Introduction, Series and Shunt Motors for Traction Services, Two SimilarMotors (Series Type) are used to drive a Motor Car, Tractive Effort	**8Hrs**

and Horse Power, AC Series Motor,Three Phase Induction Motor. **Laboratory Sessions/ Experimental learning:** Demonstration on speed control of Three Phase Motors. **Application:**Locomotive control **Web Link and Video Lectures:** 1.https://nptel.ac.in/courses/108/104/108104140/ 2. https://nptel.ac.in/content/syllabus_pdf/108104140.pdf	
UNIT-IV	
Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical DrumBrakes. **Electric Traction Systems and Power Supply:** System of Electric Traction, AC Electrification, Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC Traction,Feeding and Distribution System for DC Tramways, Electrolysis by Currents through Earth,Negative Booster, System of Current Collection, Trolley Wires. **Laboratory Sessions/ Experimental learning:** Demonstration of regenerative braking **Application:**Braking of a electric vehicle. **Web Link and Video Lectures:** 1.https://nptel.ac.in/content/storage2/courses/112105125/pdf/mod12les2.pdf 2. https://nptel.ac.in/courses/108/105/108105153/	**8Hrs**
UNIT-V	
Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving, Energy Consumption, Battery charging management in EV. **Hybrid Electric Vehicles:** Concept of Hybrid Electric Drive Trains, Architectures of Hybrid ElectricDrive Trains. **Laboratory Sessions/ Experimental learning:** Performance analysis of electric vehicles using simulation. **Application:**Electric transport. **Web Link and Video Lectures:** 1.https://nptel.ac.in/courses/108/103/108103009/ 2. https://nptel.ac.in/courses/108/102/108102121/	**8Hrs**

Course Outcomes: After completing the course, the students will be able to	
C405.5.1	Explain the different methods of electric heating & welding
C405.5.2	Explain the laws of electrolysis, extraction, refining of metals and electro deposition process
C405.5.3	Explain the laws of illumination, different types of lamps, lighting schemes and design of lighting systems
C405.5.4	Explain the systems of electric traction, speed time curves and mechanics of train movement
C405.5.5	Interpret the motors used for electric traction, their control & braking and power

	supply system used for electric traction

Textbooks/ Reference Books	
1.	A Textbook on Power System Engineering, A. Chakrabarti et al, DhanpatRai and Co, 2nd Edition, 2010.
2.	Utilization, Generation and Conservation of Electrical Energy, Sunil S Rao, Khanna Publishers, 1stEdition, 2011.
3.	Utilization of Electric Power and Electric Traction, G.C. Garg, Khanna Publishers, 9thEdition, 2014.
4.	R.K.Rajput, Utilisation of Electric Power, Laxmi publications Private Limited.,2007.

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 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):

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

Total marks: 50+50=100

CO-PO Mapping													**PSO**	
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C405.5.1	2	2	2	1	3	-	-	-	2	2	2	1	-	-
C405.5.2	2	2	2	1	3	-	-	-	2	2	2	1	-	-
C405.5.3	1	1	1	1	-	-	-	2	2	2	2	2	-	-
C405.5.4	2	2	2	1	-	-	-	2	2	2	2	2	-	-
C405.5.5	2	2	2	1	-	-	-	2	2	2	2	2	-	-

Semester: VII		
MAJOR PROJECT PHASE – II		
Course Code:	**MVJ22EEP76**	**CIE Marks: 50**
Credits:	**L:T:P: 0:0:12**	**SEE Marks: 50**
Hours:		**SEE Duration:**

Course Learning Objectives: The students will be able to	
1	Develop interactive, communication, organization, time management, and presentation skills.
2	Impart flexibility and adaptability.
3	Inspire independent and team working.
4	Expand intellectual capacity, credibility, judgment, intuition.
5	Adhere to punctuality, setting and meeting deadlines.
6	Instill responsibilities to oneself and others.
7	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 theproject report as per the norms avoiding plagiarism.

Course Outcomes: After completing the course, the students will be able to	
406.1	Describe the project and be able to defend it. Develop critical thinking and problem-solving skills.
406.2	Learn to use modern tools and techniques. Communicate effectively and to present ideas clearly and coherently both in written and oral forms.
406.3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
406.4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
406.5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation:

Continuous Internal Evaluation: The CIE (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**
406.1	2	2	2	3	3	2	1	1	2	1	1	2
406.2	2	2	2	3	3	2	1	1	2	1	2	2
406.3	2	2	2	3	3	2	1	1	2	1	2	2
406.4	2	2	2	3	3	2	1	1	2	1	2	2
406.5	2	2	2	3	3	2	1	1	2	1	2	2

High-3, Medium-2, Low-1