SRI VASAVI ENGINEERING COLLEGE

(AUTONOMOUS)

(Sponsored by Sri Vasavi Educational Society)
(Approved by AICTE, New Delhi &Recognized by UGC under section 2(f) & 12(B))
(Permanently affiliated to JNTUK, Kakinada, Accredited by NBA and NAAC with 'A' Grade)
Pedatadepalli, **TADEPALLIGUDEM–534 101.**W.G.Dist**. (A.P)**

Department of Electrical & Electronics Engineering (NBA Accredited)

Dt: 18.07.2025

The eight meeting of Board of Studies in Department of Electrical and Electronics Engineering was held at 11.00 AM on 17-07-2025 through online mode using Zoom meetings.

The following members are attended the meeting.

S. No.	**Name**	**Designation**	**Role**
1.	Dr. Sudha Rani Donepudi	Professor, Head, Dept. of EEE, SVEC, Pedatadepalli.	Chairperson
2.	Dr. R. SrinivasaRao	Professor, Dept. of EEE, UCEK, JNTUK, Kakinada	Subject Expert Nominated By V.C.
3.	Dr. M. Sydulu	Professor, Dept. of EEE, NITW, Warangal	Subject Expert Nominated By V.C.
4.	Dr. Y.P. Obulesu	Professor, School of EE, VIT, Vellore	Subject Expert Nominated By A.C.
5.	Er. B.N.V.R.C. Suresh Kumar	Retired AGM, PGCI, Hyderabad	Industry Expert Nominated By A.C
6.	Er. Ch. Vinay Kumar	Assistant Engineer, EHT Lines, APTRANSCO, Eluru.	Alumni
7.	Dr. Ch. Rambabu	Professor	Member
8.	Dr. Anilkumar Chappa	Associate Professor	Member
9.	Dr. J. Rajesh	Associate Professor	Member
10.	Mr. U. Chandra Rao	Sr. Asst. Professor	Member
11.	Mr. N. Sri Harish	Sr. Asst. Professor	Member
12.	Mr. Ch. V.S.R. Gopala Krishna	Sr. Asst. Professor	Member
13.	Mr. K. Ramesh Babu	Sr. Asst. Professor	Member
14.	Mr. K. Suresh	Asst. Professor	Member
15.	Mr. M.T.V.L. Ravi Kumar	Asst. Professor	Member

16.	Mr. G. Madhu Sagar Babu	Asst. Professor	Member
17.	Mr. A. Uma Siva Naga Prasad	Asst. Professor	Member
18.	Dr. E. Naga Venkata Durga Vara Prasad	Asst. Professor	Member
19.	Dr. D. J. Krishna Kishore	Asst. Professor	Member

The following are the minutes of the meeting

Item No. 1: Welcome note by the Chairperson BOS

The HOD extended a formal welcome and introduced the members.

Item No. 2: Approval of course structure for V and VI semesters of B. Tech EEE under V23 Regulation.

Approved the course structure for V and VI semesters of B. Tech EEE under V23 Regulation.

The details are given in Annexure I.

Item No. 3: Approval of syllabi for the courses offered for V and VI semesters B. Tech EEE under V23 Regulation.

Approved the syllabi for the courses offered for V and VI semesters B. Tech EEE under V23 Regulation.

The details are given in Annexure II.

Item No. 4: Approval of list of courses offered under open electives for all other branches except EEE under V23 Regulation.

Approved the list of courses offered under open electives for all other branches except EEE under V23 Regulation.

The details are given in Annexure III.

Item No. 5: 1. Approval of syllabi for the courses offered under open electives for all other branches except EEE under V23 Regulation.

Approved the syllabi for the courses offered under open electives for all other branches except EEE under V23 Regulation.

The details are given in **Annexure IV**.

Item No. 6: Approval of list of courses offered under Honors in B. Tech EEE under V23 Regulation.

Approved the list of courses offered under Honors in B. Tech EEE under V23 Regulation.

The details are given in Annexure V.

Item No. 7: Approval of list of courses offered under Minors in EEE for other branches of B. Tech under V23 Regulation.

Approved the list of courses offered under Minors in EEE for other branches of B. Tech under V23 Regulation.

The details are given in **Annexure VI**.

Item No. 8: Approval of course structure from I to IV semesters of M. Tech with Specialization of Power Electronics and Power Systems under V25 Regulation.

Approved the course structure from I to IV semesters of M. Tech with Specialization of Power Electronics and Power Systems under V25 Regulation.

The details are given in **Annexure VII**.

Item No. 9: Approval of the syllabi for the courses offered in I to IV semesters of M. Tech with Specialization of Power Electronics and Power Systems under V25 Regulation.

Approved the syllabi for the courses offered in I to IV semesters of M. Tech with Specialization of Power Electronics and Power Systems under V25 Regulation.

The details are given in **Annexure VIII**.

CHAIRPERSON OF BOS
DR. SUDHA RANI DONEPUDI

Annexure I

Course Structure Approved in Previous BOS Meetings

Course Structure of Electrical and Electronics Engineering – V23 Regulation

I Semester						
S.No	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**Credits**
1	V23ENT01	Communicative English	2	0	0	2
2	V23PHT01	Physics	3	0	0	3
3	V23MAT01	Linear Algebra & Calculus	3	0	0	3
4	V23EET01	Basic Electrical & Electronics Engineering	3	0	0	3
5	V23CST01	Introduction to Programming	3	0	0	3
6	V23ENL01	Communicative English Lab	0	0	2	1
7	V23PHL01	Physics Lab	0	0	2	1
8	V23EEL01	Electrical & Electronics Engineering Workshop	0	0	3	1.5
9	V23CSL01	Computer Programming Lab	0	0	3	1.5
10	V23SPT02	Health and wellness, Yoga and Sports	-	-	1	0.5
Total Contact Hours			**14**	**0**	**11**	**19.5**

II Semester						
S.No	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**Credits**
1	V23MAT02	Differential Equations & Vector Calculus	3	0	0	3
2	V23CHT01	Engineering Chemistry	3	0	0	3
3	V23CMT01	Basic Civil & Mechanical Engineering	3	0	0	3
4	V23EET02	Electrical Circuit Analysis – I	3	0	0	3
5	V23MET01	Engineering Graphics	2	0	2	3
6	V23CSL02	IT Workshop	0	0	2	1
7	V23MEL01	Engineering Workshop	0	0	3	1.5
8	V23CHL01	Engineering Chemistry Lab	0	0	2	1
9	V23EEL02	Electrical Circuit Analysis & Simulation Lab	0	0	3	1.5
10	V23SPTO1	NSS/NCC/SCOUTS & Guides/Community Services	-	-	1	0.5
Total Contact Hours			14	0	13	20.5

III Semester							
S.No	**Course Code**	**Category**	**Name of the Course**	**L**	**T**	**P**	**Credits**
1.	V23MAT04	BS	Transform Techniques & Numerical Methods	3	0	0	3
2.	V23MBT53	HSMC	Universal Human Values-Understanding Harmony	2	1	0	3
3.	V23EET03	Engineering Science	Electromagnetic Field Theory	3	0	0	3
4.	V23EET04	Professional Core	Electrical Circuit Analysis-II	3	0	0	3
5.	V23EET05	Professional Core	DC Machines & Transformers	3	0	0	3
6.	V23EEL03	Professional Core	Electrical Circuit Analysis-II and Simulation Lab	0	0	3	1.5
7.	V23EEL04	Professional Core	DC Machines & Transformers Lab	0	0	3	1.5
8.	V23CSSE12	Skill Enhancement Course	Data Structures Lab	0	1	2	2
9.	V23CEAC01	Audit Course	Environmental Science	2	0	0	-
Total Contact Hours				15	2	10	20

IV Semester							
S.No.	**Course Code**	**Category**	**Name of the Course**	**L**	**T**	**P**	**Credits**
1.	V23MBT51	Management Course- I	Managerial Economics & Financial Analysis	2	0	0	2
2.	V23ECT09	Engineering Science	Analog Circuits	3	0	0	3
3.	V23EET06	Professional Core	Power Systems-I	3	0	0	3
4.	V23EET07	Professional Core	Induction and Synchronous Machines	3	0	0	3
5.	V23EET08	Professional Core	Control Systems	3	0	0	3
6.	V23EEL05	Professional Core	Induction and Synchronous Machines Lab	0	0	3	1.5
7.	V23EEL06	Professional Core	Control Systems Lab	0	0	3	1.5
8.	V23CSSE01	Skill Enhancement course	Python Programming Lab	0	1	2	2
9.	V23MET09	Engineering Science	Design Thinking & Innovation	1	0	2	2
Total Contact Hours				15	1	10	21
Mandatory Community Service Project Internship of 08 weeks duration during Summer Vacation							

V Semester							
S.No	**Course Code**	**Category**	**Name of the Course**	**L**	**T**	**P**	**Credits**
1.	V23EET09	Professional Core	Power Electronics	3	0	0	3
2.	V23ECT24	Professional Core	Digital Circuits (BOS ECE)	3	0	0	3
3.	V23EET10	Professional Core	Power Systems-II	3	0	0	3
4.	V23EET11 V23EET12 V23EET13 V23EET14	Professional Elective- I	1. Advanced Control Systems 2. Renewable and Distributed Energy Technologies 3. Programmable Logic Controllers 4. Smart Grid Technologies	3	0	0	3
5.		Open Elective-I		3	0	0	3
6.	V23EEL07	Professional Core	Power Electronics and Simulation Lab	0	0	3	1.5
7.	V23ECL11	Professional Core	Analog and Digital Circuits Lab (BOS ECE)	0	0	3	1.5
8.	V23EEL08	Skill Enhancement course		0	1	2	2
9.	V23EEL09	Engineering Science	Tinkering Lab	0	0	2	1
	V23COSP01	Evaluation of Community Service Internship		-	-	-	2
Total Contact Hours				15	1	10	23

VI Semester							
S.No	**Course Code**	**Category**	**Name of the Course**	**L**	**T**	**P**	**Credits**
1.	V23EET15	Professional Core	Electrical Measurements and Instrumentation	3	0	0	3
2.	V23ECT16	Professional Core	Microprocessors and Microcontrollers (BOS ECE)	3	0	0	3
3.	V23EET16	Professional Core	Power System Analysis	3	0	0	3
4.	V23EET17 V23EET18 V23EET19 V23ECT17	Professional Elective-II	1. Electric Power Quality 2. Utilization of Electrical Energy 3. Switchgear and Protection 4. Digital Signal Processing (BOS ECE)	3	0	0	3
5.	V23EET20 V23EET21 V23EET22 V23EET23	Professional Elective-III	1. Electric Drives 2. Battery Management Systems and Charging Stations 3. AI Techniques for Power Systems 4. High Voltage Engineering	3	0	0	3
6.		Open Elective - II		3	0	0	3
7.	V23EEL10	Professional Core	Electrical Measurements and Instrumentation Lab	0	0	3	1.5
8.	V23ECL10	Professional Core	Microprocessors and Microcontrollers Lab (BOS ECE)	0	0	3	1.5
9.	V23EEL11	Skill Enhancement course	IoT Applications for Electrical Engineering Lab	0	1	2	2
10.	V23ENT06	Audit Course	Research Methodology & IPR (BOS ENGLISH)	2	0	0	-
Total Contact Hours				**20**	**1**	**08**	**23**

Annexure II

Syllabi for the Courses offered in V & VI Semesters B. Tech under V23 Regulation

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET09
Name of the Course	Power Electronics					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Apply the operating principles of SCR, MOSFET, and IGBT to analyze their characteristics and implement suitable triggering circuits.	K3
CO2	Analyze single-phase converter circuits to evaluate output performance under various load conditions.	K4
CO3	Analyze three-phase AC-DC and single-phase AC-AC converter circuits to evaluate output voltage performance for different load conditions.	K4
CO4	Analyze the principle operation of various DC–DC in CCM and DCM, including voltage, and current ripple.	K4
CO5	Apply the operating principles of single-phase, three-phase, and multilevel inverters to analyze output waveforms and control strategies under different load conditions.	K3

UNIT – I

Power Semi-Conductor Devices

Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics of SCR – Turn on and Turn off Methods - Triggering Methods (R, RC and UJT) – Snubber circuit design. Static and Dynamic Characteristics of Power MOSFET and Power IGBT-Numerical problems.

UNIT – II

Single-phase AC-DC Converters

Single-phase half-wave controlled rectifiers - R and RL loads with and without freewheeling diode - Single-phase fully controlled mid-point and bridge converter with R load, RL load and RLE load - Continuous and Discontinuous conduction - Effect of source inductance in Single-phase fully controlled bridge rectifier – Expression for output voltages – Single-phase Semi-Converter with R load-RL load and RLE load – Continuous and Discontinuous conduction - Dual converter and its mode of operation - Numerical Problems.

UNIT – III

Three-phase AC-DC Converters & AC – AC Converters

Three-phase half-wave Rectifier with R and RL load - Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Numerical Problems.

Single-phase AC-AC power control by phase control with R and RL loads - Expression for rms output voltage – Single-phase step down and step up Cycloconverter - Numerical Problems.

UNIT – IV

DC–DC Converters

Operation of Basic Chopper – Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple – control techniques –-Numerical Problems.

UNIT – V

DC–AC Converters

Introduction – Single-phase half-bridge and full-bridge inverters with R and RL loads – Phase Displacement Control – Three-phase square wave inverters – 120° and 180° conduction modes – Sinusoidal Pulse Width Modulation (SPWM) –Introduction to Multilevel Inverters (MLIs): Types of MLIs – Diode-Clamped, Flying Capacitor, and Cascaded H-Bridge – Advantages and Applications.

Text Books:

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore M Undeland, William P Robbins, John Wiley & Sons, 2002.
2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 2017.
3. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein. Oxford University Press; Second edition, 2014.
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics: by Daniel W.Hart, Mc Graw Hill, 2011.

Online Learning Resources:

1. https://ocw.mit.edu/courses/6-334-power-electronics-spring-2007
2. https://archive.nptel.ac.in/courses/108/101/108101126

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET10
Name of the Course	Power Systems-II					
Branches	**EEE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Calculate parameters of transmission lines for different circuit configurations.	K3
CO2	Analyze the performance of short, medium and long transmission lines.	K4
CO3	Analyze the effect of travelling waves on transmission lines.	K4
CO4	Estimate the effects of corona in transmission lines.	K2
CO5	Calculate sag and tension of transmission lines and design the line insulators.	K3

UNIT–I

Transmission Line Parameters Calculations

Conductor materials – Types of conductors – Calculation of resistance for solid conductors – Calculation of inductance for Single-phase and Three-phase single and double circuit lines– Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors, Skin and Proximity effects.

Calculation of capacitance for 2 wire and 3 wire systems – Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical single and Three-phase single and double circuit lines without and with Bundled conductors.

UNIT–II

Performance Analysis of Transmission Lines

Classification of Transmission Lines – Short, medium, long lines and their model representation –Nominal-T, Nominal-π and A, B, C, D Constants for symmetrical Networks.

Rigorous Solution for long line equations –Representation of Long lines – Equivalent T and Equivalent π network models - Surge Impedance and Surge Impedance Loading of Long Lines - Regulation and efficiency for all types of lines – Ferranti effect.

UNIT – III

Power System Transients

Types of System Transients – Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients.

Termination of lines with different types of conditions: Open Circuited Line–Short Circuited Line, Line terminated through a resistance and line connected to a cable. Reflection and Refraction at a T-Junction.

UNIT–IV

Corona& Effects of transmission lines

Description of the phenomenon – Types of Corona - critical voltages and power loss – Advantages and Disadvantages of Corona - Factors affecting corona - Radio Interference.

UNIT–V

Sag and Tension Calculations and Overhead Line Insulators:

Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice weight on conductor – Stringing chart and sag template and its applications.

Types of Insulators – Voltage distribution in suspension insulators–Calculation of string efficiency and Methods for String efficiency improvement – Capacitance grading and Static Shielding.

Text Books:

1. Electrical Power Systems – by C.L.Wadhwa, New Age International (P) Limited, 1998.
2. Power System Engineering by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 3rd Edition, 2019.

Reference Books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition
2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S. Bhatnagar A. Chakrabarthy, DhanpatRai Co Pvt. Ltd.2016.
4. Electrical Power Systems by P.S.R. Murthy, B.S. Publications, 2017.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/105/108105104
2. https://archive.nptel.ac.in/courses/108/102/108102047

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET11
Name of the Course	Advanced Control Systems					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain controllability, observability, and the principle of duality in state-space systems.	K2
CO2	Apply state-space methods to analyze controllability, observability, and design state feedback controllers.	K3
CO3	Analyze the stability of nonlinear systems using phase-plane analysis and Lyapunov's stability theorems.	K4
CO4	Examine the minimization of functional and control variable inequality constraints.	K3
CO5	Solve the optimal regulator problems.	K3

UNIT – I

Controllability - Observability and Design of Pole Placement

General concepts of controllability and observability -Tests for controllability and observability for continuous time systems - Principle of duality - Effect of state feedback on controllability and observability - Design of state feedback control through pole placement, full order and reduced order observers.

UNIT – II

Nonlinear Systems

Introduction to nonlinear systems - Types of nonlinearities. Introduction to phase plane analysis, construction of phase trajectories-Analytical and Isocline method, Describing function - Describing functions of on-off nonlinearity, on-off nonlinearity with hysteresis, and relay with dead zone.

UNIT – III

Stability analysis by Lyapunov Method

Stability in the sense of Lyapunov – Lyapunov’s stability and Lyapunov’s instability theorems – Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.

UNIT – IV

Calculus of Variations

Minimization of functionals - functionals of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints.

UNIT –V

Optimal Control

Necessary conditions for optimal control, Formulation of the optimal control problem, minimum time problem, minimum energy problem, minimum fuel problem, state regulator problem, output regulator problem.

Text Books:

1. Modern Control Engineering – by K. Ogata - Prentice Hall of India - 3rd edition - 1998.
2. Automatic Control Systems by B.C. Kuo - Prentice Hall Publication.

Reference Books:

1. Modern Control System Theory – by M. Gopal - New Age International Publishers 2nd edition – 1996.
2. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.
3. Control Systems Engineering by I.J. Nagarath and M.Gopal - New Age International (P) Ltd.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/103/108103007
2. https://archive.nptel.ac.in/courses/108/107/108107115

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET12
Name of the Course	Renewable and Distributed Energy Technologies					
Branches	**EEE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the concept of renewable and distributed energy systems.	K2
CO2	Develop wind energy systems.	K4
CO3	Develop solar PV system.	K3
CO4	Understand the operation of hydroelectric systems.	K2
CO5	Analyze storage systems and energy management in hybrid configurations.	K4

UNIT – I

Introduction and Wind energy systems

Brief idea on renewable and distributed sources - their usefulness and advantages. Wind Energy Systems: Estimates of wind energy potential-wind maps- Aerodynamic and mechanical aspects of wind machine design - Conversion to electrical energy - Aspects of location of wind farms.

UNIT – II

Wind power and energy

Wind speed and energy - Speed and power relations - Power extraction from wind -Tip speed ratio (TSR) - TSR characteristics- Functional structure of wind energy conversion systems - Pitch and speed control - Power vs speed characteristics - Fixed speed and variable speed wind turbine control - Power optimization - Electrical generators - Self-Excited and Doubly-Fed Induction Generators operation and control.

UNIT – III

Solar PV Systems

Present and new technological developments in photovoltaic - estimation of solar irradiance - components of solar energy systems - solar thermal system- applications- Modelling of PV cell - current-voltage and power-voltage characteristics - Effects of temperature and irradiance - Solar array simulator -Sun tracking - Peak power operations - PV systemMPPT techniques: Perturb and observe method, hill climbing and incremental conductance methods-Effects of partial shading on the characteristic curves and associated MPPT techniques - Solar park design outline-Solar Pond-Types of PV systems

UNIT – IV

Small Hydro and other sources

Hydel: Small-Mini-Medium -Plant layouts Water power estimates -use of hydrographs -hydraulic turbine - characteristics and part load performance - design of wheels - draft tubes and penstocks.
Other sources**:** Tidal - geothermal - gas-based generations.

UNIT – V

Hybrid Renewable systems

Requirements of hybrid/combined use of different renewable and distributed sources -Need of energy storage- Control of frequency and voltage of distributed generation in Stand-alone and Grid-connected mode - use of energy storage and power electronics interfaces for the connection to grid and loads - Design and optimization of size of renewable sources and their storages.

Text Books :

1. Math J. Bollen - Fainan Hassan 'Integration of Distributed Generation in the Power System' - IEEE Press - 2011.
2. G.D.Rai 'Non-Conventional Energy Sources' KHANNA PUBLISHERS.

Reference Books

1. Studies' Craig Anderson and Rudolf I. Howard 'Wind and Hydropower Integration: Concepts - Considerations and Case - Nova Publisher - 2012.
2. Amanda E. Niemi and Cory M. Fincher 'Hydropower from Small and Low-Head Hydro Technologies' - Nova Publisher - 2011.
3. D. YogiGoswami - Frank Kreith and Jan F. Kreider 'Principles of Solar Engineering' - Taylor & Francis 2000.
4. Math J. Bollen - Fainan Hassan 'Integration of Distributed Generation in the Power System' - IEEE Press - 2011.
5. S. Heier and R. Waddington 'Grid Integration of Wind Energy Conversion Systems' – Wiley - 2006.
6. Loi Lei Lai and Tze Fun Chan 'Distributed Generation: Induction and Permanent Magnet Generators' - Wiley-IEEE Press - 2007.
7. G.N. Tiwari 'Solar Energy Technology' - Nova Science Publishers - 2005.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/103/103/103103206
2. https://archive.nptel.ac.in/courses/103/107/103107157

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET13
Name of the Course	Programmable Logic Controllers					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand working of PLC, I/O Modules of PLC and PLC Ladder design	K2
CO2	Understand different types of devices to which PLC Input and Output modules are connected	K2
CO3	Apply of PLC timers and counters for the control of Industrial process	K3
CO4	Illustrate the program control instructions	K3
CO5	Demonstrate the Data Manipulation, Arithmetic, Logical and Sequential Instructions of PLC's	K3

UNIT I: INTRODUCTION

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT II: PLC PROGRAMMING

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams and sequence listings, ladder diagram construction.

UNIT III: PROGRAMMABLE TIMERS AND COUNTERS

Timer instructions – On delay time instruction – Off delay timer instruction – Retentive timer – Counter instructions – Up counter – Down counter - Cascading counters - Incremental encoder – Counter applications – Combining counter and timer functions.

UNIT IV: PROGRAM CONTROL INSTRUCTIONS

Master control reset instruction – Jump instructions and sub routines – Immediate input and output instructions. Data manipulation – Data transfer operation – Data compare instruction – Data manipulation programs – Numerical data I/O interfaces – Math instructions – Addition, subtraction, multiplication & division instruction – Sequential instructions – Sequence programs – Shift registers – Word shift registers.

UNIT V: APPLICATIONS

Control of water level indicator – Alarm monitor - Conveyor motor control – Parking garage – Ladder diagram for process control – PID controller.

TEXT BOOKS:

1. Programmable logic controllers by Frank D. Petruzella- McGraw Hill – 3rd Edition.
2. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI

REFERENCE BOOKS:

1. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
2. Introduction to Programmable Logic Controllers- Gary Dunning- Cengage Learning.
3. Programmable Logic Controllers –W. Bolton-Elsevier publisher

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET14
Name of the Course	Smart Grid Technologies					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the structure and benefits of smart grids.	K2
CO2	Analyze communication technologies and protocols in smart grids.	K4
CO3	Evaluate smart grid components like smart meters, energy storage, and distributed generation.	K4
CO4	Apply concepts in demand response and load management.	K3
CO5	Identify and address cyber security challenges in smart grids	K3

UNIT – 1

Introduction to Smart Grids

Evolution of Power Grids: Traditional Grids vs. Smart Grids-Key Characteristics of Smart Grids: Efficiency, Reliability, Flexibility-Smart Grid Architecture: Components and Functions-Generation, Transmission, Distribution, and Consumption Sectors-Smart Grid Vision, Goals, and Benefits-Economic, Environmental, and Operational Benefits-Role of ICT in Smart Grids: Data Management and Communication Infrastructure.

UNIT – 2

Smart Grid Communication and Networking:

Communication Technologies for Smart Grids:Wired (Ethernet, Fiber Optics) and Wireless (Zigbee, Wi-Fi, Cellular)-Power Line Communication (PLC) for Smart Metering and Control-Smart Metering Systems: Functionality and Communication Protocols: Advanced Metering Infrastructure (AMI)-Protocols in Smart Grids: IEC 61850, Modbus, DNP3, and others-Data Acquisition and Control Systems in Smart Grids-Integration of Internet of Things (IoT) in Smart Grid Communication.

UNIT – 3

Smart Grid Components and Technologies

Smart Meters: Role, Functionality, and Types-Energy Storage Systems: Batteries, Super capacitors, Flywheels, and Their Role in Grid Stability-Distributed Generation and

Renewable Energy Integration: Solar, Wind, and Microgrids-Energy Management Systems (EMS): Load Flow Analysis and Optimization Techniques-Smart Grid Automation: SCADA Systems, Automated Metering, and Fault Detection-Real-Time Monitoring and Control: Techniques and Technologies.

UNIT – 4

Integration of Renewable Energy and Demand-Side Management

Challenges in Integrating Renewable Energy into the Grid: Variability, Intermittency, and Storage Solutions-Role of Smart Grids in Renewable Energy Integration: Grid Stability and Power Quality, Wind and Solar Power Forecasting Techniques-Demand-Side Management (DSM) and Smart Appliances: Load Shifting, Load Shedding, and Peak Demand Reduction, Role of Consumers in Grid Optimization (Smart Home Technologies)-Electric Vehicle (EV) Integration and Smart Charging Infrastructure

UNIT – 5

Security, Privacy, and Policy Issues in Smart Grids

Cyber security in Smart Grids: Threats, Vulnerabilities, and Risks :Cyber Attacks on Critical Infrastructure-Privacy Concerns and Data Protection in Smart Grid Systems: Consumer Data, Smart Meters, and Privacy Regulations-Authentication, Authorization, and Secure Communication Protocols: IEC 62351 Security Standards-Smart Grid Regulations and Policies: Global Standards and Frameworks.

NIST, IEC, IEEE Standards, Policy Challenges in Grid Modernization and Renewable Energy Adoption-Future Trends and Challenges in Smart Grid Development.

Textbooks:

1. "Smart Grids: Infrastructure, Technology, and Solutions" by Stuart Borlase.
2. "Smart Grid: Fundamentals of Design and Analysis" by James A. Momoh.
3. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle.
4. Smart Grid Security: An End-to-End View of Security in the New Electric Grid" by Tony Flick and Justin Morehouse.

Reference Books:

1. "Smart Grid: Technology and Applications" by Janaka Ekanayake, Kithsiri Liyanage, Jiangzhou Wang, Nick Jenkins, and Xiangyu Zhang.
2. "The Smart Grid: Enabling Energy Efficiency and Demand Response" by Galina P. L. P. Shapiro.
3. "The Smart Grid: Enabling Energy Efficiency and Demand Response" by Clark W. Gellings.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/107/108107113

Semester	**V SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V23	0	0	3	1.5	V23EEL07
Name of the Course	Power Electronics and Simulation Lab					
Branches	**EEE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyze the characteristics and switching behavior of power semiconductor devices such as Thyristor, MOSFET, and IGBT through experimental evaluation.	K4
CO2	Develop triggering and firing circuits for Thyristor-based converters and validate their performance with different load types.	K3
CO3	Evaluate the operation of single-phase AC voltage controllers and inverters under R and RL loads through experimental and simulation-based analysis.	K5
CO4	Analyze the performance of DC–DC converters and three-phase converters for various input and output configurations.	K4
CO5	Analyze the output waveforms for various multilevel inverter topologies.	K4

Any 10 of the Following Experiments are to be conducted

1. Study of Characteristics of Thyristor, MOSFET & IGBT.
2. Design and development of a firing circuit for Thyristor.
3. Single -Phase Half controlled converter with R and RL load
4. Single -Phase fully controlled bridge converter with R and RL loads
5. Single -Phase AC Voltage Regulator with R and RL Loads
6. Single -Phase square wave bridge inverter with R and RL Loads
7. Design and verification of voltages gain of Boost converter in Continuous Conduction Mode (CCM).
8. Simulation of single-phase full converter using RLE loads, and single phase AC voltage controller using RL loads.
9. Simulation of three phase full converter using MOSEFET and IGBTs.
10. Simulation of Boost and Buck converters.

11. Simulation of single phase inverter with PWM control.
12. Simulation of three- phase inverter with 120^0 and 180^0 conduction mode.
13. Simulation of single-phase five-level CHB inverter.
14. Simulation of diode clamped and flying capacitor multilevel inverter.

Reference Books:

1. Simulation of power electronic circuit by MB patil, V. ramanarayan, V.T. Ranganathan Narosha, 2009.
2. Pspice for circuits and electronics using PSPICE-by M.H. Rashid, M/s PHI Publications. Pspice A/D user's manual-Microsim, USA.

Semester	**V SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V23	0	0	2	1	V23EET09
Name of the Course	Tinkering Lab					
Branches	**EEE, ME, CE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Apply basic electronic principles to construct and test circuits using components like LEDs and sensors	K3
CO2	Utilize CAD software to design and 3D print functional prototypes	K3
CO3	Develop Program to control devices such as motors or robots	K3
CO4	Assemble and test simple mechanical systems using tinkering lab tools	K3
CO5	Demonstrate the integration of sensors and actuators in a functional IoT project	K3

List of experiments:

1. **Design Parallel and Series Circuits on a Breadboard**
   Build and demonstrate both parallel and series circuits for any selected real-life application using a breadboard.
2. **Traffic Light Controller on Breadboard**
   Assemble and demonstrate a basic traffic light control system using LEDs and timers on a breadboard.
3. **Automatic Street Light using LDR**
   Construct a circuit using a Light Dependent Resistor (LDR) to automatically turn street lights on/off based on ambient light.
4. **Arduino LED Blinking Simulation on Tinkercad**
   Simulate an Arduino-based LED blinking project using Tinkercad's online simulation environment.
5. **Arduino LED Blinking with Arduino IDE**
   Build and run a basic LED blinking program on an Arduino board using the Arduino IDE.
6. **Interface IR Sensor and Servo Motor with Arduino**
   Connect and program an IR sensor and servo motor with Arduino to perform an automated task such as object detection or obstacle avoidance.
7. **LED Blinking with ESP32**
   Write and upload a program to an ESP32 microcontroller to blink an LED.

8. **LDR Interfacing with ESP32**
   Connect an LDR sensor to ESP32 to detect ambient light levels and perform actions such as controlling an LED.
9. **Control an LED via Mobile App**
   Set up a system to control an LED remotely using a smartphone app (via Wi-Fi or Bluetooth).
10. **Design and 3D Print a Walking Robot**
    Create a 3D model of a simple walking robot, print its parts, and assemble them.
11. **Design and 3D Print a Rocket**
    Design a small model rocket using CAD software and 3D print it for demonstration.
12. **Real-Time Soil Moisture Monitoring System**
    Build a project using a soil moisture sensor and microcontroller to monitor a plant's moisture levels remotely via a computer dashboard.
13. **Apply Design Thinking to Redesign a Motorbike**
    Follow all steps of the design thinking process (Empathize, Define, Ideate, Prototype, Test) to redesign a more innovative and user-friendly motorbike.

Students need to refer to the following links:

1. https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2. https://atl.aim.gov.in/ATL-Equipment-Manual/
3. https://aim.gov.in/pdf/Level-1.pdf
4. https://aim.gov.in/pdf/Level-2.pdf
5. https://aim.gov.in/pdf/Level-3.pdf

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET15
Name of the Course	Electrical Measurements and Instrumentation					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand analog ammeters, voltmeters, torque mechanisms, instrument transformers, and error compensation.	K2
CO2	Explain analog wattmeters, power factor meters, potentiometers, and solve related problems.	K2
CO3	Operate DC and AC bridges to measure electrical parameters	K3
CO4	Explain various transducers and their applications.	K2
CO5	Understand digital meters and CRO functions, and measure frequency and phase.	K2

UNIT - I

Analog Ammeter and Voltmeters

Classification – deflecting, control and damping torques – PMMC, moving iron type and electrostatic instruments – Construction – Torque equation – Range extension – Errors and compensations – advantages and disadvantages. Instrument transformers: Current Transformer and Potential Transformer – theory –Ratio and phase angle errors–Numerical Problems.

UNIT - II

Analog Wattmeters and Power Factor Meters

Electrodynamometer type wattmeter (LPF and UPF) – Power factor meters: Dynamometer and M.I type (Single phase and Three phase) – Construction – torque equation – advantages and disadvantages. Potentiometers: Principle and operation of D.C Crompton's potentiometer – Standardization –Applications –AC Potentiometer (Polar and coordinate types) –Standardization – Applications – Numerical Problems.

UNIT - III

Measurements of Electrical parameters

DC Bridges: Method of measuring low, medium and high resistance –Wheat stone's bridge for measuring medium resistance– Kelvin's double bridge for measuring low resistance – Loss of charge method for measurement of high resistance – Megger – measurement of earth resistance – Numerical Problems.

AC Bridges: Measurement of inductance and quality factor – Maxwell's bridge – Hay's bridge – Anderson's bridge. Measurement of capacitance and loss angle – Desauty's bridge – Schering Bridge – Wien's bridge –Numerical Problems.

UNIT - IV

Transducers

Definition – Classification – Resistive, Inductive and Capacitive Transducer – LVDT – Strain Gauge – Thermistors – Thermocouples – Piezo electric and Photo Diode Transducers – Hall effect sensors – Numerical Problems.

UNIT - V

Digital meters

Digital Voltmeters – Successive approximation DVM – Ramp type DVM and Integrating type DVM – Digital frequency meter – Digital multimeter – Digital tachometer – Digital Energy Meter – Q meter. CRO – measurement of phase difference and Frequency using lissajious patterns – Numerical Problems.

Text Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis - 5th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.SawhneyDhanpat Rai & Co. Publications - 19th revised edition - 2011.
2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput - S.Chand - 3rd edition.
3. Electrical Measurements by Buckingham and Price - Prentice – Hall
4. Electrical Measurements by Forest K. Harris. John Wiley and Sons

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/105/108105153

Semester	**VI SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V23	3	0	0	3	V23EET16
Name of the Course	Power System Analysis					
Branches	**EEE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Compute YBUS matrix for a power system network.	K3
CO2	Find the load flow solution of a power system network using load flow methods.	K3
CO3	Develop the ZBUS for a power system network and calculate the fault currents for symmetrical faults.	K3
CO4	Compute the sequence components of currents for unbalanced power system network.	K3
CO5	Understand the concepts of power system stability.	K2

UNIT - I

Circuit Topology

Graph theory definitions – Formation of element node incidence and bus incidence matrices – Primitive network representation – Formation of Y_{bus} matrix by singular transformation and direct inspection methods.

Per Unit Representation

Per Unit Quantities–Single line diagram – Impedance diagram of a power system – Numerical Problems.

UNIT - II

Power Flow Studies

Necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) – Decoupled and Fast Decoupled methods – Algorithmic approach – Numerical Problems on 3–bus system only.

UNIT - III

Z-Bus Algorithm

Formation of Z_{bus}**:** Algorithm for the Modification of Z_{bus} Matrix (without mutual impedance) – Numerical Problems.

Symmetrical Fault Analysis

Reactance's of Synchronous Machine – Three Phase Short Circuit Currents - Short circuit MVA calculations for Power Systems – Numerical Problems.

UNIT - IV

Symmetrical Components

Definition of symmetrical components – symmetrical components of unbalanced three phase systems – Power in symmetrical components – Sequence impedances and Sequence networks of Synchronous generator , Transformers andTransmission line-Numerical Problems.

Unsymmetrical Fault analysis

Various types of faults: LG– LL– LLG and LLL on unloaded alternator-Numerical problems.

UNIT - V

Power System Stability Analysis

Elementary concepts of Steady state – Dynamic and Transient Stabilities – Swing equation – Steady state stability – Equal area criterion of stability – Applications of Equal area criterion – Factors affecting transient stability – Methods to improve steady state and transient stability – Numerical problems.

Text Books:

1. Power System Analysis by Grainger and Stevenson - Tata McGraw Hill.2003
2. Modern Power system Analysis – by I.J.Nagrath& D .P.Kothari: Tata McGraw–Hill Publishing Company - 3rd edition - 2007.

Reference Books:

1. Power System Analysis – by A.R.Bergen - Prentice Hall - 2nd edition - 2009.
2. Power System Analysis by HadiSaadat – Tata McGraw–Hill 3rd edition - 2010.
3. Power System Analysis by B.R.Gupta - A H Wheeler Publishing Company Limited - 1998.
4. Power System Analysis and Design by J.Duncan Glover - M.S.Sarma - T.J.Overbye – Cengage Learning publications - 5th edition - 2011.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/117/105/117105140
2. https://archive.nptel.ac.in/courses/108/105/108105104

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET17
Name of the Course	Electric Power Quality					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand different types of power quality problems.	K2
CO2	Explain the sources transient over voltages and over voltage protection.	K2
CO3	Explain the principles long duration over voltages and voltage regulation improvement methods.	K2
CO4	Analyse voltage distortion and current distortion and their indices.	K4
CO5	Understand the concepts of interfacing the distributed generation technologies and power quality monitoring.	K2

UNIT - I

Introduction

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sag – Voltage Swell.

UNIT - II

Transient over Voltages and over voltage protection

Sources of Transient over voltages - Principles of over voltage protection- Devices for over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.

UNIT - III

Long – Duration Voltage Variations and voltage regulation

Principles of regulating the voltage – Devices for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End user capacitor application – Regulating utility voltage with distributed resources – voltage flicker.

UNIT - IV

Harmonic distortion and solutions

Voltage distortion verses current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors, transformers, motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.

UNIT - V

Distributed Generation and Monitoring

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

Monitoring

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.

Textbooks:

1. Electrical Power Systems Quality - Dugan R C - McGranaghan M F - Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley india publications - 2011.
3. Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

1. Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
2. Power System Harmonics - Arrillaga J and Watson N R - Second Edition -John Wiley & Sons - 2003.
3. Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula - Van Nostrad Reinhold - New York.
4. Power Quality C.Shankaran - CRC Press - 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
6. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs- Mohammad A.S.Masoum–Elsevier.

Online Learning Resources:

1. https://nptel.ac.in/courses/108102179
2. https://nptel.ac.in/courses/108107157

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET18
Name of the Course	Utilization of Electrical Energy					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Choose a suitable motor for electric drives and industrial applications	K3
CO2	Select appropriate heating and welding techniques for different applications	K2
CO3	Recognise lightning system for particular inputs and constraints.	K2
CO4	Illustrate the speed-time characteristics of traction motors.	K3
CO5	Estimate the energy consumption levels at various modes of operation.	K2

UNIT – I: SELECTION OF MOTORS

Choice of motor, type of electric drives, starting and running characteristics – Speed control – Temperature rise – Applications of electric drives – Types of industrial loads – Continuous, Intermittent and variable loads – Load equalization.

UNIT – II: ELECTRIC HEATING AND WELDING

Advantages and methods of electric heating and welding –Resistance heating, induction heating and dielectric heating. Classification - Resistance welding and types - Arc welding and types–Electric welding equipment–Comparison between AC and DC Welding

UNIT – III: ILLUMINATION

Basic terms used in illumination – Laws of illumination – MHCP and MSCP– Sources of light: Working of Filament lamps, Arc lamps and Discharge lamps.

Basic principles of light control – Types of lighting schemes – Street, Flood and LED lighting – Lumen or flux method of lighting calculation – Numerical Examples.

UNIT – IV: ELECTRIC TRACTION – I

Review of existing electric traction systems in India – System of electric traction and track electrification– Special features of traction motor – Mechanics of train movement – Speed-time curves for different services – Trapezoidal and quadrilateral speed time curves.

UNIT – V: ELECTRIC TRACTION – II

Calculations of tractive effort– power –Specific energy consumption for given run–Effect of varying acceleration and braking retardation–Adhesive weight and braking, retardation adhesive weight and coefficient of adhesion.

TEXT BOOKS:

1. Utilization of Electric Energy by E. Openshaw Taylor, SI Edition, Orient Longman, 1971.
2. Art and Science of Utilization of Electrical Energy by H. Partab, Dhanpat Rai & Sons, 2006.

REFERENCE BOOKS:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N. V. Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy by C.L. Wadhwa, New Age International (P) Limited, Publishers, 1997.
3. https://www.governmentpolytechnicnayagarh.org/upload/ueet(Pm).pdf,
4. https://sites.google.com/site/eeenotes2u/courses/electrical-power-utilization-epu-notes

Semester	**VI SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V23	3	0	0	3	V23EET19
Name of the Course	Switchgear and Protection					
Branches	**EEE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the operation, types, and characteristics of circuit breakers and arc interruption principles.	K2
CO2	Explain electromagnetic relays, their classifications, operating principles, and applications in power system protection.	K2
CO3	Describe protection schemes for generators and transformers, including differential and Buchholz relay protection.	K2
CO4	Explain feeder, bus bar protection schemes, and static relays.	K2
CO5	Understand causes of overvoltages and grounding methods, and explain protective measures against lightning and faults.	K2

UNIT – I
Circuit Breakers

Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Concept of oil circuit breakers– Description and operation of Air Blast– Vacuum and SF_6 circuit breakers– Circuit Breaker ratings and specifications– Concept of Auto reclosing.

UNIT – II
Electromagnetic Protection

Relay connection – Balanced beam type attracted armature relay - induction disc and induction cup relays–Torque equation - Relays classification–Instantaneous– DMT and IDMT types– Applications of relays: Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays: Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

UNIT – III

Generator Protection

Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples.

Transformer Protection

Percentage differential protection– Design of CT's ratio– Buchholz relay protection– Numerical examples.

UNIT – IV

Feeder and Bus bar Protection & Static Relays:

Over current Protection schemes – PSM - TMS – Numerical examples – Carrier current and three zone distance relay using impedance relays. Protection of bus bars by using Differential protection. Static relays: Introduction – Classification of Static Relays – Basic Components of Static Relays.

UNIT – V

Protection against over voltage and grounding

Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters. Grounded and ungrounded neutral systems – Effects of ungrounded neutral on system performance – Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices.

Text Books:

1. Power System Protection and Switchgear by Badri Ram and D.N Viswakarma - Tata McGraw Hill Publications - 2nd edition - 2011.
2. Power system protection- Static Relays with microprocessor applications by T.S.Madhava Rao - Tata McGraw Hill - 2nd edition.

Reference Books:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide. - PHI - 2003.
2. Art & Science of Protective Relaying – by C R Mason - Wiley Eastern Ltd.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/107/108107167
2. https://archive.nptel.ac.in/courses/108/105/108105167

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET20
Name of the Course	Electric Drives					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Apply the basic principles of electric drives to analyze load torque characteristics, stability, braking methods, and four-quadrant operation.	K3
CO2	Analyze converter-fed DC motor drives and their speed–torque characteristics.	K4
CO3	Analyze the performance of DC motors fed by DC–DC converters under various quadrants.	K4
CO4	Analyze the speed control methods and performance characteristics of 3-phase induction motor drives.	K4
CO5	Analyze the control strategies and performance of synchronous motor and PMSM drives.	K4

UNIT - I

Fundamentals of Electric Drives

Electric drive and its components– Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods: Dynamic Braking, Plugging and Regenerative Braking –Numerical problems.

UNIT - II

Converter Fed DC Motor Drives

3-phase half and fully-controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque characteristics and expressions – 3-phase Dual converter fed DC motor drives – Numerical problems.

UNIT - III

DC–DC Converter Fed DC Motor Drives

Single quadrant, two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous Current Mode of operation - Output voltage and current waveforms – Speed-torque characteristics and expressions – Closed loop operation (qualitative treatment only) – Numerical problems.

UNIT - IV

Control of 3-phase Induction motor Drives

Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop V/f control of induction motor drives (qualitative treatment only).

Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics– Numerical problems.

UNIT - V

Control of Synchronous Motor Drives

Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive (qualitative treatment only)– PMSM: Basic operation and advantages .

Text Books:

1. Fundamentals of Electric Drives – G K Dubey - Narosa Publications - 2nd edition – 2002.
2. Power Semiconductor Drives - S.B.Dewan- G.R.Slemon - A.Straughen - Wiley India - 1984.

Reference Books:

1. Electric Motors and Drives Fundamentals - Types and Apllications - by Austin Hughes and Bill Drury - Newnes.4th edition - 2013.
2. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publications - 1987.
3. Power Electronic Circuits - Devices and applications by M.H.Rashid - PHI - 3rd edition - 2009.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/104/108104140
2. https://nptel.ac.in/courses/108104011

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET21
Name of the Course	Battery Management Systems and Charging Stations					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Describe the construction and operation of different batteries for EV applications	K2
CO2	Describe charging algorithms of different batteries and balancing methods of battery packs	K2
CO3	Describe the different kinds of infrastructure needed in the charging stations	K2
CO4	Describe the requirements of battery management and their maintenance	K2
CO5	Obtain the modelling of batteries and develop their simulation models.	K2

Unit - I: EV Batteries Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries: Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery.

Unit - II: Battery charging strategies Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.

Unit -III: Charging Infrastructure Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging

Station, Battery Swapping Station, Move-and-charge zone.

Unit - IV: Battery-Management-System Requirements Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics .

Unit - V: Battery Modelling General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

Text Books

1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk. (Unit-1)
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016. (Unit-2)

Reference Books:

1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001. (Unit-3)
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016. (Unit-4)
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002. (Unit-5)

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET22
Name of the Course	AI Techniques for Power Systems					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain the basics of Artificial Neural Networks and how perceptron models work.	K2
CO2	Apply different ANN models like Back Propagation and Kohonen networks for learning tasks.	K3
CO3	Compare classical and fuzzy sets and perform basic fuzzy operations.	K3
CO4	Design a fuzzy logic controller using fuzzification, rules, and defuzzification.	K6
CO5	Apply AI techniques like back propagation and fuzzy logic in power system applications.	K3

UNIT– 1

Introduction

Artificial Neural Networks (ANN) – Humans and computers – Biological Neural Networks – ANN Terminology – Models of Artificial neuron – activation functions –typical architectures – biases and thresholds – learning strategy(supervised, unsupervised and reinforced) learning rules, perceptron training and classification using Discrete and Continuous perceptron algorithms, limitations and applications of perceptron training algorithm– linear separability and non-separability with examples.

UNIT– 2

ANN Paradigms

Generalized delta rule – Back Propagation algorithm- Radial Basis Function (RBF) network. Kohonen's self-organizing feature map (KSOFM), Learning Vector Quantization (LVQ) – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.

UNIT– 3

Classical and Fuzzy Sets

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT– 4

Fuzzy Logic Controller (FLC)

Fuzzy logic system components: Fuzzification, Inference engine (development of rule base and decision-making system), Defuzzification to crisp sets- Defuzzification methods.

UNIT– 5

Application of AI Techniques

Load forecasting using back propagation algorithm –load flow studies using back propagation algorithm, single area and two area load frequency control using fuzzy logic.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – McGraw Hill Inc, 1997.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publication.
2. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam, S Sumathi, S N Deepa TMGH.
3. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam, S Sumathi, S N Deepa Springer, 2007.

Online Learning Resources:

1. https://nptel.ac.in/courses/127105006

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EET23
Name of the Course	High Voltage Engineering					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand how electrical breakdown happens in gases and vacuum, and the key theories and laws behind it.	K2
CO2	Describe the breakdown mechanisms in liquid and solid insulators and compare the factors affecting their performance.	K2
CO3	Illustrate the methods used for generating high DC and AC voltages using voltage multiplier circuits and transformer arrangements.	K3
CO4	Analyze impulse voltage and current generation circuits and interpret their waveforms and control mechanisms.	K4
CO5	Apply appropriate techniques to measure high DC, AC, and impulse voltages and currents using standard instruments.	K2

UNIT - I

Break down phenomenon in Gaseous and Vacuum:

Insulating Materials: Types, properties and its applications. Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases and its limitations – Streamers Theory of break down – time lag – Paschen's law- Paschen's curve, Penning Effect.

Breakdown mechanisms in Vacuum.

UNIT - II

Break down phenomenon in Liquids:

Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquids- Mechanisms.

Break down phenomenon in Solids:

Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of composite solid dielectrics.

UNIT - III

Generation of High DC voltages:

Voltage Doubler Circuit - Voltage Multiplier Circuit – Vande- Graaff Generator.

Generation of High AC voltages:

Cascaded Transformers – Resonant Transformers –Tesla Coil.

UNIT - IV

Generation of Impulse voltages:

Specifications of impulse wave – Analysis of RLC circuits - Marx Circuit.

Generation of Impulse currents:

Definitions – Circuits for producing Impulse current waves – Wave shape control - Tripping and control of impulse generators.

UNIT - V

Measurement of High DC & AC Voltages:

Resistance potential divider - Generating Voltmeter - Capacitor Voltage Transformer (CVT) - Electrostatic Voltmeters – Sphere Gaps.

Measurement of Impulse Voltages & Currents:

Potential dividers with CRO - Hall Generator - Rogowski Coils.

Text Books:

1. High Voltage Engineering: Fundamentals by E.Kuffel - W.S.Zaengl - J.Kuffel by Elsevier - 2nd Edition.
2. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications - 3rd Edition.

Reference Books:

1. High Voltage Engineering and Technology by Ryan - IET Publishers - 2nd edition.
2. High Voltage Engineering by C.L.Wadhwa - New Age Internationals (P) Limited – 1997.
3. High Voltage Insulation Engineering by RavindraArora - Wolfgang Mosch - New Age International (P) Limited - 1995.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/104/108104048
2. https://bharatsrajpurohit.weebly.com/high-voltage-engineering-course.html

Semester	VI SEM	L	T	P	C	COURSE CODE
Regulation	V23	0	0	3	1.5	V23EEL10
Name of the Course	Electrical Measurements and Instrumentation Lab					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Calibrate various types of electrical measuring instruments like wattmeters, energy meters, ammeters, and voltmeters using standard techniques.	K3
CO2	Measure resistance, inductance, and capacitance using appropriate bridge methods such as Kelvin's, Anderson, and Schering bridges.	K3
CO3	Test instrument transformers (CT and PT) and determine ratio error and phase angle using standard methods.	K4
CO4	Analyze the characteristics of transducers like thermocouples, LVDTs, capacitive transducers, and strain gauges.	K4
CO5	Evaluate the parameters of electrical components like choke coils and verify power measurement methods using voltmeter-ammeter techniques.	K5

Any 10 of the following experiments are to be conducted

1. Calibration of dynamometer wattmeter using phantom loading
2. Measurement of resistance using Kelvin's double Bridge and Determination of its tolerance.
3. Measurement of Capacitance using Schering Bridge.
4. Measurement of Inductance using Anderson Bridge.
5. Calibration of LPF Wattmeter by direct loading.
6. Measurement of 3 phase reactive power using single wattmeter method for a balanced load.
7. Testing of C.T. using mutual inductor – Measurement of % ratio error and phase angle of given C.T. by Null deflection method.
8. P.T. testing by comparison – V.G as Null detector – Measurement of % ratio error and phase angle of the given P.T.
9. Determination of the characteristics of a Thermocouple.
10. Determination of the characteristics of a LVDT.

11. Determination of the characteristics for a capacitive transducer.
12. Measurement of strain for a bridge strain gauge.
13. Measurement of Choke coil parameters and single-phase power using three voltmeter and three ammeter methods.
14. Calibration of single-phase Induction Type Energy Meter.
15. Calibration of DC ammeter and voltmeter using Crompton DC Potentiometer.
16. AC Potentiometer: Polar Form / Cartesian Form - Calibration of AC voltmeter - Parameters of choke.

Semester	V SEM	L	T	P	C	COURSE CODE
Regulation	V23	0	1	2	2	V23EEL11
Name of the Course	IOT Applications for Electrical Engineering Lab					
Branches	EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Operate the Arduino Integrated Development Environment with embedded C.	K2
CO2	Program the embedded Python in Raspberry Pi OS.	K3
CO3	Interface various sensors with Arduino/Raspberry Pi in the IoT environment.	K3
CO4	Connect different displays with Arduino/Raspberry Pi	K3
CO5	Interconnect with wireless communication technologies	K3

Topics to be covered in Tutorials

Module–1: Programming Arduino: (3 hrs)

Arduino - Classification of Arduino Boards - Pin diagrams – Arduino Integrated Development Environment (IDE) – Programming Arduino.

Module–2: Sensors: (5 hrs)

Working of temperature sensor, proximity sensor, IR sensor, Light sensor, ultrasonic sensor, PIR Sensor, Colour sensor, Soil Sensor, Heart Beat Sensor, Fire Alarms etc. Actuators: Stepper Motor, Servo Motor andtheir integration with Arduino/Raspberry Pi.

Module–3: Raspberry Pi: (2 hrs)

Introduction, Classification of Rasperberry Pi Series - Pin diagrams – Programming Rasperberry Pi.

Module–4: Display: (2 hrs)

Working of LEDs, LED, OLED display, LCDs, Seven Segment Display, Touch Screen etc. Analog Input and Digital Output Converter etc. and their integration with Arduino/Raspberry Pi.

Module–5: Wireless Communication Devices: (4 hrs)

Working of Bluetooth, Wi-Fi, Radio Frequency Identification (RFID), GPRS/GSM Technology, ZigBee, etc and their integration with Arduino/Raspberry Pi. Features of Alexa.

List of experiments:

Any 10 of the following experiments are to be conducted:

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. Interfacing of LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. Interfacing of Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. Interfacing of temperature sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. Interfacing of Organic Light Emitting Diode (OLED) with Arduino/Raspberry Pi
6. Interfacing of Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
7. Interfacing of Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
8. Write a program on Arduino/Raspberry Pi to upload and retrieve temperature and humidity data to thing speak cloud.
9. Interfacing of 7 Segment Display with Arduino/Raspberry Pi
10. Interfacing of Joystick with Arduino/Raspberry Pi
11. Interfacing of Analog Input & Digital Output with Arduino/Raspberry Pi
12. Night Light Controlled & Monitoring System
13. Interfacing of Fire Alarm Using Arduino/Raspberry Pi
14. IR Remote Control for Home Appliances
15. A Heart Rate Monitoring System
16. Alexa based Home Automation System

Annexure III

List of courses offered under OPEN ELECTIVES

S. No.	Course Code	Title	L	T	P	C
1.	V23EEOE01	Basics of Control systems	3	0	0	3
2.	V23EEOE02	Renewable Energy Sources	3	0	0	3
3.	V23EEOE03	Concepts of Energy Auditing & Management	3	0	0	3
4.	V23EEOE04	Fundamentals of Electric Vehicles	3	0	0	3
5.	V23EEOE05	Electrical Wiring Estimation and Costing	3	0	0	3
6.	V23EEOE06	Battery Management Systems and Charging Stations	3	0	0	3
7.	V23EEOE07	Concepts of Smart Grid Technologies	3	0	0	3
8.	V23EEOE08	Concepts of Power System Engineering	3	0	0	3
9.	V23EEOE09	Electrical Measuring Instruments	3	0	0	3
10.	V23EEOE10	Programmable Logic Controller and Applications	3	0	0	3

Annexure IV

Proposed Syllabi for the Open Electives

Semester	V to VII SEMESTERS	L	T	P	C	Course Code
Regulation	V23	3	-	-	3	V23EEOE01
Name of the Course	Basics of Control systems (Open Elective)					
Branches	Except EEE, ECE & ECT					

Course Outcomes:

After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Construct the transfer function of various mechanical and electrical systems using block diagram algebra and signal flow graphs.	K2
CO2	Find the time response specifications of second order systems and absolute, relative stability of LTI systems using routh's stability criterion and the root locus method.	K3
CO3	Assess the stability of LTI systems using frequency response methods.	K3
CO4	Construct the lag, lead, lag-lead compensators from bode diagrams to improve the system performance.	K2
CO5	Understand the concepts in state space representation of LTI systems, controllability and observability.	K2

UNIT – I: Mathematical modeling of control systems

Classification of control systems, open loop and closed loop control systems and their differences, Feedback characteristics, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems, transfer function of DC servo motor – AC servo motor – synchro, transmitter and receiver – block diagram algebra – representation by signal flow graph – reduction using Mason's gain formula.

UNIT-II: Time response analysis

Standard test signals – time response of first and second order systems – time domain specifications, steady state errors and error constants, effects of proportional (P), proportional-integral (PI),proportional-integral derivative(PID) systems.

Stability and root locus technique

The concept of stability – Routh's stability criterion – limitations of Routh's stability, root locus concept –construction of root loci (simple problems), Effect of addition of Poles and zeros to the transfer function.

UNIT–III: Frequency response analysis
Introduction to frequency domain specifications – Bode diagrams – transfer function from the Bode diagram –phase margin and gain margin – stability analysis from Bode plots, Polar plots, Nyquist stability criterion.

UNIT–IV: Classical control design techniques
Lag, lead, lag-lead compensators, design of compensators using Bode plots.

UNIT–V: State space analysis of LTI systems
Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and it's Properties, concepts of controllability and observability.

Text Books:

1. Control Systems principles and design, M. Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition, 2014.
2. Automatic control systems, Benjamin C. Kuo, Prentice Hall of India,2ndEdition, 2014.

Reference Books:

1. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India, 2002.
2. Control Systems, ManikDhanesh N, Cengage Publications, 2012.
3. Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition, 2007.
4. Control Systems Engineering, S.Palani, Tata McGraw Hill Publications, 2009.
5. https://nptel.ac.in/courses/107/106/107106081/

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE02
Name of the Course	Renewable Energy Sources **(Open Elective)**					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand solar radiation data, extra-terrestrial radiation, radiation on earth's surface and solar Energy Storage.	K2
CO2	Illustrate the components of wind energy systems.	K3
CO3	Illustrate the working of biomass, hydel plants and Geothermal plants.	K3
CO4	Understand the principle of Energy production from OTEC, Tidal and Waves.	K2
CO5	Understand the concept and working of Fuel cells & MHD power generation.	K2

UNIT–I

Solar Energy

Introduction - Renewable Sources - prospects, solar radiation at the Earth Surface - Equivalent circuit of a Photovoltaic (PV) Cell - I-V & P-V Characteristics - Solar Energy Collectors: Flat plate Collectors, concentrating collectors - Solar Energy storage systems and Applications: Solar Pond - Solar water heating - Solar Green house.

UNIT–II

Wind Energy

Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of Wind Energy Conversion Systems (WECS) - Classification - Applications.

UNIT–III

Biomass, Hydel and Geothermal Energy

Biomass: Introduction - Biomass conversion technologies- Photosynthesis. Factors affecting Bio digestion.

Hydro plants: Basic working principle – Classification of hydro systems**:** Large, small, micro hydel plants.

Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems.

UNIT–IV

Energy From oceans, Waves & Tides:

Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India.

Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices.

Tides: Basic principle of Tide Energy -Components of Tidal Energy.

UNIT–V

Chemical Energy Sources:

Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications.

Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications

Magneto Hydro Dynamic (MHD) Power generation: Principle of Operation - Types.

Text Books:

1. G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
2. John Twidell& Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

Reference Books:

1. S.P.Sukhatme&J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.
2. John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.
3. ShobaNath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/103/103/103103206
2. https://archive.nptel.ac.in/courses/103/107/103107157

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE03
Name of the Course	Concepts of Energy Auditing & Management **(Open Elective)**					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the principles of energy audit along with various Energy related terminologies.	K2
CO2	Understand the role of Energy Manager and Energy Management program.	K2
CO3	Understand the designing of energy efficient motors and good lighting system.	K2
CO4	Understand the methods to improve the power factor and identify the energy instruments for various real time applications.	K2
CO5	Understand the computational techniques with regard to economic aspects.	K2

UNIT–I

Basic Principles of Energy Audit

Energy audit- definitions - concept - types of **Energy** audit - energy index - cost index - pie charts - Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry, thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017)

UNIT–II:

Energy Management

Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.

UNIT–III:

Energy Efficient Motors and Lighting

Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

UNIT–IV

Power Factor Improvement and Energy Instruments

Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on power factor - power factor motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.

UNIT–V

Economic Aspects and their Computation

Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

Text Books:

1. Energy management by W.R.Murphy & G.Mckay Butter worth - Heinemann publications - 1982.
2. Energy management hand book by W.CTurner - John wiley and sons - 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995
2. Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

Online Learning Resources:

1. https://nptel.ac.in/courses/108106022
2. https://archive.nptel.ac.in/courses/108/106/108106022

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE04
Name of the Course	Fundamentals of Electric Vehicles **(Open Elective)**					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Illustrate the use and advantages of different types of electric vehicles.	K3
CO2	Understand the suitable power converters for EV application.	K2
CO3	Understand the selection of suitable electric motor for EV power train.	K2
CO4	Understand the design of HEV configuration for a specific application.	K2
CO5	Understand various storage systems and battery management system for EVs.	K2

UNIT – I

Introduction

Fundamentals of vehicles – Vehicle model – Calculation road load and tractive force – Components of conventional vehicles – Drawbacks of conventional vehicles – Need for electric vehicles– Advantages and applications of Electric Vehicles – History of Electric Vehicles – EV Market in India and outside India –Types of Electric Vehicles.

UNIT – II

Components of Electric Vehicles

Main components of Electric Vehicles – Electric Traction MotorandController –Power Converters – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.

UNIT – III

Motors for Electric Vehicles

Characteristics of traction drive – requirements of electric machines for EVs – Comparison of Different motors for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched

Reluctance Motors (Construction details and working only).

UNIT – IV

Hybrid Electric Vehicles

Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs – Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples – Merits and Demerits.

UNIT – V

Energy Sources for Electric Vehicles

Batteries– Types of Batteries – Lithium-ion – Nickel-metal hydride – Lead-acid – Comparison of Batteries – Battery Charging – Fast Charging –Battery Management System – Ultra capacitors – Flywheels – Compressed air energy storage (CAES)– Fuel Cell – it's working.

Text Books

1. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2. Tom Denton, Hayley Pells - Electric and hybrid vehicles, Third Edition, 2024

Reference Books:

1. Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2. Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
3. Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.

Online Learning Resources:

1. MOOC at https://www.edx.org/learn/electric-cars
2. https://archive.nptel.ac.in/courses/108/106/108106170

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE05
Name of the Course	Electrical Wiring Estimation and Costing **(Open Elective)**					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain the various electrical apparatus and their interconnections.	K2
CO2	Examine various components of electrical installations.	K2
CO3	Estimate the cost for installation of wiring for different types of building and small industries.	K2
CO4	Illustrate the components of electrical substations.	K2
CO5	Construct suitable control circuit for starting of three phase induction motor and synchronous motor.	K2

UNIT - I

Electrical Symbols and Simple Electrical Circuits

Identification of electrical symbols - Electrical wiring Diagrams - Methods of representation of wiring diagrams - introduction to simple light and fan circuits - system of connection of appliances and accessories.

UNIT - II

Design Considerations of Electrical Installations

Electric supply system - Three-phase four wire distribution system - protection of electric installation against overload - short circuit and earth fault - earthing - neutral and earth wire - types of loads - systems of wiring - permissible of voltage drops and sizes of wires - estimating and costing of electrical installations.

UNIT - III

Electrical Installation for Different Types of Buildings and Small Industries

Electrical installations for electrical buildings - estimating and costing of material - simple examples on electrical installation for residential buildings - electrical installations for commercial buildings - electrical installation for small industries-case study.

UNIT - IV

Substations

Introduction - types of substations - outdoor substations-pole mounted type - indoor substations-floor mounted type - simple examples on quantity estimation-case study.

UNIT - V

Motor control circuits

Introduction to AC motors - starting of three phase squirrel cage induction motors - starting of wound rotor motors - starting of synchronous motors - contractor control circuit components - basic control circuits - motor protection – Schematic and wiring diagrams for motor control circuits.

Text Books:

1. Electrical Design and Estimation Costing - K. B. Raina and S.K.Bhattacharya – New Age International Publishers - 2007.

References Books:

1. Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khanna publishers - 6th edition - 1987.
2. A course in electrical installation estimating and costing – J.B.Gupta –Kataria SK & Sons - 2013.

Online Learning Resources:

1. https://onlinecourses.swayam2.ac.in/nou25_ec07/preview

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE06
Name of the Course	Battery Management Systems and Charging Stations (Open Elective)					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Describe the construction and operation of different batteries for EV applications	K2
CO2	Describe charging algorithms of different batteries and balancing methods of battery packs	K2
CO3	Describe the different kinds of infrastructure needed in the charging stations	K2
CO4	Describe the requirements of battery management and their maintenance	K2
CO5	Obtain the modelling of batteries and develop their simulation models.	K2

Unit - I: EV Batteries Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries: Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery.

Unit - II: Battery charging strategies Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.

Unit -III: Charging Infrastructure Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

Unit - IV: Battery-Management-System Requirements Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics .

Unit - V: Battery Modelling General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

Text Books

1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk. (Unit-1)
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016. (Unit-2)

Reference Books:

1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001. (Unit-3)
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016. (Unit-4)
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002. (Unit-5)

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE07
Name of the Course	Concepts of Smart Grid Technologies (Open Elective)					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the concepts of smart grids and analyse the smart grid policies and developments in smart grids.	K2
CO2	Understand concepts of smart grid technologies in hybrid electrical vehicles etc.	K2
CO3	Understand the concepts of smart substations - feeder automation - Battery Energy storage systems etc.	K2
CO4	Understand micro grids and distributed generation systems.	K2
CO5	Understand the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.	K2

UNIT – I

Introduction to Smart Grid

Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid - Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid.

UNIT – II

Smart Grid Technologies: Part 1

Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading(AMR) - Outage Management System(OMS) - Plug in Hybrid Electric Vehicles(PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Phase Shifting Transformers - Net Metering.

UNIT – III

Smart Grid Technologies: Part 2

Smart Substations - Substation Automation - Feeder Automation. Geographic Information System(GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection. Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting

Magnetic Energy Storage Systems (SMES) - Pumped Hydro - Compressed Air Energy Storage (CAES)

UNIT – IV

Micro grids and Distributed Energy Resources

Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources - Demand Response.

UNIT - V

Information and Communication Technology for Smart Grid

Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

Text Books:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W.Gellings - Fairmont Press - 2009.
3. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.
4. Smart Grids by Jean-Claude Sabonnadière - NouredineHadjsaïd - Wiley publishers – 2013.
5. Smart Power: Climate Changes - the Smart Grid - and the Future of Electric Utilities - by Peter S. Fox Penner - Island Press; 1st edition - 8 Jun 2010
6. Microgrids and Active Distribution Networks by S. Chowdhury - S. P. Chowdhury - P.Crossley - Institution of Engineering and Technology - 30 Jun 2009

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Control and Automation of Electric Power Distribution Systems (Power Engineering) by James Northcote - Green - Robert G. Wilson - CRC Press - 2017.
3. Substation Automation (Power Electronics and Power Systems) by Mladen Kezunovic - Mark G. Adamiak - Alexander P. Apostolov - Jeffrey George Gilbert - Springer - 2010.
4. Electrical Power System Quality by R. C. Dugan - Mark F. McGranghan - Surya Santoso - H. Wayne Beaty - McGraw Hill Publication - 2nd Edition

Semester	V to VII SEMESTERS	L	T	P	C	Course Code
Regulation	V23	3	-	-	3	V23EEOE08
Name of the Course	Concepts of Power System Engineering (Open Elective)					
Branches	Except EEE					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the working of thermal and nuclear power generating stations.	K2
CO2	Estimate the R,L and C parameters of transmission lines (Nominal T and π models).	K2
CO3	Find the parameters of DC and AC distribution systems along with voltage drop.	K3
CO4	Understand the operation of fuses and circuit breakers.	K2
CO5	Illustrate the speed/time characteristics of different types of traction motors.	K2

UNIT – I: Introduction to the Sources of Energy
Thermal Power Stations Selection of site, general layout of a thermal power plant showing paths of coal, steam, water, air, ash and flue gasses, ash handling system & operation of thermal plant

Nuclear Power Stations: Location of nuclear power plant, Working principle, Nuclear fission, Nuclear fuels, Nuclear chain reaction, nuclear reactor Components: Moderators, Control rods, Reflectors and Coolants.

UNIT – II: Parameters of Transmission line
Types of conductors - calculation of resistance for solid conductors - Calculation of inductance for single phase and three phase, concept of GMR & GMD- Calculation of capacitance for 2 wire and 3 wire systems, effect of ground on capacitance. Classification of Transmission Lines and their model representations -Nominal-T, Nominal-π, Ferranti effect - Numerical Problems.

UNIT – III: Distribution Systems
Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages),

ring main distributor.

UNIT-IV: Protective devices
Principle of operation of HRC fuses – SF6, oil circuit breakers, circuit reclosures and Line sectionalizes.
UNIT–V: Electric Traction
System of electric traction and track electrification– Review of existing electric traction systems in India–Special features of traction motor–Mechanics of train movement–Speed–time curves for different services –Trapezoidal and quadrilateral speed time curves.

Text Books:

1. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa New age International (P) Limited, Publishers, 2015.
2. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd., 2008
3. Utilization of Electric Energy – by E. Openshaw Taylor, Orient Longman,1971.

Reference Books:

1. Electrical Power Systems by P.S.R. Murthy, B.S. Publications, 2017.
2. Art & Science of Utilization of electrical Energy – by Partab, DhanpatRai & Sons, 2017

Semester	V to VII SEMESTERS	L	T	P	C	COURSE CODE
Regulation	V23	3	0	0	3	V23EEOE09
Name of the Course	**Electrical Measuring Instruments** (Open Elective)					
Branches	Except EEE					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Demonstrate the application of torque principles and operating mechanisms for analog instruments in both AC and DC.	K3
CO2	Choose right type of instrument for measurement of power and energy and able to calibrate energy meter by suitable method.	K3
CO3	Use DC and AC potentiometers to perform accurate measurements of unknown electrical quantities.	K3
CO4	Apply bridge methods and instrument techniques to measure various electrical and magnetic parameters.	K3
CO5	Illustrate the operating principles of digital instruments and use CRO-based techniques to measure voltage, frequency, and phase difference in electronic circuits.	K3

UNIT–I: MEASURING INSTRUMENTS

Classification – Deflecting, control and damping torques – Ammeters and Voltmeters – PMMC, moving iron type, dynamometer and electrostatic instruments – Expression for the deflecting torque and control torque – Errors and compensations– Extension of range using shunts and series resistance – Numerical problems.

UNIT –II: MEASUREMENT OF POWER AND ENERGY

Single phase and three phase dynamometer wattmeter – LPF and UPF – Expression for deflecting and control torques - Single phase induction type energy meter – Driving and braking torques – errors and compensations – Three phase induction type energy meter.

UNIT – III: POTENTIOMETERS

Principle and operation of D.C. Crompton's potentiometer – Standardization – Measurement of unknown Resistance, Current and Voltage. AC Potentiometers: polar and coordinate types – Applications.

UNIT – IV: MEASUREMENT OF ELECTRICAL & MAGNETIC PARAMETERS

Electrical Parameters

Method of measuring low, medium and high resistance – Sensitivity of Wheat stone's bridge – Kelvin's double bridge for measuring low resistance– Megger– Measurement of earth resistance – Measurement of inductance and Quality Factor by Anderson's bridge – Measurement of capacitance and loss angle by Schering Bridge.

Magnetic Parameters

Ballistic galvanometer – Equation of motion – Flux meter (Constructional details), Determination of B–H Loop: methods of reversals (six-point method only).

UNIT – V: DIGITAL METERS

Digital Voltmeters: Successive approximation type – Measurement of phase difference and Frequency using Lissajous patterns in CRO– Digital multimeter – Digital Tachometer.

TEXT BOOKS:

1. Electrical & Electronic Measurement & Instruments by A. K. Sawhney Dhanpat Rai & Co. Publications, 2013.
2. Modern Electronic Instrumentation and Measurement Techniques – A. D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.
3. Electrical Measurements and measuring Instruments – by E.W. Golding and F. C. Widdis, fifth Edition, Wheeler Publishing, 2011.
4. Electronic Instrumentation by H S Kalsi, Second Edition, Tata McGraw Hill Company, 2004.

REFERENCE BOOKS:

1. Electrical and Electronic Measurements and instrumentation by R. K. Rajput, S. Chand, 2007.
2. Electrical Measurements – by Buckingham and Price, Prentice – Hall, 1988.
3. Electrical Measurements by Forest K. Harris. John Wiley and Sons,1952.
4. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International P) Limited, Publishers, 1967.

Semester	V to VII SEMESTERS	L	T	P	C	Course Code
Regulation	V23	3	-	-	3	V23EEOE10
Name of the Course	Programmable Logic Controller and Applications (Open Elective)					
Branches	Except EEE					

Course Outcomes:

After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the basic concepts of PLCs and their I/O modules.	K2
CO2	Construct the control algorithms to PLC using ladder logic.	K2
CO3	Illustrate the PLC registers for effective utilization in different applications.	K2
CO4	Understand the function of various program control instructions.	K2
CO5	Apply the suitable controller in real time applications.	K3

Unit I: Introduction
PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Unit II: PLC Programming
PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams and sequence listings, ladder diagram construction.

Unit III: Programmable Timers and Counters
Timer instructions – On delay time instruction – Off delay timer instruction – Retentive timer – Counter instructions – Up counter – Down counter – Cascading counters – Incremental encoder – Counter applications– Combining counter and timer functions.

Unit IV: Program Control Instructions
Master control reset instruction – Jump instructions and sub routines – Immediate input

and output instructions.-Data manipulation – Data transfer operation – Data compare instruction – Data manipulation programs –
Numerical data I/O interfaces – Math instructions – Addition, subtraction, multiplication & division instruction– Sequential instructions – Sequence programs – Shift registers – Word shift registers.

Unit V: Applications
Control of water level indicator – Alarm monitor - Conveyor motor control – Parking garage – Ladder diagram for process control – PID controller.

Text Books:

1. Programmable logic controllers by Frank D. Petruzella- McGraw Hill – 3rd Edition.
2. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI

Reference Books:

1. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
2. Introduction to Programmable Logic Controllers- Gary Dunning- Cengage Learning. Programmable Logic Controllers –W. Bolton-Elsevier publisher, 2005.

Annexure V

List of courses for B. Tech EEE Honors

S.No.	Course name	Number of Weeks	Credits	
1.	Advance power electronics and Control(IITR)	8	2	**Students have to acquire a minimum of 18 credits by completing MOOCs/ NPTEL course from the Pool**
2.	Advanced IOT Applications (IISc)	8	2	
3.	Advances in UHV Transmission and Distribution (IISC)	8	2	
4.	Control and Tuning Methods in Switched Mode Power Converters (IITKGP)	12	3	
5.	Dc Microgrid and control systems(IITR)	8	2	
6.	Design of photovoltaic systems (IISc)	12	3	
7.	Design of Power Electronic Converters	8	2	
8.	Digital Control in Switched Mode Power Converters and FPGA-based Prototyping (IITKGP)	12	3	
9.	Digital Protection of Power System	8	2	
10.	Electric vehicles and Renewable energy,(IITM)	12	3	
11.	Electrical Distribution System Analysis, (IITR)	8	2	
12.	Electricity & safety measures, (IGNOU)	12	3	
13.	High Power Multilevel Converters- Analysis, design and operational issues, (IITD)	12	3	
14.	Introduction to Smart Grid, (IITR)	8	2	
15.	Linear Systems Theory, (IITM)	12	3	
16.	Power Management Integrated Circuits, (IITM)	12	3	
17.	Power Quality Improvement Technique, (IITR)	8	2	
	or Power Quality,(IITD)	12	3	
18.	Power System Dynamics, Control and Monitoring, (IIT Kharagpur)	12	3	
19.	Real-Time Digital Signal Processing, (IISc)	12	3	
20.	Charging Infrastructure (IITR)	12	3	

NOTE: However the list is not exhaustive. Before registering the course, take the approval from HOD.

Annexure VI

List of Courses for Minors Degree in Electrical Engineering

<table>
<tr><th>S.No.</th><th>Course name</th><th>Number of Weeks</th><th>Credits</th><td rowspan="19">Students have to acquire a minimum of 18 credits by completing MOOCs/ NPTEL course from the Pool</td></tr>
<tr><td>1.</td><td>Network Analysis (IITKGP)</td><td>12</td><td>3</td></tr>
<tr><td>2.</td><td>Electrical Machines – I (IITKGP)</td><td>12</td><td>3</td></tr>
<tr><td>3.</td><td>Electrical Machines - II (IIT KGP)</td><td>12</td><td>3</td></tr>
<tr><td>4.</td><td>Control Engineering (IITM)</td><td>12</td><td>3</td></tr>
<tr><td>5.</td><td>Electrical Measurement And Electronic Instruments (IITKGP)</td><td>12</td><td>3</td></tr>
<tr><td>6.</td><td>Electricity & Safety Measures (IGNOU)</td><td>12</td><td>3</td></tr>
<tr><td>7.</td><td>Electromagnetic Theory (IITK)</td><td>12</td><td>3</td></tr>
<tr><td>8.</td><td>Digital Circuits (IITKGP)</td><td>12</td><td>3</td></tr>
<tr><td>9.</td><td>Power System Engineering (IITKGP)</td><td>12</td><td>3</td></tr>
<tr><td>10.</td><td>Fundamental of Power Electronics (IISc)</td><td>12</td><td>3</td></tr>
<tr><td>11.</td><td>Fundamentals of Electric Drives (IITK)</td><td>8</td><td>2</td></tr>
<tr><td>12.</td><td>Design of photovoltaic systems (IISc)</td><td>12</td><td>3</td></tr>
<tr><td>13.</td><td>Power System Protection (IITKGP)</td><td>12</td><td>3</td></tr>
<tr><td>14.</td><td>Power Quality Improvement Technique (IITR)</td><td>8</td><td>2</td></tr>
<tr><td>15.</td><td>Introduction to Smart Grid (IITR)</td><td>8</td><td>2</td></tr>
<tr><td>16.</td><td>Power System Dynamics, Control and Monitoring (IIT Kharagpur)</td><td>12</td><td>3</td></tr>
<tr><td>17.</td><td>Power Management Integrated Circuits (IITM)</td><td>12</td><td>3</td></tr>
<tr><td>18.</td><td>Electric vehicles and Renewable energy,(IITM)</td><td>12</td><td>3</td></tr>
<tr><td>19.</td><td>Charging Infrastructure (IITR)</td><td>12</td><td>3</td><td></td></tr>
</table>

NOTE: However the list is not exhaustive. Before registering the course, take the approval from HOD.

Annexure VII

POWER ELECTRONICS & POWER SYSTEMS

COURSE STRUCTURE

M. Tech I – Semester

S. No.	Course Code	Course Title	L	T	P	C
1	V25PET01	**Program Core – I** Power Electronic Converters	3	1	0	4
2	V25PET02	**Program Core – II** Smart Grid Technologies	3	1	0	4
3	V25PET03	**Program Core – III** Power System Operation & Control	3	1	0	4
4		**Program Elective – I**	3	0	0	3
5		**Program Elective – II**	3	0	0	3
6	V25PEL01	**Laboratory – I** Power Systems Laboratory	0	1	2	2
7	V25PEL02	**Laboratory – II** Power Electronics Simulation Laboratory	0	1	2	2
8	V25SE01	Seminar-I	0	0	2	1
		TOTAL	**15**	**5**	**6**	**23**

List of Professional Elective Courses in I Semester (Electives I&II)

S. No.	Course Code	Course Title
1.	V25PET04	Electrical Machine Modeling and Analysis
2.	V25PET05	Renewable Energy Technologies
3.	V25PET06	HVDC Transmission and Flexible AC Transmission Systems
4.	V25PET07	Electrical Distribution Automation
5.	V25PET08	Reactive Power Compensation and Management
6.	V25PET09	Electric Vehicles

M. Tech II – Semester

S. No.	Course Code	Course Title	L	T	P	C
1	V25PET10	**Program Core – IV** Power Electronic Control of Electrical Drives	3	1	0	4
2	V25PET11	**Program Core – V** Switched Mode Power Conversion	3	1	0	4
3	V25PET12	**Program Core – VI** Real Time Control of Power Systems	3	1	0	4
4		**Program Elective – III**	3	0	0	3
5		**Program Elective – IV**	3	0	0	3
6	V25PEL03	**Laboratory – III** Power System Simulation Laboratory	0	1	2	2
7	V25PEL04	**Laboratory – IV** Power Converters & Drives Laboratory	0	1	2	2
8	V25SE02	Seminar – II	0	0	2	1
		TOTAL	**15**	**5**	**6**	**23**

List of Professional Elective Courses in II Semester (Electives III&IV)

S. No.	Course Code	Course Title
1.	V25PET13	Advanced Digital Signal Processing
2.	V25PET14	Applications of Power Converters
3.	V25PET15	Industrial Internet of Things
4.	V25PET16	Power Quality Enhancement using Custom Power Devices
5.	V25PET17	Advanced Power Systems Protection
6.	V25PET18	Battery Management Systems and Charging Stations

M. Tech III - Semester

S. No.	Course Code	Course Title	L	T	P	C
1	V25MOOCS1	Research Methodology and IPR *Swayam 12 week MOOC course*	3	0	0	3
2	V25SIM01	Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3	V25CV01	Comprehensive Viva#	-	-	-	2
4	V25PEP01	Dissertation Part – A$	-	-	20	10
		TOTAL	**3**	**-**	**20**	**18**

* Student attended during summer / year break and assessment will be done in III Sem.
# Comprehensive viva can be conducted courses completed upto II sem.
$ Dissertation – Part A, internal assessment.

M. Tech IV – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	V25PEP02	Dissertation Part – B%	-	-	32	16
		TOTAL	**-**	**-**	**32**	**16**

% External Assessment.

Annexure VIII

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	1	0	4	V25PET01
Name of the Course	POWER ELECTRONIC CONVERTERS (Program Core – I)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyze characteristics and gate drive requirements of modern power semiconductor switching devices.	**K4**
CO2	Evaluate performance of single-phase and three-phase controlled rectifiers with RL loads and power factor control.	**K5**
CO3	Compare modulation techniques for voltage control in single-phase and three-phase PWM inverters.	**K4**
CO4	Explain operation and features of diode-clamped, cascaded H-bridge, and modular multilevel inverters.	**K2**
CO5	Apply multilevel PWM schemes to improve harmonic performance and voltage balancing.	**K3**

UNIT– I
Overview of Switching Devices
Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.
UNIT– II
AC-DC converters
Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor- Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control, Single-phase single stage boost power factor corrected rectifier.
Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.

UNIT– III
PWM Inverters: Voltage control of single-phase inverters employing phase displacement Control, Bipolar PWM, Unipolar PWM. Three-phase Voltage source inverters: Six stepped VSI operation-Voltage Control of Three-Phase Inverters

employing Sinusoidal PWM, Third Harmonic PWM, Space Vector Modulation-Comparison of PWM Techniques- Three phase current source inverters.

UNIT– IV
Multilevel Inverters:
Introduction, Multilevel Concept, Types of Multilevel Inverters, Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode Clamped Inverter, Cascaded H-bridge Multilevel Inverter, Principle of Operation, Features of Cascaded H-bridge Inverter, Fault tolerant operation of CHB Inverter, Comparison of DCMLI & CHB, Modular multilevel converters, principle of operation.

UNIT– V
PWM Multilevel Inverters:

CHB Multilevel Inverter: Stair case modulation-SHE PWM- Phase shifted Multicarrier Modulation-Level shifted PWM- Diode clamped Multilevel inverter: SHE PWM-Sinusoidal PWM- Space vector PWM-Capacitor voltage balancing.

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M.
2. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003
3. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint-2008.

Reference Books:

1. Power Electronics Semiconductor Switches – Ram Shaw, 1993.
2. Power Electronics Daniel W. Hart - McGraw-Hill, 2011.
3. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	3	1	0	4	V25PET02
Name of the Course	SMART GRID TECHNOLOGIES (Program Core – II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyse the smart grid policies and its developments.	**K4**
CO2	Develop the concepts of smart grid technologies in hybrid electrical vehicles etc.	**K3**
CO3	Understand smart substations, feeder automation, GIS etc.	**K2**
CO4	Analyze micro grids and its applications.	**K4**
CO5	Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.	**K4**

UNIT – 1
Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT – 2
Smart Grid Technologies: Part-1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT – 3
Smart Grid Technologies: Part-2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Phase Measurement Unit(PMU),Wide Area Measurement System(WAMS).

UNIT – 4
Micro grids: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid.

UNIT – 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley Blackwell 19
3. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press.
6. Andres Carvallo, John Cooper, “The Advanced Smart Grid: Edge Power Driving Sustainability: 1”, Artech House Publishers July 2011.

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	3	1	0	4	V25PET03
Name of the Course	POWER SYSTEM OPERATION & CONTROL (Program Core – III)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyze smart grid policies and their recent developments.	**K4**
CO2	Apply smart grid technologies in applications such as hybrid electric vehicles.	**K3**
CO3	Understand smart substations, feeder automation, and GIS in power systems.	**K2**
CO4	Analyze microgrid concepts and their practical applications.	**K4**
CO5	Assess power quality issues and recent ICT advancements in smart grids.	**K3**

UNIT – 1
Unit commitment problem and optimal power flow solution: Unit commitment: Constraints in UCP, UC solution methods. Priority list method, Dynamic programming Approach.
Optimal power flow: OPF without inequality constraints, inequality constraints on control variables and dependent variables.

UNIT – 2
Single area Load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response.

UNIT – 3
Two area Load Frequency Control: Block Diagram development of two-area system, uncontrolled case and controlled case, tie-line bias control, steady state representation. Optimal two-area LF control- performance Index and optimal parameter adjustment. Load frequency control and Economic dispatch control, Automatic generation control (AGC)

UNIT – 4
Generation with limited Energy supply: Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard

limits and slack variables, Fuel scheduling by linear programming.

UNIT – 5

Interchange Evaluation and Power Pools Economy Interchange: Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange transactions, Other types of Interchange, power pools, transmission effects and issues.

Text Books:

1. Power Generation, Operation and Control - by A.J.WoodandF.Wollenberg, Johnwiley& sons Inc. 1984.
2. Modern Power System Analysis - by I.J.Nagrath & D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.

Reference Books:

1. Power system operation and control PSR Murthy B.S publication.
2. Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3. Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET04
Name of the Course	ELECTRICAL MACHINES MODELING AND ANALYSIS (PROGRAM ELECTIVE– I & II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Develop mathematical models and analyze the dynamic behavior of DC machines using state-space and transfer function approaches.	**K3**
CO2	Apply reference frame theory and perform phase transformations for modeling three-phase induction motors.	**K3**
CO3	Model three-phase induction motors in various reference frames and derive state-space equations for dynamic analysis.	**K4**
CO4	Formulate the circuit and voltage equations of three-phase synchronous motors using dq0 reference frames and develop their state-space models.	**K4**
CO5	Model special electrical machines including permanent magnet synchronous motors, brushless DC motors, and switched reluctance motors.	**K4**

UNIT– I
Basic Concepts of Modeling & DC Machine Modeling:
Basic two-pole D.C. machine - Primitive 2-axis machine – Voltage and Current relationship – Torque equation. Mathematical model of separately excited D.C. motor and D.C. Series motor in state variable form – Mathematical model of D.C. shunt motor and D.C. Compound motor in state variable form, Steady state analysis – Transient state analysis, Transfer function of the D.C. motor, Sudden application of inertia load.

UNIT– II
Reference Frame Theory & 3-phase Induction Motor dq model:
Linear transformation – Phase transformation (abc to αβ0) – Power equivalence, Active transformation (αβ0 to dq0), transformations in complex plane, Commonly used reference frames and transformation between reference frames, Circuit model of a 3 phase Induction motor – Flux linkage

equation – dq transformation of flux linkages in the complex plane – voltage equations

UNIT– III
Modeling of 3-phase Induction motor in various reference frames
Voltage equation transformation to a synchronous reference frame, dq model of induction motor in the stator reference frame, rotor reference frame and arbitrary

reference frame, power equation, electromagnetic torque equation, state space model in induction motor with flux linkages as variables and current-flux variables

UNIT– IV

Modeling of 3-phase Synchronous Motor

Synchronous machine inductances – Circuits model of a 3-phase synchronous motor – derivation of voltage equations in the rotor's dq0 reference frame electromagnetic torque – State space model with flux linkages as variables.

UNIT– V

Special Machines:

Modeling of Permanent Magnet Synchronous motor – Modeling of Brushless DC Motor, Modeling of Switch Reluctance Motors

Text Books

1. Generalized theory of Electrical Machines -Fifth edition, Khanna Publishers P. S. Bimbhra, 1985.
2. AC Motor control and electric vehicle applications – Kwang Hee Nam – CRC press, Taylor & Francis Group, 2010.
3. Analysis of Electric Machinery and Drive Systems, 3rd Edition-Wiley-IEEE Press-Paul Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, Junr 2013.

Reference Books:

1. Dynamic simulation of Electric machinery using MATLAB / Simulink – CheeMunOng- Prentice Hall, 2003.
2. Magneto electric devices transducers, transformers and machines-G. R. Slemon-Wiley in New York, London, 1966.
3. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications.

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET05
Name of the Course	RENEWABLE ENERGY TECHNOLOGIES (PROGRAM ELECTIVE – I & II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain renewable energy sources, distributed generation concepts, and evaluate the economics of renewable power systems.	K2
CO2	Analyze principles, operation, and control of self-excited and interconnected induction generators.	K4
CO3	Assess wind power plant site selection, turbine classifications, and the design of small wind energy conversion systems.	K3
CO4	Understand photovoltaic power generation, model PV panels, and apply maximum power point tracking techniques under varying conditions.	K2
CO5	Describe fuel cell types, construction, equivalent models, and practical applications including hydrogen storage considerations.	K2

UNIT– 1
Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics- Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy based power Systems

UNIT– 2
Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated - Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation - Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation - Speed and Voltage Control.

UNIT– 3
Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation- General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines - Generators and Speed Control Used in Wind Power Energy; Analysis of Small wind energy conversion system.

UNIT– 4
Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT

schemes: P&O,INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy

UNIT– 5

Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyzer Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage

Text Books:

1. Felix A. Farret, M. Godoy Simo` es, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET06
Name of the Course	HVDC TRANSMISSION AND FLEXIBLE AC TRANSMISSION SYSTEMS (PROGRAM ELECTIVE –I&II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Describe the evolution, components, and advantages of HVDC transmission systems compared to HVAC systems.	K2
CO2	Analyze HVDC converter configurations, Graetz circuit operation, and valve conduction modes with voltage waveform characteristics	K4
CO3	Explain HVDC link control techniques, power flow control, and design of harmonic filters for system performance improvement.	K2
CO4	Understand FACTS concepts, types of controllers, and their role in enhancing AC power flow and system stability.	K2
CO5	Analyze static shunt and series compensators, including SVC, STATCOM, TCSC, SSSC, and Unified Power Flow Controller operation and control	K4

UNIT– 1
HVDC Transmission: DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems.

UNIT– 2
Analysis of HVDC Converters: Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms.

UNIT– 3
HVDC Control: Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control.AC-DC power flow.
Harmonics and Filters: effects of Harmonics, sources of harmonic generation, Types of filters – Design examples.

UNIT– 4
Flexible AC Transmission Systems (FACTS): FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters,

Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters.

UNIT– 5

Static Shunt Compensators: Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, STATCOM, basic operating principle, control approaches and characteristics

Static Series Compensators: Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power.

Text Books:

1. NarainG.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.
2. K.R.Padiyar: HVDC Power Transmission Systems –Technology and System Interactions, New Age International Publishers, 2011.

Reference Books:

1. Kimbark: Direct Current Transmission, 1971.
2. Jos Arrillaga: High Voltage Direct Current Transmission, The Institution of electrical Engineers, 1998.
3. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET07
Name of the Course	ELECTRICAL DISTRIBUTION AUTOMATION (PROGRAM ELECTIVE–I&II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain load modeling, characteristics, and factors affecting distribution system planning.	K2
CO2	Analyze and design distribution feeders, substations, and optimal placement for efficient service.	K4
CO3	Understand protective devices and coordinate their operation for reliable distribution system protection.	K2
CO4	Assess capacitive compensation and voltage control techniques for improved power factor and voltage regulation	K3
CO5	Describe distribution automation functions, including EMS, DMS, SCADA, GIS, and synchrophasor applications	K2

UNIT – 1
General : Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modelling and characteristics - definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT – 2
Distribution Feeders and Substations: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading. Design practice of the secondary distribution system.
Location of Substations, Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations.

UNIT – 3
Protective devices and coordination: Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers.
Coordination of protective devices: General coordination procedure; types of coordination.

UNIT – 4

Capacitive compensation and Voltage control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location.

Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

UNIT – 5

Distribution automation functions: Electrical system automation, EMS functional scope, DMS functional scope functionality of DMS- Steady state and dynamic performance improvement; Geographic information systems- AM/FM functions and Database management; communication options, supervisory control and data acquisition: SCADA functions and system architecture; Synchrophasors and its application in power systems.

Text Books:

1. "Electric Power Distribution System Engineering" by Turan Gonen, McGraw-Hill Book Company, 1986.
2. Distribution System Analysis and Automation, by Juan M. Gers, The Institution of Engineering and Technology, UK 2014.

Reference Books:

1. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.
2. Electrical Distribution V.Kamaraju –Mc Graw Hill
3. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET08
Name of the Course	REACTIVE POWER COMPENSATION AND MANAGEMENT (PROGRAM ELECTIVE–I&II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyze load compensation techniques for voltage regulation, phase balancing, and power factor correction in unbalanced loads.	**K4**
CO2	Assess line compensation methods including passive and dynamic shunt and series compensation under steady-state and transient conditions.	**K3**
CO3	Model reactive power coordination, plan operations, and assess power quality disturbances in electrical systems.	**K4**
CO4	Plan and implement reactive power management on distribution and user sides to reduce losses and improve power factor.	**K3**
CO5	Analyze reactive power control requirements and compensation methods in electric traction systems and arc furnaces	**K4**

UNIT– 1
Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT– 2
Line compensation: Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples.
Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples.

UNIT– 3
Reactive power coordination: Objective – Mathematical modelling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences.

UNIT– 4
Distribution side Reactive power Management:
System losses –loss reduction methods – examples – Reactive power planning – objectives

– Economics Planning capacitor placement – retrofitting of capacitor banks.

User side reactive power management:
KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations.

UNIT– 5

Reactive power management in electric traction systems and arc furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace.

Text Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982 .
2. Reactive power Management by D.M.Tagare, Tata McGraw Hill, 2004

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	3	0	0	3	V25PET09
Name of the Course	ELECTRIC VEHICLES (PROGRAM ELECTIVE–I&II)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Describe fundamentals, components, and classifications of conventional, electric, and hybrid vehicles, highlighting key differences.	**K2**
CO2	Explain hybridization concepts including HEV, PHEV, and fuel cell vehicles, and compare their architectures.	**K2**
CO3	Analyze motor selection, motor control units, and regenerative braking techniques in electric vehicles.	**K4**
CO4	Understand various power electronic converters and their applications in hybrid electric vehicles for energy conversion and control.	**K2**
CO5	Assess different energy storage technologies and their characteristics for electric and hybrid vehicles	**K3**

UNIT– 1
Introduction:
Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept and classification of electric vehicle and hybrid electric vehicle; History of electric and hybrid vehicles, Comparison of conventional vehicle with electric and hybrid vehicles.

UNIT– 2
Hybridization of Automobile:
Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.

UNIT– 3
Motor Control in Electric Vehicles:
Role of motors in Electric Vehicles, factors to choose motors for EV, Comparison of motors for EV power train, Motor Controller Unit (MCU)- need and components, Motor control units of two- and four –wheel EVs, Regenerative braking.

UNIT– 4
Power Electronics in HEVs:
Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated

bidirectional DC- DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

UNIT– 5

Battery and Storage Systems

Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource

Text Books

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H. Partab: Modern Electric Traction – Dhanpat Rai & Co, 2007.
4. Pistooa G., “Power Sources , Models, Sustanability, Infrastructure and the market”, Elsevier 2008.
5. Mi Chris, Masrur A., and Gao D.W., “ Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives” 1995.

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	0	1	2	2	V25PEL01
Name of the Course	POWER SYSTEMS LABORATORY (LABORATORY – I)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Calculate the sequence impedances of the synchronous machine.	**K3**
CO2	Calculate the sequence impedances and explain the connections of the transformer.	**K3**
CO3	Describe the Ferranti effect and compensation in transmission lines.	**K2**
CO4	Analyze the performance and importance of transmission line parameters.	**K4**
CO5	Analyze the operation of various protection relays.	**K4**

List of Experiments:

1. Determination of Sequence Impendence of an Alternator by direct method.
2. Determination of Sequence impedance of an Alternator by fault Analysis.
3. Measurement of sequence impedance of a three phase transformer
   (a) by application of sequence voltage. (b) using fault analysis.
4. Power angle characteristics of a salient pole Synchronous Machine.
5. Poly-phase connection on three single phase transformers and measurement of phase displacement.
6. Determination of equivalent circuit of 3-winding Transformer.
7. Measurement of ABCD parameters on transmission line model.
8. Performance of long transmission line without compensation.
9. Study of Ferranti effect in long transmission line.
10. Performance of long transmission line with shunt compensation.

Semester	I SEM	L	T	P	C	COURSE CODE
Regulation	V25	0	1	2	2	V25PEL02
Name of the Course	POWER CONVERTERS SIMULATION LABORATORY (LABORATORY – 2)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understanding of power MOSFET and IGBT switching behavior, including their advantages and limitations in power electronic applications	**K2**
CO2	Apply driver circuit designs for effective control of MOSFET and IGBT power devices in switching converters	**K3**
CO3	Analyze the performance of simulated converter and inverter circuits under various load conditions and modulation schemes for improved power electronic system design.	**K4**
CO4	20. Analyze multilevel inverter configurations through simulation to improve power quality and system performance in advanced applications.	**K4**

Any 10 of the following experiments are to be conducted.

List of Experiments:

1. Illustrate the switching characteristics of power MOSFET and power IGBT
2. Illustrate the use of Driver circuit for power MOSFET and power IGBT
3. Simulation of three phase full converter with RL & RLE loads.
4. Simulation of three-phase dual converter.
5. Simulation of single-phase full bridge inverter using unipolar & bipolar PWM techniques.
6. Simulation of three-phase two-level inverter for 120º & 180º mode of conduction.
7. Simulation of three phase two-level inverter using SPWM.
8. Simulation of three phase two-level inverter using Third Harmonic PWM,
9. Simulation of three phase two-level inverter using space vector PWM.
10. Simulation of three phase three-level NPC inverter using SPWM.
11. Simulation of three phase five-level diode clamped inverter using SPWM
12. Simulation of Stair case modulation and SHE PWM for single-phase seven-level cascaded H- bridge inverter.
13. Simulation of Multicarrier PWM techniques for three-phase five-level cascaded H-bridge inverter.
14. Simulation of Modular Multilevel Converter.

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	0	0	2	1	V25SE01
Name of the Course	SEMINAR - I					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Identify and investigate a contemporary topic relevant to their area of specialization through a critical literature review	**K4**
CO2	Illustrate advanced oral communication and presentation skills for effective knowledge dissemination	**K3**
CO3	Prepare a comprehensive seminar report that adheres to standards of academic and professional integrity	**K6**
CO4	Demonstrate the ability to participate in academic discourse and respond effectively to questions related to the seminar topic.	**K5**

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	1	0	4	V25PET10
Name of the Course	POWER ELECTRONIC CONTROL OF ELECTRICAL DRIVES (PROGRAM CORE – IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain and implement vector control techniques including direct, indirect, and rotor/stator field-oriented control for induction motors.	**K2**
CO2	Analyze sensorless speed control methods of induction motors using voltage-current models, MRAS, observers, and Kalman filters	**K4**
CO3	Describe the principles and control strategies of Direct Torque Control (DTC) and compare it with vector control for induction motors.	**K2**
CO4	Understand control approaches for Permanent Magnet Synchronous Machines and Brushless DC motors, including torque ripple reduction methods.	**K2**
CO5	Analyze switched reluctance motor structure, control schemes, and techniques for torque ripple minimization and speed regulation.	**K4**

UNIT– 1
Vector Control of Induction Motor Drive:
Open loop and closed loop V/f control, Principle of vector control – direct and indirect vector control, implementation of direct and indirect vector control, rotor field-oriented control, implementation of rotor field-oriented control, stator field-oriented control, field weakening control of induction motor.

UNIT– 2
Sensor less Control of induction Motor Drive:
Advantages of speed sensor less control, voltage current based speed sensor less control, MRAS- model reference adaptive systems, state equation of an induction motor, state observers, full-order observer, reduced order observer, Extended Kalman filter observers.

UNIT– 3
Direct Torque Control of Induction Motor Drive:
Principle of Direct torque control (DTC), concept of space vectors, DTC control strategy of induction motor, comparison between vector control and DTC, modified DTC of induction motor with constant switching frequency, space vector modulation based DTC of induction motors.

UNIT– 4

Control of Permanent Magnet Synchronous Machines (PMSM) and Brushless DC (BLDC) Motor Drives:

Advantages and limitations of Permanent magnet machines, operating principle of PMSM, vector control for PMSM, operating principle of BLDC, modeling of BLDC, similarities and difference between PMSM and BLDC, need for position sensing in BLDC motors, control strategies for PMSM and BLDC, methods of reducing torque ripples of BLDC motor.

UNIT– 5

Control of Switched Reluctance Motor (SRM) Drive:

SRM structure, Merits and limitations, stator excitation, converter topologies, SRM waveforms, Torque control schemes, speed control of SRM, torque ripple minimization, instantaneous -torque control using current controllers and flux controllers.

Text Books:

1. Bose B. K., "Power Electronics and Variable Frequency Drives', IEEE Press, Standard Publisher Distributors. 2001.
2. Kwang Hee Nam, "AC Motor Control and Electrical Vehicle Applications" Second Edition, CRC Press.

Reference Books:

1. Seung-Ki Sul, "Control of Electric Machine Drive Systems" IEEE Press, A John Wiley & Sons, Inc. Publications. 2011.
2. Krishnan R., "Electric Motor Drives – Modeling, Analysis and Control", Prentice Hall of India Private Limited.
3. Switched Reluctance Motors and Their Control-T. J. E. Miller, Magna Physics, 1993.
4. Power electronic converters applications and design-Mohan, Undeland, Robbins-Wiley publications.

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	1	0	4	V25PET11
Name of the Course	SWITCHED MODE POWER CONVERSION (PROGRAM CORE – V)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyze the operation and control of non-isolated DC-DC converters including buck, boost, buck-boost, and CUK converters	**K4**
CO2	Explain the topologies and working principles of isolated switched mode converters such as forward, flyback, push-pull, half-bridge, and full-bridge converters.	**K2**
CO3	Understand resonant converter circuits and their zero current/voltage switching techniques for efficiency improvement	**K2**
CO4	Develop and design power converter components including inductors, transformers, filters, and thermal management systems	**K3**
CO5	Develop mathematical models and design controllers for switched mode power converters using circuit averaging and frequency response techniques.	**K3**

UNIT– 1
Non-isolated switch mode converters:
Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, continuous and discontinuous operation, Converter realization with non-ideal components.

UNIT– 2
Isolated switched mode converters:
Forwarded converter, flyback converter, push-pull converter, half-bridge converter, full bridge converter.

UNIT– 3
Resonant converters:
Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter, load resonant converter.

UNIT– 4
Design of Power Converters Components: Magnetic concepts - design of inductor, design of transformer, Selection of filter capacitors, Selection of ratings for devices, input filter design, Thermal design

UNIT– 5

Modeling and Controller design:

Circuit averaging method and average switch model technique to obtain averaged large signal model, steady state model, small signal models of buck, boost, buck-boost converters, Derivation of converter transfer functions for buck, boost and buck-boost topologies. Voltage mode control, Current mode control, current mode control instability, slope compensation, Controller design using Bode approach.

Text Books:

1. Fundamentals of Power Electronics-Erickson, Robert W., Maksimovic, Dragan, Springer, 2011.
2. Power switching converters-Simon Ang, .Alejandro Oliva, CRC Press, 2010
3. Power Electronics: Essentials and applications- L. Umanand, Wiley publications

Reference Books:

1. Design of Magnetic Components for Switched Mode Power Converters- Umanand, S.P. Bhat, John Wiley & Sons Australia, 1992
2. Switching Power Supply Design-Abraham I. Pressman, McGraw-Hill Ryerson, Limited, 1991.
3. Power Electronics – IssaBatareseh, Jhon Wiley publications, 2004.
4. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	3	1	0	4	V25PET12
Name of the Course	REAL TIME CONTROL OF POWER SYSTEMS (PROGRAM CORE – VI)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Assess various types of state estimation techniques and handle bad data in measurements and assess system observability.	**K3**
CO2	Analyze system security and perform contingency analysis for generator and line outages using iterative and fast decoupled power flow models.	**K4**
CO3	Understand and explain the operating states of power systems and the architecture and function of SCADA systems.	**K2**
CO4	Assess voltage stability using P-V and Q-V curves, and analyze long-term voltage stability and collapse scenarios.	**K3**
CO5	Demonstrate knowledge of PMU structure, phasor representation, GPS synchronization, and evaluate DFT estimation for off-nominal frequency signals.	**K3**

UNIT – 1:
State Estimation: Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

UNIT – 2:
Security and Contingency Evaluation : Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

UNIT – 3:
Computer Control of Power Systems: Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres, software requirements for implementing the above functions.

UNIT – 4:
Voltage Stability: Definitions of Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V’ curves and `Q-V’ curves, voltage stability

in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices.

UNIT – 5:

Synchro phasor Measurement units: Introduction, Phasor representation of sinusoids, a generic PMU, GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.

Text Books:

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation andcontrol, John Wiley & Sons, 1984.
3. A.G.Phadka and J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer, 2008

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics, WileyEastern Ltd. 1986
3. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
4. P.D.Wasserman : `Neural Computing : Theory and Practice' Van Nostrand -Feinhold, New York.

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET13
Name of the Course	ADVANCED DIGITAL SIGNAL PROCESSING (PROGRAM ELECTIVE – III&IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain various digital filter structures, including FIR, IIR, lattice, and all-pass filters, and analyze their computational complexities.	K2
CO2	Develop IIR and FIR digital filters using methods such as bilinear transformation, spectral transformation, and least-square optimization.	K3
CO3	Implement DSP algorithms including discrete Fourier transform, arithmetic operations, and tunable digital filters efficiently.	K3
CO4	Analyze finite word length effects including quantization errors, round-off errors, and limit cycles in digital filter realizations.	K4
CO5	Apply non-parametric and parametric methods for power spectrum estimation of finite-duration signals.	K3

UNIT– 1
Digital Filter Structure: Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures- FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

UNIT– 2
Digital filter design: Preliminary considerations-Bilinear transformation method of IIR filter design- design of lowpass, high pass-band pass, and band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on windowed Fourier series-design of FIR digital filters with least –mean- square-error-constrained least-square design of FIR digital filters

UNIT– 3
DSP algorithm implementation: Computation of the discrete Fourier transform-number representation-arithmetic operations handling of overflow-tunable digital filters-function approximation.

UNIT– 4
Analysis of finite Word length effects: The quantization process and errors-quantization of fixed
-point and floating -point Numbers-Analysis of coefficient quantization effects, Analysis of arithmetic round-off errors, dynamic range scaling-signal- to- noise ratio in

low -order IIR filters- low-sensitivity digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters, Round-off errors in FFT Algorithms.

UNIT– 5
Power Spectrum Estimation: Estimation of spectra from finite duration observations signals – Non- parametric methods for power spectrum estimation – parametric method for power spectrum estimation, estimation of spectral form-finite duration observation of signals-non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.

Text Books:

1. Digital signal processing-Sanjit K. Mitra-TMH second edition, 2002.
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint

21.

Reference Books:

1. Digital Signal Processing and principles, algorithms and Applications – John G.Proakis - PHI –3rd edition-2002.
2. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
3. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar&Bernold.
4. Digital Filter Analysis and Design-Auntonian-TMH.

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET14
Name of the Course	APPLICATIONS OF POWER CONVERTERS (PROGRAM ELECTIVE – III&IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand the design and operation of inverters for induction heating applications such as cooking, hardening, melting, and welding.	K2
CO2	Analyze power converters for lighting, pumping, and refrigeration systems including electronic ballasts and LED drivers with grid and PV sources	K4
CO3	Describe high voltage power supplies for X-ray, radar, space applications, and low voltage, high current supplies for microprocessor loads.	K2
CO4	Explain bi-directional DC-DC converters used in electric traction, automotive electronics, and solar charge control applications.	K2
CO5	Assess power conditioners including UPS, active power filters, and unified power quality conditioners for power quality improvement	K3

UNIT-1
Inverters for Induction Heating: For induction cooking, induction hardening, melting, and welding applications.

UNIT-2
Power Converters for Lighting, pumping and refrigeration Systems: Electronic ballast, LED power drivers for indoor and outdoor applications. PFC based grid fed LED drivers, PV / battery fed LED drivers. PV fed power supplies for pumping/refrigeration applications.

UNIT-3
High Voltage Power Supplies - Power supplies for X-ray applications - power supplies for radar applications - power supplies for space applications.
Low voltage high current power supplies: Power converters for modern microprocessor and computer loads

UNIT-4
Bi-directional DC-DC (BDC) converters: Electric traction, automotive Electronics and charge/discharge applications, Line Conditioners and Solar Charge Controllers

UNIT-5
Power Conditioners:
Uniterupted Power Supplies - Active Power Filters - Shunt active power filters - Series active power filters - Hybrid active power filters - UPQC

Text Books:

1. Ali Emadi, A. Nasiri, and S. B. Bekiarov: Uninterruptible Power Supplies and Active Filters, CRC Press, 2005.
2. M. Ehsani, Y. Gao, E. G. Sebastien and A. Emadi: Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 1st Edition,CRC Press, 2004.

References Books:

1. William Ribbens: Understanding Automotive Electronics, Newnes, 2003.

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET15
Name of the Course	INDUSTRIAL INTERNET OF THINGS (PROGRAM ELECTIVE – III&IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Describe IoT communication technologies, networking basics, protocols, and interoperability issues.	**K2**
CO2	Develop IoT control applications using Arduino and Raspberry Pi platforms, integrating sensors and actuators	**K3**
CO3	Understand solid-state lighting technologies, LED characteristics, drivers, and dimming for domestic and industrial use.	**K2**
CO4	Analyze the application of BLDC motors, inverter technologies, and smart devices in home and industrial appliances.	**K4**
CO5	Explain IoT cloud computing concepts, SDN architecture, data analytics, and applications in smart cities, agriculture, and healthcare.	**K2**

UNIT-1
IoT Communication Technologies: Introduction to IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications. Interoperability in IoT.

UNIT-2
IoT Control Technologies and Programming: Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Internet of Things Open-Source Systems. Introduction to Python programming, Introduction to Raspberry. Implementation of IoT with Raspberry Pi, Smart Grid Hardware Security.

UNIT-3
Domestic & Industrial Appliances (Part-1): Solid State Lamps: Introduction - Review of Light sources - white light generation techniques-Characterization of LEDs for illumination application. Power LEDs - High brightness LEDs - Electrical and optical properties. LED driver considerations- Power management topologies -color issues of white LEDs- Dimming of LED sources,

UNIT-4
Domestic & Industrial Appliances (Part-2): BLDC motors for pumping and domestic fan appliances, inverter technology-based home appliances, Smart devices and equipment. Industrial IoT applications Factories and Assembly Line- Power Plants, Plant Safety and Security (Including AR and VR safety applications)- Oil and chemical Industry-

Applications of UAVs in Industries.

UNIT-5
IoT Cloud Computation and Applications: Introduction to SDN. SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor- Cloud. Fog Computing, Smart Cities and Smart Homes, Electric Vehicles, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring, Role of ML and AI in IoT.

Text Books:

1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0, CRC press, 2021.
2. Kostas Siozios, Dimitrios Anagnostos, Dimitrios Soudris, Elias Kosmatopoulos, IoT for Smart Grids: Design Challenges and Paradigms, Springer publishers, 2019.
3. Vinod Kumar Khanna, Fundamentals of Solid-State Lighting: LEDs, OLEDs, and Their Applications in Illumination and Displays, CRC press, 2014, 1st Edition.

Reference Books:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress Publishers, 2016.
2. Craig Di Louie, Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications, River publishers, 2006, e-book, 2021,1st Edition.
3. Chang-liang Xia, Permanent Magnet Brushless DC Motor Drives and Controls, John Wiley & Sons Singapore Pte. Ltd., 2012, 1st Edition.

Other Suggested Readings:
https://nptel.ac.in/courses/106105166

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET16
Name of the Course	POWER QUALITY ENHANCEMENT USING CUSTOM POWER DEVICES (PROGRAM ELECTIVE–III &IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	22. Identify the issues related to power quality in power systems.	**K2**
CO2	23. Address the problems of transient and long duration voltage variations in power systems.	**K2**
CO3	24. Analyze the effects of harmonics and study of different mitigation techniques.	**K4**
CO4	25. Identify the importance of custom power devices and their applications.	**K2**
CO5	26. Acquire knowledge on different compensation techniques to minimize power quality disturbances.	**K3**

UNIT– 1

Introduction to power quality: Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads.

UNIT– 2

Transient and Long Duration Voltage Variations: Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems.

Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed generation

UNIT– 3

Harmonic Distortion and solutions: Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic

Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics

UNIT– 4

Custom Power Devices: Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.

UNIT– 5

Application of custom power devices in power systems: Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR), Operation and control of Interline Power Flow Controller (IPFC), Operation and control of Unified Power Quality Conditioner (UPQC), Generalized power quality conditioner.

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis).
5. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier
6. Power Quality, C. Shankaran, CRC Press, 2001
7. Instantaneous Power Theory and Application to Power Conditioning, H. Akagiet.al., IEEE Press, 2007.

8. Custom Power Devices - An Introduction, ArindamGhosh and Gerard Ledwich, Springer, 2002
9. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET17
Name of the Course	ADVANCED POWER SYSTEM PROTECTION (PROGRAM ELECTIVE–III &IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Distinguish static and electromagnetic relays and explain fundamental static relay tools and triggering circuits.	**K2**
CO2	Examine amplitude and phase comparator principles and design various types of static comparator circuits	**K3**
CO3	Understand and apply static overcurrent, distance, directional, and differential relay characteristics and fault impedance measurement.	**K2**
CO4	Explain pilot protection schemes including wire pilot, carrier current, and optical fiber-based protection techniques.	**K2**
CO5	Describe microprocessor-based and numerical relay principles along with protection algorithms such as Mann-Morrison and DFT techniques.	**K2**

UNIT – 1
Static Relays classification and Tools: Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

UNIT – 2
Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.
Phase Comparison: Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

UNIT – 3
Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings.

UNIT – 4

PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

UNIT – 5

Microprocessor based relays and Numerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay.
Numerical Protection: Introduction - numerical relay - numerical relaying algorithms – mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability Kimbark Vol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –Bhavesh Bhalaja, R.PMaheshwari, Nilesh G.Chothani-Oxford publisher

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	3	0	0	3	V25PET18
Name of the Course	BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS (PROGRAM ELECTIVE – III &IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Describe different types of EV batteries, their construction, characteristics, and performance parameters.	**K2**
CO2	Explain various battery charging algorithms and balancing methods for efficient and safe battery pack charging.	**K2**
CO3	Understand the design and requirements of domestic and public EV charging infrastructure, including fast charging and battery swapping.	**K2**
CO4	Examine Battery Management System design requirements, sensing, control, communication, and diagnostics for EV battery packs.	**K3**
CO5	Develop and simulate battery models for Li-ion and NiCd batteries to predict performance under different conditions.	**K3**

Unit - I:
EV Batteries
Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. **Lead Acid Batteries:** Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. **Nickel-based Batteries:** Nickel cadmium, Nickel metal hydride batteries.
Sodium-Based Batteries:
Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries.
Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery.

Unit - II:
Battery charging strategies
Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.

Unit -III:
Charging Infrastructure
Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

Unit - IV:
Battery-Management-System Requirements
Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics .

Unit - V:
Battery Modelling
General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

Text Books
1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk. (Unit-1)
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016. (Unit-2)

Reference Books:
1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001. (Unit-3)
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016. (Unit-4)
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002. (Unit-5)

Semester	II SEM	L	T	P	C	COURSE CODE
Regulation	V25	0	1	2	2	V25PEL03
Name of the Course	POWER SYSTEM SIMULATION LABORATORY (LABORATORY – III)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Distinguish between different load flow methods.	**K2**
CO2	Building and analyzing Y-bus & Z-bus algorithms.	**K3**
CO3	Practice and analyze the symmetrical & unsymmetrical faults.	**K3**
CO4	Recognize the importance of Load frequency control and Economic load dispatch.	**K4**
CO5	Recognize the importance of transient stability analysis.	**K4**

List of Experiments

Any 10 of the following experiments are to be conducted

1. Formation of Y- Bus by Direct-Inspection Method
2. Load Flow Solution Using Gauss-Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Load Flow Solution Using Decoupled Method
5. Load Flow Solution Using Fast Decoupled Method
6. Formation of Z-Bus by Z-bus building algorithm
7. Symmetrical Fault analysis using Z-bus
8. Unsymmetrical Fault analysis using Z-bus
9. Economic Load Dispatch with & without transmission losses
10. Transient Stability Analysis Using Point By Point Method
11. Load Frequency Control of Single Area Control with and without controllers.
12. Load Frequency Control of Two Area Control system with and without controllers.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	0	1	2	2	V25PEL04
Name of the Course	POWER CONVERTERS & DRIVES LABORATORY (LABORATORY – IV)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understanding of converter and inverter operation, PWM techniques, and their effects on power quality and load characteristics.	**K2**
CO2	27. Apply modulation schemes and vector control principles to develop open-loop and closed-loop speed control of various motor drives effectively.	**K3**
CO3	28. Analyze waveforms, modulation patterns, and motor drive responses under different control schemes including rotor flux-oriented vector control and direct torque control.	**K4**
CO4	Assess the performance and suitability of advanced inverter and motor control methods.	**K3**

Any 10 of the following experiments are to be conducted.
List of Experiments:

1. Analysis of single phase full converter with RL & RLE loads.
2. Analysis of three phase full converter with RL & RLE loads.
3. Analysis of single-phase full bridge inverter using unipolar & bipolar PWM techniques.
4. Analysis of three-phase two-level inverter for 120º & 180º mode of conduction.
5. Analysis of three phase two-level inverter using SPWM.
6. Analysis of three phase two-level inverter using space vector PWM.
7. Analysis of three phase three-level NPC inverter using SPWM
8. Analysis of Multicarrier PWM techniques for three-phase five-level cascaded H-bridge inverter.
9. Speed control of induction motor in open loop and closed loop using V/f method
10. Indirect vector control of induction motor with rotor field-oriented scheme.
11. Direct vector control of induction motor with rotor field-oriented scheme.
12. Switching table based direct torque control of induction motor.
13. Space vector modulation based direct torque control of induction motor.
14. Vector control of permanent magnet synchronous motor.
15. Speed control of brushless DC motor drive
16. Speed control of switched reluctance motor drive.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	0	0	2	1	V25SE02
Name of the Course	SEMINAR - II					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Critically review and synthesize advanced literature to identify research challenges in their discipline.	**K5**
CO2	Demonstrate the ability to communicate research findings through articulate presentations and logical argumentation.	**K3**
CO3	Prepare a comprehensive and well-structured seminar report adhering to standards fit for academic publication.	**K6**
CO4	Defend their review and conclusions through active academic engagement and discussion.	**K5**

Semester	**III SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	0	0	0	3	V25SIM01
Name of the Course	SUMMER INTERNSHIP/ INDUSTRIAL TRAINING (8-10 WEEKS)					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Apply theoretical knowledge and engineering principles to real-world industry problems.	**K3**
CO2	Analyze and solve technical challenges encountered during the internship.	**K4**
CO3	Communicate technical information effectively through reports and presentations.	**K3**
CO4	Evaluate the effectiveness of engineering solutions and suggest improvements.	**K5**
CO5	Demonstrate professionalism, teamwork, and ethical responsibility in a work environment.	**K3**

Semester	III SEM	L	T	P	C	COURSE CODE
Regulation	V25	0	0	0	2	V25CV01
Name of the Course	COMPREHENSIVE VIVA					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Explain comprehensively to answer questions from all courses studied in the program.	K2
CO2	Recall and apply theoretical knowledge to solve problems and justify answers during the viva.	K3
CO3	Analyze and evaluate questions critically, provide reasoned arguments and solutions.	K4
CO4	Synthesize knowledge across subjects to create coherent, integrated responses.	K6
CO5	Engage confidently in academic discourse and defend ideas under questioning.	K5

Semester	III SEM	L	T	P	C	COURSE CODE
Regulation	V25	0	0	20	10	V25PEP01
Name of the Course	DISSERTATION PART – A					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Identify a research topic in the advanced areas of specialization	K4
CO2	Review and critically analyze literature to identify gaps, and define clear objectives and scope of work.	K5
CO3	Develop an appropriate research methodology or framework based on literature insights.	K6
CO4	Construct models, experimental setups or computational techniques necessary to meet the research objectives	K6

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V25	0	0	32	16	V25PEP02
Name of the Course	DISSERTATION PART – B					
Specialization	PE&PS					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Demonstrate the implementation and development of the research plan formulated in Part A	**K5**
CO2	Analyze experimental/simulation results and validate the research hypotheses	**K4**
CO3	Develop and optimize solutions or models based on research findings.	**K6**
CO4	Prepare and present a detailed dissertation report that meets academic standards for publication and defence.	**K6**
CO5	Defend the dissertation during viva-voce with clarity and confidence, addressing all technical questions.	**K5**