GOVERNMENT COLLEGE OF ENGINEERING, BARGUR

Regulation – 2018

AUTONOMOUS

Curriculum for Full Time – M.E. –Power Electronics and Drives

From the Academic Year 2018-2019 onwards

Programme Outcomes (PO):

PO1 Apply the knowledge of science and mathematics in designing, analyzing and using power converters for various industrial and domestic applications.

PO2 Design the modern electric machines, drives, power converters, and control circuits for specific application.

PO3 Use modern tools, professional software platforms, embedded systems for the Diversified applications.

PO4 Explore ideas for inculcating research skills.

PO5 Solve the problems which need critical and independent thinking to show reflective learning.

PO6 Imagine the larger picture and correlate the domain knowledge with the global industrial problems.

PO7 Acquire sound knowledge in Power Electronics and Drives.

PO8 Analyze Power electronics and drives related Engineering problems and synthesize the information for conducting high level of research.

PO9 Ability to form, understand group dynamics and work inter-disciplinary groups in order to achieve the goal.

PO10 Ability to update knowledge and skills through lifelong learning to keep abreast with the technological developments.

PO11 Understand the leadership principles and subject oneself to introspection and take voluntary remedial measures for effective professional practice in the field of Power Electronics and Electric Drives.

Programme Specific Outcomes (PSO):

PSO1 Specify, design, prototype and test modern power electronic systems using various software tools.

PSO2 Ability to understand the Practical Problems in Electric drives, Power System and Renewable Energy technology.

PSO3 Inculcate the ability to apply power electronic concepts and practices into engineering systems for the betterment of industry as well as society..

ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM DESIGN

CREDIT SUMMARY

Name of the PG Programme: **M.E – POWER ELECTRONICS AND DRIVES**

Credit Summary

Sl. No	**Subject Area**	**Credits per Semester**				**Credits Total**	**As per AICTE model curriculum**
S.NO	**Semester**	**I**	**II**	**III**	**IV**		**Credits**
1.	PC	16	13			29	22
2.	PE	6	6	3		15	15
3.	OE			3		03	03
4.	PROJ		3	6	12	21	28
	Total	22	22	12	12	68	68

GOVERNMENT COLLEGE OF ENGINEERING, BARGUR

(An Autonomous Institution Affiliated to Anna University)

M.E. POWER ELECTRONICS AND DRIVES
2018 REGULATIONS

FIRST SEMESTER

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
THEORY								
1	18PEPC01	Power Semiconductor Devices	PCC	45	3	0	0	3
2	18PEPC02	Advanced Power Electronic Circuits	PCC	45	3	0	0	3
3	18PEPC03	Digital Control of Power Electronic System	PCC	45	3	0	0	3
4	18PEPC04	FACTS and Custom Power Devices	PCC	45	3	0	0	3
5		Professional Elective I	PEC	45	3	0	0	3
6		Professional Elective II	PEC	45	3	0	0	3
7		Audit Course I	MC	30	2	0	0	0
PRACTICALS								
8	18PEPC05	Advanced Power Electronics Laboratory	PCC	60	0	0	4	2
9	18PEPC06	Digital Control of Power Electronic System Laboratory	PCC	60	0	0	4	2
				TOTAL	20	0	8	22

SECOND SEMESTER

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
THEORY								
1	18PEPC07	Power Electronic Converters and DC Drives	PCC	45	3	0	0	3
2	18PEPC08	Power Electronic Inverters and AC Drives	PCC	45	3	0	0	3
3	18PEPC09	Modeling and Analysis of Electrical Machines	PCC	45	3	0	0	3
4		Professional Elective III	PEC		3	0	0	3
5		Professional Elective IV	PEC	45	3	0	0	3
PRACTICALS								
6	18PEEE10	Mini Project with Seminar	EEC	90	0	0	6	3
7	18PEPC11	Power Electronic Converters and DC Drives Lab	PCC	60	0	0	4	2
8	18PEPC12	Power Electronic Inverters and AC Drives Lab	PCC	60	0	0	4	2
				TOTAL	15	0	14	22

THIRD SEMESTER

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
THEORY								
1		Professional Elective V	PEC	45	3	0	0	3
2		Open Elective Course	OEC	45	3	0	0	3
3		Audit Course II	MC	30	2	0	0	0
PRACTICALS								
4	18PEEE13	Project Phase I	EEC	180	0	0	12	6
				TOTAL	8	0	12	12

FOURTH SEMESTER

Semester IV								
SI No	**Course Code**	**Course Name**	**Course Category**	**Contact Hours**	**L**	**T**	**P**	**C**
PRACTICALS								
1	18PEEE14	Project Phase II	EEC	360	0	0	24	12
				TOTAL	0	0	24	12

GRAND TOTAL CREDITS: 68

LIST OF PROFESSIONAL ELECTIVE COURSES

PROFESSIONAL ELECTIVES								
SI No	**Course Code**	**Course Name**	**Course Category**	**Contact Hours**	**L**	**T**	**P**	**C**
1.	18PEPE01	Dynamics of Electrical Machines	PEC	45	3	0	0	3
2.	18PEPE02	Soft Computing Techniques	PEC	45	3	0	0	3
3.	18PEPE03	Electric Vehicles and Power Management	PEC	45	3	0	0	3
4.	18PEPE04	Solar and Energy Storage System	PEC	45	3	0	0	3
5.	18PEPE05	Wind energy Conversion System	PEC	45	3	0	0	3
6.	18PEPE06	PWM converter and Applications	PEC	45	3	0	0	3
7.	18PEPE07	Switched Mode and Resonant Converters	PEC	45	3	0	0	3
8.	18PEPE08	Digital Signal Processing and Applications	PEC	45	2	1	0	3
9.	18PEPE09	Industrial Load Modeling and Control	PEC	45	3	0	0	3
10.	18PEPE10	Microcontroller based Systems	PEC	45	3	0	0	3

11.	18PEPE11	Distributed Power Generation	PEC	45	3	0	0	3
12.	18PEPE12	Smart Grid Technologies	PEC	45	3	0	0	3
13.	18PEPE13	SCADA Systems and Applications	PEC	45	3	0	0	3
14.	18PEPE14	Modern Power System Analysis	PEC	45	2	1	0	3
15.	18PEPE15	HVDC	PEC	45	3	0	0	3
16.	18PEPE16	Power Quality	PEC	45	3	0	0	3
17.	18PEPE17	Analog and Digital Controllers	PEC	45	3	0	0	3
18.	18PEPE18	MEMS Technology	PEC	45	3	0	0	3
19.	18PEPE19	Energy Economics, Management and Auditing	PEC	45	3	0	0	3
20.	18PEPE20	System Theory	PEC	45	3	0	0	3
21.	18PEPE21	Robotics and Control	PEC	45	3	0	0	3

OPEN ELECTIVES
(OFFERED TO THE OTHER DEPARTMENTS)

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
Open Electives offered by Power Electronics and Drives								
1	18PEOE01	Waste to Energy	OEC	45	3	0	0	3
2	18PEOE02	Machine Learning and Automation	OEC	45	3	0	0	3
3	18PEOE03	Software for Circuit Simulation	OEC	45	3	0	0	3
4	18PEOE04	Power Electronics for Solar Photovoltaic systems	OEC	45	3	0	0	3
5	18PEOE05	Electric Vehicle	OEC	45	3	0	0	3

LIST OF AUDIT COURSES

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
1	18ZAC001	Disaster Management	MC	30	2	0	0	0
2	18ZAC002	English for Research Paper Writing	MC	30	2	0	0	0
3	18ZAC003	Research Methodology and IPR	MC	30	2	0	0	0
4	18ZAC004	Sanskrit for Technical Knowledge	MC	30	2	0	0	0
5	18ZAC005	Value Education	MC	30	2	0	0	0
6	18ZAC006	Pedagogy Studies	MC	30	2	0	0	0
7	18ZAC007	Stress Management by Yoga	MC	30	2	0	0	0
8	18ZAC008	Personality Development through Life Enlightenment Skills	MC	30	2	0	0	0

LIST OF PROGRAM CORE COURSES

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
1.	18PEPC01	Power Semiconductor Devices	PCC	45	3	0	0	3
2.	18PEPC02	Advanced Power Electronic Circuits	PCC	45	3	0	0	3
3.	18PEPC03	Digital Control of Power Electronic System	PCC	45	3	0	0	3
4.	18PEPC04	FACTS and Custom Power Devices	PCC	45	3	0	0	3
5.	18PEPC05	Advanced Power Electronics Laboratory	PCC	45	0	0	4	2
6.	18PEPC06	Digital Control of Power Electronic System Laboratory	PCC	45	0	0	4	2

7.	18PEPC07	Power Electronic Converters and DC Drives	PCC	45	3	0	0	3
8.	18PEPC08	Power Electronic Inverters and AC Drives	PCC	45	3	0	0	3
9.	18PEPC09	Modeling and Analysis of Electrical Machines	PCC	45	3	0	0	3
10.	18PEPC11	Power Electronic Converters and DC Drives Lab	PCC	45	0	0	4	2
11.	18PEPC12	Power Electronic Inverters and AC Drives Lab	PCC	45	0	0	4	2

LIST OF EMPLOYABILITY ENHANCEMENT COURSES

SI No	Course Code	Course Name	Course Category	Contact Hours	L	T	P	C
1	18PEEE10	Mini Project with Seminar	EEC	90	0	0	6	3
2	18PEEE13	Project Phase I	EEC	180	0	0	12	6
3	18PEEE14	Project Phase II	EEC	360	0	0	24	12

Semester-I

18PEPC01	POWER SEMICONDUCTOR DEVICES		L	T	P	C
			3	0	0	3
OBJECTIVES:						
•	To improve power semiconductor device structures for adjustable speed motor control applications.					
•	To understand the static and dynamic characteristics of current controlled power semiconductor devices					
•	To understand the static and dynamic characteristics of voltage controlled power					
•	To enable the students for the selection of devices for different power electronics					
•	To understand the control and firing circuit for different devices					
UNIT I	**INTRODUCTION**					**09**
Power switching devices overview – Attributes of an ideal switch ,application requirements, circuit symbols ; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching-Power diodes - Types, forward and reverse characteristics , switching characteristics – rating.						
UNIT II	**CURRENT CONTROLLED DEVICES**					**09**
BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; Thyristors – Physical and electrical principle under lying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor- Basics of GTO, MCT,FCT,RCT						
UNIT III	**VOLTAGE CONTROLLED DEVICES**					**09**
Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - and IGCT. New semiconductor materials for devices – Intelligent power modules - Integrated gate commutated thyristor (IGCT) - GAN, SiC, IEGT- Comparison of all power devices.						
UNIT IV	**OTHER GATE CONTROLLED DEVICES**					**09**
Necessity of isolation, pulse transformer, opto coupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT- Overvoltage, over current and gate protections; Design of snubbers, GTO, MCT and other thyristors.						
UNIT V	**THERMAL PROTECTION**					**09**
Heat transfer – conduction, convection and radiation ; Cooling – liquid cooling ,vapour – phase cooling; Guidance for hear sink selection–Thermal resistance and impedance - Electrical analogy of thermal components ,heat sink types and design–Mounting types - switching loss calculation for power device.						
						TOTAL :45 PERIODS
OUTCOMES: After completion of this course, the student will be able to:						
1	Determine the suitable device for the application.					

2	Design of semiconductor device and its parameters.
3	Design of protection circuits.
4	Design of firing and control circuit.
5	Determine the reliability of the system.
REFERENCES:	
1.	*B.W.Williams, "Power Electronics Circuit Devices and Applications".*
2.	*Rashid M.H., "Power Electronics Circuits ,Devices and Applications", Prentice Hall India, Third Edition, New Delhi,2004*
3.	*MD Singhand K.B Khanchandani, "PowerElectronics", TataMcGrawHill, 2001.*
4.	*Mohan, Undeland and Robins, "Power Electronics–Concepts, applications and Design John Wiley and Sons, Singapore, 2000.*
5.	*Joseph Vithayathil, "Power Electronics: Principles and Applications", Delhi, Tata McGraw - Hill, 2010.*
6.	*Donald A.Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, New Delhi, Fourth Edition, 2012.*
7.	*Kassakian,J.G.et.al., "Principles of Power Electronics", Pearson Education India., 2012.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	1	-	-	-	-	2	2
CO2	-	3	-	-	-	-	2					-	2	-
CO3	-	3	-	-		-	-	-	-	2	-	-	-	2
CO4	-	3	-	-	-	-	-	-	-	2	-	-	-	2
CO5	-	3	-	-	-	-	-	-	2	-	-	-	2	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC02	ADVANCED POWER ELECTRONIC CIRCUITS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand non isolated converter
- To Understand isolated converter.
- To Understand the operation of advanced power electronic circuit topologies.
- To Learn few practical circuits, used in practice.

UNIT I	NON ISOLATED CONVERTERS	9

Boost type APFC and control – Three phase utility interphases and control – Buck, Boost, Buck-Boost SMPS Topologies.

UNIT II	ISOLATED CONVERTERS	9

Modes of operation – Push-Pull and Forward Converter Topologies – Voltage Mode Control – Half and Full Bridge Converters.

UNIT III	RESONANT CONVERTERS	9

Introduction to Resonant Converters – Load Resonant Converter – Zero Voltage Switching – Clamped Voltage Topologies.

UNIT IV	CONTROL FOR SWITCH MODE POWER CIRCUITS	9

Resonant DC Link Inverters with Zero Voltage Switching – High Frequency Link Integral Half Cycle Converter.

UNIT V	MODELING AND DESIGN	9

Modeling and design of DC-DC Converters for various renewable energy conversion – Few power electronic circuits used in practice for controlling electric drives.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand the concept of isolated and non- isolated converter.
2	Learn analysis and design of Resonant converters.
3	Acquire knowledge about analysis and design of Switched Mode Rectifiers, APFC.
4	Understand the concept of DC-DC Converters
5	Model the DC-DC Converters.

REFERENCES:

1. *Rashid "Power Electronics" Prentice Hall India 2007*
2. *G.K.Dubey et.al "Thyristorised Power Controllers" Wiley Eastern Ltd., 2005, 06*
3. *Dewan & Straughen "Power Semiconductor Circuits" John Wiley &Sons., 1975.*
4. *G.K. Dubey & C.R. Kasaravada "Power Electronics & Drives" Tata McGraw Hill., 1993*
5. *Cyril W Lander "Power Electronics" McGraw Hill., 2005.*
6. *B. K Bose "Modern Power Electronics and AC Drives" Pearson Education (Asia)., 2007*
7. *Abraham I Pressman "Switching Power Supply Design" McGraw Hill Publishing Company, 2001.*
8. *UC385 Manual, TI Manual*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	2	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	2	-	-	-	-	2	-
CO3	-	3	-	-	-	-	-	-	-	2	-	-	-	2
CO4	-	3	-	-	-	-	-	-	-	-	2	-	-	2
CO5	-	3	-	-	-	-	-	2	-	-	-	-	2	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC03	DIGITAL CONTROL OF POWER ELECTRONIC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand different control strategies
- To understand state space modeling of different converters
- To perform simulation of different power converters

UNIT I	CONTROL STRATEGIES OF P, PI AND PID CONTROLLERS	9

Review of numerical methods – Application of numerical methods to solve transients in D.C. – Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits – State space modeling and simulation of linear systems – Introduction to electrical machine modeling: induction, DC, and synchronous machines – Simulation of basic electric drives, stability aspects.

UNIT II	DRIVER CIRCUITS	9

Modeling of diode in simulation – Diode with R, R-L, R-C and R-L-C load with AC supply – Modeling of SCR, TRIAC, IGBT and Power Transistors in simulation – Application of numerical methods to R, L, C circuits with power electronic switches – Simulation of gate/base drive circuits – Simulation of snubber circuits

UNIT III	PROTECTION AND ISOLATION	9

Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers – Converters with self-commutated devices – Simulation of power factor correction schemes.

UNIT IV	DC DRIVES USING PWM GENERATION	9

Simulation of converter fed DC motor drives – Simulation of thyristor choppers with voltage.
– Current and load commutation schemes – Simulation of chopper fed DC motor.

UNIT V	AC DRIVES SENSORS AND DATA ACQUISITION SYSTEMS	9

Simulation of single and three phase inverters with thyristors and self commutated devices – Space vector representation –Pulse-width modulation methods for voltage control – Waveform control – Simulation of inverter fed induction motor drives.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire knowledge about the transient of dc switches.
2	Simulate power electronic systems and analyse the system response.
3	Model and simulate power simulation circuits and systems.
4	Model and simulate various DC drives systems.
5	Model and simulate various AC drives systems.

REFERENCES:

1. *Simulink Reference Manual, Math works, USA*
2. *Hadeed Ahmed Sher"Simulation of power Electronics Circuits using Simulink"Lambert Academic Publishing,2013*
3. *Simone Buso and Paolo Mattavelli" Digital Control in Power Electronics" Morgan and Claypool Publications, 2006*

4.	*Slobodan N.Vukosavik,"Digital Control of Electrical Drives"Springer Science,2007*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	2	-	-	-	-	2	2
CO2	-	3	-	-	-	-	2	-	-	-	-	-	2	-
CO3	-	3	-	-	-	-	-	-	-	2	-	-	-	2
CO4	-	3	-	-	-	-	-	-	2	-	-	-	-	2
CO5	-	3	-	-	-	-	-	-	2	-	3	-	2	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC04	FACTS AND CUSTOM POWER DEVICES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the active and reactive power flow control in power system
- To understand the need for static compensators
- To develop the different control strategies used for compensation

UNIT I	REACTIVE POWER COMPENSATION	9

Reactive power flow control in Power Systems – Control of dynamic power unbalances in Power System – Power flow control – Constraints of maximum transmission line loading – Benefits of FACTS Transmission line compensation – Uncompensated line – Shunt compensation – Series compensation – Phase angle control – Reactive power compensation – Shunt and Series compensation principles – Reactive compensation at transmission and distribution level .

UNIT II	STATIC SHUNT COMPENSATORS	9

Static versus passive VAR compensator – SVC and STATCOM – Operation and control of TSC, TCR and STATCOM – Compensator control – Comparison between SVC and STATCOM.

UNIT III	STATIC SERIES COMPENSATION	9

TSSC, SSSC -Static voltage and phase angle regulators – TCVR and TCPAR Operation and Control –Applications – Static series compensation – GCSC,TSSC, TCSC and Static synchronous series compensators and their Control – SSR and its damping.

UNIT IV	UNIFIED POWER FLOW CONTROLLER	9

Circuit Arrangement – Operation and control of UPF – Basic Principle of P and Q control-Independent real and reactive power flow control – Applications – Introduction to interline power flow controller

UNIT V	FACTS CONTROLLERS	9

Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers – Power quality problems in distribution systems, harmonics – Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering – shunt , series and hybrid and their control –Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners – IEEE standards on power quality.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems..
2	Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled.
3	Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls
4	Analyze about Unified Power flow controllers.
5	To develop analytical modeling skills needed for modeling and analysis of such Static VAR Systems

REFERENCES:

1. *K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.*
2. *X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control", Springer Verlag, Berlin, 2006.*

3.	*N.G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.*
4.	*K.S.Sureshkumar, S.Ashok , “FACTS Controllers & Applications”, E-book edition, Nalanda Digital Library, NIT Calicut, 2003.*
5.	*G. T.Heydt, “Power Quality”, McGraw-Hill Professional, 2007.*
6.	*T. J. E. Miller, “Static Reactive Power Compensation”, John Wiley and Sons, Newyork, 1982.*

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	2	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	2	-	-	-	-	2	-
CO3	-	3	-	-	-	-	-	2	-	2	-	-	-	2
CO4	-	3	-	-	-	-	-	-	-	2	-	-	-	2
CO5	-	3	-	-	-	-	-	-	-	-	3	-	2	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC05	ADVANCED POWER ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To provide an insight on the switching behavior of power electronic switches
- To make the students familiar with the digital tools used in generation of gate pulses for the power electronic switches
- To make the students acquire knowledge on mathematical modeling of power electronic circuits and implementing the same using simulation tools
- To facilitate the students to design and fabricate a power converter circuits at appreciable voltage/power levels
- To develop skills on PCB design and fabrication among the students

LIST OF EXPERIMENTS

1. Study of switching characteristics of Power electronic switches with and without snubber (i) IGBT (ii) MOSFET
2. Modeling and system simulation of basic electric circuits using MATLAB – SIMULINK / SCILAB
   a) DC source fed resistive load and Resistive – inductive load
   b) DC source fed RLC load for different damping conditions
   c) DC source fed DC motor load
3. Modeling and System simulation of basic power electronic circuits using MATLAB-SIMULINK / SCILAB
   a) AC Source with Single Diode fed Resistive and Resistive-Inductive Load
   b) AC source with Single SCR fed Resistive and Resistive-Inductive Load
4. Modeling and System Simulation of SCR based full converter with different types of load using MATLAB-Simulink / SCILAB
   a) Full converter fed resistive load.
   b) Full converter fed Resistive-Back Emf(RE) load at different firing angles.
   c) Full Converter fed Resistive-Inductive Load at different firing angles.
   d) Full converter fed DC motor load at different firing angles.
5. Circuit Simulation of Voltage Source Inverter and study of spectrum analysis with and without filter using MATLAB / SCILAB.
   a) Single phase square wave inverter.
   b) Three phase sine PWM inverter.
   c) Hybrid solar and wind based single phase power generation.
   d) Analysis of grid tied inverter.
6. Performance characteristics of multilevel inverter.
7. Performance evaluation of buck converter.
8. Performance evaluation of boost converter.
9. Performance evaluation of buck-boost converter.

TOTAL :60 PERIODS

OUTCOMES: After completion of this course, the student will be able to:	
1	Design, simulate and analyze various controlled rectifiers.
2	Design, simulate and analyze various DC-DC converters.
3	Design, simulate and analyze the single phase and three phase inverters
4	Design analog circuits for Power electronic control applications.
5	Iimplement analog circuits for Power electronic control applications.

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	2	-	-	-	-	3	-	-
CO2	2	-	-	-	-	-	-	2	-	-	-	2	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	3	-	-
CO4	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	3	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC06	DIGITAL CONTROL OF POWER ELECTRONIC SYSTEM LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To understand PWM generation of AC-DC converter
- To understand PWM generation of DC-DC converter
- To understand PWM generation of AC-AC converter
- To understand PWM generation of DC-AC converter

LIST OF EXPERIMENTS

1. PWM generation for Chopper Circuit using DSP
2. PWM generation for Four Quadrant Chopper Circuit using DSP
3. Triggering Circuit design for Half converter using digital controller
4. Triggering Circuit design for Full converter using digital controller
5. Pulse Generation scheme for cycloconverter using DSP
6. PWM Generation for Single phase inverter using PIC controller
7. PWM Generation for Three phase inverter using PIC controller
8. Sine PWM generation for Three phase Inverter using PIC controller
9. PWM generation using FPGA for Multilevel inverter
10. PLC based controller design for DC chopper

TOTAL :60 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Generate PWM for chopper circuits
2	Generate PWM for inverter circuits
3	Generate PWM for Rectifier circuits
4	Generate PWM for Cycloconverter circuits
5	Generate PWM using FPGA for inverters.

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	2	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO3	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO4	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO5	-	2	-	-	-	-	-	-	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

SEMESTER II

18PEPC07	**POWER ELECTRONIC CONVERTERS AND DC DRIVES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To determine the operation and characteristics of controlled rectifiers.
- To apply switching techniques and basic topologies of DC-DC switching regulators.
- Study and analyze the operation of the converter fed DC drives, both qualitatively and quantitatively.
- Study and analyze the operation of the chopper fed DC drives, both qualitatively and quantitatively.
- Study and analyze the operation of closed loop control.

UNIT I — SINGLE PHASE & THREE PHASE CONVERTERS — 9

Principle of phase controlled converter operation – single-phase full converter and semi-converter (RL, RLE load) – single phase and three phase dual converter – Three phase operation full converter and semi-converter (R, RL, RLE load) – reactive power – power factor improvement techniques – PWM rectifiers.

UNIT II — DC-DC CONVERTERS — 9

Limitations of linear power supplies, switched mode power conversion, Non-isolated DC- DC converters: operation and analysis of Buck, Boost, Buck – Boost, Cuk & SEPIC – under continuous and discontinuous operation – Isolated converters: basic operation of Flyback, Forward and Push-pull topologies, Half and Full Bridge Converters.

UNIT III — CONVERTER CONTROL OF DC DRIVES — 9

types of load; Requirements of drives characteristics - stability of drives – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating. Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance

UNIT IV — CHOPPER CONTROL OF DC DRIVES — 9

Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Multi-phase chopper; Related problems.

UNIT V — CLOSED LOOP AND DIGITAL CONTROL OF DC DRIVES — 9

Modelling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Closed loop speed control – current and speed loops, P, PI and PID controllers: Phase Locked Loop and micro-computer control of DC drives

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Demonstrate the basic concept of steady state operation of single and three phase AC-DC converters.

2	Analyze the operation of various DC-DC converters.
3	Design and analyze the operation of the various controlled rectifier fed DC drives.
4	Design and analyze the operation of the various chopper fed DC drives
5	Explain the concept of closed loop control

REFERENCES:

1.	*Ned Mo h a n , T . M Undelanda n d W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons. Wiley India edition, 2006.*
2.	*Rashid M.H.,"Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi,2004.*
3.	*P.C.Sen, "Modern Power Electronics", Wheeler Publishing Co, First Edition, NewDelhi, 1998.*
4.	*P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition,2003*
5.	*Simon Ang, Alejandro Oliva, "Power-Switching Converters, Second Edition, CRC Press, Taylor& Francis Group, 2010.*
6.	Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Yersy, 1989.
7.	*VedamSubramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.*
8.	Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosal Publishing House, New Delhi, Second Edition ,2009

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	2	-	-	-	-	-	2	-
CO2	2	3	-	-	-	-	2	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	2	-	-	-	-	-	3	-
CO4	-	-	2	-	-	-	-	-	-	2	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	2	-	3	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC08	POWER ELECTRONIC INVERTERS AND AC DRIVES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To design different single phase and three phase inverters.
- To design and analyze current source inverters.
- To impart knowledge on multilevel inverters and modulation techniques
- To familiarize the students on the operation of VSI and CSI fed induction motor drives.
- To impart knowledge on the control of synchronous motor drives

UNIT I	SINGLE AND THREE PHASE VOLTAGE SOURCE INVERTERS	09

Single phase and three phase voltage source inverters (both120^o mode and180^o mode)–Voltage & harmonic control--PWM techniques: Sinusoidal PWM, modified sinusoidal PWM - multiple PWM –Introduction to space vector modulation

UNIT II	CURRENT SOURCE INVERTERS	09

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters – PWM techniques for current source inverters, Grid-tied Inverters

UNIT III	MULTILEVEL INVERTERS	09

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI – Single phase & Three phase Impedance source inverters.

UNIT IV	ROTOR CONTROLLED AND FIELD ORIENTED CONTROL OF INDUCTION MOTOR DRIVES	09

Static rotor resistance control - injection of voltage in the rotor circuit – static scherbius drives - power factor considerations – modified Kramer drives-Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy

UNIT V	SYNCHRONOUS MOTOR DRIVES	09

Wound field cylindrical rotor motor – Equivalent circuits – performance equations of operation from a voltage source – Power factor control and V curves – starting and braking, self control – Load commutated Synchronous motor drives - Brush and Brushless excitation

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Suggest and Demonstrate the application of single and three phase inverters
2	Analyze the operation of CSI inverter
3	Evaluate the performance of multilevel inverter.
4	Understand the control of induction motor drives.
5	Design and Analyze the operation of synchronous motor drives

REFERENCES:	
1.	*Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.*
2.	*P.C. Sen, "Modern Power Electronics",Wheeler Publishing Co, First Edition, New Delhi, 1998*
3.	*P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003*
4.	Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., NewYersy, 1989.
5.	*Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.*
6.	*Ned Mohan,T.M Undeland and W.P Robbin, "Power Electronics:*
7.	*R.Krishnan, "Electric Motor Drives – Modelling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	2	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	2	-	-	2	-
CO5	-	2	-	-	-	-	-	-	-	-	3	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC09	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

•	To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque.
•	To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.
•	To provide the knowledge of theory of transformation of three phase variables to two phase variables.
•	To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.
•	To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

UNIT I	PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION	09

Magnetic circuits, permanent magnet, stored magnetic energy, co-energy – force and torque in singly and doubly excited systems – machine windings and air gap mmf – winding inductances and voltage equations.

UNIT II	DC MACHINES	09

Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt d.c. motors – Time domain block diagrams – solution of dynamic characteristic by Laplace transformation – digital computer simulation of permanent magnet and shunt D.C. machines.

UNIT III	REFERENCE FRAME THEORY	09

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame – variables observed from several frames of reference.

UNIT IV	INDUCTION MACHINES	09

Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations.

UNIT V	SYNCHRONOUS MACHINES	09

Three phase synchronous machine and analysis of steady state operation – voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations– Generalized theory of rotating electrical machine and Krons primitive machine.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand the various electrical parameters in mathematical form.
2	Understand the different types of reference frame theories and transformation relationships.
3	Find the electrical machine equivalent circuit parameters.

4	Model of Induction machines.
5	Model of Synchronous Machines
REFERENCES:	
1	*Paul C.Krause, Oleg Wasyzczuk, ScottS, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.*
2	*P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.*
3	*A.E,Fitzgerald, Charles Kingsley, Jr, and Stephan D,Umanx, "ElectricMachinery", Tata Mc Graw Hill, 5th Edition, 1992*
4	*R. Krishnan, Electric Motor &Drives: Modeling, Analysis and Control, New Delhi, Prentice Hall of India,2001*
5	*Richard T.Smith ,"Analysis of of Electric Machines" , Pergoman press.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	2	-	-	-	-	-	-
CO2	3		-	-	-	-	-	2	-	-	-	-	-	-
CO3	-		-	-	-	-	-	2	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	2	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	2	-	-	-	3	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEEE10	MINI PROJECT WITH SEMINAR	L	T	P	C
		0	0	6	3

COURSE OBJECTIVES:	**Upon completion of this course, the students will be familiar with:**
•	Usage of mathematical, computational and natural sciences gained by study, experience
•	Practice with judgment to develop effective use of matter, energy and information to the benefit of mankind.
•	Plan, execute, manage and document a project.

It is intended to start the Mini-project work from the learning of subjects from semester one and carry out both design and fabrication of a Power Electronics and Drives whose working can be demonstrated.This project should be independent project and not linked with any other project.

The students in individual takes works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL PERIODS:90

OUTCOMES:	Upon completion of this course, the students will be able to:
1.	Identify research intensive feasible problems by considering societal/industrial Demands.
2.	Perform exhaustive literature survey on identified problem.
3.	Use design/simulation tools to implement critical methods/algorithms of the identified problem from the literature.
4.	Perform preliminary implementation to achieve encouraging results.
5.	Develop and deliver a good quality formal presentation.

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	3	2	3	3	2	3	3	3	1
CO2	3	2	1	3	1	3	2	1	3	1	3	3	2	1
CO3	3	3	1	3	1	3	3	2	3	1	3	3	2	1
CO4	3	3	2	2	2	1	3	1	2	1	2	3	2	3
CO5	3	3	2	2	2	1	3	3	2	1	2	2	2	2

1-Low, 2-Moderate (Medium), 3-High

18PEPC11	POWER ELECTRONIC CONVERTERS AND DC DRIVES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To design and analyse the various DC drives.
- To generate the firing pulses for converters using digital processors
- To Design controllers for linear and nonlinear systems
- To Implement closed loop system using hardware simulation.

LIST OF EXPERIMENTS

1. Speed control of converter fed DC motor
2. Speed control of chopper fed DC motor
3. Regenerative/ Dynamic braking operation of DC motor
4. Closed loop speed control of DC motor using Step/Ramp/Parabolic input and PID controller
5. PC/PLC based DC motor control operation
6. Four quadrant operation of dual converter based DC drive
7. Speed control of single phase induction motor using TRIAC
8. Micro controller based speed control of stepper motor
9. DSP based speed control of SRM Motor
10. Determination of output voltage and characteristics of 1-phase dual converter with RL load

TOTAL :60 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1.	Perform various measurements of input/output on power electronics converters and analyze the issues of results
2.	Build and test various power electronic converters, for drives applications by using different types of motor controllers
3.	Design and implement analog circuits for Power Electronic control applications.
4.	Design a power converter circuit at a reasonable power level.
5	Implement a power converter circuit at a reasonable power level.

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	-	2	-	-	-	3	-
CO2	3		-	-	-	-	-	-	-	2	-	-	-	-
CO3	-		-	-	-	-	2	-	-	-	-	3	-	-
CO4	-	2	-	-	-	-	-	-	-	-	2	-	3	2
CO5	-	-	-	-	-	-	-	-	-	-	2	3	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPC12	POWER ELECTRONIC INVERTERS AND AC DRIVES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

•	To design and analyse the various AC drives.
•	To generate the firing pulses for inverters using digital processors
•	To Design controllers for linear and nonlinear systems
•	To Implement closed loop system using hardware simulation.

LIST OF EXPERIMENTS

1. VSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM Software
2. PWM Inverter fed three phase induction motor drive control using MATLAB/PSPICE/PSIM Software
3. Variable frequency operation of three phase AC motor using SCADA and PLC
4. Cyclo converter based Induction Motor drive
5. Single phase Multi Level Inverter based induction motor drive
6. Voltage regulation of three phase synchronous generator
7. Four quadrant operation of three phase induction motor
8. PC/PLC based AC motor control operation
9. Regenerative/ Dynamic braking operation of AC motor
10. Speed control of three phase slip ring induction motor using static rotor resistance control using rectifier and chopper MOSFET
11. PIC Microcontroller based speed control of linear Induction motor
12. Study of power quality analyzer
13. Determination of speed and output voltage of 3-phase A.C. Voltage controller fed induction motor drive
14. Study of permanent Magnet Synchronous Motor drive fed by PWM Inverter using software
15. Speed control of BLDC motor

TOTAL :60 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1.	Perform various measurements of input/output on power electronics inverters and analyze the issues of results
2.	Build and test various power electronic inverters for drives applications by using different types of motor controllers
3.	Design and implement analog circuits for Power Electronic control applications.
4.	Design and fabricate a power converter circuit at a reasonable power level.
5	Implement a power converter circuit at a reasonable power level.

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	2	-	-	-	-	3	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO3	-	3	-	-	-	-	2	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	2	-	3	2
CO5	-	-	-	-	-	-	-	-	-	-	2	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEEE13	PROJECT PHASE I	L	T	P	C
		0	0	12	6

COURSE OBJECTIVES:	**Upon completion of this course, the students will be familiar with**
•	Usage of mathematical, computational and natural sciences gained by study, experience and practice with judgment
•	Develop effective use of matter, energy and information to the benefit of mankind.

It is intended to start the project work early in the third semester of Power Electronic and Drives. Literature survey, The design, Analysis and Simulation is expected to be completed in the Third semester and the fabrication and demonstration will be carried out in the fourth semester.

The student individually works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL PERIODS:180

OUTCOMES:	Upon completion of this course, the students will be able to:
1.	Identify research intensive feasible problems by considering societal/industrial Demands.
2.	Perform exhaustive literature survey on identified problem.
3.	Use design/simulation tools to implement critical methods/algorithms of the identified problem from the literature.
4.	Develop and deliver a good quality formal presentation.
5.	Write clear, concise, and accurate technical document for journal publication.

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	3	2	3	3	2	3	3	1	1
CO2	3	2	1	3	1	3	2	1	3	2	3	3	1	1
CO3	2	2	1	3	1	3	3	1	3	2	3	3	1	1
CO4	2	2	1	2	2	2	3	1	2	2	1	2	3	3
CO5	3	2	2	2	2	2	3	3	2	2	1	2	2	2

1-Low, 2-Moderate (Medium), 3-High

18PEEE14	PROJECT PHASE II	L	T	P	C
		0	0	24	12
COURSE OBJECTIVES	**Upon completion of this course, the students will be familiar with:**				
•	Usage of mathematical, computational and natural sciences gained by study, experience and practice with judgment				
•	Develop effective use of matter, energy and information to the benefit of mankind.				

It is intended to finish the project work in the fourth semester. The phase-I remaining work is carried out in phase-II. Both design and fabrication in Power Electronic and Drives whose working can be demonstrated.

The progress of the project is evaluated based on a minimum of three reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

	TOTAL PERIODS:360
OUTCOMES:	Upon completion of this course, the students will be able to:
1.	Identify research intensive feasible problems by considering societal/industrial Demands.
2.	Perform exhaustive literature survey on identified problem.
3.	Use design/simulation tools to implement critical methods/algorithms of the identified problem from the literature.
4.	Develop and deliver a good quality formal presentation.
5.	Write clear, concise, and accurate technical document for journal publication.

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	3	2	3	3	2	3	3	1	1
CO2	3	2	1	3	1	3	2	1	3	2	3	3	1	1
CO3	2	2	1	3	1	3	3	1	3	2	3	3	1	1
CO4	2	2	1	2	2	2	3	1	2	2	1	2	3	3
CO5	3	2	2	2	2	2	3	3	2	2	1	2	2	2

1-Low, 2-Moderate (Medium), 3-High

PROFESSIONAL ELECTIVES

18PEPE01	DYNAMICS OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Learn Performance characteristics of machine.
- To understand the dynamics of the machine.
- To understand how to determine stability of machine.
- To Learn the synchronous machine analysis.

UNIT I	PRIMITIVE 4 WINDING COMMUTATOR MACHINE	9

Stability – Primitive 4 Winding Commutator Machine – Complete Voltage Equation of Primitive 4 Winding Commutator Machine.

UNIT II	DYNAMICS OF DC AND INDUCTION MACHINE	9

Torque Equation. Analysis of Simple DC Machines using the Primitive Machine Equations. The Three Phase Induction Motor – Transformed Equations – Different Reference Frames for Induction Motor Analysis – Transfer Function Formulation.

UNIT III	DYNAMICS OF SYNCHRONOUS MACHINES	9

Three Phase Salient Pole Synchronous Machine – Parks Transformation- Steady State Analysis.

UNIT IV	LARGE SIGNAL TRANISENTS I	9

Large Signal Transient – Small Oscillation Equations in State Variable Form – Dynamical Analysis of Interconnected Machines.

UNIT V	LARGE SIGNAL TRANISENTS II	9

Large Signal Transient Analysis using Transformed Equations – DC Generator /DC Motor System. – Alternator /Synchronous Motor System.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Formulate electrodynamic equations of all electric machines and analyze the performance characteristics
2	Acquire the Knowledge of transformations for the dynamic analysis of machines
3	Acquire the Knowledge of determination of stability of the machines under small signal and transient conditions
4	Study about electrical machine
5	Study about synchronous machine

REFERENCES:

1	*D.P. Sengupta & J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980*
2	*R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001*
3	*P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company, 1987*
4	*I. Boldia & S.A. Nasar, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1992*
5	*C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967*

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	2	2	-	-	-	-	-	2	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	2	-	-	-	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE02	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

•	To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
•	To implement soft computing based solutions for real-world problems.
•	To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
•	To provide student an hand-on experience on MATLAB to implement various strategies.

UNIT I	INTRODUCTION TO SOFT COMPUTING	09

Evolution of Computing – Soft Computing Constituents – From Conventional AI to Computational Intelligence – Machine Learning Basics – Recent Trands in deep learning – various classifiers – neural networks and genetic algorithm –

UNIT II	FUZZY LOGIC	09

Fuzzy Sets – Operations – Fuzzy Relations – Membership Functions – Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

UNIT III	NEURAL NETWORKS	09

Machine Learning Using Neural Network – Adaptive Networks – Feed forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures – Advances in Neural networks

UNIT IV	GENETIC ALGORITHMS	09

Introduction to Genetic Algorithms (GA) – Applications of GA in Machine Learning – Machine Learning Approach to Knowledge Acquisition.

UNIT V	SOFT COMPUTING USING SOFTWARES	09

Introduction to Matlab/Python – Arrays and array operations – Functions and Files – Study of neural network toolbox and fuzzy logic toolbox – Simple implementation of Artificial Neural Network and Fuzzy Logic – Implementation of recently proposed soft computing techniques

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Identify and describe soft computing techniques and their roles in building intelligent machines
2	Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
3	Apply genetic algorithms to combinatorial optimization problems.
4	Evaluate solutions for various soft computing approaches for a given problem.
5	Compare solutions by various soft computing approaches for a given problem.

REFERENCES:

1.	*Jyh Shing Roger Jang, Chuen Tsai Sun, Eiji Mizutani, "Neuro Fuzzy and Soft Computing", Prentice Hall of India, 2003*
2.	*George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic "Theory and Applications", Prentice Hall, 199*
3.	*MATLAB / Python Toolkit Manual*

4.	*Devendra k.Chathruvedi, Soft computing techniques and its applications in electrical engineering, Springer.*
5.	*Hagan, Demuth, Beale, "Neural Network Design", Cengage Learning, 2012.*
6.	*N.P.Padhy, "Artificial IntelligenceandIntelligentSystems",Oxford,2013*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	1	-	-
CO3	-	-	-	-	-	-	-	-	-	2	-	-	2	-
CO4	-	-	-	-	2	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	2	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE03	ELECTRIC VEHICLES AND POWER MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concept of electrical vehicles and its operations
- To understand the need for energy storage in hybrid vehicles
- To provide knowledge about various possible energy storage technologies that can be used in electric vehicles

UNIT I	ELECTRIC VEHICLES AND VEHICLE MECHANICS	09

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

UNIT II	ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS	09

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) - Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT III	CONTROL OF DC AND AC DRIVES	09

DC/DC chopper based four quadrant operations of DC drives– Inverter based/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor based vector control operation– Switched reluctance motor (SRM) drives.

UNIT IV	BATTERY ENERGY STORAGE SYSTEM	09

Battery Basics, Different types, Battery Parameters, Battery modelling, Traction Batteries.

UNIT V	ALTERNATIVE ENERGY STORAGE SYSTEMS	09

Fuel cell – Characteristics – Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand the operation of Electric vehicle
2	Understand the Architecture of Electric vehicle
3	Acquire Knowledge on various power electronic converter for electrical vehicles
4	Acquire Knowledge on battery storage technologies for electrical vehicles
5	Acquire Knowledge on various energy storage technologies for electrical vehicles

REFERENCES:

1. *Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).*
2. *Ali Emadi, Mehrdad Ehsani, JohnM.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc2010.*
3. *Iqbal Husain, "Electric and Hybrid Vehicles" ", CRC Press, 2004*
4. *Chris Mi and M.Abdul Masrur, "Electric and Hybrid Vehicles" by Willey & Sons 2011*
5. *Amir Khajepour, , "Electric and Hybrid Vehicles" John Wiley & Sons, 2011*

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	2	-	-	-
CO3	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	3	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE04	SOLAR AND ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Study about solar modules and PV system design and their applications.
- To Deal with Standalone PV System
- To Deal with grid connected PV systems.
- To Discuss about different energy storage systems.

UNIT I	INTRODUCTION	09

Characteristics of sunlight–semiconductors and P-N junctions–behavior of solar cells–cell properties–PV cell interconnection

UNIT II	STANDALONE PV SYSTEM	09

Solar modules–storage systems–power conditioning and regulation-MPPT-protection–Standalone PV systems design–sizing

UNIT III	GRID CONNECTED PV SYSTEMS	09

PV systems in buildings–design issues for central power stations–safety–Economic aspect – Efficiency and performance- International PV programs – Synchronization issues

UNIT IV	ENERGY STORAGE SYSTEMS	09

Impact of intermittent generation–Battery energy storage–solar thermal energy storage–Pumped hydro electric energy storage

UNIT V	APPLICATIONS	09

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Develop more knowledge on solar energy storage systems
2	Develop basic knowledge on standalone PV system
3	Understand the issues in grid connected PV systems
4	Modeling of different energy storage systems and their performances
5	Attain more knowledge on different applications of solar energy.

REFERENCES:

1. *Solanki C.S., "Solar Photovoltaics: Fundamentals, Technologies And Applications", PHI Learning Pvt. Ltd., 2015.*
2. *Stuart R.Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, "Applied Photovoltaics", 2007, Earthscan, UK.*
3. *Eduardo Lorenzo G. Araujo, "Solar electricity engineering of photovoltaic systems", Progensa, 1994.*
4. *Frank S. Barnes& Jonah G. Levine, "Large Energy storage Systems Handbook", CRC Press, 2011.*
5. *McNeils, Frenkel, Desai, "Solar & Wind Energy Technologies", Wiley Eastern, 1990*
6. *S.P.Sukhatme, "Solar Energy", Tata McGraw Hill, 1987*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO2	-	1	-	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	2	-	2	-
CO5	-	-	-	-	-	-	-	-	-	-	2	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE05	WIND ENERGY CONVERSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion
- To analyze the grid integration issues.

UNIT I	INTRODUCTION	09

Components of WECS - WECS schemes - Power obtained from wind - simple momentum theory- Power coefficient - Sabinin's theory - Aerodynamics of Wind turbine.

UNIT II	WIND TURBINES	09

HAWT – VAWT - Power developed – Thrust – Efficiency - Rotor selection - Rotor design considerations - Tip speed ratio - No of Blades - Blade profile - Power Regulation - yaw control - Pitch angle control - stall control - Schemes for maximum power extraction.

UNIT III	FIXED SPEED SYSTEMS	09

Generating Systems - Constant speed constant frequency systems - Choice of Generators - Deciding factors - Synchronous Generator - Squirrel Cage Induction Generator - Model of Wind Speed - Model wind turbine rotor - Drive Train model - Generator model for Steady state and Transient stability analysis.

UNIT IV	VARIABLE SPEED SYSTEMS	09

Need of variable speed systems – Power - wind speed characteristics - Variable speed constant frequency systems synchronous generator – DFIG – PMSG - Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V	GRID CONNECTED SYSTEMS	09

Wind interconnection requirements – low-voltage ride through (LVRT) – ramp rate limitations, and supply of ancillary services for frequency and voltage control – current practices and industry trends wind inter connection impact on steady-state and dynamic performance of the power system including modelling issue.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire knowledge on the basic concepts of Wind energy conversion system.
2	Understand the mathematical modelling and control of the Wind turbine
3	Develop more understanding on the design of Fixed speed system
4	Develop more understanding on the design of Variable speed system
5	Learn about Grid integration issues and current practices of wind interconnections with power system.

REFERENCES:

1. *L.L. Freris "Wind Energy conversion Systems", Prentice Hall,1990*
2. *S.N.Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Sytems", Oxford University Press, 2010.*
3. *Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006*
4. *E.W.Golding "The generation of Electricity by wind power", Red wood burn Ltd., Trowbridge, 1976.*
5. *N.Jenkins, "Wind Energy Technology" John Wiley & Sons, 1997.*

6.	*S.Heir "Grid Integration of WECS", Wiley 1998*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO2	-	1	-	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	2	-	2	-
CO5	-	-	-	-	-	-	-	-	-	-	2	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE06	PWM CONVERTER AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
- To understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

UNIT I	FUNDAMENTALS OF CONVERTERS	09

AC/DC and DC/AC power conversion – Overview of applications of voltage source converters and current source converters – Practical devices in converter – Calculation of switching and conduction power losses.

UNIT II	PWM TECHNIQUES	09

Pulse width modulation techniques for bridge converters – Bus clamping PWM – Space vector based PWM – Advanced PWM techniques.

UNIT III	MODEL OF PWM CONVERTER	09

Compensation for dead time and DC voltage regulation - Dynamic model of PWM converter - Multilevel converters - Constant V/F induction motor drives.

UNIT IV	POWER FACTOR COMPENSATION	09

Estimation of current ripple and torque ripple in inverter fed drives – Line-side converters with power factor compensation.

UNIT V	REACTIVE POWER AND HARMONICS COMPENSATION	09

Active power filtering – Reactive power compensation - Harmonic current compensation – Selective harmonic elimination – PWM technique for high power electric drives

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Design PWM converters.
2	Analyse the PWM converters in steady-state conditions.
3	Analyse the PWM converters in dynamic conditions.
4	Analyse power converters with various PWM techniques for Steady-State.
5	Analyse power converters with various PWM techniques for transient.

REFERENCES:

1.	*Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John's Wiley and Sons.*
2.	*Erickson RW, "Fundamentals of Power Electronics", Chapman and Hall.*
3.	*Vithyathil. J, "Power Electronics: Principles and Applications", McGraw Hill.*
4.	*Edison Roberto Cabral Da Silva,'Advanced Power Electronics Converter',Wiley.*
5.	*D.Grahame Holmes Thomas A.Lipo, 'Pulse Width Modulation for Power Converters'Wiley IEEE Press.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	2	-	-	-	-	3	-	-
CO2	-	-	-	-	-	-	-	-	2	-	-	-	2	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	2	-
CO4	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	-	-	-	2	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE07	SWITCHED MODE AND RESONANT CONVERTERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand different types of converters
- To understand different switch mode topologies & control methods
- To understand different resonant converter topologies.

UNIT I	SMPS TOPOLOGIES	09

Buck, Boost, Buck-Boost SMPS Topologies – Basic Operation – Waveforms – modes of operation – switching stresses – Switching and conduction losses – Optimum switching frequency – Practical voltage, current and power limits – design relations – Voltage mode control principles – Push-Pull and Forward Converter Topologies – Basic Operation, Waveforms – Flux Imbalance Problem and Solutions

UNIT II	FERRITE TRANSFORMERS	09

Transformer Design – Output Filter Design – Switching Stresses and Losses – Forward Converter Magnetics – Voltage Mode Control – Half and Full Bridge Converters – Basic Operation and Waveforms – Magnetics – Output Filter – Flux Imbalance – Switching Stresses and Losses – Power Limits – Voltage Mode Control.

UNIT III	RESONANT CONVERTERS	09

Classification of Resonant Converters – Basic Resonant Circuit Concepts – Load Resonant Converter – Resonant Switch Converter – Zero Voltage Switching – Clamped Voltage Topologies – Resonant DC Link Inverters with Zero Voltage Switching – High Frequency Link Integral Half Cycle Converter – Fly back Converter – discontinuous mode operation, waveforms, control – Magnetics – Switching Stresses and Losses, – Disadvantages – Continuous Mode Operation, waveforms, control, design relations.

UNIT IV	CONTROL OF SMPS	09

Voltage Mode Control of SMPS – Loop Gain and Stability Considerations – Error Amp–frequency Response and Transfer Function – Trans-conductance Current Mode Control of SMPS – Current Mode Control Advantages, Current Mode Vs Voltage Mode – Current Mode Deficiencies – Slope Compensation – Study of a typical Current Mode PWM Control IC UC3842 – Modeling of SMPS – Small Signal Approximation – General Second Order Linear Equivalent Circuits – Study of popular PWM Control ICs (SG 3525,TL 494,MC34060 etc.)

UNIT V	DC TRANSFORMER	09

DC Transformer – Voltage Mode SMPS Transfer Function – General Control Law Consideration – EMI Generation and Filtering in SMPS – Conducted and Radiated Emission Mechanisms in SMPS – Techniques to reduce Emissions – Control of Switching Loci –Shielding and Grounding – Power Circuit Layout for minimum EMI – EMI Filtering at Input and Output – Effect of EMI Filter on SMPS Control Dynamics.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire knowledge about the principles of operation of non-isolated hard-switched DC-DC converters.
2	Acquire knowledge about the principles of operation of isolated hard-switched DC-DC

	converters.
3	Acquire knowledge on various loss components in a switched mode converter
4	Acquire knowledge on choice of switching frequency with a view towards design of such converters.
5	Acquire knowledge about the principles of operation of DC Transformer.
REFERENCES:	
1.	*Abraham I Pressman, "Switching Power Supply Design," McGraw Hill Publishing Company, 2001.*
2.	*Daniel M Mitchell, "DC-DC Switching Regulator Analysis," McGraw Hill Publishing Company-1988.*
3.	*Ned Mohan et.al, "Power Electronics," John Wiley and Sons 2006.*
4.	*Marian K.Kazimierczuk Dariusz Czarkowski, "Resonant ower converters",Wiley.*
5.	*Simon Ang Alejandro Oliva,"Power Switching Converters" ,CRC Press.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	2	-	-	-	-	3	-	-
CO2	-	2	-	-	-	-	-	2	-	-	-	3	-	-
CO3	-	2	-	-	-	-	-	-	-	2	-	3	-	-
CO4	-	-	2	-	-	-	-	-	-	2	-	3	-	-
CO5	-	-	2	-	-	-	-	2	-	-	-	3	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE08	DIGITAL SIGNAL PROCESSING AND APPLICATIONS	L	T	P	C
		2	1	0	3

OBJECTIVES:

- Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
- Analyse discrete-time systems using z-transform.
- Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- Design digital filters for various applications.
- Apply digital signal processing for the analysis of real-life signals.

UNIT I — DISCRETE TIME SIGNALS AND SYSTEMS — 09

Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate

UNIT II — Z TRANSFORM — 09

z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z transforms.

UNIT III — DISCRETE FOURIER TRANSFORM — 09

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

UNIT IV — DESIGN OF DIGITAL FILTERS — 09

Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and Highpass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

UNIT V — APPLICATIONS OF DIGITAL SIGNAL PROCESSING — 09

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1. Ability to operate with discrete signals and systems
2. Apply z transform in signal processing
3. Apply discrete fourier transform for processing discrete signals
4. Design the digital FIR and IIR filters using various methods
5. Apply digital signal processing technique in real time applications

REFERENCES:

1. *S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.*
2. *A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.*

3.	*J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.*
4.	*L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.*
5.	*J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.*
6.	*D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	2	-	-	-	3	-	-
CO2	2	-	-	-	-	-	-	2	-	-	-	3	-	-
CO3	2	-	-	-	-	-	-	2	-	-	-	-	-	-
CO4	-	-	-	2	-	-	-	2	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	2	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE09	INDUSTRIAL LOAD MODELING AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the energy demand scenario
- To understand the modeling of load and its ease to study load demand industrially
- To know Electricity pricing models
- To Study Reactive power management in Industries

UNIT I	**DEMAND SIDE MANAGEMENT**	**09**

Electric Energy Scenario – Demand Side Management – Industrial Load Management – Load Curves – Load Shaping Objectives – Methodologies – Barriers; Classification of Industrial Loads – Continuous and Batch processes – Load Modeling.

UNIT II	**ECONOMICS**	**09**

Electricity pricing – Dynamic and spot pricing – Models – Direct load control – Interruptible load control – Bottom up approach – scheduling – Formulation of load models – Optimization and control algorithms – Case studies.

UNIT III	**ENERGY SAVING**	**09**

Reactive power management in industries – controls – power quality impacts – application of filters – Energy saving in industries.

UNIT IV	**THERMAL MANAGEMENT**	**09**

Cooling and heating loads – load profiling – Modeling – Cool storage – Types – Control strategies – Optimal operation – Problem formulation – Case studies.

UNIT V	**OPTIMAL OPERATION**	**09**

Captive power units – Operating and control strategies – Power Pooling – Operation models – • Energy banking – Industrial Cogeneration – Selection of Schemes Optimal Operating Strategies – Peak load saving – Constraints – Problem formulation – Case study – Integrated Load management for Industries

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire Knowledge about load control techniques in industries and its application.
2	Know the different types of industrial processes and optimize the process using tools like LINDO
3	Know the different types of industrial processes and optimize the process using tools like LINGO.
4	Apply load management to reduce demand of electricity during peak time.
5	Apply different energy saving opportunities in industries.

REFERENCES:

1. *C.O. Bjork "Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989.*
2. *C.W. Gellings and S.N. Talukdar, "Load management concepts," IEEE Press, New York, 1986,pp. 3-28.*
3. *Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on*

	PAS, April 1981.
4.	*H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Inter science Publication, USA, 1989.*
5.	*I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995.*
6.	*IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective Planning in Industrial facilities", IEEE Inc, USA.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	-	2
CO2	-	-	-	2	-	-	-	-	2	-	-	-	-	2
CO3	-	-	-	-	-	2	-	-	2	-	-	-	-	-
CO4	-	-	-	2	-	-	-	-	2	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	2	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE10	MICROCONTROLLER BASED SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the architecture of advance microcontrollers
- To understand the applications of these controllers
- To get some introduction to FPGA.

UNIT I	BASIC COMPUTER ORGANIZATION	09

Basic Computer Organization – Accumulator based processes – Architecture – Memory – Organization – I/O Organization

UNIT II	MICRO-CONTROLLERS	09

Micro-Controllers – Registers, Memories – I/O Ports, Serial Communication – Timers, Interrupts, Programming – Image Process.

UNIT III	INTEL 8051	09

Intel 8051 – Assembly language programming – Addressing – Operations – Stack & Subroutines, Interrupts – DMA.

UNIT IV	PIC 16F877	09

Architecture Programming – Interfacing Memory/ I/O Devices, Serial I/O and data communication

UNIT V	DIGITAL SIGNAL PROCESSOR AND APPLICATIONS	09

Motor control applications – Stepper motor control using micro controller – Converter and inverter design.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Develop applications based on an advanced processor based system
2	Configure different peripherals in a digital system
3	Compile and debug a Program
4	Compile and debug a Program using PIC Controller.
5	Compile and debug a Program using DSP.

REFERENCES:

1. *John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981.*
2. *Ramesh S.Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing (India), 1994.*
3. *Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005.*
4. *Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004.*
5. *John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005.*
6. *Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008.*
7. *Microchip datasheets for PIC16F877.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	-	-	2	-	-	-	2	-	-
CO3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
CO4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	2	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE11	DISTRIBUTED POWER GENERATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To illustrate the concept of distributed generation
- To analyze the impact of grid integration.
- To study concept of Micro grid and its configuration
- To Understand and analyse of micro grid operations.

UNIT I	MICROGRIDS	09

Introduction to micro-grids – Types of micro-grids: autonomous and non-autonomous grids Sizing of micro-grids – Modeling & analysis of Micro-grids with multiple DGs

UNIT II	GRID INTEGRATION OF DGS	09

Need for Distributed generation – Renewable sources in distributed generation and current scenario in Distributed Generation – Planning of DGs – Sitting and sizing of DGs optimal placement of DG sources in distribution systems – Grid integration of DGs – Different types of interfaces – Inverter based DGs and rotating machine based interfaces. – Aggregation of multiple DG units.

UNIT III	IMPACTS OF DGS IN POWER SYSTEM	09

Technical impacts of DGs – Transmission systems – Distribution Systems – De-regulation Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems – Steady-state and Dynamic analysis.

UNIT IV	ECONOMICS OF DG OPERATION	09

Economic and control aspects of DGs Market facts – Issues and challenges – Limitations of DGs, Voltage control techniques – Reactive power control – Harmonics – Power quality issues – Reliability of DG based systems.

UNIT V	PROTECTION OF MICROGRID	09

Micro-grids with power electronic interfacing units – Transients in micro-grids – Protection of micro-grids – Case studies – Recent Trends in Microgrid

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand the planning and operational issues related to Distributed Generation.
2	Understand integration related to Distributed Generation.
3	Understand the impact of Distributed Generation in Power system.
4	Understand economic operation related to Distributed Generation.
5	Acquire Knowledge about Distributed Generation Learn Micro-Grids

REFERENCES:

1. *H. Lee Willis, Walter G. Scott, "Distributed Power Generation – Planning and Evaluation",Marcel Decker Press.*
2. *M.GodoySimoes, Felix A.Farret, "Renewable Energy Systems – Design and Analysis with Induction Generators", CRC press.*
3. *Stuart Borlase. "Smart Grid: Infrastructure Technology Solutions" CRC Press*
4. *H.Lee WIillis Walter G.Scott,' Distributed Power Generation', CRC Press.*
5. *Farhad Shahnia Ali Arefi Gerard Ledwidh Editors," Electic Distribution Network*

	Planning"Springer.

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	2	-	-	-	-	-	1	-	-	-	-	3
CO2	-	-	-	-	-	1	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	-	3	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE12	SMART GRID TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand concept of smart grid and its advantages over conventional grid.
- To know smart metering techniques.
- To learn wide area measurement techniques.
- To understand the problems associated with integration of distributed generation & its solution through smart grid.

UNIT I	INTRODUCTION TO SMART GRID	9

Introduction to Smart Grid – Evolution of Electric Grid Concept of Smart Grid – Definitions, Need of Smart Grid Concept of Robust &Self-Healing Grid – Present development & International policies in Smart Grid

UNIT II	SMART GRID AUTOMATION	9

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 – Smart Substations – Substation Automation – Feeder Automation

UNIT III	SMART GRID TECHNOLOGIES	9

Geographic Information System (GIS) – Intelligent Electronic Devices (IED) & their application for monitoring & protection – Smart storage like Battery, SMES, Pumped Hydro – Compressed Air Energy Storage – Wide Area Measurement System (WAMS) – Phase Measurement Unit(PMU).

UNIT IV	POWER QUALITY IN SMART GRID	9

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

UNIT V	COMMUNICATION IN SMART GRID	9

Advanced Metering Infrastructure (AMI) – Home Area Network (HAN) – Neighbourhood Area Network (NAN) – Wide Area Network (WAN) – Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication – Wireless Mesh Network. Basics of CLOUD Computing &Cyber Security for Smart Grid – Broadband over Power line (BPL) – IP based protocols

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Appreciate the difference between smart grid & conventional grid.
2	Apply smart metering concepts to industrial and commercial installations.
3	Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.
4	Analyze Power quality solutions in the areas of smart substations, distributed generation and wide area measurements
4	Come up with smart grid solutions using modern communication technologies

REFERENCES:

1. *Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011.*
2. *Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",*

	CRC Press, 2009.
3.	*Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley 2012.*
4.	*Stuart Borlas'e, "Smart Grid:Infrastructure, Technology and solutions "CRC Press.*
5.	*A.G.Phadke , "Synchronized Phasor Measurement and their Applications",Springer.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	1	-	-	-	2	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	1	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	1	-	2	-
CO5	-	-	-	-	-	-	-	1	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE13	SCADA SYSTEMS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand what is meant by SCADA and its functions.
- To know SCADA communication.
- To get an insight into its application.

UNIT I	**INTRODUCTION TO SCADA**	**9**
Data acquisition systems, Evolution of SCADA, Communication technologies – Monitoring and supervisory functions – SCADA applications in Utility Automation – Industries SCADA		
UNIT II	**INDUSTRIES SCADA SYSTEM COMPONENTS**	**9**
Schemes – Remote Terminal Unit (RTU) – Intelligent Electronic Devices (IED) – Programmable Logic Controller (PLC) – Communication Network – SCADA Server – SCADA/HMI Systems		
UNIT III	**SCADA ARCHITECTURE**	**9**
Various SCADA architectures – advantages and disadvantages of each system – single unified standard architecture – IEC 61850.		
UNIT IV	**SCADA COMMUNICATION**	**9**
Various industrial communication technologies – wired and wireless methods and fiber optics – Open standard communication protocols.		
UNIT V	**SCADA APPLICATIONS**	**9**
Utility applications – Transmission and Distribution sector – Operations, monitoring, analysis and improvement – Industries: Oil, gas and water – Case studies, Implementation, Simulation Exercises		

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.
2	Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.
3	Knowledge about single unified standard architecture IEC 61850.
4	To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
5	Learn and understand about SCADA applications in transmission and distribution sector, industries etc.

REFERENCES:

1.	*Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.*
2.	*Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK,2004.*
3.	*William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006.*
4.	*David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.*
5.	*Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well 1999.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	1	-	-	-	-	2	-	-	-	-	-	-
CO2	-	-	-	-	1	-	-	2	-	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	-	2	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-		2	-	-	1
CO5	-	-	-	-	-	-	-	1	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE14	MODERN POWER SYSTEM ANALYSIS	L	T	P	C
		2	1	0	3

OBJECTIVES:

- Study various methods of load flow and their advantages and
- Understand how to analyze various types of faults in power system disadvantages
- Understand power system security concepts and study the methods to rank the contingencies
- Understand need of state estimation and study simple algorithms for state estimation
- Study voltage instability phenomenon

UNIT I	LOAD FLOW	9

Overview of Newton-Raphson, Gauss-Siedel fast decoupled methods – Convergence properties, sparsity techniques – Handling Qmax – Violations in constant matrix – Inclusion in frequency effects – AVR in load flow – Handling of discrete variable in load flow

UNIT II	FAULT ANALYSIS	9

Simultaneous faults – Open conductors faults – Generalized method of fault analysis

UNIT III	SECURITY ANALYSIS	9

Security state diagram – Contingency analysis – Generator shift distribution factors – Line outage distribution factor – Multiple line outages Overload index ranking

UNIT IV	POWER SYSTEM EQUIVALENT AND STATE ESTIMATION	9

Power System Equivalents: WARD – REI.equivalents – State Estimation: Sources of errors in measurement – Virtual and Pseudo, – Measurement – Observability – Tracking state estimation – WSL method – Bad data correction.

UNIT V	VOLTAGE STABILITY	9

Voltage collapse – P-V curve – Multiple power flow solution – Continuation power flow – Optimal multiple load flow – Voltage collapse proximity indices

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Able to calculate voltage phasors at all buses , given the data using various methods of load flow
2	Able to calculate fault currents in each phase
3	Rank various contingencies according to their severity
4	Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps , CB status etc
5	Estimate closeness to voltage collapse and calculate PV curves using continuation power flow

REFERENCES:

1. *J.J. Grainger &W.D.Stevenson, "Power system analysis ", McGraw Hill ,2003*
2. *A. R. Bergen & Vijay Vittal , "Power System Analysis" ,Pearson , 2000*
3. *L.P. Singh , "Advanced Power System Analysis and Dynamics", New Age International, 2006*
4. *G.L. Kusic, "Computer aided power system analysis" ,Prentice Hall India, 1986*

5.	*A.J. Wood, " Power generation, operation and control" , John Wiley, 1994*
6.	*P.M. Anderson, "Faulted power system analysis" , IEEE Press , 1995*

COURSE ARTICULATION MATRIX:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	1	-	-	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-	1	-	-	-	1	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	1	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	1	-	-	-	-	1
CO5	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE15	HVDC	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand state of the art HVDC technology.
- To Learn the Methods to carry out modeling and analysis of HVDC system frontier-area power flow regulation.
- To model HVDC in power systems
- To understand HVDC standards and digital techniques.

UNIT I	HVDC INTRODUCTION	9

Development of HVDC Technology – DC versus AC Transmission – Selection of converter configuration.

UNIT II	POWER ELECTRONIC CIRCUITS IN HVDC	9

Rectifier and Inverter operation – Digital Simulation of converters – Control of HVDC converters and Systems – Individual phase control, Equidistant firing controls, Higher level controls – Characteristics and non-characteristics harmonics filter design

UNIT III	HVDC IN POWER SYSTEMS	9

Fault development and protection – Interaction between AC-DC power systems – Over voltages on AC/DC side – Multi-terminal HVDC systems – Control of MTDC systems

UNIT IV	HVDC MODELING	9

Modeling of HVDC systems – Per unit system – Representation for power flow solution - Representation for stability studies.

UNIT V	STANDARDS AND DIGITAL TECHNIQUES IN HVDC	9

Introduction to relevant national and international standards – safe clearances for HV – Study regulations for HV tests – Digital techniques in HV measurements.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Expose the students to the state of the art HVDC technology
2	Model and analysis of Power electronics circuits in HVDC system
3	Acquire knowledge of HVDC in Power system.
4	Model and analysis of HVDC system for inter-area power flow regulation.
5	Acquire knowledge of digital techniques used in HVDC transmission.

REFERENCES:

1. *J. Arrillaga, "High Voltage Direct Transmission", Peter Peregrinus Ltd. London, 1983.*
2. *K. R. Padiyar, "HVDC Power Transmission Systems", Wiley Eastern Ltd., 1990.*
3. *E. W. Kimbark, "Direct Current Transmission", Vol. I, Wiley Interscience, 1971.*
4. *Erich Uhlmann, "Power Transmission by Direct Current", B.S. Publications, 2004.*
5. *Hadi Saadat, 'Power System Analysis,' PSA Publishing; Third Edition, 2010.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	2	-	-	-	-	-	-	2	-	-	-	2
CO2	-	-	-	-	-	-	-	-	1	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
CO4	-	-	-	-	-	-	-	-	-	-	1	-	-	2
CO5	-	-	-	-	-	-	-	-	-	-	1	-	-	2

1-Low, 2-Moderate (Medium), 3-High

18PEPC16	POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the different power quality issues to be addressed
- To understand the recommended practices by various standard bodies like IEEE, IEC, etc. on voltage & frequency, harmonics
- To understanding STATIC VAR Compensators

UNIT I	INTRODUCTION	9

Power quality – Voltage quality – Overview of power quality phenomena – Classification of power quality issues – Power quality measures and standards – THD – TIF – DIN – C – message weights – Flicker factor – Transient phenomena – Occurrence of power quality problems – Power acceptability curves – IEEE guides – Standards and recommended practices.

UNIT II	POWER ANALYSIS FOR AC SYSTEMS	9

Single phase sinusoidal, non-sinusoidal source supplying linear and non linear loads –Three phase Balance system – Three phase unbalanced system – Three phase unbalanced and distorted source supplying on linear loads – Concept of PF – Three phase three wire – Three phase four wire system.

UNIT III	HARMONICS	9

Harmonics – individual and total harmonic distortion – RMS value of a harmonic waveform – Triplex harmonics – Important harmonic introducing devices. – SMPS – Three phase power converters – Arcing devices – Saturable devices – Harmonic distortion of fluorescent lamps – Effect of power system harmonics on power system equipment and loads.

UNIT IV	MODELING OF NETWORKS AND COMPONENTS UNDER NON-SINUSOIDAL CONDITIONS	9

Transmission and distribution systems – Shunt capacitors – transformers –.Electric machines – Ground systems – loads that cause power quality problems – Power quality problems created by drives and its impact on drive.

UNIT V	POWER FACTOR IMPROVEMENT	9

Power Factor Improvement Introduction – Passive Compensation – Passive Filtering – Harmonic Resonance –Impedance Scan Analysis – Active Power Factor Corrected Single Phase Front End – Control Methods for Single Phase APFC – Three Phase APFC and Control Techniques – PFC based on Bilateral Single Phase and Three Phase Converter.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
2	Analyse Polyphase AC systems with linear and nonlinear loads for power factor and harmonic analysis.
3	Develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components
4	Understand active power factor correction based on static VAR compensators and its control techniques
5	Understand series and shunt active power filtering techniques for harmonics.

REFERENCES:	
1.	*G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007*
2.	*Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000*
3.	*J. Arrillaga, "Power System Quality Assessment", John wiley, 2000*
4.	*J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley, 1997*
5.	*E.Aeha and M.Madrigal, "Power System Harmonics, Computer Modelling and Analysis, " WileyIndia, 2012.*

COURSE ARTICULATION MATRIX

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-	-	2	-	-	-	-	1	-	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	-	2	-
CO4	-	3	-	-	-	-	-	-	1	-	-	-	-	-
CO5	-	-	-	-	-	2	-	-	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE17	ANALOG AND DIGITAL CONTROLLERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide a overview of the control system and converter control methodologies
- To provide an insight to the analog controllers generally used in practice
- To introduce Embedded Processers for Digital Control
- To study on the driving techniques, isolation requirements, signal conditioning and protection methods
- To provide a Case Study by implementing an analog and a digital controller on a converter

UNIT I CONTROL SYSTEM- OVERVIEW — 09

Feedback and Feed-forward control, Right Half Plane Zero, Gain margin and Phase Margin, Stability, Analysis and Transfer function of PI and PID controllers and its effects . Voltage mode control, Peak Current mode Control, Average Current mode Control for Converters – Need, advantages and disadvantages.

UNIT II ANALOG CONTROLLERS — 09

Major components of a controller–Op-Amp based PI and PID controller–Proportional ,Integral and Differential gains in terms of Resistance and Capacitance , Error Amplifiers ,PWM generator using Ramp or Triangular generator and comparator , and Driver ,Voltage mode controller design using UC3524,Peak Current mode controller design using UC3842, Average Current mode controller design using UC3854, PFC-CCM (UCC28070).

UNIT III DIGITAL CONTROLLERS — 09

Micro Controllers and Digital Signal Controllers for Converter Control Application, Interface Modules for Converter Control–A/D , Capture , Compare and PWM , Analog Comparators for instantaneous overcurrent detection, interrupts ,Discrete PI and PID equations ,Algorithm for PI and PID implementation, Example Code for PWM generation.

UNIT IV SIGNAL CONDITIONING, DRIVER, ISOLATION AND PROTECTION — 09

Voltage feedback sensing circuits , Hall effect sensors and Shunts for current feedback sensing, Low off set Op-Amps for signal conditioning, Single and dual supply op-amps, To tempole drivers, Need for isolated drivers, Optically isolated drivers, low side drivers, high side drivers with boot strap power supply, Vcesat sensing , CT based Device current sensing and pulse blocking.

UNIT V CONTROLLER IMPLEMENTATION — 09

Analog and Digital Controller Design for Buck Converter–Power circuit transfer function and bode plot , PI controller bode plot , Combined bode plot with required Gain and Phase margins, Implementation of Analog controller and Digital controller.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1. Understand control system and converter control methodologies.

2.	Design of analog controllers
3.	Design of digital controllers.
4.	Understand signal conditioning and protection
5.	Implement Controllers in Electrical systems.
REFERENCE:	
1.	*Nadim Maluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.*
2.	*Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2001.*
3.	*Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.*
4.	*James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.*
5.	*Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,”Springer, 2010.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	2	-	-	-	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	-	-	1	-	-	-	2	-	-
CO3	-	-	-	-	2	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	1	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE18	MEMS TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

•	To teach the students properties of materials ,microstructure and fabrication methods.
•	To teach the design and modeling of Electrostatic sensors and actuators.
•	To teach the characterizing thermal sensors and actuators through design and modeling
•	To teach the fundamentals of piezoelectric sensors and actuators through exposure

UNIT I	**MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS**	**09**

Overview of micro fabrication–Silicon and other material based fabrication processes–Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II	**ELECTROSTATIC SENSORS AND ACTUATION**	**09**

Principle ,material ,design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

UNIT III	**THERMAL SENSING AND ACTUATION**	**09**

Principle ,material ,design and fabrication of thermal couples ,thermal bimorph sensors, thermal resistor sensors-Applications

UNIT IV	**PIEZOELECTRIC SENSING AND ACTUATION**	**09**

Piezoelectric effect-cantilever piezoelectric actuator model-properties of piezoelectric materials-Applications.

UNIT V	**CASE STUDIES**	**09**

Piezo resistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices

Note: Classroom discussions and tutorial scan include the following guidelines for improved teaching/learning process : Discussions/Exercise/Practice on Work bench : on the basics/device model design aspects of thermal/peizo/resistive sensors etc.

TOTAL :45 PERIODS

OUTCOMES:	After the completion of this course the student will be able to:
1	Understand basics of micro fabrication, develop models and simulate electrostatic and electromagnetic sensors and actuators
2	Understand material properties important for MEMS system performance, analyse dynamics of resonant micromechanical structures
3	The learning process delivers insight onto design of micro sensors, embedded sensors & Actuators in power aware systems like grid.
4	Understand the design process and validation for MEMS devices and systems,

	and learn the state of the art in optical micro systems.
5	Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded systems design.
REFERENCE:	
1	*Vikas Choudhary , “Fundamental Technology and Applications”,CRC Press.*
2	*Ai-Qun liu , “RF Mems Switchs and integrated switching circuits”, Springer.*
3	*Jeffrey H.Lang , “Multi-wafer rotating Mems Machines”, Springer.*
4	*Herbert R. Shea , “Mems Relibility”, Springer.*
5	*Chandan kumar sarkar, “Mems and Nanotechnology for Gas sensors”, CRC Press.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	2	-	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	1	-	2	-
CO3	-	-	2	-	-	-	-	-	2	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	2	-	-	2

1-Low, 2-Moderate (Medium), 3-High

<table>
<tr><td>18PEPE19</td><td colspan="2">ENERGY ECONOMICS, MANAGEMENT AND AUDITING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="3"></td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">OBJECTIVES:</td></tr>
<tr><td>•</td><td colspan="6">To study the concepts behind economic analysis and Load management.</td></tr>
<tr><td>•</td><td colspan="6">To emphasize the energy management on various electrical equipments and metering.</td></tr>
<tr><td>•</td><td colspan="6">To illustrate the concept of lighting systems and cogeneration.</td></tr>
<tr><td>UNIT I</td><td>INTRODUCTION</td><td colspan="5">09</td></tr>
<tr><td colspan="7">Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting- energy audit process.</td></tr>
<tr><td>UNIT II</td><td>ENERGY COST AND LOAD MANAGEMENT</td><td colspan="5">09</td></tr>
<tr><td colspan="7">Important concepts in an economic analysis-Economic models-Time value of money-Utility rate structures-cost of electricity-Loss evaluation-Load management : Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification.</td></tr>
<tr><td>UNIT III</td><td>ENERGY MANAGEMENT FOR MOTORS, SYSTEMS, AND ELECTRICAL EQUIPMENT</td><td colspan="5">09</td></tr>
<tr><td colspan="7">Systems and equipment- Electric motors-Transformers and reactors-Capacitors and synchronous machines.</td></tr>
<tr><td>UNIT IV</td><td>METERING FOR ENERGY MANAGEMENT</td><td colspan="5">09</td></tr>
<tr><td colspan="7">Relationships between parameters-Units of measure-Typical cost factors- Utility meters- Timing of meter disc for kilowatt measurement-Demand meters –Paralleling of current transformers- Instrument transformer burdens-Multitasking solid-state meters-Metering location vs .requirements-Metering techniques and practical examples.</td></tr>
<tr><td>UNIT V</td><td>LIGHTING SYSTEMS & COGENERATION</td><td colspan="5">09</td></tr>
<tr><td colspan="7">Concept of lighting systems-The task and the working space-Light sources-Ballasts- Luminaries - Lighting controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality-Cost analysis techniques-Lighting and energy standards Cogeneration: Forms of cogeneration- feasibility of cogeneration- Electrical interconnection</td></tr>
<tr><td colspan="2"></td><td colspan="5">TOTAL :45 PERIODS</td></tr>
<tr><td>OUTCOMES:</td><td colspan="6">After completion of this course, the student will be able to:</td></tr>
<tr><td>1</td><td colspan="6">Learn about the need for energy management and auditing process</td></tr>
<tr><td>2</td><td colspan="6">Learn about basic concepts of economic analysis and load management.</td></tr>
<tr><td>3</td><td colspan="6">Understand the energy management on various electrical equipments.</td></tr>
<tr><td>4</td><td colspan="6">Have knowledge on the concepts of metering and factors influencing cost Function</td></tr>
<tr><td>5</td><td colspan="6">Learn about the concept of lighting systems, light sources and various forms of cogeneration</td></tr>
<tr><td colspan="7">REFERENCE:</td></tr>
<tr><td>1</td><td colspan="6">Frank Kreith, “Energy Management and Conservation”, CRC Press.</td></tr>
</table>

2	*Steve Doty, "Commercial Energy Auditing".*
3	*Robin Smith, "Water and Energy Management in Food Processing".*
4	*Albert Thumann, "Energy Audits".*
5	*Barun Kumar De, "Energy Management , Audit and Conservation"*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	-	2	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	-	-	2	-	-
CO3	-	-	3	-	-	-	-	-	-	-	1	-	-	-
CO4	-	-	-	-	2	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	-	1	-	-	-	-	-	1

1-Low, 2-Moderate (Medium), 3-High

18PEPE20	SYSTEM THEORY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of physical systems in terms of its linear and Non linear models.
- To educate on representing systems in state variable form
- To exploit the properties of linear systems such as controllability and observability
- To educate on stability analysis of systems using Lyapunov's theory
- To educate on modal concepts and design of state and output feedback controllers

UNIT I	STATE VARIABLE REPRESENTATION	09

Introduction-Concept of State – State equations for Dynamic Systems-Time invariance and linearity-Non uniqueness of state model –Physical Systems and State A s s i g n m e n t -free and forced responses-State Diagrams.

UNIT II	SOLUTION OF STATE EQUATIONS	09

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Linear Time Varying State equations - State transition matrix and its properties–Evaluation of matrix exponential-System modes-Role of Eigen values and Eigen vectors

UNIT III	STABILITY ANALYSIS OF LINEAR SYSTEMS	09

Controllability and Observability definitions and Kalman rank conditions – Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case- Output Controllability-Reducibility-System Realizations.

UNIT IV	STATE FEEDBACK CONTROLAND STATE ESTIMATOR	09

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems- The Effect of State Feedback on Controllability and Observability – Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

UNIT V	LYAPUNOV STABILTY ANALYSIS	09

Introduction-Equilibrium Points–BIBO Stability-Stability of LTI Systems-Stability in the sense of Lyapunov – Equilibrium Stability of Nonlinear Continuous-Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous-Time Autonomous Systems–Krasovskil's and Variable-Gradient Method.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Construct the state space model for the given electrical/electro-mechanical systems.
2	Design pole placement controller for the given system to achieve desired specifications.
3	Design pole placement and observer for the given system to achieve desired specifications.

4	Identify the stability of the given linear system using Lyapunov stability theory.
5	Identify the stability of the given nonlinear system using Lyapunov stability theory.

TEXT BOOKS:	
1.	M.Gopal, “Modern Control SystemTheory”, New AgeInternational,2005.
2.	K. Ogatta, “Modern Control Engineering”, PHI,2002.
3.	JohnS. Bay,“FundamentalsofLinear StateSpaceSystems”, McGraw-Hill,1999.

REFERENCES:	
1.	*D.Roy Choudhury,“Modern Control Systems”,NewAge International,2005.*
2.	*JohnJ. D’Azzo,C.H.HoupisandS. N.Sheldon,“Linear Control System Analysis and Design with MATLAB”, Taylor Francis,2003.*
3.	*Z.Bubnicki, ”Modern Control Theory”, Springer, 2005.*
4.	*C.T.Chen,“Linear Systems Theory and Design’’ Oxford University Press, 3rd Edition, 1999.*
5.	*M.Vidyasagar,“Nonlinear Systems Analysis’, 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	3	-	-	-	-	1	-	-	-	-	-
CO2	-	1	-	-	-	-	-	-	1	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	1	-	2	-	-
CO4	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEPE21	**ROBOTICS AND CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

•	To introduce robot terminologies and robotic sensors
•	To educate direct and inverse kinematic relations
•	To educate on formulation of manipulator Jacobians and introduce path planning techniques
•	To educate on robot dynamics.
•	To introduce robot control techniques.

UNIT I	**INTRODUCTION AND TERMINOLOGIES**	**09**

Definition-Classification-History-Robots components-Degrees of freedom-Robot joints-coordinates-Reference frames-workspace-Robot languages-actuators-sensors-Position,velocity and acceleration sensors-Torque sensors-tactile and touch sensors-proximity and range sensors-vision system-social issues.

UNIT II	**KINEMATICS**	**09**

Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics solution and programming-degeneracy and dexterity

UNIT III	**DIFFERENTIAL MOTION AND PATH PLANNING**	**09**

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Robot Path planning.

UNIT IV	**DYNAMIC MODELLING**	**09**

Lagrangian mechanics-Two-DOF manipulator-Lagrange-Euler formulation–Newton-Euler formulation–Inverse dynamics

UNIT V	**ROBOT CONTROL SYSTEM**	**09**

Linear controls chemes-joint actuators-decentralized PID control- Extended Kalman Filter-computed torque control-force control- hybrid position force control- Impedance/ Torque control.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand the components in Robotics
2	Understand the basic terminology of Robotics
3	Model the motion of Robots and analyze the workspace and trajectory Panning of robots
4	Ability to develop application based Robots
5	Formulate models for the control of mobile robots in various industrial applications

REFERENCE:

1.	*R.K.Mittal andI J Nagrath, "Robotics and Control", Tata MacGraw Hill, Fourth*

	edition.
2.	*Saeed B. Niku, "Introduction to Robotics ", Pearson Education, 2002*
3.	*R.K.Mittal and I.J.Nagrath, Robotics and Control,Tata McGraw Hill,New Delhi,4th Reprint, 2*
4.	*JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education2009.*
5.	*M.P.Groover, M.Weiss,R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hil Singapore, 1996*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	2	-	-	-	-	-	2	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO3	-	-	2	-	-	-	-	-	-	1	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	2	-	-	2
CO5	-	-	-	-	-	-	-	-	-	-	2	-	-	-

1-Low, 2-Moderate (Medium), 3-High.

OPEN ELECTIVE COURSES

18PEOE01	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the various types of wastes
- To study the pyrolysis, gasification and combustion process of biomass
- To study the properties, features, and applications of biogas

UNIT I	INTRODUCTION TO ENERGY FROM WASTE	09

Classification of waste as fuel – Agro based, Forest residue, Industrial waste – MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II	BIOMASS PYROLYSIS	09

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III	BIOMASS GASIFICATION	09

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV	BIOMASS COMBUSTION	09

Biomass stoves – Improved chullahs, types, some exotic designs – Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, – Design, construction and operation - Operation of all the above biomass combustors.

UNIT V	BIOGAS	09

Properties of biogas (Calorific value and composition) – Biogas plant technology and status – Bio energy system – Design and constructional features – Biomass resources and their classification – Biomass conversion processes – Thermo chemical conversion – Direct combustion – biomass gasification – Pyrolysis and liquefaction – biochemical conversion – anaerobic digestion – Types of biogas Plants – Applications – Alcohol production from biomass – Bio diesel production – Urban waste to energy conversion – Biomass energy programme in India.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Explain the types of wastes and its applications in energy conversion
2	Apply pyrolysis, combustion, gasification process of biomass to produce energy
3	Apply the biogases to produce energy and other manufacturing process.

REFERENCES:

1. *Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.*
2. *Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.*
3. *Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.*
4. *Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.*
5. *Stehik,Petr, "up-to-date-waste to Energy Approach "Springer.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	2	-	-	-	2	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	-	-	1	-	-
CO3	-	2	-	-	-	-	-	1	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEOE02	MACHINE LEARNING AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the need for machine learning for various problem solving
- To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning
- To understand the latest trends in machine learning
- To design appropriate machine learning algorithms for problem solving

UNIT I	INTRODUCTION	09

Learning Problems – Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.

UNIT II	NEURAL NETWORKS AND GENETIC ALGORITHMS	09

Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evaluation and Learning.

UNIT III	BAYESIAN AND COMPUTATIONAL LEARNING	09

Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – Bayesian Belief Network – EM Algorithm – Probability Learning – Sample Complexity – Finite and Infinite Hypothesis Spaces – Mistake Bound Model

UNIT IV	INSTANT BASED LEARNING	09

K- Nearest Neighbour Learning – Locally weighted Regression – Radial Basis Functions – Case Based Learning.

UNIT V	ADVANCED LEARNING	09

Learning Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Differentiate between supervised, unsupervised, semi-supervised machine learning approaches
2	Discuss the decision tree algorithm and indentity and overcome the problem of overfitting
3	Discuss and apply the back propagation algorithm and genetic algorithms to various problems
4	Apply the Bayesian concepts to machine learning
5	Analyse and suggest appropriate machine learning approaches for various types of problems

REFERENCES:	
1	*Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.*
2	*Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.*
3	*Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC Press, 2009.*
4	Carlos Puerto – *Santana, "Industrial Applications of Machine Learning", CRC Press.*
5	*Tom M.Mitchell, "Machine Learning", McGraw-Hill Education (India) Private Limited*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	2	-	2	-	2	1	2	-	2	-	-	3	-
CO2	-	3	2	-	-	-	-	2	2	-	-	3	-	-
CO3	-	2	-	-	-	-	-	1	2	-	-	3	-	-
CO4	-	-	-	-	3	-	-	-	-	2	-	3	-	-
CO5	3	2	-	-	-	-	-	-	-	2	-	-	-	3

1-Low, 2-Moderate (Medium), 3-High

18PEOE03	SOFTWARE FOR CIRCUIT SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide Knowledge about power electronic components.
- To analyse Various algorithms in power electronics systems.
- To analyse DC and AC circuits
- To provide student hand-on experience on MATLAB to implement various strategies.

UNIT I	INTRODUCTION	09

Importance of simulation – General purpose circuit analysis – programs – Method of analysis of power electronic systems– Review of modeling of power electronic components and systems.

UNIT II	ADVANCED TECHNIQUES IN SIMULATION	09

Analysis of power electronic systems in a sequential manner coupled and decoupled systems– Various algorithms for computing steady state solution in power electronic systems–Future trends in computer simulation.

UNIT III	PSPICE	09

Introduction – Pspice overview – DC circuit Analysis – AC circuit analysis – Transient and the time domain – Fourier Series and Harmonic components – An introduction to Pspice devices BJT,FET, MOSFET and is model–Amplifiers and Oscillators–Nor linear Devices.

UNIT IV	MATLAB	09

Introduction – function description – Data types–Tool boxes–Graphical Display :Import and Export of data–Programs for solution of state equations.

UNIT V	SIMULINK	09

Introduction – Graphical user Interface – Selection of objects – Blocks – lines Simulation - Application programs.

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire Knowledge about the simulation of Power Electronics Devices.
2	Learn Various advance techniques in Simulation.
3	Learn about DC and AC circuits analysis using Pspice.
4	Learn about DC and AC circuits analysis using Matlab.
5	Acquire Knowledge about Graphical user Interface

REFERENCES:

1	*Rajagopalan .V ‘Computer aided analysis of power electronic systems’ Marcell Dekker1987.*
2	*John Keown ‘Microsim Pspice and circuit analysis” Prentice hall Inc, 1998.*
3	*Orcad Pspice User manual,Orcad Corporation, 2006.*
4	*Matlab /Simulinkmanual,MathsWork2007.*
5	*Adrian Loinovici, “Computer Aided analysis of Active circuits”.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	2	-	2	-	-	-	2	-	1	2	3	-	-
CO2	3	3	-	2	-	-	-	-	2	1	2	3	-	-
CO3	3	3	3	2	-	-	-	3	-	2	2	3	-	-
CO4	3	3	3	2	-	-	-	3	-	2	2	3	-	-
CO5	3	3	-	2	-	-	-	-	-	2	2	3	-	-

1-Low, 2-Moderate (Medium), 3-High

18PEOE04	POWER ELECTRONICS FOR SOLAR PHOTOVOLTAIC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand PV cell and its characteristics.
- To estimate Sun's Solar Energy.
- To understand Battery and its Application for PV.
- To study different Power converters for Solar PV.
- To Know the applications of solar PV.

UNIT I — THE PV CELL AND CHARACTERISTICS — 09

A historical perspective, PV cell characteristics and equivalent circuit, Model of PV cell, Short Circuit, Open Circuit and peak power parameters, Datasheet study, Cell efficiency, Effect of temperature, Temperature effect calculation example, Fill factor, PV cell simulation. Identical cells in series, Load line, Non-identical cells in series, protecting cells in series, interconnecting modules in series, Simulation of cells in series, identical cells in parallel, Non-identical cells in parallel, protecting cells in parallel, interconnecting modules in parallel, Simulation of cells in parallel, Measuring I-V characteristics.

UNIT II — SUN INCIDENT ENERGY ESTIMATION — 09

Insolation and irradiance, Insolation variation with time of day, Earth centric viewpoint and declination, solar geometry, Insolation on a horizontal flat plate, Energy on a horizontal flat plate, Sunrise and sunset hour angles. Energy on a tilted flat plate, Atmospheric effects, Air Mass, Energy with atmospheric effects, Clearness index.

UNIT III — BATTERY FOR PV — 09

Sizing PV for applications without batteries, Batteries - Capacity, C-rate, Efficiency, Energy and power densities, Battery selection, other energy storage methods, Direct PV-battery connection, Charge controller, Battery charger - Understanding current control, slope compensation, Batteries in series - charge equalization, Batteries in parallel

UNIT IV — POWER ELECTRONICS IN PV — 09

PV system design, Load profile, Days of autonomy and recharge, Battery size, PV array size.MPPT concept, Input impedance of DC-DC converters -Boost converter, Buck converter, Buck-Boost converter - PV and DC-DC interface.Impedance control methods, Reference cell, Sampling method, Power slope methods, Hill climbing method.

UNIT V — PV APPLICATIONS — 09

Solar home lighting systems – Solar street lighting systems - Solar lanterns – Applications - Rural electrification process -Water pumping principle, Hydraulic energy and power, Total dynamic head, Numerical solution - Colebrook formula, Centrifugal pump, Reciprocating pump, PV power, Pumped hydro application

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Learn about the solar PV systems.
2	Analyze of the estimation of solar energy from Sun.
3	Learn about Batteries for PV systems.

4	Acquire knowledge about the power electronics in PV system.
5	Acquire knowledge about PV Applications.
REFERENCES:	
1	*Chenming, H. and White, R.M., Solar Cells from B to Advanced Systems, McGraw Hill Book Co, 1983*
2	*Ruschenbach, HS, Solar Cell Array Design Hand Varmostrand, Reinhold, NY, 1980.*
3	*HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010*
4	*Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications Prentice- Hall, 2008.*
5	*Rai, G.D., Solar Energy Utilization, Khanna Publishers,Delhi, 2010.*
6	*Rashid .M. H "power electronics Hand book", Academic press, 2007.*
7	*Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	2	-	2	-	-	-	2	-	-	2	3	3	-
CO2	3	2	-	2	-	-	-	1	-	-	-	3	3	-
CO3	-	2	-	-	-	-	-	1	-	-	-	3	3	-
CO4	3	1	-	-	-	-	-	1	-	-	2	3	3	-
CO5	3	1	-	-	-	-	-	2	-	-	3	3	3	-

1-Low, 2-Moderate (Medium), 3-High

18PEOE05	ELECTRIC VEHICLE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand basics of Electric Vehicles
- To Understand different Electric drive motors.
- To Know about Energy storage methods.
- To design drive system
- To understand management of electrical energy in Electric vehicles

UNIT I	INTRODUCTION	09

History electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT II	ELECTRIC DRIVES	09

Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT III	ENERGY STORAGE	09

Introduction to Energy Storage Requirements in Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT IV	DESIGN OF ELECTRIC DRIVE	09

Matching the electric machine, Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

UNIT V	ENERGY MANAGEMENT AND STRATEGIES	09

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.
Case Studies: Design of a Battery Electric Vehicle (BEV).

TOTAL :45 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand the operation of Electric Vehicles
2	Acquire Knowledge on various Energy storage technologies for Electric Vehicles
3	Learn about the need for energy vehicles.
4	Understand energy storage systems in EV
5	Understand the concept of Energy Management.

REFERENCES:

1 *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.*

2	*Electric and Hybrid Vehicles" by Tom Denton Taylor and Francis , 2016.*
3	*MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.*
4	*James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.*
5	*"Build Your Own Electric Vehicle" by Seth Leitman and Bob Brant Mccraw Hills – MCGRA 2nd Edition, 2013*
6	*"Introduction to Hybrid Vehicle System Modeling and Control" by Wei Liu John Willy & Sons.*
7	*"Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines)" by Ali Emadi CRC Press, 2015.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	3	-	2	-	-	-3	2	-	2	-	-	3	-
CO2	3	2	-	-	-	-	-	-	2	2	-	1	3	2
CO3	3	2	-	-	-	-	3	1	-	2	-	-	3	-
CO4	3	2	-	-	-	-	-	-	-	1	-	-	3	2
CO5	3	3	-	-	-	-	2	-	-	2	-	-	3	1

1-Low, 2-Moderate (Medium), 3-High

AUDIT COURSES (I&II)

18ZAC001	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To understand various disasters, hazards and its effects.
- To monitor and manage the disasters
- To prepare risk assessment report
- To understand the various methods to mitigate the disasters.

UNIT I	INTRODUCTION TO DISASTERS	6

Disaster: Definition, factors and significance – Difference between hazard and disaster – Natural and manmade disasters: Difference, nature, types and magnitude – Study of seismic zones – Areas prone to floods and droughts – Landslides and avalanches – Areas prone to cyclonic and coastal hazards with special reference to tsunami – Post-disaster diseases and epidemics

UNIT II	REPERCUSSIONS OF DISASTERS AND HAZARDS	6

Economic damage – Loss of human and animal life – Destruction of ecosystem – Natural disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches – Man-made disaster: Nuclear reactor meltdown, Industrial accidents, Oil slicks and spills, Outbreaks of disease and Epidemics, War and conflicts.

UNIT III	DISASTER PREPAREDNESS AND MANAGEMENT	6

Preparedness – Monitoring of phenomena triggering a disaster or hazard – Evaluation of risk: application of remote sensing – Data from Meteorological and other agencies – Media reports: Governmental and Community preparedness.

UNIT IV	RISK ASSESSMENT	6

Disaster risk: Concept and elements – Disaster risk reduction – Global and National disaster risk situation – Techniques of risk assessment – Global co- operation in risk assessment and warning – People's participation in risk assessment – Strategies for survival

UNIT V	DISASTER MITIGATION	6

Meaning – Concept and strategies of disaster mitigation – Emerging trends in mitigation – Structural mitigation and Non-structural mitigation – Programs of disaster mitigation in India.

TOTAL :30 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2	Evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4	Understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

REFERENCES:

1.	*R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company.*
2.	*Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.*
3.	*Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	-	-	2	-	-	-	2	-	-	-	-	-	-
CO2	-	-	-	-	-	3	-	-	2	-	-	-	-	-
CO3	-	2	-	-	-	-	-	1	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

<table>
<tr><td>18ZAC002</td><td colspan="2">ENGLISH FOR RESEARCH PAPER WRITING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="3"></td><td>2</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="7">OBJECTIVES:</td></tr>
<tr><td>•</td><td colspan="6">Understand that how to improve your writing skills and level of readability</td></tr>
<tr><td>•</td><td colspan="6">Learn about what to write in each section</td></tr>
<tr><td>•</td><td colspan="6">Understand the skills needed when writing a Title</td></tr>
<tr><td>•</td><td colspan="6">Ensure the good quality of paper at very first-time submission</td></tr>
<tr><td>UNIT I</td><td colspan="5">PLANNING AND PREPARATION</td><td>6</td></tr>
<tr><td colspan="7">Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness</td></tr>
<tr><td>UNIT II</td><td colspan="5">RESEARCH FINDINGS</td><td>6</td></tr>
<tr><td colspan="7">Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction</td></tr>
<tr><td>UNIT III</td><td colspan="5">LITERATURE REVIEW</td><td>6</td></tr>
<tr><td colspan="7">Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">PAPER WRITING SKILLS-I</td><td>6</td></tr>
<tr><td colspan="7">key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,</td></tr>
<tr><td>UNIT V</td><td colspan="5">PAPER WRITING SKILLS-II</td><td>6</td></tr>
<tr><td colspan="7">skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions useful phrases, how to ensure paper is as good as it could possibly be the first- time submission</td></tr>
<tr><td colspan="7" align="right">TOTAL :30 PERIODS</td></tr>
<tr><td colspan="7">OUTCOMES: After completion of this course, the student will be able to:</td></tr>
<tr><td>1</td><td colspan="6">Write the technical report, research proposal without grammatical errors,</td></tr>
<tr><td>2</td><td colspan="6">Write the literature review on specific research topic</td></tr>
<tr><td>3</td><td colspan="6">Write the research paper for the proposal</td></tr>
<tr><td colspan="7">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="6">Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)</td></tr>
<tr><td>2.</td><td colspan="6">Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press</td></tr>
<tr><td>3.</td><td colspan="6">Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .</td></tr>
<tr><td>4.</td><td colspan="6">Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011</td></tr>
</table>

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18ZAC003	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To identify the problems and solutions for research in various areas
- To prepare literature survey and write thesis report
- To prepare research proposal in various agencies like DST, AICTE etc..,
- To understand the Intellectual property rights and patenting
- To understand the patent rights and its developments

UNIT I	RESEARCH PROBLEM AND SOLUTION	6

Meaning of research problem – Sources of research problem – Criteria Characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem – Approaches of investigation of solutions for research problem – data collection – analysis – interpretation – Necessary instrumentations

UNIT II	LITERATURE SURVEY AND WRITING	6

Effective literature studies approaches – Analysis – Plagiarism – Research ethics – Effective technical writing.

UNIT III	RESEARCH PROPOSAL	6

How to write report and Paper Developing a Research Proposal – Format of research proposal – a presentation and assessment by a review committee.

UNIT IV	NATURE OF INTELLECTUAL PROPERTY	6

Patents – Designs – Trade and Copyright – Process of Patenting and Development: technological research – innovation – patenting – development – International Scenario: International cooperation on Intellectual Property – Procedure for grants of patents – Patenting under PCT.

UNIT V	PATENT RIGHTS AND NEW DEVELOPMENTS	6

Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications – Administration of Patent System –IPR of Biological Systems – Computer Software etc – Traditional knowledge – Case Studies: IPR and IITs.

TOTAL :30 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understand research problem formulation.
2	Analyze research related information
3	Understand that tomorrow world will be ruled by ideas, concept, and creativity.
4	Understand that IPR would require in growth of individuals & nation.
5	Understand the importance of IPR protection.

REFERENCES:

1.	*Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"*
2.	*Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"*
3.	*Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"*

4.	*Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.*
5.	*Mayall , "Industrial Design", McGraw Hill, 1992.*
6.	*Niebel , "Product Design", McGraw Hill, 1974.*
7.	*Asimov , "Introduction to Design", Prentice Hall, 1962.*
8.	*Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.*
9.	*T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	2	-	-	-	-	2	-	-	-	-	-	3
CO2	-	-	-	2	-	-	-	-	2	-	-	-	-	-
CO3	-	2	-	-	-	3	-	1	-	-	-	-	2	-
CO4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	1	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18ZAC004	SANSKRIT FOR TECHNICAL KNOWLEDGE	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

UNIT I	BASICS	6

Alphabets in Sanskrit – Past/Present/Future Tense,

UNIT II	SENTENCES	6

Simple Sentences

UNIT III	ROOTS	6

Order – Introduction of roots

UNIT IV	TECHNICAL INFORMATION	6

Technical information about Sanskrit Literature

UNIT V	SANSKRIT IN ENGINEERING	6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL :30 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Understanding basic Sanskrit language
2	Ancient Sanskrit literature about science & technology can be understood
3	Being a logical language will help to develop logic in students

REFERENCES:

1. *Dr.Vishwas, "Abhyaspustakam", Samskrita-Bharti Publication, New Delhi*
2. *Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, "Teach Yourself Sanskrit", New Delhi Publication*
3. *Suresh Soni, "India's Glorious Scientific Tradition" Ocean books (P) Ltd., New Delhi.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18ZAC005	VALUE EDUCATION	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To understand value of education and self- development
- To Imbibe good values in students
- To know about the importance of character

UNIT I	**ETHICS**	**6**

Values and self-development – Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT II	**ELEMENTS OF VALUE EDUCATION**	**6**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature

UNIT III	**PERSONALITY DEVELOPMENT**	**6**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.

UNIT IV	**DIFFERENT VALUES**	**6**

Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT V	**CHARACTER AND COMPETENCE**	**6**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

TOTAL :30 PERIODS

OUTCOMES: After completion of this course, the student will be able to:

1	Acquire the knowledge of self-development
2	Learn the importance of Human values
3	Develop the overall personality

REFERENCES:

1. *Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO3	1	-	-	-	-	-	-	-	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18ZAC006	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To Review existing evidence on the review topic to inform programme design and policy making undertaken by the HRD, other agencies and researchers.
- To Identify critical evidence gaps to guide the development.

UNIT I	INTRODUCTION AND METHODOLOGY	6

Aims and rationale – Policy background – Conceptual framework and terminology – Theories of learning, Curriculum, Teacher education – Conceptual framework – Research questions**.** – Overview of methodology and Searching

UNIT II	THEMATIC OVERVIEW	6

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. – Curriculum – Teacher education.

UNIT III	EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES	6

Evidence on the effectiveness of pedagogical practices – Methodology for the in depth stage: quality assessment of included studies – How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? – Theory of change – Strength and nature of the body of evidence for effective pedagogical practices – Pedagogic theory and pedagogical approaches –Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV	PROFESSIONAL DEVELOPMENT	6

Alignment with classroom practices and followup support – Peer support – Support from the head teacher and the community – Curriculum and assessment – Barriers to learning: limited resources and large class sizes

UNIT V	RESEARCH GAPS AND FUTURE DIRECTIONS	6

Research design – Contexts – Pedagogy – Teacher education – Curriculum and assessment – Dissemination and research impact.

TOTAL :30 PERIODS

OUTCOMES: After completion of this course, the student will be able to understand:

1	Understand the pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
2	Understand the evidence on the effectiveness of pedagogical practices.
3	Understand the teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.

REFERENCES:

1. *Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.*
2. *Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.*
3. *Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.*
4. *Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning*

	of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5.	*Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.*
6.	*Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.*
7.	*www.pratham.org/images/resource%20working%20paper%202.pdf*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	1	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18ZAC007	STRESS MANAGEMENT BY YOGA	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To achieve overall health of body and mind
- To overcome stress

UNIT I	ASHTANGA	6

Definitions of Eight parts of yog.

UNIT II	YAM	6

Do`s and Don't's in life: Ahinsa, satya, astheya, bramhacharya and aparigraha

UNIT III	NIYAM	6

Do`s and Don't's in life: Shaucha, santosh, tapa, swadhyay, Ishwar pranidhan

UNIT IV	ASAN	6

Various yoga poses and their benefits for mind & body

UNIT V	PRANAYAM	6

Regularization of breathing techniques and its effects-Types of pranayam

TOTAL :30 PERIODS

OUTCOMES:

After completion of this course, the student will be able to understand:

1	Develop healthy mind in a healthy body thus improving social health also
2	Improve efficiency

REFERENCES:

1. *Janardan Swami Yogabhyasi Mandal, "Yogic Asanas for Group Tarining-Part-I", Nagpur*
2. *Swami Vivekananda, "Rajayoga or conquering the Internal Nature" Advaita Ashrama (Publication Department), Kolkata*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	1	-	-	-	-	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High

18ZAC008	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
		2	0	0	0

OBJECTIVES:

•	To learn to achieve the highest goal happily
•	To become a person with stable mind, pleasing personality and determination
•	To awaken wisdom in students

UNIT I	**HOLISTIC DEVELOPMENT OF PERSONALITY**	**6**
Neetisatakam – Holistic development of personality: Wisdom (Verses- 19,20,21,22) – Pride & Heroism (Verses- 29,31,32) – Virtue (Verses- 26,28,63,65)		
UNIT II	**DO'S AND DONT'S**	**6**
Neetisatakam – Dont's (Verses- 52,53,59) – Do's (Verses- 71,73,75,78)		
UNIT III	**APPROACH TO DAY TO DAY WORK AND DUTIES**	**6**
Shrimad Bhagwad Geeta : Chapter 2 (Verses 41, 47,48) – Chapter 3 (Verses 13, 21, 27, 35) – Chapter 6 (Verses 5,13,17,23, 35) – Chapter 18 (Verses 45, 46, 48)		
UNIT IV	**STATEMENTS OF BASIC KNOWLEDGE**	**6**
Shrimad Bhagwad Geeta: Chapter2 (Verses 56, 62, 68) – Chapter 12 (Verses 13, 14, 15, 16,17, 18)		
UNIT V	**PERSONALITY OF ROLE MODEL**	**6**
Shrimad Bhagwad Geeta: Chapter2 (Verses 17) – Chapter 3 (Verses 36,37,42) – Chapter 4 (Verses 18, 38,39) – Chapter18 (Verses 37,38,63)		
		TOTAL :30 PERIODS

OUTCOMES: After completion of this course, the student will be able to understand:

1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3	Study of Neetishatakam will help in developing versatile personality of students.

REFERENCES:

1.	*Swami Swarupananda "Srimad Bhagavad Gita" by Advaita Ashram (Publication Department), Kolkata*
2.	*P.Gopinath, "Bhartrihari's Three Satakam (Niti-sringar-vairagya)", Rashtriya Sanskrit Sansthanam, New Delhi.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO1	PSO2	PSO3
CO1	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1-Low, 2-Moderate (Medium), 3-High