Course Title	Power System Analysis	Semester	VI
Course Code	MVJ19EE61	CIE	50
Total No. of Contact Hours	50	SEE	50
No. of Contact Hours/week	5, 3:1:1 (L: T:P)	Total	100
Credits	4	Exam. Duration	3 Hours

The course objective is to: This course will enable students to

- Understand per unit quantities, network models, and bus admittance matrix
- Compute steady-state load flow analysis with numerical iterative techniques
- Compute short circuit faults occurring in power systems
- Explain numerical solution of swing equation for multi-machine stability
- Illustrate problems of unit commitment and economic load dispatch

Module-1	L1, L2, L3	10Hrs.

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

Module-2	L1, L2, L3	10Hrs.

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

Module-3	L1, L2, L3	10Hrs.

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		
Module-4	**L1, L2, L3**	**10Hrs.**
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		
Module-5	**L1, L2, L3**	**10Hrs.**
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/		
Course outcomes:		
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.

Text 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.

Reference Books:

1	J.Duncan Glover et al, " Power System Analysis and Design" , Cengage, 4th Edition, 2008
2	Hadi Sadat, " Power System Analysis", McGraw Hill , 1st Edition, 2002

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	Industrial Drives and Applications	**Semester**	VI
Course Code	MVJ19EE62	**CIE**	50
Total No. of Contact Hours	50	**SEE**	50
No. of Contact Hours/week	5, 3:1:1 (L:T:P)	**Total**	100
Credits	4	**Exam. Duration**	3 Hours

Course objective is to: This course will enable students to

- Understand the electric drive
- Explain dynamics and modes of operation of electric drives.
- Explain selection of motor power ratings and control of dc motor using rectifiers.
- Analyze the performance of induction motor drives under different conditions
- Explain the control of induction motor, synchronous motor and stepper motor drives.

Module-1	L1, L2, L3	10Hrs.

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 Torque Conventions and Multiquadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State 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/
2. https://www.watelectrical.com/electric-drive-working-and-its-applications/

Module-2	L1, L2, L3	10Hrs.

Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.

Direct Current Motor Drives: Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately 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 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

Module-3	L1, L2, L3	10Hrs.

Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with 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/
2. https://instrumentationtools.com/squirrel-cage-induction-motor-vs-slip-ring-induction-motor/

Module-4	L1, L2, L3	10Hrs.

Synchronous Motor Drives Operation from fixed frequency supply-starting, synchronous motor, Self-controlled synchronous motor drive employing load commutated 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

Module-5	L1, L2, L3	10Hrs.

Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, 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 MATLAB simulation

Application: CNC milling machines.

Web Link and Video Lectures:

1. https://nptel.ac.in/courses/112/106/112106153/
2. https://nptel.ac.in/courses/108/102/108102156/

Course outcomes:

C311.1	Explain the electric drives and its advantages
C311.2	Understand the multi-quadrant operation of dc Separately Excited Motor
C311.3	Explain the various speed control techniques
C311.4	Interpret the self-controlled synchronous motor drive
C311.5	Understand the applications of drives in various industries

Text 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

Reference Books:

1	Vedam Subrahmaniam, Electric Drives (Concepts and Applications), Tata McGraw-Hill, 2010
2	Pillai.S.K , A First Course on Electric Drives, Wiley Eastern Limited, 2012

CIE Assessment:

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

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

SEE Assessment:

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

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

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

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

High-3, Medium-2, Low-1

Course Title	HVDC and FACTS	Semester	VI
Course Code	MVJ19EE631	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L:T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Explain the basic concepts and requirements of FACTS
- Understand the working and design of shunt devices.
- Understand the working and design of series devices.
- Understand the working and design of combined devices.
- Understand the phenomena of HVDC, converter control techniques.

Module-1	L1, L2	8Hrs.

FACTS Concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What Limits the Loading Capability? Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.

Laboratory Sessions/ Experimental learning: Cost benefit analysis of HVDC v/s FACTS

Applications: Reactive power compensation, enhancement of power flow in the line.

Video link :https://nptel.ac.in/courses/108/107/108107114/

Module-2	L1, L2, L3	8Hrs.

Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of transient stability. methods of controllable VAR generation – Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC).Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators.

Laboratory Sessions/ Experimental learning: Design a TCR for reactive power compensation in SIMULINK.

Applications: Reactive power compensation in the long transmission lines. **Video link** :https://nptel.ac.in/courses/108/107/108107114/		
Module-3	**L1, L2, L3, L4**	**8Hrs.**
Static Series Compensators: Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static Synchronous Series Compensator, transmitted power versus transmission angle characteristic. **Laboratory Sessions/ Experimental learning**: Design a control scheme of series compensator in SIMULINK. **Applications**: Power flow control and enhancement of power handling capacity of transmission line. **Video link** : https://nptel.ac.in/courses/108/107/108107114/		
Module-4	**L1, L2, L3, L4**	**8Hrs.**
Combined compensators: Introduction, Unified Power Flow Controller-basic operating principles, conventional control capabilities, independent real and reactive power control, control structure, basic control system for P and Q control, Interline Power Flow Controller- basic operating principles, control structure, practical and application considerations, Generalized and Multifunctional FACTS controllers. **Laboratory Sessions/ Experimental learning**: Design a control scheme for UPFC in SIMULINK. **Applications**: Voltage control and power flow control of multiple line. Power flow control between the lines. **Video link** :https://nptel.ac.in/courses/108/107/108107114/		
Module-5	**L1, L2, L3, L4**	**8Hrs.**
Basic Concepts of DC Transmission: Introduction, Comparison of AC and DC, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. **Analysis of HVDC Converters and System Control:** Types of converters, converter configurations (Only diagrams), Converter Control for an HVDC System, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability. **Laboratory Sessions/ Experimental learning**: Design the firing angle control scheme for converter station in the SIMULINK.		

Applications: Design of HVDC transmission lines and converter stations, Design of control schemes for converter station. **Video link** :https://nptel.ac.in/courses/108/104/108104013/	
Course outcomes:	
C312.1.1	Understanding the requirements of FACTS devices
C312.1.2	Design of shunt devices
C312.1.3	Design of series devices
C312.1.4	Design of combined devices
C312.1.5	Develop the knowledge on HVDC converter and system controls.
Text Books:	
1	Narain G Hingorani, Laszlo Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley Publications.
2	Chan-Ki Kim et al, "HVDC Transmission: Power Conversion Applications in Power Systems", Wiley Publications.
Reference Books:	
1	K.R.Padiyar, "HVDC Power Transmission Systems: Technology and system Interactions", New Age International (P) Limited, and Publishers.
2	E.W.Kimbark, ,"Direct Current Transmission", John Wiley & Sons Publications
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)	
SEE Assessment:	
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.	

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C312.1.1	2	1	-	-	3	-	-	-	-	-	-	1
C312.1.2	2	2	-	-	3	-	-	-	-	-	-	1
C312.1.3	2	1	-	-	3	-	-	-	-	-	-	1
C312.1.4	2	2	-	-	2	-	-	-	-	-	-	1
C312.1.5	2	2	-	-	2	-	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	Industrial Automation	Semester	VI
Course Code	MVJ19EE632	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L:T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: Students will enable students to

- Discuss architecture of industrial automation system and draw block diagram of industrial automation & control system.
- Describe the basic and application of PLC for automation.
- Discuss the fundamentals of PLC Wiring Diagram and Ladder Logic Program.
- Discuss different program control instruction in PLC
- Discuss the fundamentals of SCADA and HMI.

Module-1	L1, L2	08Hrs.

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/

Module-2	L1, L2, L3	08Hrs.

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

Module-3	L1, L2, L3	08Hrs.
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: converting Relay Schematics into PLC Ladder Programs, writing a Ladder Logic Program Timer Instructions, On/offDelay Timer Instruction, Retentive Timer, Cascading Timers Programming Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, 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		
Module-4	**L1, L2, L3**	**08Hrs.**
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		
Module-5	**L1, L2, L3**	**08Hrs.**
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		

Course outcomes:	
C312.2.1	Explain the architecture of industrial automation system and draw a block diagram of industrial automation & control system

C312.2.2	Explain basic concepts and Application of PLC to process control industries.
C312.2.3	Develop the fundamental PLC Wiring Diagrams and Ladder Logic Programs for different applications.
C312.2.4	Develop the ladder diagram using different program control instructions.
C312.2.5	Explain the fundamentals of SCADA and HMI.
Text 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.
Reference Books:	
1	Process Control Instrumentation Technology By. C.D. Johnson, PHI
2	Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies

CIE Assessment:

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

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

SEE Assessment:

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C312.2.1	3	2		2		-	-	-	-	-	-	3
C312.2.2	3	2	2	2	2	-	-	-	-	-	-	3

C312.2.3	3	3	3	2	2	-	-	-	-	-	-	3
C312.2.4	3	2	2	2	1	-	-	-	-	-	-	2
C312.2.5	3	2		2		-	-	-	-	-	-	2

High-3, Medium-2, Low-1

Course Title	VLSI Design	Semester	VI
Course Code	MVJ19EE633	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L: T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Understand the characteristics of CMOS circuit construction
- Introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).
- Design CMOS combinational and sequential logic at the transistor level, with mask layout.
- Design for higher performance or lower area using alternative circuit families
- Testing and Verification of VLSI Design

Module-1	L1, L2	8Hrs.

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/

Module-2	L1, L2, L3	8Hrs.

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/		
Module-3	**L1, L2, L3**	**8Hrs.**
Scaling of MOS Circuits: Scaling Models & Scaling Factors for Device Parameters. **Subsystem Design Processes**: Some General considerations, An illustration of 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		
Module-4	**L1, L2, L3**	**8Hrs.**
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/		
Module-5	**L1, L2, L3**	**8Hrs.**
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)	
Course outcomes:	
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 of physical 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
Text 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.
Reference Books:	
1	Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition, Oxford University Press, International Version, 2009.
2	Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition – 1994).
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)	
SEE Assessment:	

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	High Voltage Engineering	Semester	VI
Course Code	MVJ19EE641	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L:T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Comprehend Breakdown phenomenon in air, solid and liquid insulation
- Understand the basic generation of High voltage and High current for testing purposes
- Understand the basic measurement of High voltage and High current
- Measurement of - dielectric loss.
- Test high voltage electrical Equipment with various testing devices

Module-1	L1, L2, L3	8Hrs.

Breakdown in Gases: Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.

Breakdown in Liquid and Solid Insulating Materials: Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating medium.

Laboratory Sessions/ Experimental learning: Experiment on measuring insulation strength of air.

Applications: In design of switchgear components having dielectrics subjected to High voltage.

Video link: https://nptel.ac.in/courses/108/108/108108078/

Module-2	L1, L2, L3	8Hrs.

Generation of High Voltages: Generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Laboratory Sessions/ Experimental learning: Industrial visit to IISC Bangalore to witness generation of HV.

Applications: Nuclear physics, lightning arrestors and fuse testing

Video link: https://nptel.ac.in/courses/108/108/108108078/		
Module-3	**L1, L2, L3**	**8Hrs.**
Measurements of High Voltages and Currents: Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements **Laboratory Sessions/ Experimental learning**: Study of Impulse Voltage Generator (virtual lab) **Applications:** To diagnose the insulation condition **Video link**: https://nptel.ac.in/courses/108/108/108108078/		
Module-4	**L1, L2, L3**	**8Hrs.**
Lightning and switching over-voltages: Charge formation in clouds, stepped leader, Dart leader, Lightning Surges. Switching overvoltage, Protection against over-voltages, Surge diverters, Surge modifiers. **Laboratory Sessions/ Experimental learning**: Critical Flashover of a Sphere Gap using IVG (virtual lab) **Applications:** to bypass surge currents or limiting voltage on equipment **Video link** : https://nptel.ac.in/courses/108/108/108108078/		
Module-5	**L1, L2, L3**	**8Hrs.**
High Voltage Testing of Electrical Apparatus: IEC standards for HV Testing of electrical apparatus, testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs **Laboratory Sessions/ Experimental learning**: Parametric Analysis of Impulse Voltage Waveform. (Virtual lab). **Applications:** Design of insulators and cables. **Video link** : https://nptel.ac.in/courses/108/108/108108078		
Course outcomes:		
C313.1.1	Comprehend Breakdown phenomenon in air, solid and liquid insulation	
C313.1.2	Understand the basic generation of High voltage and High current for testing purposes	

C313.1.3	Understand the basic measurement of High voltage and High current
C313.1.4	Measurement of dielectric loss.
C313.1.5	Test high voltage electrical Equipment with various testing devices

Text Books:	
1	Naidu M. S. and Kamaraju V., "High Voltage Engineering", fourth Edition, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2009.
2	Wadhwa C.L., "High Voltage Engineering", third edition, New Age publishers, New Delhi, 2010.
Reference Books:	
1	Rakosh Das Begamudre, "High Voltage Engineering, Problems and Solutions", New Age International Publishers, New Delhi, 2010.
2	Dieter Kind, Kurt Feser, "High Voltage Test Techniques", Reed educational and professional publishing ltd. (Indian edition), New Delhi-2001

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C313.1.1	3	2	-	2	-	-	-	-	-	-	-	2
C313.1.2	3	2	-	2	-	-	-	-	-	-	-	2
C313.1.3	3	2	-	2	-	-	-	-	-	-	-	2
C313.1.4	3	2	-	2	-	-	-	-	-	-	-	2

C313.1.5	3	2	-	3	-	-	-	-	-	-	-	2

High-3, Medium-2, Low-1

Course Title	Energy Storage and Management system for Electric Vehicles	Semester	VI
Course Code	MVJ19EE642	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L: T: P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Understand the needs and types of energy storage.
- Explain the battery characteristics and dynamics.
- Explain IoT based BMS
- Understand energy management systems for EV
- Analyze energy management system for HESS.

Module-1	L1,L2	8Hrs.

Energy storage: Introduction to energy storage requirements in Hybrid and Electric vehicles, Battery Parameters, Types of Batteries, modeling of Battery, Battery based energy storage and its analysis, Fuel cell basic principle and operations, Types of Fuel cells, Hybridization of different energy storage devices. super capacitors and Flywheel based energy storage and its analysis

Activity: Poster presentation of different types electrical energy storage systems.

Applications: Electric vehicles

Video link: https://youtu.be/2D3h8zwj6QQ

Module-2	L1,L2,L3	8Hrs.

Battery Characteristics &Battery Pack: Cells and Batteries- conversion of chemical energy to electrical energy- Battery Specifications: Variables to characterize battery operating conditions, Efficiency of batteries; Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods.

Laboratory Sessions/ Experimental learning: MATLAB Simulation for design of battery pack and estimation of SOC.

Applications: Design of battery packs for EVs.

Web Link and Video Lectures: https://youtu.be/WBbefOjmiEQ

Module-3	L1,L2,L3	8Hrs.
IoT based Battery Management System: Battery Management System: Definition, Functional blocks: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests, IoT based BMS. **Laboratory Sessions/ Experimental learning**: MATLAB Simulation of IoT based BMS **Application**: Design of smart BMS. **Web Link and Video Lectures**: https://youtu.be/DSoHQupqC30		
Module-4	L1,L2,L3	8Hrs.
Energy Management System: Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges. **Laboratory Sessions/ Experimental learning**: MATLAB Simulation of an EV charger. **Application**: Design of EV charger, Start up and Marketing aspects of electric vehicles. **Web Link and Video Lectures**: https://youtu.be/V004WUdpHeA		
Module-5	L1,L2,L3	8Hrs.
Energy Management of Hybrid Energy Storage System (HESS) in PHEV With Various Driving Mode: Introduction, Problem Description, and Formulation, Modelling of HESS and its Analysis. **Laboratory Sessions/ Experimental learning**: Industrial Visit to EV industry. **Application**: Design of energy storage for PHEV. **Web Link and Video Lectures**: https://youtu.be/G8g1WI1L2YY		

Course outcomes:	
C313.2.1	Explain needs and typesof energy storage for EVs.
C313.2.2	Select and design battery pack for EVs.
C313.2.3	Discuss IoT based battery management system.
C313.2.4	Explain different charging methods for EVs.
C313.2.5	Model and analyse energy management of HESS in PHEV

Text Books:	
1	Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles, Chitra A, P. Sanjeevi kumar, and S. Himavathi, Wiley, 2020.
2	Modern Electric, Hybrid Electric, andFuel Cell Vehicles: Fundamentals, Theory, and Design, M. Ehsani, Y. Gao, S.Gay and Ali Emadi, CRC Press, 2005
Reference Books:	

1	Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain CRC Press, 2003
2	Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C313.2.1	2	2	-	-	2	2	1	-	-	-	-	1
C313.2.2	2	3	-	-	1	2	1	-	-	-	-	1
C313.2.3	2	3	-	-	1	2	1	-	-	-	-	1
C313.2.4	2	3	-	-	2	2	1	-	-	-	-	1
C313.2.5	2	2	-	-	2	2	1	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	Advanced Control System	Semester	VI
Course Code	MVJ19EE643	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L: T: P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Explain development of state models for linear continuous – time and discrete – time systems
- Define controllability and observability of a system and testing techniques for controllability and observability of a given system
- Explain about inherent and intentional nonlinearities that can occur in control system and developing the describing function for the nonlinearities.
- Explain stability analysis of nonlinear systems using describing function analysis.
- Explain the analysis of nonlinear systems using Lyapunov function and design of Lyapunov function for stable systems.

Module-1	L1, L2, L3	8Hrs.

State Variable Analysis and Design: State Space Representation, Solution of State Equation, State Transition Matrix, Canonical Forms – Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form.

Laboratory Sessions/ Experimental learning: State space design of servomotors.

Applications: State space design of real systems for developing controllers.

Web Link and Video Lectures:

1. https://youtu.be/6iqj_vUxMXc
2. https://youtu.be/xhIaD2lNsZc

Module-2	L1, L2, L3	8Hrs.

Controllability and Observability: Concepts of Controllability and Observability, Controllability and observability tests for continuous time, linear time-invariant systems. Controllability and Observability modes in State. Jordan's canonical form, Controllable and Observable companion forms for single input single output Systems, pole placement by State feedback.

Laboratory Sessions/ Experimental learning: Identification of systems controllability and observability through MATLAB. **Applications**: Checking of stability of real systems. **Web Link and Video Lectures:** https://youtu.be/eKSoJlQjwgg		
Module-3	**L1, L2, L3**	**8Hrs.**
Nonlinear Systems: Behaviour of Nonlinear systems, jump resonance, Sub-harmonic oscillation, Limit cycles, common physical non-linearity, Singular points. **Laboratory Sessions/ Experimental learning**: **Applications**: Identification of non-linear system behavior. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=tBfWD1xbHhc		
Module-4	**L1, L2, L3**	**8Hrs.**
Phase plane-method: Construction of phase plane trajectories, Isoclines method, Delta method, Describing function Analysis – Basic concepts. **Laboratory Sessions/ Experimental learning:** MATLAB design of Sliding Mode Controller **Applications**: Visualizing the behavior and design of physical systems. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=gA0CmZKyJcs		
Module-5	**L1, L2, L3**	**8Hrs.**
Stability: Lyapunov's stability criteria, Theorems, Direct method of Lyapunov For linear systems, Non-Linear Systems, Methods of constructing Lyapunov function, Krasovki's Method. **Laboratory Sessions/ Experimental learning:** MATLAB simulation of Lyapunov's stability **Applications**: Closed-loop nonlinear control of any electrical system. **Web Link and Video Lectures:** https://youtu.be/dm0k8jINX-A		
Course outcomes:		
C313.3.1	Determine the state model for electrical, mechanical, and electromechanical systems.	
C313.3.2	Solve the state equations by different methods.	
C313.3.3	Analyze the controllability of the system and design the controller.	
C313.3.4	Analyze the observability of the system and design the observer.	
C313.3.5	Understand nonlinear systems and evaluate the stability of nonlinear systems.	
Text Books:		
1	Ogata K, –Modern Control Engineering‖, Prentice Hall of India, New Delhi, 2013	

2	M.Gopal, "Digital Control and State Variable Methods: Conventional and Intelligent Control Systems", Tata McGraw-Hill, 2007.

Reference Books:

1	Norman S Nise, –Control System Engineering –, John Wiley & Sons, New Delhi, 2013.
2	A. Anand Kumar "Control systems" PHI, 2nd edition. 2018.

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	Renewable Energy Sources	Semester	VI
Course Code	MVJ19EE651	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L:T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Understand energy resources and availability of renewable energy
- Examine types of solar collectors, their configurations, solar cell system, their characteristics, and their applications.
- Discuss generation of energy from hydrogen, wind, and geothermal system
- Discuss production of energy from biomass, biogas and tidal.
- Discuss sea wave energy and OTEC.

Module-1	L1,L2	8hrs

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

Module-2	L1,L2, L3	8hrs

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		
Module-3	**L1,L2**	**8hrs**
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		
Module-4	**L1,L2**	**8hrs**
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		
Module-5	**L1,L2**	**8hrs**
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		

Course outcomes:	
C314.1.1	Understand energy resources and availability of renewable energy
C314.1.2	Examine types of solar collectors, their configurations, solar cell system, its characteristics, and their applications
C314.1.3	Discuss generation of energy from hydrogen, wind, and geothermal system
C314.1.4	Discuss production of energy from biomass, biogas, and tidal.
C314.1.5	Discuss sea wave energy and OTEC.
Text Books:	
1	Nonconventional Energy Resources ShobhNath Singh Pearson 1 st Edition, 2015
2	Nonconventional Energy Resources B.H. Khan McGraw Hill 3 rd edition
Reference Books:	
1	Renewable Energy; Power for a sustainable Future Godfrey Boyle Oxford 3 rd Edition, 2012
2	Renewable Energy Sources: Their Impact on global Warming and Pollution Tasneem Abbasi S.A. Abbasi PHI
CIE Assessment:	

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

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

SEE Assessment:

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C314.1.1	1	1	1	-	-	2	2	1	3	1	1	1
C314.1.2	1	1	1	-	-	2	2	2	-	2	1	2
C314.1.3	1	1	1	-	-	2	3	1	3	2	1	1
C314.1.4	1	2	1	-	-	2	2	1	-	1	1	2
C314.1.5	1	2	1	-	-	2	1	1	-	1	1	1

High-3, Medium-2, Low-1

Course Title	Industrial Instrumentation	Semester	VI
Course Code	MVJ19EE652	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L: T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Understand the basics in measurement techniques of force, torque and speed and
- Learn about methods of measurement of acceleration, Vibration and density
- Gain knowledge on basics of transmitter and types of transmitters.
- Understand micro electromechanical systems.
- Understand the digital data acquisition system and control

Module-1	L1,L2,L3	8Hrs.

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/

Module-2	L1,L2,L3	8Hrs.

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

Module-3	L1,L2,L3	8Hrs.

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

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

Module-4	L1,L2,L3	8Hrs.

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

Module-5	L1,L2,L3	8Hrs.

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:

C314.2.1	Describe the different types of measurement techniques to measure force, torque and speed.

C314.2.2	Describe the techniques of acceleration, Vibration and density
C314.2.3	Describe the basics of transmitter and its types.
C314.2.4	Describe the basics of micro electromechanical system
C314.2.5	Describe the digital data acquisition systems & control.
Text 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.
Reference Books:	
1	D. Patranabis, 'Principles of Industrial Instrumentation', Tata McGraw Hill Publishing Company Ltd, 1996.
2	A.K. Sawhney and P. Sawhney, 'A Course on Mechanical Measurements, Instrumentation and Control', DhanpathRai and Co, 2004.

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C314.2.1	3	1	-	2	-	-	-	-	-	-	-	2
C314.2.2	3	1	-	2	-	-	-	-	-	-	-	2
C314.2.3	3	2	-	2	-	-	-	-	-	-	-	2
C314.2.4	3	2	-	2	-	-	-	-	-	-	-	2
C314.2.5	3	2	-	2	-	-	-	-	-	-	-	2

High-3, Medium-2, Low-1

Course Title	Utilization of Electrical Power	Semester	VI
Course Code	MVJ19EE653	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	4, 2:1:1 (L: T:P)	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Discuss electric heating, air-conditioning and electric welding.
- Explain the terminology of illumination, laws of illumination, construction and working of electric lamps.
- Discuss systems of electric traction, speed time curves and mechanics of train movement.
- Discuss braking of electric motors, traction systems and power supply and other traction systems.

Module-1	L1, L2, L3	08Hrs.

Heating and welding: Electric Heating, Resistance ovens, Radiant Heating, Induction Heating, High frequency 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

Module-2	L1, L2, L3	08Hrs.

Illumination: Introduction, Radiant Energy, Definitions, Laws of Illumination, Polar Curves, Photometry, Measurement of Mean Spherical Candle Power by Integrating Sphere, Illumination Photometer, 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/		
Module-3	**L1, L2, L3**	**08Hrs.**
Electric Traction: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion. **Motors for Electric traction**: Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort 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		
Module-4	**L1, L2, L3**	**08Hrs.**
Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes. **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/		
Module-5	**L1, L2, L3**	**08Hrs.**
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 Electric Drive 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/	
Course outcomes:	
C314.3.1	Explain the different methods of electric heating & welding
C314.3.2	Explain the laws of electrolysis, extraction, refining of metals and electro deposition process
C314.3.3	Explain the laws of illumination, different types of lamps, lighting schemes and design of lighting systems
C314.3.4	Explain the systems of electric traction, speed time curves and mechanics of train movement
C314.3.5	Interpret the motors used for electric traction, their control & braking and power supply system used for electric traction
Text 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.
Reference Books:	
1	Utilization of Electric Power and Electric Traction, G.C. Garg, Khanna Publishers, 9thEdition, 2014.
2	R.K.Rajput, Utilisation of Electric Power, Laxmi publications Private Limited.,2007.
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)	
SEE Assessment:	

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

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

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C314.3.1	2	2	2	1	3	-	-	-	2	2	2	1
C314.3.2	2	2	2	1	3	-	-	-	2	2	2	1
C314.3.3	1	1	1	1	-	-	-	2	2	2	2	2
C314.3.4	2	2	2	1	-	-	-	2	2	2	2	2
C314.3.5	2	2	2	1	-	-	-	2	2	2	2	2

High-3, Medium-2, Low-1

Course Title	Machine Design and Electrical Drawing	Semester	VI
Course Code	MVJ19EEL66	CIE	50
Total No. of Contact Hours	20	SEE	50
No. of Contact Hours/week	4,0:2:2 (L: T: P)	Total	100
Credits	2	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Design the electrical machines winding diagram
- Design and draw the sectional view & elevation view of DC machines
- Design and draw the sectional view & elevation view of AC machines
- Design and draw the sectional view & elevation view of transformers.
- Draw the single line diagram of the substation

Sl No	Experiment Name	RBT Level	Hours
1	Design and draw the progressive simplex single layer lap winding and wave winding for DC machines.	L3	2
2	Design and draw the progressive simplex single layer lap winding and wave winding for a three-phase AC machine.	L3	2
3	Design and draw the single layer mush type winding for a three-phase AC machine.	L3	2
4	Design and draw the sectional view and elevation view of the DC machine.	L3	2
5	Design and draw the sectional view and elevation view of the squirrel cage induction motor.	L3	2
6	Design and draw the sectional view and elevation view of slipring induction motor.	L3	2
7	Design and draw the sectional view elevation view of single-phase core type transformer.	L3	2
8	Draw the single line diagram of a substation for given details.	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	Design and draw the progressive simplex double layer lap winding and wave winding for DC machine.	L3	2
2	Design and draw the retrogressive simplex double layer lap winding and wave winding for DC machine.	L3	2
3	Design and draw the sectional view and elevation view of salient pole alternator.	L3	2

Course outcomes:	
C315.1	Design, winding diagram of electrical machines using AUTOCAD tool.
C315.2	Design, DC machine using AUTOCAD tool.
C315.3	Design, AC machine using AUTOCAD tool.
C315.4	Design different sectional views of the transformer using the AUTOCAD tool.
C315.5	Design single line diagram of generating, transmitting, and distributing station using AUTOCAD tool.

Scheme of Evaluation

SEE :
Examinations will be conducted for 100 marks and scaled down to 50. The weight age shall be,
Write-up: 20 marks
Conduction: 40 marks
Analysis of results : 20 marks
Viva : 20

CIE :
Regular Lab work :20
Record writing :5
Lab Tests(Minimum 2 tests shall be conducted for 15 marks and average of two will be taken)
Viva 10 marks

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C315.1	3	3	3	1	1	-	-	-	-	-	1	2
C315.2	3	3	3	3	3	-	-	-	-	-	1	2
C315.3	3	3	3	3	3	-	-	-	-	-	1	2

C315.4	3	3	3	3	3	-	-	-	-	-	2	2
C315.5	3	3	3	3	3	-	-	-	-	-	2	2

High-3, Medium-2, Low-1

Course Title	Power System Simulation Lab	Semester	VI
Course Code	MVJ19EEL67	CIE	50
Total No. of Contact Hours	20	SEE	50
No. of Contact Hours/week	4, 0:2:2 (L: T: P)	Total	100
Credits	2	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Understand the Y-bus and Z-bus formation for transmission system using MATLAB
- Understand the load flow analysis of power system using MATLAB
- Understand the transfer function models of power system equipment using MATLAB.
- Understand the power system analysis using MI-Power software
- Understand the optimal scheduling of thermal plants using MI-Power software

Sl No	Experiment Name	RBT Level	Hours
1	Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular Transformation and Inspection Method.	L3	2
2	Formation of Z Bus (without mutual coupling) using Z-Bus Building Algorithm.	L3	2
3	ABCD parameters: i) Formation for symmetric π/T configuration ii) Verification of AD-BC=1	L3	2
4	Load flow analysis of transmission system using N-R method.	L3	2
5	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinate Using Mi Power package.	L3	2
6	Load flow analysis using Gauss siedel and NR methods Using Mi-Power package	L3	2
7	Short Circuit Studies using Using Mi-Power package	L3	2
8	To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.	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	Optimal placement of distributed generation in the distribution system using PSO	L3	2
2	Frequency control in micro grid with two generating plants with a step load change.	L3	2
3	Transfer function model for a microgrid with multiple energy resources using SIMULINK.	L3	2

Course outcomes:

C316.1	Build the Y-bus and Z-bus for a given transmission system.
C316.2	Analyze the power system with the help of load flow analysis using MATLAB
C316.3	Build the transfer function models of the power system.
C316.4	Analyze the power system with the help of Mi-Power software
C316.5	Schedule the thermal power plant with the help of Mi-Power software

Scheme of Evaluation

SEE :
Examinations will be conducted for 100 marks and scaled down to 50. The weight age shall be,
Write-up: 20 marks
Conduction: 40 marks
Analysis of results: 20 marks
Viva: 20

CIE :
Regular Lab work:20
Record writing:5
Lab Tests(Minimum 2 tests shall be conducted for 15 marks and the average of two will be taken)
Viva 10 marks

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C316.1	3	3	3	3	2	-	-	-	1	2	2	1
C316.2	3	3	3	3	3	-	-	-	1	3	3	3
C316.3	3	3	3	3	3	-	-	-	1	3	2	2
C316.4	3	3	2	3	3	-	-	-	1	3	2	1
C316.5	3	3	2	3	3	-	-	-	1	3	2	1

High-3, Medium-2, Low-1

Course Title	MINI PROJECT	Semester	VI
Course Code	MVJ19EEMP68	CIE	50
Total No. of Contact Hours	L : T : P :: 0 : 0 : 6	SEE	50
No. of Contact Hours/week	-	Total	100
Credits	03	Exam. Duration	3 Hours

Course Objective: The objective of the course is to

- Support independent learning and an innovative attitude.
- Guide to select and utilize adequate information from varied resources upholding ethics.
- Guide to organize the work appropriately and present information (acknowledging the sources).
- Develop interactive, communication, organization, time management, and presentation skills.
- 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.

Mini Project : Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

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

C317.1	Describe the project and be able to defend it. Develop critical thinking and problem-solving skills.
C317.2	Learn to use modern tools and techniques. Communicate effectively and present ideas clearly and coherently both in written and oral forms.
C317.3	Develop skills to work in a team to achieve a common goal. Develop skills in project management and finance.

C317.4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
C317.5	Prepare them for life-long learning to face the challenges and support the technological changes to meet 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
C317.1	2	2	2	3	3	2	1	1	2	1	1	2
C317.2	2	2	2	3	3	2	1	1	2	1	2	2
C317.3	2	2	2	3	3	2	1	1	2	1	2	2
C317.4	2	2	2	3	3	2	1	1	2	1	2	2
C317.5	2	2	2	3	3	2	1	1	2	1	2	2