



GOVERNMENT COLLEGE OF ENGINEERING, SALEM
(NAAC Accredited with A⁺, An Autonomous Institution, Affiliated to Anna University, Chennai)

POSTGRADUATE CURRICULUM

(Applicable to the students admitted in M.E. Programme, from the Academic Year 2026-2027)

Programme: M.E. Power Electronics and Drives

Regulations: 2026

Overview of Credits

Sem	BS	ES(PC)	ES(PE)	SD	MC	AC	Total
I	3	13		1	3	0	20
II		16	6			0	22
III			6	8			14
IV				14			14
Total	3	29	12	23	3		70
% of Category	4.29	41.43	17.14	32.86	4.29	0	100

Abbreviations:

Course Type:

T - Theory
L - Laboratory
LIT - Laboratory Integrated Theory
PW -Project Work

Category :

BS - Basic Science
ES - Engineering Science [Programme Core(**PC**)
Programme Elective(**PE**)]
SD - Skill Development
MC -Mandatory Course
AC- Audit Course

Others :

TH-Total Contact Periods
L - Lecture
T - Tutorial
P - Practical

Semester I											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26MP102	Applied Mathematics for Power Engineers	T	45	0	0	45	3	BS	40	60
2.	26PE101	Modern Power Semiconductor Devices	T	45	0	0	45	3	ES(PC)	40	60
3.	26PE102	Analysis of Power Converters	LIT	45	0	60	105	5	ES(PC)	50	50
4.	26PE103	Digital Controller Based System Design	LIT	45	0	60	105	5	ES(PC)	50	50
5.	26MLC01	Research Methodology and IPR	T	45	0	0	45	3	MC	40	60
6.	26PE104	Technical Seminar	-	0	0	30	30	1	SD	100	0
7.	26AC00X	Audit Course - I	T	30	0	0	30	0	AC	100	0
Total							405	20			

Semester II											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26PE201	Advanced Electrical Drives	LIT	45	0	60	105	5	ES(PC)	50	50
2.	26PE202	Power Converters for Renewable Energy System	LIT	45	0	60	105	5	ES(PC)	50	50
3.	26PE203	Modelling and Analysis of Electrical Machines	T	45	0	0	45	3	ES(PC)	40	60
4.	26PE204	Electric Vehicles and Power Management	T	45	0	0	45	3	ES(PC)	40	60
5.	26PEEXX	Programme Elective - I	T	45	0	0	45	3	ES(PE)	40	60
6.	26PEEXX	Programme Elective - II	T	45	0	0	45	3	ES(PE)	40	60
7.	26AC00X	Audit Course - II	T	30	0	0	30	0	AC	100	0
Total							420	22			

Semester III											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26PEEXX	Programme Elective - III	T	45	0	0	45	3	ES(PE)	40	60
2.	26PEEXX	Programme Elective - IV	T	45	0	0	45	3	ES(PE)	40	60
3.	26PE301	Dissertation Phase - I	PW	0	0	240	240	8	SD	60	40
Total							330	14			

Semester IV											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26PE401	Dissertation Phase – II	PW	0	0	420	420	14	SD	60	40
Total							420	14			
Total Credits for the Programme = 20 + 22+ 14 + 14								70			

Programme Electives

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
Programme Elective - I (Semester II)											
1.	26PEE01	Advanced Power Electronic Converters	T	45	0	0	45	3	ES(PE)	40	60
2.	26PEE02	Digital Control System	T	45	0	0	45	3	ES(PE)	40	60
3.	26PEE03	Modern Rectifiers and Resonant Converters	T	45	0	0	45	3	ES(PE)	40	60
4.	26PEE04	Power Electronic Converter Dynamics and Control	T	45	0	0	45	3	ES(PE)	40	60
5.	26PEE05	Design of Power Converters	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - II (Semester II)											
6.	26PEE06	Power Quality And Custom Power Devices	T	45	0	0	45	3	ES(PE)	40	60
7.	26PEE07	Multilevel Inverters	T	45	0	0	45	3	ES(PE)	40	60
8.	26PEE08	EMI and EMC in Power Converters	T	45	0	0	45	3	ES(PE)	40	60
9.	26PEE09	Digital Simulation of Power Electronics System	T	45	0	0	45	3	ES(PE)	40	60
10.	26PEE10	Modelling of Switched Mode Power Converters	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - III (Semester III)											
11.	26PEE11	Smart Grid Technology	T	45	0	0	45	3	ES(PE)	40	60
12.	26PEE12	Distributed Generation and Microgrid	T	45	0	0	45	3	ES(PE)	40	60
13.	26PEE13	FACTS and HVDC System	T	45	0	0	45	3	ES(PE)	40	60
14.	26PEE14	Advanced Electrical Drives for Electric Vehicle	T	45	0	0	45	3	ES(PE)	40	60
15.	26PEE15	Design of Magnetics for Power Converters	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - IV (Semester III)											
16.	26PEE16	Grid Integration of Renewable Energy Sources	T	45	0	0	45	3	ES(PE)	40	60
17.	26PEE17	Energy Storage Technologies	T	45	0	0	45	3	ES(PE)	40	60
18.	26PEE18	Internet of Things	T	45	0	0	45	3	ES(PE)	40	60
19.	26PEE19	Artificial Intelligence for Power Electronics	T	45	0	0	45	3	ES(PE)	40	60
20.	26PEE20	Power Electronics Drives for Electric Vehicle	T	45	0	0	45	3	ES(PE)	40	60

Audit Courses

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26AC001	English for Research paper writing	T	30	0	0	30	0	AC	100	0
2.	26AC002	Disaster Management	T	30	0	0	30	0	AC	100	0
3.	26AC003	Sanskrit for Technical Knowledge	T	30	0	0	30	0	AC	100	0
4.	26AC004	Value Education	T	30	0	0	30	0	AC	100	0
5.	26AC005	Constitution of India	T	30	0	0	30	0	AC	100	0
6.	26AC006	Pedagogy Studies	T	30	0	0	30	0	AC	100	0
7.	26AC007	Stress Management by Yoga	T	30	0	0	30	0	AC	100	0
8.	26AC008	Personality Development through Life Enlightenment Skills	T	30	0	0	30	0	AC	100	0
9.	26AC009	Sustainable Development Goals	T	30	0	0	30	0	AC	100	0

26MP102	APPLIED MATHEMATICS FOR POWER ENGINEERS		SEMESTER			I
Prerequisites		Category	BS	Credits		3
Basic knowledge of linear algebra, calculus, differential equations, probability and basic engineering mathematics is required.		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	Use the linear algebra concepts in Electrical Engineering problems.					
2.	To familiarize the students in the field of differential equations to solve boundary value problems associated with engineering applications.					
3.	Formulate and solve engineering problems involving random variables.					
4.	To develop analytical skills using Z-transforms and Fourier series for engineering applications.					
UNIT - I	ADVANCED LINEAR ALGEBRA					9
Vector spaces – Norms – Inner Products – The Cholesky decomposition – QR factorization – Singular value decomposition (SVD) – Pseudo inverses – Least squares method.						
UNIT - II	CALCULUS OF VARIATIONS					9
Concept of variation and its properties – Euler’s Equation – Functionals dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Direct method: Ritz method.						
UNIT - III	ONE-DIMENSIONAL RANDOM VARIABLE					9
Random variables – PMF and PDF – Moments – Moment generating functions and their properties – Binomial, Poisson, Uniform and Normal distributions – Functions of Random Variables.						
UNIT - IV	Z – TRANSFORMS					9
Definition – Standard Z-transforms – Damping rule – Shifting rule – Initial value and Final value theorems (without proofs) and problems – Inverse Z-transform using partial fraction and convolution methods – Applications to Difference Equations.						
UNIT - V	FOURIER SERIES					9
Periodic Functions and Power Signals – Convergence of series – Even and odd function: cosine and sine series – Half-range expansions – Power signals: Exponential Fourier series – Parseval’s theorem and power spectrum.						
L:45, T: 0, P: 0,Total: 45 Hours						
Weightage:						
Continuous Assessment: 40%						
End Semester Examinations: 60%						

REFERENCE BOOKS:			
1.	Bronson, R., "Matrix Operations", McGraw Hill, 2011.		
2.	Elsgolts, L. D., "Calculus of Variations", Dover Publications Inc., 2007.		
3.	Grewal, B. S., "Higher Engineering Mathematics", Khanna Publishers, 2018.		
4.	Andrews, L. C., and Phillips, R. L., "Mathematical Techniques for Engineers and Scientists", Prentice Hall, 2005.		
5.	Papoulis, A., and Pillai, S. U., "Probability, Random Variables and Stochastic Processes", McGraw Hill, 2019.		
E-RESOURCES:			
1.	NPTEL Linear Algebra https://nptel.ac.in/courses/111/106/111106051		
2.	Khan Academy – Calculus of Variations https://www.khanacademy.org/math/calculus-variations		
3.	NPTEL – Probability & Statistics https://nptel.ac.in/courses/111/105/111105041		
4.	NPTEL – Z-Transforms https://nptel.ac.in/courses/117/103/117103017		
5.	NPTEL – Fourier Series https://nptel.ac.in/courses/111/102/111102113		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the principles of matrix decompositions, variational methods, random variables and probability distributions, Z-transforms, and Fourier series relevant to power engineering applications.	PO3	PSO1
CO2	Apply matrix decomposition techniques, variational methods, probability distributions, Z-transforms, and Fourier series to solve power engineering problems.	PO1, PO3	PSO1
CO3	Analyze power engineering systems using least squares methods, functions of random variables, Z-transform techniques, and Fourier series representations.	PO1, PO3	PSO1, PSO2
CO4	Evaluate and select appropriate mathematical methods, including matrix decompositions, variational techniques, probabilistic models, Z-transforms, and Fourier series, for modeling and analysis of power engineering problems.	PO1, PO3	PSO2
CO5	Develop mathematical models and obtain solutions for power engineering problems using linear algebra tools, variational methods, probabilistic analysis, Z-transforms, and Fourier series techniques.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	2	2	-
CO2	3	-	3	3	-
CO3	3	-	3	3	3
CO4	2	-	2	-	2
CO5	2	2	2	2	2
AVERAGE	2.5	2	2.4	2.5	2.3

Activities:

1.	Compare Cholesky, QR and SVD methods for solving linear systems and least squares problems and justify the most suitable approach.
2.	Evaluate the accuracy of solutions obtained using pseudo inverse and least squares method for a given linear system.
3.	Formulate a variational problem, apply Euler's equation or Ritz method, and develop the optimal solution.
4.	Develop a probability model for an engineering system using suitable distributions and compute moments and statistical characteristics using MGF.
5.	Construct Z-transform based solutions for a discrete system and develop Fourier series representation to analyze power spectrum.

Rubrics for evaluation: CO4 (Evaluation of Mathematical Methods for Engineering Applications)

Sl. No.	Criterion	Marks	Excellent (9-10)	Good (6-8)	Satisfactory (1-5)
1.	Understanding of Mathematical Techniques	8	Demonstrates strong understanding of mathematical techniques and their applicability	Shows adequate understanding with minor gaps	Demonstrates limited understanding
2.	Selection of Suitable Mathematical Method	8	Appropriate mathematical method selected with clear justification	Suitable method selected with minor issues	Incorrect or unclear method selection
3.	Formulation of Mathematical Model	8	Problem is correctly formulated into an appropriate mathematical model	Model formulation is adequate with minor errors	Model formulation is incomplete or incorrect
4.	Analytical Accuracy and Correctness of Solution	8	Mathematical analysis and solution are accurate, valid, and properly interpreted	Minor errors in analysis or calculations	Major errors affecting correctness of the solution

5.	Analysis, Interpretation and Technical Presentation	8	Results are critically analyzed, clearly interpreted, and presented in a systematic manner	Interpretation is acceptable with minor presentation issues	Poor analysis, interpretation, and presentation
Total		40			

Rubrics for evaluation: CO5 (Development of Mathematical Models and Engineering Solutions)

Sl. No.	Criterion	Marks	Excellent (9-10)	Good (6-8)	Satisfactory (1-5)
1.	Problem Formulation and Mathematical Modelling	8	Engineering problem is clearly formulated with an appropriate mathematical model	Minor issues in formulation or modelling	Problem formulation and modelling are unclear
2.	Selection of Mathematical Method	8	Appropriate mathematical technique is selected with clear justification	Suitable method selected with minor issues	Inappropriate or unclear method selection
3.	Methodology and Solution Development	8	Mathematical procedures are correctly developed and systematically presented	Methodology is adequate with minor errors	Methodology is incomplete or incorrect
4.	Solution Accuracy and Validation	8	Solutions are accurate and properly verified or validated	Validation is adequate with minor issues	Poor or incomplete validation of solutions
5.	Analysis, Engineering Interpretation and Presentation	8	Results are effectively analyzed, related to engineering applications, and presented clearly in a well-organized report	Interpretation is acceptable with minor presentation or documentation issues	Poor interpretation, presentation, and documentation
Total		40			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24	-	-	24	3
CO3	24	24	-	-	24	3
CO4	-	-	40	-	20	2
CO5	-	-	-	40	20	2
Total	60	60	40	40	100	

Strength = 3 (if percentage >20%); Strength =2 (if percentage 10% to 20%);
Strength = 1 (if percentage <10%);

26PE101	MODERN POWER SEMICONDUCTOR DEVICES		SEMESTER			I	
Prerequisites			CATEGORY	ES(PC)	Credit		3
Power Electronics			Hours/ Semester	L	T	P	TH
				45	0	0	45
Course Objectives:							
1.	To provide knowledge about wide band gap devices, their characteristics and applications in DC-DC and DC-AC converters.						
2.	To perform electrical and thermal modeling of wide band gap devices and design EMI filters for high-frequency power converters						
3.	To understand general guidelines and best practices for single-layer and multilayer PCB design according to industrial standards						
UNIT - I		Wide Band Gap Devices					9
Introduction to basic power devices, characteristics, advantages, and challenges in designing converters - Silicon Power MOSFETs, SiC Planar Power MOSFETs, SiC Trench-Gate Power MOSFETs, Need for GaN devices, basic GaN transistor structure, GaN vertical power HEMTs, and horizontal power HEMTs.							
UNIT - II		SiC Power Device					9
Planer SiC Power Mosfets: Blocking characteristics, On, Resistance, Threshold voltage, Reliability- Shielded SiC Planner Power Mosfet, Device structure blocking mode, channel structure & On-Resistance- SiC Trench Power Mosfets: Blocking characteristics, On-Resistance, Threshold voltage, Reliability- Shielded Trench Power Mosfets characteristics - Introduction to silicon bipolar transistor (BJT) for achieving ultra-high voltage.							
UNIT - III		GaN POWER DEVICE					9
Pulsed static characterization: Turn-ON and Turn-OFF switching characteristics of GaN devices, hard switching loss analysis, Junction capacitance characterization, Gate drive for dynamic characterization: gate driver design, impact of gate resistance, dv/dt and di/dt immunity, etc. - protection design for double pulse test setup, Electrical and thermal modeling of GaN transistors, Cross-talk considerations, High-frequency design complexity, EMI filter design for high-frequency power converters - Heat sink design.							
UNIT - IV		PCB Design					9
Power circuit design, driver circuit design considerations, single, layer and multilayer PCBs, separation of power and driver circuits, high-frequency power loop optimization - design examples.							
UNIT - V		Applications of WBG Device					9
GaN in AC/DC and DC/AC power converters, GaN in switched, mode power amplifiers, wireless energy transfer, electric vehicle applications, and renewable energy applications							
L:45, T: 0, P: 0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Lidow, A., Strydom, J., de Rooij, M. D., &Reusch, D. (2014). GaN transistors for efficient power conversion. Wiley				
2.	Baliga, B. J. (2017). Gallium nitride and silicon carbide power devices. World Scientific Publishing Company.				
3.	Wang, F., Zhang, Z., & Jones, E. A. (2018). Characterization of wide bandgap power semiconductor devices. IET				
4.	Di Polo Emilio, M. (2024). GaN and SiC power devices. Springer				
5.	Hu, R. (2019). PCB design and layout fundamentals for EMC. Independently Published.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/108106480				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the characteristics, operation, and applications of wide band gap semiconductor devices such as SiC and GaN power devices.		PO1	PSO1	
CO2	Analyze the electrical characteristics, switching behavior, and reliability aspects of SiC and GaN power semiconductor devices.		PO1, PO3	PSO1	
CO3	Describe electrical and thermal modeling techniques, EMI filter design, and PCB design considerations for high-frequency power converters.		PO1, PO3	PSO1, PSO2	
CO4	Study and simulate the performance of wide bandgap power semiconductor devices and high-frequency converter circuits using MATLAB or open-source simulation software through self-learning activities and interpret the findings while considering practical engineering applications.		PO1, PO2, PO3	PSO1, PSO2	
CO5	Study the applications of wide bandgap semiconductor devices in electric vehicles, renewable energy systems, and power converters through self-learning activities and present the findings while considering societal, environmental, and economic impacts.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1			3	
CO2	2		1	3	
CO3	3		1	3	2
CO4	2	1	2	2	2
CO5	2	2	1	3	3
Activities:					
1.	Perform simulation and analysis of SiC/GaN based converter circuits, switching characteristics, thermal behavior, or EMI filter performance using MATLAB/Simulink or open-source simulation software tools.				
2.	Analyze practical applications of wide bandgap semiconductor devices in electric vehicles, renewable energy systems, wireless power transfer, and high-frequency converters through case studies, self-learning activities, and technical presentations.				

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Problem formulation and device/converter modeling	20	Correctly formulates the problem with appropriate drive model and parameters	Formulates the problem with minor errors in model selection	Basic formulation with incomplete or incorrect parameters
2.	Development of simulation model and result generation	30	Simulation executed correctly with accurate results and waveforms	Simulation completed with minor errors in results/waveforms	Simulation partially completed with inadequate results
3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis
4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Understanding of wide bandgap device applications and converter concept	20	Demonstrates strong understanding with relevant EV applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts
3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	10	10			10	2
C02	20	20			20	2
C03	30	30			30	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

26PE102	ANALYSIS OF POWER CONVERTERS	SEMESTER			I
Prerequisites		Category	ES(PC)	Credits	5
Electronic Devices and Circuits, Power Electronics		Hours/ Semester	L	T	P
			45	0	60
COURSE OBJECTIVES					
1.	To provide a comprehensive understanding of the operation, design, and control of hard switched and soft switched power electronic converters.				
2.	To analyse and evaluate the performance of single-phase and three-phase power converters under various load conditions.				
3.	To enhance practical skills through laboratory experiments that reinforce theoretical concepts and provide exposure to real-world converter operation and analysis.				
UNIT - I					
SINGLE-PHASE CONTROLLED RECTIFIERS		9+12			
Semi and fully controlled rectifiers with R, RL, and RLE loads. Freewheeling diode effects: Continuous and discontinuous conduction modes. Inversion operation; Dual converter operation. PWM rectifiers. Performance parameters: Harmonics, ripple, distortion, power factor. Effect of source inductance Practical: Simulation and Experimentation of single-phase half and fully controlled converters. / Gate drivers and firing circuits for single phase rectifiers. / Waveform analysis under various load conditions. / Input power factor and harmonic analysis.					
UNIT - II		9+12			
THREE-PHASE CONTROLLED RECTIFIERS		9+12			
Three-phase semi and fully controlled rectifiers with R, RL, and RLE loads. Freewheeling diode, inversion operation, continuous/discontinuous modes. Multi-pulse (6 and 12 pulse) and dual converters. Effect of source inductance and commutation overlap. Performance parameters. Practical: Simulation and Experimentation of three-phase line-commutated converters.					
UNIT - III		9+12			
DC TO DC CONVERTERS		9+12			
Non-isolated topologies: Buck, Boost, Buck-Boost, Cuk Converter. Isolated topologies: Single and multiple switch converters- Operation in CCM and DCM; Synchronous and interleaved converters. Practical: Design and testing of driver circuits for DC-DC converters (totem pole/transformer based/boot strap/opto coupler based)					
UNIT - IV		9+12			
DC-AC INVERTERS		9+12			
Single-phase and three-phase VSI and CSI; 120° and 180° conduction modes. PWM techniques: Sine PWM, Space Vector PWM, 60° PWM, Third harmonic PWM. Multilevel inverters: Diode-clamped, flying capacitor, cascaded H-bridge. Voltage control methods and harmonic elimination. Filter design and device selection. Practical: Simulation and analysis of single phase and three-phase inverters / Generation of PWM pulses with different modulation techniques/ Harmonic spectrum and THD analysis					

UNIT - V	AC-AC CONVERTERS			9+12	
AC voltage controllers: Single-phase and three-phase with R, RL loads. Phase angle control and integral cycle control. Working principle of Resonant converters: ZVS, ZCS, quasi, and multi-resonant types, Circuit topology, operation and applications of three phase Matrix converters.					
Practical: Simulation and Experimentation of AC voltage regulators / Simulation and experimentation of resonant converters					
L:45,T:0,P:60 , Total: 105 Hours					
Weightage: Continuous Assessment 50% End Semester Examinations 50%					
REFERENCE BOOKS:					
1.	Rashid M.H., "Power Electronics: Circuits, Devices and Applications ", Pearson, 4 th Edition, 2021.				
2.	Bimal K. Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.				
3.	Umanand, L., "Power electronics: Essentials & applications", Wiley, First Edition, 2010.				
4.	Mohan, N., Undeland, T. M., & Robbins, W. P., "Power Electronics: Converters, Application and Design", Wiley India (P) Ltd, New Delhi, 3 rd Edition 2010.				
5.	Bimbhra, P.S, "Power Electronics ", Khanna Publishers, New Delhi, 4 th Edition, 2012.				
E-RESOURCES:					
1.	https://onlinecourses.nptel.ac.in/noc24_ee88/preview .				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Analyze the operation and performance of single-phase and three-phase rectifiers under various load conditions.			PO1, PO3	PSO1 PSO2
CO2	Design and evaluate isolated and non-isolated DC-DC converter topologies for specific applications.			PO1, PO3	PSO1 PSO2
CO3	Implement PWM techniques in single and three phase inverters and assess performance.			PO1, PO3	PSO1, PSO2
CO4	Examine and compare multilevel inverters and resonant converter architectures for high-power applications.			PO1, PO2, PO3	PSO1 PSO2
CO5	Conduct experiments and simulations to validate theoretical concepts and evaluate real-time converter behaviour.			PO1, PO2 PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
CO	PO1	PO2	PSO3	PSO1	PSO2
CO1	3		3	3	2
CO2	2		2	3	3
CO3	3		2	3	3
CO4	3	2	2	3	1
CO5	3	2	3	3	3

Activities:

1.	Assignment (CO1 and CO2) : Solving Problems in single and three-phase rectifiers/ design of DC-DC converter
2.	Seminar Presentation (CO3 and CO4): PWM techniques / Multilevel inverters / Resonant converters

Rubrics for evaluation: CO1 and CO2 –Assignment: Solving Problems in single and three-phase rectifiers/ design of DC-DC converters

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topological / Problem Formulation & Circuit Setup	20	Problem and boundary conditions are clearly defined	Problem defined, but some of the boundary conditions are unclear	Problem statement defined but unclear boundary conditions
2.	Mathematical Analysis	30	Mathematical analysis and calculation are well-presented	Mathematical analysis is done, but with minor errors.	Mathematical analysis and calculation are incomplete
3.	Result Accuracy	20	Results are completely correct and error-free	Results are mostly correct but contains minor factual errors	Results contains major factual errors
4.	Report presentation	20	Report is clear and well structured	Report is structured, but needs improvement	Poorly structured report
	Total	100			

Rubrics for evaluation: (CO3 and CO4) - Seminar Presentation : PWM techniques / Multilevel inverters / Resonant converters

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content & Understanding	30	Clearly explains Topology Structure and working principles	Explanation needs improvement	Limited understanding
2.	Performance analysis and Applications	30	Clearly presents analysis and grid/EV applications	Performance analysis is present but somewhat descriptive	Lacks analysis and Fails to give practical application
3.	Evidence of self-learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Theory component				Laboratory component		Percentage Allocation	Mapping Strength
	Test I	Test II	Activity I	Activity II	Observation and Record	Practical Test		
C01	44		20				16	2
C02	16	10	20				11.50	2
C03		22		20			10.50	2
C04		28		20			12	2
C05					100	100	50	3
Total	60	60	40	40	100	100	100	

26PE103		DIGITAL CONTROLLER BASED SYSTEM DESIGN		SEMESTER		I	
Prerequisites			Category	ES(PC)	Credits		5
Power Electronics, Control System			Hours/ Semester	L	T	P	TH
				45	0	60	105
COURSE OBJECTIVES							
1.	To implement digital control for power electronic applications						
2.	To learn various DSP peripherals for proper implementations to power applications						
UNIT - I		INTRODUCTION TO DSPIC 30F DIGITAL SIGNAL CONTROLLER					9+12
DSPIC 30F CPU Core – Programmers Model – CPU Registers – DSP Engine – Memory Organization – Data – Program – Flash and EEPROM Programming.							
UNIT - II		SYSTEM CONFIGURATION					9+12
Oscillator Configuration – Power saving Modes - Various Resets – Device Configuration – Low Voltage Detect - I/O Ports							
UNIT - III		CONTROL PERIPHERALS					9+12
Study, Configuration and control - Interrupt Structure – Timers – Capture and Compare – AD Converter– Introduction to IDE for dsPIC and Project development with simple C programming.							
UNIT - IV		MOTOR CONTROL PERIPHERALS					9+12
Motor Control PWM – Different PWM modes – Dead Time – Output and Polarity Control – PWM Fault Pins – Quadrature Encoder Interface.							
UNIT - V		APPLICATIONS					9+12
Closed loop Control of Single and three Phase VSI, Sensored and Sensorless BLDC Motor Control – AC Induction Motor Control – Vector Control of AC Induction Motor - Servo Control of a DC-Brush Motor - Four Channel Digital Voltmeter with Display.							
L:45,T:0,P:60, Total: 105 Hours							
Weightage: Continuous Assessment 50% End Semester Examinations 50%							
REFERENCE BOOKS:							
1.	DSPIC30F Family Reference Manual, Datasheets.						
2.	Creed Huddleston, "Intelligent Sensor Design using Microchip dsPIC ", Newnes, 2007.						
3.	Zoran Milivojević, DjordjeŠaponjić, "Programming DSPIC (Digital SignalControllers) in C", MicroElectronika						

E-RESOURCES:

1. www.microchip.com - documents

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Understand various DSP peripherals	PO1	PSO1
CO2	Analyze the configurations of peripherals for appropriate power applications	PO1	PSO1
CO3	Write C coding for implementing controls using peripherals	PO1, PO2	PSO1
CO4	Implement interfacing and control techniques with DSP for control applications to enhanced employability and entrepreneurship skills	PO2, PO3	PSO2
CO5	Design and conduct experiments towards research.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	3			3	
CO2	3			3	
CO3	3	3		3	
CO4		3	3		3
CO5	2	3	3	2	3

Skill based laboratory activities:

1. Interfacing of LCD with DSC and displaying a message
2. Generation of Square Trigger Pulse using DSC
3. Measurement of Voltage/Current/Temperature
4. Open loop control of Buck/Boost/Buck-Boost Converter using DSC
5. Closed loop control of Buck/Boost/Buck-Boost Converter using DSC
6. Single phase square wave inverter control in open loop using DSC
7. Single phase square wave inverter control in closed loop using DSC
8. Single Phase AC-DC Converter in open loop using DSC
9. Single Phase AC-DC Converter in closed loop using DSC
10. Sine PWM based single phase inverter using DSC
11. Single phase AC Voltage controller control using DSC
12. Three Phase Inverter control using DSC

Rubrics for evaluation:CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Experimental Design	20	Independently designs, conducts and analyses experiments with appropriate methodology	Designs and conducts experiments with minimal guidance and arrives at reasonable conclusions.	Conducts experiments following prescribed procedures, performs basic analysis, and reports observations with guidance.
2.	Execution of Simulation	30	Simulation is done and plots are well-presented	Simulation is done, but minor error in plots	Simulations and plots are incomplete
3.	Execution of hardware experiment	20	Results are clearly interpreted from the hardware	Results are interpreted but limited justification	Unclear interpretation
4.	Report presentation	10	Report is clear and well structured	Report is structured, but needs improvement	Poorly structured report
Total		100			

Rubrics for evaluation:CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding the emerging control strategies in microcontroller-based system design	20	Clearly explains control methodology for the specific DSC	Explanation needs improvement	Limited understanding
2.	Safety &Economic considerations	30	Clearly discusses safety aspects and economic choice of components without compromising the output	Safety aspects discussed but economic considerations are not met	Poorly explained
3.	Evidence of self-learning	30	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
Total		100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Theory Component				Laboratory Component		Percentage allocation	Mapping Strength
	Test I	Test II	Activity I	Activity II	Observation and Record	Practical Test		
C01	12	12					6	1
C02	24	24					12	2
C03	24	24			60	60	42	3
C04			40				10	2
C05				40	40	40	30	3
Total	60	60	40	40	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26MLC01	RESEARCH METHODOLOGY AND IPR			SEMESTER		I	
Prerequisites			Category	MC	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To develop the subject of the research						
2.	To encourage the formation of higher level of trained intellectual ability, critical analysis, rigor and independence of thought.						
3.	To initiate individual judgement and skill in the application of research theory and methods						
4.	To gain knowledge to file patents.						
5.	To develop skills required in writing research proposals, reports and dissertations.						
UNIT – I		INTRODUCTION TO RESEARCH					9
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 the research problem, Approaches to investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.							
UNIT – II		EFFECTIVE LITERATURE STUDIES APPROACHES, ANALYSIS					9
Developing the theoretical framework of research - Developing operational statements of the problem - Criteria for evaluating research approach - Hypotheses: Parametric and non-parametric testing- Establishing the reliability and validity of findings with literature review and experiments – documentation, Plagiarism, Research ethics.							
UNIT – III		EFFECTIVE TECHNICAL WRITING AND RESEARCH PROPOSAL					9
Developing a Research Proposal, Formats for thesis, report and research papers, Documentation and presentation tools- introduction to LATEX and MS Office - presentation and assessment by a review committee.							
UNIT – IV		NATURE OF INTELLECTUAL PROPERTY					9
Patents, Designs, Trade and Copyright, The 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					9
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.							
L:45, T:0, Total: 45 Hours							

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Kothari.C.R, Research Methodology – Methods and Techniques, New age Publications, New Delhi, 2009
2.	Stuart Melville and Wayne Goddard, "Research methodology: An introduction for science & Engineering students"
3.	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
4.	Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
5.	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007
6.	Mayall, "Industrial Design", McGraw Hill, 1992.
7.	Niebel, "Product Design", McGraw Hill, 1974.
8.	Asimov, "Introduction to Design", Prentice Hall, 1962.
9.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in the New Technological Age", 2016.
10.	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

E-RESOURCES:

1.	https://nptel.ac.in/courses/121106007
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COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to**

		Mapping POs	Mapping PSOs
CO1	Explain the fundamental concepts of research methodology, literature review techniques, technical documentation, intellectual property rights, and patent systems.		
CO2	Apply research approaches, data collection methods, hypothesis testing, research ethics, and documentation practices in engineering research problems.	PO1	PSO2
CO3	Analyze research problems, evaluate literature findings, validate research outcomes, and examine intellectual property and patenting procedures.	PO1	PSO2
CO4	Assess the effectiveness of research methodologies, technical reports, research proposals, and patent protection strategies for engineering applications.	PO2, PO3	PSO1
CO5	Develop research proposals, technical reports, and innovative intellectual property solutions by integrating research methodology and patenting concepts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	-	-	2
CO3	3	-	-	-	2
CO4	-	3	2	2	-
CO5	3	3	3	2	2
AVERAGE	3	3	2.5	2	2

Activities:

1.	Evaluation of Research Methodologies, Technical Reports, and Patent Case Studies through Self-Learning Activities and Report Submission
2.	Development of Research Proposals, Technical Reports, and Innovative Patent Concepts through Self-Learning Activities and Technical Presentation.

Rubrics for evaluation:CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Selection of Research Paper and Patent	20	Highly relevant and appropriate selection	Relevant selection	Basic selection
2.	Analysis of Research Methodology	20	Comprehensive evaluation with critical insights	Adequate evaluation	Limited evaluation
3.	Assessment of Patent Protection Strategy	20	Thorough assessment with clear justification	Good assessment	Basic assessment
4.	Technical Report Preparation	20	Well-structured and professionally documented	Good organization with minor errors	Basic documentation
5.	Conclusions and Recommendations	20	Insightful conclusions with strong recommendations	Relevant conclusions	Basic conclusions
	Total	100			

Rubrics for evaluation:CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification and Objective Formulation	20	Clearly defined problem and objectives	Adequately defined problem and objectives	Basic problem identification
2.	Research Proposal Development	20	Comprehensive and feasible proposal	Good proposal with minor gaps	Basic proposal

3.	Innovation and Patent Concept Development	20	Highly innovative and patentable concept	Moderately innovative concept	Limited innovation
4.	Technical Report Documentation	20	Professional and well-organized report	Good report with minor deficiencies	Basic report preparation
5.	Technical Presentation and Defence	20	Excellent presentation with strong justification	Good presentation and justification	Satisfactory presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Strength = 3 (if percentage >20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PE104		TECHNICAL SEMINAR		SEMESTER			I
Prerequisites			Category	SD	Credits		1
			Hours/ Semester	L	T	P	TH
				0	0	30	30
COURSE OBJECTIVES							
1.	To work on a specific technical topic in power electronics and drives related topics to acquire the skills of oral presentation						
2.	To acquire technical writing abilities for seminars and conferences.						
3.	To identify and compare technical and practical issues related to the area of course specialization.						
4.	To outline annotated bibliography of research demonstrating scholarly skills						
5.	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting						
CONTENTS							
1.	The students will work for two hours per week guided by a group of staff members.						
2.	They will be asked to talk on any topic of their choice related to Engineering design, and search relevant journal paper on the selected topics for presentation and to engage in dialogue with the audience.						
3.	Student is expected to present two seminars per semester.						
4.	The student will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic along with the journal reference copy.						
5.	A Faculty Advisor and two experts from the Department will evaluate the seminar.						
6.	Evaluation will be based on the technical presentation, seminar paper and also on the interaction during the seminar using the specific rubrics.						
Total=30Hours							
Weightage:							
Continuous Assessment 100%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs		
CO1	Explain the selected engineering design topic and its technical background using appropriate literature sources						
CO2	Collect, review, and summarize technical information from journals, conference papers, and industry reports.			PO1	PSO2		
CO3	Analyze and compare technical approaches, practical issues, and recent developments related to the selected topic.			PO1	PSO2		
CO4	Evaluate research findings, identify gaps, and respond to technical queries during seminar discussions.			PO2, PO3	PSO1		
CO5	Prepare and deliver a professional technical seminar report and presentation demonstrating communication, documentation, and scholarly skills.			PO1, PO2, PO3	PSO1, PSO2		

The Course Articulation Matrix (CAM) for defined COs						
COs / POs		PO1	PO2	PO3	PS01	PS02
CO1		2	1		1	1
CO2		3			1	2
CO3		3	2		2	2
CO4			3	2	2	
CO5		3	3	3	2	2
AVERAGE		2.75	2.25	2.50	1.60	1.75
Activities:						
1.	Literature Review and Annotated Bibliography					
2.	Technical Seminar Presentation and Discussion					
Rubrics for evaluation:1						
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)	
1.	Topic Selection and Relevance	20	Highly relevant and current topic	Relevant topic	Limited relevance	
2.	Literature Search Quality	20	Comprehensive and credible sources	Adequate sources	Few or weak sources	
3.	Annotated Bibliography	20	Clear, concise, and analytical summaries	Adequate summaries	Minimal analysis	
4.	Technical Understanding	20	Strong understanding of the topic	Moderate understanding	Limited understanding	
5.	Documentation and Formatting	20	Professional and error-free	Minor formatting issues	Poor formatting	
	Total	100				
Rubrics for evaluation:2						
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)	
1.	Technical Content and Accuracy	20	Highly accurate and in-depth	Generally accurate	Superficial content	
2.	Organization and Clarity	20	Excellent flow and clarity	Adequate organization	Poor organization	
3.	Presentation Skills	20	Confident, engaging, professional delivery	Adequate delivery	Weak delivery	

4.	Response to Questions	20	Accurate and insightful responses	Adequate responses	Unable to answer satisfactorily
5.	Report Quality and Referencing	20	Well-structured report with proper references	Adequate report	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component		Percentage allocation	Mapping Strength
	Review 1	Review 2		
CO1	10	10	10	2
CO2	10	10	10	2
CO3	10	10	10	2
CO4	35	35	35	3
CO5	35	35	35	3
Total	100	100	100	

Note: Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PE201	ADVANCED ELECTRICAL DRIVES	SEMESTER			II
Prerequisites		Category	ES(PC)	Credits	5
Electrical Machines, Power Electronics, Special Electrical Machines		Hours/ Semester	L	T	P
			45	0	60
COURSE OBJECTIVES					
1.	To understand the modeling and advanced control techniques of induction motor, PMSM, BLDC and SRM drives.				
2.	To learn about PWM Inverter model, modulation techniques and other parameter measurements				
UNIT - I					
Induction Motor Drive					9+12
Dynamic Modelling of Induction Machine – Stationary and Synchronous Frame - Flux linkage, voltage and Torque equations in d-q axis– d-q axis model of Induction Motor - d-q axis equivalent circuit - Average and Instantaneous torque controls - Vector Control (VC) – Direct and Indirect VC – Detuning in Indirect VC – Field weakening and Sensorless control - Direct Torque and Flux Control (DTFC) - Feedback Linearization Control (FLC).					
UNIT - II					9+12
PMSM Drive					
Dynamic Modelling of PMSM – Stationary and Synchronous Frame - Flux linkage, voltage and Torque equations in d-q axis - d-q axis model of PMSM - d-q axis equivalent circuit – Vector Control of SPMSM and IPMSM – Current, Voltage and speed limits – Current control methods – Sensorless control					
UNIT - III					9+12
BLDC Drive					
Dynamic Modelling of BLDC Motor – Voltage and Torque equations – Torque ripple – Speed and Current Controls – Phase current control – Pseudo Vector Control - Sensorless control using Back EMF – Control at High-Speed Region					
UNIT - IV					9+12
SRM Drive					
Modelling of SRM – Control of SRM – Power Converters – Switching Angle Control – Fixed Angle and Advanced angle controls – Switch-off angle controls – Current Controls – Direct Torque Control.					
UNIT - V					9+12
PWM Inverter Model, Modulation Techniques and Parameter Measurements					
PWM Inverters – d-q model for Voltage source Inverter – d-q model for PWM operation – Basic PWM Techniques – Programmed, Carrier-based and Space Vector PWM techniques – Over-modulation methods – Dead time, its effect and compensation - Current and Voltage Sensing – Position and speed sensors – Quadrature Encoder Interface - Interfacing with microcontroller					
L:45,T:0,P:60, Total: 105 Hours					
Weightage:					
Continuous Assessment 50%					
End Semester Examinations 50%					

REFERENCE BOOKS:					
1.	Ion Boldea, "Electric Drives", CRC Press, Fourth Edition, 2025				
2.	Seung-Ki Sul, "Control of Electric Machine Drive Systems", John Wiley & Sons, Inc., Publication.				
3.	Mohammed Fazlur Rahman, SanjeetK.Dwivedi, "Modeling, Simulation and Control of Electrical Drives", The Institution of Engineering and Technology, 2019				
4.	Novotny D.W and Lipo T.A, " <i>Vector Control and Dynamics of AC Drives</i> ", Oxford, England: Clarendon Press/Oxford University Press, 1996				
5.	Ned Mohan , Siddharth Raju , " Analysis and Control of Electric Drives Simulations and Laboratory Implementation", John Wiley & Sons, 2021				
6.	Sang-Hoon Kim, "Electric Motor Control", Elsevier – 2017				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/108104011				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Analyze dynamic modeling and advanced control techniques to analyze the performance of induction motor, PMSM, BLDC and SRM drives.		PO1	PSO1	
CO2	Analyze the dynamic behavior and implement the control strategies for electric drives		PO1	PSO1	
CO3	Analyze PWM inverter models, modulation techniques, parameter measurement methods for drive control		PO1	PSO1	
CO4	Design and conduct experiments towards research.		PO2, PO3	PSO2	
CO5	Enhanced employability and entrepreneurship skills through the study of emerging control strategies and modern electric drive technologies.		PO1, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1	3		2	3	2
CO2	3		2	3	2
CO3	3		2	3	2
CO4		3		2	3
CO5			3	2	3
Skill based laboratory activities:					
1.	1. V/f and vector control of three phase induction motor drive using DSC 2. DSP based speed control of SRM motor 3. FPGA based speed control of BLDC and SRM drive 4. DTC control of Induction motor drive 5. Closed loop control of PMSM motor drive using DSC and FPGA 6. Simulation study of field oriented control of induction motor drive using MATLAB 7. Simulation study of CSI fed three phase induction motor drive using MATLAB 8. Simulation study of closed loop control of BLDC motor drive using MATLAB				

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Experimental Design	20	Independently designs, conducts and analyzes experiments with appropriate methodology	Designs and conducts experiments with minimal guidance and arrives at reasonable conclusions.	Conducts experiments following prescribed procedures, performs basic analysis, and reports observations with guidance
2.	Execution of Simulation	30	Simulation is done and plots are well-presented	Simulation is done, but minor error in plots	Simulations and plots are incomplete
3.	Execution of hardware experiment	20	Results are clearly interpreted from the hardware	Results are interpreted but limited justification	Unclear interpretation
4.	Report presentation	10	Report is clear and well structured	Report is structured, but needs improvement	Poorly structured report
Total		100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding the emerging control strategies in advanced electric drive technologies	20	Clearly explains control methodology for the specific drive technology	Explanation needs improvement	Limited understanding
2.	Safety & Economic considerations	30	Clearly discusses safety aspects and economic choice of components without compromising the output	Safety aspects discussed but economic considerations are not met	Poorly explained
3.	Evidence of self-learning	30	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
Total		100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Theory Component				Laboratory Component		Percentage allocation	Mapping Strength
	Test I	Test II	Activity I	Activity II	Observation and Record	Practical Test		
CO1	12	12					6	1
CO2	24	24			40	40	32	3
CO3	24	24			60	60	42	3
CO4			40				10	2
CO5				40			10	2
Total	60	60	40	40	100	100	100	

Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PE202	POWER CONVERTERS FOR RENEWABLE ENERGY SYSTEM	SEMESTER			II
Prerequisites		Category	ES(PC)	Credits	5
Power Electronics		Hours/ Semester	L	T	P
			45	0	60
COURSE OBJECTIVES					
1.	To understand the importance of standalone, grid-connected, and hybrid modes of operation in renewable energy systems.				
2.	To design power converters used in renewable energy systems.				
3.	To enhance practical knowledge through laboratory experiments involving the application of power converters in renewable energy systems.				
UNIT - I	Control Technology of Photovoltaic Generation Systems				9+12
Photovoltaic (PV) systems – Solar PV modelling and characteristics, Solar PV modules associated with maximum power point operation in overall control, Classification of MPPT methods, Perturb and Observe Algorithm, Incremental Conductance Algorithm, Separate Maximum Power Point Tracking for large scale PV power stations, centralized three-level inverter with separate PV modules Practical: Simulation of Solar PV System with different MPPT Algorithms.					
UNIT - II	Photovoltaic Inverters				9+12
Classification of Photovoltaic Inverters, single stage and two-stage inverters for transformerless structures, Requirements of Functions and Performances for Inverters, Leakage current analysis for Photovoltaic Panels, Circuit components of Photovoltaic Inverters, control framework for PV inverter with generalized topology, Outer Loop for Power Control, Middle Loop for DC Voltage Control, Inner Loop for AC Current Control Practical: Simulation of single phase and three phase Photovoltaic Inverters for grid tied operation.					
UNIT - III	Wind Energy Conversion System Control				9+12
Wind Turbine Components, Wind Turbine Aerodynamics, Wind Energy Conversion System Configurations, Grid-connected inverter in a wind energy system, Voltage Oriented Control, Voltage-oriented control with a decoupled controller Practical: Case Study: Operation and Analysis of Grid-Connected Inverter for wind energy conversion system					
UNIT - IV	Fuel Cell Energy Conversion System				9+12
Fuel Cell Fundamentals, Fuel Cell Operation, Fuel Cell Materials, Fuel Cell Types, Power electronic converters for fuel cells, Applications of Fuel Cells for Electric Vehicles Practical: Simulation and analysis of PEM Fuel Cell and Solid oxide Fuel Cell with Power Electronic Converters					
UNIT - V	Hybrid Renewable Energy Systems				9+12
Structure of hybrid renewable energy system, Hybrid Energy System Configurations, Component Sizing of Hybrid RE Systems, Techno-Economical Analysis, Energy Storage Systems for hybrid RE systems Practical: Analysis of hybrid energy system using open source simulation tool					
L:45, T:0,P:60, Total: 105 Hours					

Weightage: Continuous Assessment 50% End Semester Examinations 50%					
REFERENCE BOOKS:					
1.	Chenghui Zhang., "Advanced Control Technology of Photovoltaic Power Generation Systems", Springer, 2021.				
2.	Bin Wu "power conversion and control of wind Energy systems", IEEE Press, 2011.				
3.	UmakantaSahoo, "Hybrid Renewable Energy Systems", Scrivener Publishing, 2021				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/108107128				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Understand the different power electronic converters used in solar, wind and fuel cell energy conversion.		-	-	
CO2	Select and Design a suitable power converter any type of renewable energy system		PO3	PSO2	
CO3	Analysis the performance of Solar, wind and hybrid energy system with grid side control techniques		PO3	PSO2	
CO4	Prepare and present the technical report on the environmental impacts of renewable energy technologies and demonstrate their application in harnessing electrical power		PO1, PO2	PSO2	
CO5	Use open source simulation tool for simulation of three phase solar or wind energy system with suitable power converter and control strategy and analysis its performance.		PO1, PO2	PSO2	
The Course Articulation Matrix (CAM) for defined COs					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2			3		3
CO3			2		2
CO4	2	2			3
CO5	2	2			3
Activities:					
1.	Activity 1 (CO4) technical report preparation: Prepare and present the technical report on the environmental impacts of renewable energy technologies and demonstrate their application in harnessing electrical power				
2.	Activity 2 (CO5) open source simulation tool usage: Use open source simulation tool for simulation of three phase solar or wind energy system with suitable power converter and control strategy and analysis its performance.				

Rubrics for evaluation: CO4 - Prepare and present the technical report on the environmental impacts of renewable energy technologies and demonstrate their application in harnessing electrical power

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Survey on environmental impacts of renewable energy technologies	40	Environmental impacts of renewable energy technologies with full analysis	Environmental impacts of renewable energy technologies with partial analysis	Environmental impacts of renewable energy technologies with satisfactory level
2.	Technical report preparation	40	Report well prepared	Report with modifications need	Report in satisfactory level
3.	Report presentation	20	Report clearly communicated with full analysis	Report clearly communicated but needs improvement	Report presented
	Total	100			

Rubrics for evaluation:(CO5) - Use open source simulation tool for simulation of three phase solar or wind energy system with suitable power converter and control strategy and analysis its performance.

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Simulation studies on open source tool	40	Select a suitable simulation tool and simulation studies done well	Simulation studies needs improvement	Limited understanding
2.	Performance analysis and Applications	40	Clearly presents analysis and grid applications	Performance analysis is present but somewhat descriptive	Lacks analysis and Fails to give practical application
3.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Theory component				Laboratory component		Percentage Allocation	Mapping Strength
	Test I	Test II	Activity I	Activity II	Observation and Record	Practical Test		
CO1	12	12					6	1
CO2	24	24			60	60	42	3
CO3	24	24			40	40	32	3
CO4			40				10	2
CO5				40			10	2
Total	60	60	40	40	100	100	100	

26PE203	MODELLING AND ANALYSIS OF ELECTRICAL MACHINES		SEMESTER		II	
Prerequisites		Category	ES(PC)	Credits	3	
DC Machines, Synchronous and Induction Machines.		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To provide knowledge about the fundamentals of magnetic circuits & analyse the steady state and dynamic state operation of DC machine through mathematical modelling.					
2.	To study the procedure to compute the steady and dynamic performance operation of Induction machine using transformation theory based mathematical modelling.					
3.	To interpret the principles of reference frame theory.					
4.	To study the procedure of dynamic modelling and analysis of PMSM and BLDC motor.					
UNIT - I	MODELLING OF DC MACHINES					9
Equivalent circuit and electromagnetic torque - Electromechanical modelling - Field excitation: separate, shunt, series and compound excitation - commutator action. Effect of armature mmf - Analytical fundamentals: Electric circuit aspects- magnetic circuit aspects- interpoles.						
UNIT - II	DYNAMIC MODELLING OF INDUCTION MACHINES					9
Equivalent circuits - steady state performance equations - Dynamic modelling of induction machines: Real time model of a two phase induction machine, Three phase to two phase transformation - Electromagnetic torque - generalized model in arbitrary reference frames - stator reference, rotor reference, synchronously rotating reference frames model.						
UNIT - III	PHASE CONTROLLED AND FREQUENCY CONTROLLED INDUCTION MOTOR					9
Stator voltage control: Steady state analysis- approximate analysis- slip power recovery scheme: principle of operation - steady state analysis: Range of slip - equivalent circuit - performance characteristics - Static Scherbius drive. Constant Volts/Hz controls implementation - steady state performance - dynamic simulation. PWM voltages: Generation - machine model - computation of steady state performance.						
UNIT - IV	VECTOR CONTROLLED INDUCTION MOTOR					9
Principle of vector control-direct vector control: flux and torque processor-DVC in stator reference frames with space vector modulation. Indirect vector control scheme: derivation and implementation. Flux weakening operation: principle of flux weakening operation-flux weakening in stator flux linkages-controlled schemes and rotor flux linkages-controlled schemes						
UNIT - V	MODELLING AND ANALYSIS OF SPECIAL MACHINES					9
Permanent magnet synchronous machine: surface permanent magnet (square and sinusoidal back emf type) – interior permanent magnet type – Construction, operating principle and dynamic modelling – Analysis of BLDC motors.						
L:45, T:0, P:0, Total: 45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:

1.	R.Krishnan, "Electric Motor Drives: Modelling, Analysis, And Control", Pearson Education India; First Edition, 2015.
2.	Paul Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, "Analysis of Electric Machinery and Drive Systems", Wiley IEEE Press, Third Edition, 2013.
3.	A.E. Fitzgerald., Charles Kingsley. Jr., Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill Publishing Co-Ltd, 2015.
4.	P.S.Bimbra, "Generalized Theory of Electric Machines", Khanna publishers, 5 th Edition, 2017
5.	Miller, T.J.E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press.
6.	Ned Mohan, "Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink", Wiley & Sons, 1 st Edition, 2014.

E-RESOURCES:

1.	https://ece.mst.edu/media/academic/ece/documents/12_Permanent_Magnet_DC_Machine_Simulation_in_MATLAB_Simulink.pdf
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COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Analyze the electric and magnetic circuits of DC, AC and special machines.	PO1, PO3	PSO1, PSO2
CO2	Develop mathematical model of DC, and Induction machines.	PO1, PO2, PO3	PSO1, PSO2
CO3	Apply proceduresto compute the steady state and dynamic performance of DC, and Induction machines.	PO1, PO2, PO3	PSO1, PSO2
CO4	Implement control methods of induction motor under phase, frequency and vector controlled mode of operation.	PO1, PO3	PSO1, PSO2
CO5	Develop mathematical model and analyze the dynamic performance of PMSM and BLDC motor.	PO1, PO2, PO3,	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2		1	1	
CO2	2		1	2	
CO3	2	1	2	2	
CO4	3		2	3	1
CO5	2	1	2	3	1

Activities:

1.	Assignment: Solving of problems in modelling and analysis DC and induction machines (CO3)
2.	Technical Seminar Presentation (CO5): Dynamic modelling and analysis of PMSM and BLDC motors / Analyze dynamic performance of Induction motor Vector Controlled Induction Motor

Rubrics for evaluation: CO4 - Assignment / Simulation

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Problem formulation & boundary conditions	20	Problem and boundary conditions are clearly defined	Problem defined, but some of the boundary conditions are unclear	Problem statement defined but unclear boundary conditions
2.	Mathematical Analysis	30	Mathematical analysis and calculation are well-presented	Mathematical analysis is done, but with minor errors.	Mathematical analysis and calculation are incomplete
3.	Result Accuracy	20	Results are clearly Interpreted & justified	Results are interpreted but limited justification	Unclear interpretation
4.	Report presentation	20	Report is clear and well structured	Report is structured, but needs improvement	Poorly structured report
	Total	100			

Rubrics for evaluation: CO5 - Technical Seminar Presentation

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical content and Understanding	30	Clearly explains the concepts of modelling of Electrical machines	Explanation needs improvement	Limited understanding
2.	Performance analysis and interpretations	30	Clearly presents performance analysis and interpretations	Performance analysis is present and but interpretations are inadequate	Lacks in analysis and interpretation
3.	Evidence of self-learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	8	8			7	1
CO2	24				12	2
CO3	28		40		34	3
CO4		32		20	26	3
CO5		20		20	21	3
Total	60	60	40	40	100	

26PE204		ELECTRIC VEHICLES AND POWER MANAGEMENT		SEMESTER		II	
Prerequisites			Category	ES(PC)	Credit		3
Power Electronics, Solid state drives			Hours/ Semester	L	T	P	TH
				45	0	0	45
Course Objectives:							
1.	To provide knowledge on electric vehicle architecture and its charging infrastructure						
2.	To impart knowledge on power electronic interface for vehicle control and electric propulsion system.						
UNIT - I		Electric Vehicle					9
Configurations of Electric Vehicles (EV), Performance of Electric Vehicles, Tractive Effort in Normal Driving and Energy Consumption, Hybrid Electric Vehicles (HEV): Classification, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains.							
UNIT - II		Plug-In Hybrid Electric Vehicle and Fuel Cell Electric Vehicle					9
Functions and Benefits of PHEV, Components of PHEVs, Operating Principle of Plug-in Hybrid Vehicle, Control Strategy of PHEV, Fuel Cell: Operation and Types, Fuel Cell Electric Vehicle: Configuration and Control Strategy.							
UNIT - III		Electric Propulsion System					9
Typical electric propulsion system, Classification of electric motor drives for EV and HEV, Multi quadrant Control of Chopper-Fed DC Motor Drives, Vector Control of Induction Motor drives, Permanent Magnetic Brush-Less DC Motor Drives, Switched Reluctance Motor Drives for Electric Vehicles.							
UNIT - IV		Power Electronics and Energy Management					9
Power Electronic Architecture of EVs, DC-DC Converters, Bidirectional DC-DC Converters, Traction Inverters, On-board Chargers (OBC), Charger Classification and Standards, AC Level-1, Level-2 and DC Fast Chargers, Wireless Charging Techniques, Battery Energy Management System (BMS): SOC Estimation, SOH Estimation, Cell Balancing, Thermal Management, Battery Protection, Power Flow Control between Battery, Motor and Auxiliary Loads.							
UNIT - V		EV Charging Infrastructure and Smart Energy Management					9
EV Charging Infrastructure, Charging Standards, Charging Modes, Smart Charging, Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), Grid Integration of EVs, Renewable Energy Integrated Charging Stations, Charging Algorithms, Fast Charging Technologies, Energy Storage Systems, AI-Based Energy Management, Smart Grid Applications for Electric Vehicles							
L:45, T:0, P:0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, Taylor & Francis Group, Second Edition, 2011.						
2.	MehrdadEhsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles CRC Press, 2016						
3.	Ali Emadi, MehrdadEhsani, John M.Miller , "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2010						

E-RESOURCES:					
1.	https://nptel.ac.in/courses/108104011				
2.	https://nptel.ac.in/courses/108106182				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain the fundamentals, configurations, and performance characteristics of electric and hybrid electric vehicles.			PO1, PO3	PSO1
CO2	Describe the operating principles and control strategies of Plug-in Hybrid Electric Vehicles (PHEV) and Fuel Cell Electric Vehicles (FCEV).			PO1, PO3	PSO1
CO3	Analyze the operation and control of electric propulsion systems and motor drives used in electric vehicles and hybrid electric vehicles.			PO1, PO3	PSO1, PSO2
CO4	Study and simulate power electronic converters and charging systems used in electric vehicles using MATLAB or open-source simulation software through self-learning activities and interpret the findings while considering practical engineering applications.			PO1, PO2, PO3	PSO1, PSO2
CO5	Study electric vehicle charging infrastructure, battery charging methods, and energy management techniques through self-learning activities and present the findings while considering societal, environmental, and economic impacts.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1		1	1	
CO2	2		2	1	
CO3	2		2	1	1
CO4	3	2	2	2	2
CO5	3	2	2	1	2
Activities:					
1.	Perform simulation and analysis of EV charger circuits, DC-DC converters, inverter systems, or wireless charging systems using MATLAB/Simulink or open-source software tools.				
2.	Analyze EV charging infrastructure, battery charging algorithms, and grid integration techniques through case studies, self-learning activities, and technical presentations.				
Rubrics for evaluation:CO4					
Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Problem formulation and converter/charger system modeling	20	Correctly formulates the problem with appropriate drive model and parameters	Formulates the problem with minor errors in model selection	Basic formulation with incomplete or incorrect parameters

2.	Development of simulation model and result generation	30	Simulation executed correctly with accurate results and waveforms	Simulation completed with minor errors in results/waveforms	Simulation partially completed with inadequate results
3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis
4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Understanding of EV charging infrastructure and energy management concepts	20	Demonstrates strong understanding with relevant EV applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts
3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PE301		DISSERTATION PHASE - I		SEMESTER			III
Prerequisites			Category	SD	Credits		8
			Hours/ Semester	L	T	P	TH
				0	0	240	240
COURSE OBJECTIVES							
1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.						
2.	To train the students in preparing project reports and to face reviews and viva voce examination.						
CONTENTS							
1.	Each student shall undertake an individual technical project under the guidance of a faculty member with expertise in the selected domain. The selected topic shall be relevant to the field of power electronics and drives and may involve theoretical investigations, analytical studies, simulation-based research, or engineering case studies.						
2.	The student shall formulate a well-defined engineering problem with clearly stated objectives, scope, and expected outcomes. A comprehensive literature review shall be conducted to analyze existing research, identify knowledge gaps, and establish the technical background for the proposed work.						
3.	An appropriate research methodology shall be developed, including problem formulation, design approach, analytical methods, computational tools, simulation techniques, or experimental procedures, as applicable. The work shall demonstrate the application of engineering principles, design methodologies, analytical reasoning, and technical problem-solving skills.						
4.	The student shall present and defend the work through a report, presentation and viva-voce examination before a panel of examiners, including one external examiner, to assess technical competence, analytical ability, presentation skills, and understanding of the chosen topic. The evaluation shall be based on the quality of problem identification, literature survey, and technical methodology, originality of work, report quality, presentation, and viva-voce performance.						
5.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.						
Total=240 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs		
CO1	Explain the research problem, background, objectives, and relevant engineering concepts through comprehensive literature review.						
CO2	Apply research methodologies, analytical tools, and engineering principles for problem formulation and investigation.			PO1	PSO2		
CO3	Analyze existing literature, identify research gaps, and formulate appropriate approaches to solve engineering problems.			PO1	PSO1, PSO2		
CO4	Evaluate alternative methodologies, technical feasibility, and preliminary results for addressing the identified research problem.			PO2, PO3	PSO1		
CO5	Develop a structured dissertation proposal including problem statement, objectives, methodology, work plan, and preliminary findings.			PO1, PO2, PO3	PSO1, PSO2		

The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	3	
CO5	3	3	3	3	2
AVERAGE	3.0	3.0	3.0	2.67	2.33
Activities:					
1.	Research Gap Identification and Literature Survey				
2.	Dissertation Proposal Development				
Rubrics for evaluation:1					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and relevance	20	Clearly defined, novel, and significant research problem	Relevant problem with minor limitations	Basic problem formulation
2.	Literature Survey	20	Relevant survey with proper references	Adequate survey	Limited literature survey
3.	Methodology implementation	20	Effective implementation with technical rigor	Adequate implementation	Partial implementation
4.	Technical competence	20	Strong understanding and execution capability	Good understanding	Basic understanding
5.	Review presentation and discussion	20	Excellent presentation and response to queries	Good presentation	Basic presentation
	Total	100			
Rubrics for evaluation:2					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Research objectives and scope	20	Well-defined and achievable objectives	Adequately defined objectives	Objectives lack clarity
2.	Methodology selection	20	Appropriate and technically sound methodology	Adequate methodology	Limited methodology justification
3.	Feasibility and resource planning	20	Comprehensive feasibility assessment	Moderate feasibility study	Basic planning
4.	Preliminary investigation/results	20	Meaningful preliminary work and analysis	Partial investigation completed	Minimal progress

5.	Review presentation and technical discussion	20	Excellent presentation and response to queries	Good presentation	Limited discussion
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Dissertation proposal quality	20	Comprehensive and professionally prepared proposal	Good proposal structure	Basic proposal
2.	Technical progress achieved	20	Significant progress with validated outcomes	Moderate progress	Limited progress
3.	Analysis and interpretation	20	Strong analytical approach and interpretation	Adequate analysis	Basic analysis
4.	Work plan and future scope	20	Realistic and well-defined execution plan	Adequate planning	Limited planning
5.	Presentation, report and viva voce	20	Excellent communication and defense of work	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	10		20	2
CO3	20	30		20	2
CO4	10	40	20	25	3
CO5		20	80	25	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PE401		DISSERTATION PHASE - II		SEMESTER		IV	
Prerequisites			Category	SD	Credits		14
			Hours/ Semester	L	T	P	TH
				0	0	420	420
COURSE OBJECTIVES							
1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.						
2.	To train the students in preparing project reports and to face reviews and viva voce examination						
CONTENTS							
1.	Each student shall undertake an individual technical project under the guidance of a faculty member with expertise in the selected domain. The selected topic shall be relevant to the field of power electronics and drives and may involve theoretical investigations, analytical studies, simulation-based research, or engineering case studies.						
2.	The student shall formulate a well-defined engineering problem with clearly stated objectives, scope, and expected outcomes. A comprehensive literature review shall be conducted to analyze existing research, identify knowledge gaps, and establish the technical background for the proposed work.						
3.	An appropriate research methodology shall be developed, including problem formulation, design approach, analytical methods, computational tools, simulation techniques, or experimental procedures, as applicable. The work shall demonstrate the application of engineering principles, design methodologies, analytical reasoning, and technical problem-solving skills.						
4.	The student shall present and defend the work through a report, presentation and viva-voce examination before a panel of examiners, including one external examiner, to assess technical competence, analytical ability, presentation skills, and understanding of the chosen topic. The evaluation shall be based on the quality of problem identification, literature survey, and technical methodology, originality of work, report quality, presentation, and viva-voce performance.						
5.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.						
Total=420 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs		
CO1	Explain the research problem, methodology, experimental procedures, and technical concepts related to the dissertation work						
CO2	Apply advanced engineering principles, computational tools, experimental techniques, and research methodologies to solve the identified problem.			PO1	PSO2		
CO3	Analyze experimental, simulation, or analytical results and interpret findings to validate the proposed research objectives.			PO1	PSO1, PSO2		
CO4	Evaluate the effectiveness, feasibility, and significance of the developed solution through validation, comparison, and performance assessment.			PO2, PO3	PSO1		
CO5	Develop and successfully demonstrate an innovative engineering solution, dissertation report, technical publication, and research presentation.			PO1, PO2, PO3	PSO1, PSO2		

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	3	
CO5	3	3	3	3	2
AVERAGE	3.0	3.0	3.0	2.67	2.33

Activities:

1.	Research Paper Preparation and Publication Review
2.	Prototype / Simulation Demonstration and Thesis Preparation

Rubrics for evaluation: 1

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and relevance	20	Clearly defined, novel, and significant research problem	Relevant problem with minor limitations	Basic problem formulation
2.	Literature Survey	20	Relevant survey with proper references	Adequate survey	Limited literature survey
3.	Methodology implementation	20	Effective implementation with technical rigor	Adequate implementation	Partial implementation
4.	Technical competence	20	Strong understanding and execution capability	Good understanding	Basic understanding
5.	Review presentation and discussion	20	Excellent presentation and response to queries	Good presentation	Basic presentation
	Total	100			

Rubrics for evaluation: 2

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Experimental / Simulation results	20	Comprehensive and reliable results obtained	Adequate results	Limited results
2.	Analysis and interpretation	20	Strong analytical interpretation and insight	Moderate analysis	Basic analysis
3.	Validation and comparison	20	Thorough validation with literature / theory / experiments	Adequate validation	Limited validation
4.	Novelty and technical contribution	20	Significant research contribution and originality	Moderate contribution	Limited novelty
5.	Review presentation and technical defense	20	Excellent technical defense and communication	Good communication	Basic communication
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Achievement of objectives and outcomes	20	All objectives successfully achieved and validated	Most objectives achieved	Partial achievement
2.	Quality of dissertation report	20	Professional, publication-quality dissertation	Good report quality	Basic report quality
3.	Innovation and engineering contribution	20	Significant contribution with strong originality	Moderate contribution	Limited contribution
4.	Results, conclusions and future scope	20	Comprehensive conclusions and meaningful future work	Adequate conclusions	Limited conclusions
5.	Final presentation and viva voice	20	Excellent presentation, confidence, and technical defense	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	20		20	2
CO3	20	40	20	20	2
CO4	10	30	60	25	3
CO5		10	20	25	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PEE01	ADVANCED POWER ELECTRONIC CONVERTERS		SEMESTER			II
Prerequisites		Category	ES(PE)	Credits		3
Power Electronics		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the operating principles, configurations and applications of power electronic circuits					
2.	To analyse the control strategies of converters for efficient power conversion in advanced applications.					
UNIT - I	MULTIPULSE CONVERTERS					9
Concept of multi-pulse converters, Configurations for twelve pulse, eighteen pulse and twentyfour pulse rectifiers, operation and waveform analysis, phase shifting transformer configurations for multi-pulse converters, Applications						
UNIT - II	PULSE-WIDTH-MODULATED DC-DC CONVERTERS					9
Forward converter, Half bridge and full-bridge converters, SEPIC Converter; Interleaved boost converter, transformer-isolated converter topologies, continuous and discontinuous conduction modes of operation, current ripple analysis of DC-DC converters						
UNIT - III	HIGH POWER CONVERTERS					9
Diode Clamped Type and Flying Capacitor Type Multi-Level Inverters and suitable modulation strategies - Multi-level inverters of Cascade Type, Series Inverters. Analysis of Series Inverters. Modified Series Inverter. Three Phase Series Inverter						
UNIT - IV	BIDIRECTIONAL CONVERTERS					9
Single Phase and three Phase bidirectional converters in rectifier mode, control of DC voltage - control of Input Current. Hysteresis control in Single Phase and three Phase inverter mode - Frequency control in hysteresis, Constant switching frequency control methods.						
UNIT - V	RESONANT CONVERTERS					9
Resonant switch converters, Zero voltage switching clamped voltage converters, Resonant DC link inverters High frequency link integral half cycle converters, Phase modulated resonant converters, Dual active bridge converters, High gain converters.						
L:45, T:0, P:0, Total: 45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2017.					
2.	N. Mohan, Power Electronics: A First Course, John Wiley & Sons, 2014.					
3.	B. K Bose "Modern Power Electronics and AC Drives" Pearson Education, 2022.					
4.	https://archive.nptel.ac.in/courses/108/107/108107128					
E-RESOURCES:						
1.	https://nptel.ac.in/courses/108102584					

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the operating modes of new DC-DC voltage regulators	PO1	PSO1
CO2	Select appropriate phase shifting converter for a multi-pulse converter operation	PO1, PO3	PSO1
CO3	Analyze resonant converters and identify an inverter configuration for high power AC applications	PO1, PO2, PO3	PSO1, PSO2
CO4	Use of appropriate control method for bidirectional converters	PO1, PO3	PSO1, PSO2
CO5	Apply advanced converter concepts to solve real-world power conversion problems through hands-on design and simulation exercises	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	3			3	
CO2	3		3	3	
CO3	3	3	3	3	3
CO4	3		3	3	3
CO5	3	3	3	3	3

Skill based laboratory activities:

1.	1. V/f and vector control of three phase induction motor drive using DSC 2. DSP based speed control of SRM motor 3. FPGA based speed control of BLDC and SRM drive 4. DTC control of Induction motor drive 5. Closed loop control of PMSM motor drive using DSC and FPGA 6. Simulation study of field oriented control of induction motor drive using MATLAB 7. Simulation study of CSI fed three phase induction motor drive using MATLAB 8. Simulation study of closed loop control of BLDC motor drive using MATLAB
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Rubrics for evaluation:

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Experimental Design	20	Independently designs, conducts and analyzes experiments with appropriate methodology	Designs and conducts experiments with minimal guidance and arrives at reasonable conclusions.	Conducts experiments following prescribed procedures, performs basic analysis, and reports observations with guidance
2.	Execution of Simulation	30	Simulation is done and plots are well-presented	Simulation is done, but minor error in plots	Simulations and plots are incomplete

3.	Execution of hardware experiment	20	Results are clearly interpreted from the hardware	Results are interpreted but limited justification	Unclear interpretation
4.	Report presentation	10	Report is clear and well structured	Report is structured, but needs improvement	Poorly structured report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE02		DIGITAL CONTROL SYSTEM		SEMESTER		II	
Prerequisites			Category	ES(PE)	Credits	3	
Control Systems, and Signals and Systems			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To introduce the fundamental concepts, principles and application of digital control system analysis and design.						
2.	To impart knowledge on classical control design methods as well as the modern control design Techniques.						
UNIT - I		REPRESENTATIONAND MODELING OF DISCRETE-TIME SYSTEMS					9
Basics of digital control system- Representation of discrete time system - Mathematical modelling of sampling process- Data reconstruction. Z-transform and Inverse Z transform for analysing discrete time system - Mapping of s-plane to z-plane - Pulse transfer function - Pulse transfer function of closed loop system - Sampled signal flow graph.							
UNIT - II		TIME RESPONSE AND STABILITY ANALYSIS					9
Transient and steady state responses - Time response parameters of a prototype second order system. Stability Analysis by Jury's test – using bilinear transformation - Nyquist stability criteria.							
UNIT - III		CLASSICAL METHODS OF DESIGN					9
Root locus method - Controller design using Root locus plots - Root locus based controller design using MATLAB – Bode plots - design of digital lead, lag, lag-lead compensator using Bode plots - Design of digital control systems with deadbeat response -Practical issues with deadbeat response - Sampled data control systems with deadbeat response.							
UNIT - IV		DISCRETE STATE SPACE MODEL					9
Introduction to state variable model - Various Canonical forms - Characteristic equation, state transition matrix - Solution to discrete state equation - Controllability and observability – stability - Lyapunov stability theorem.							
UNIT - V		STATE VARIABLE METHODS OF DESIGN					9
Pole placement by state feedback - Set point tracking controller - Full order observer - reduced order observer - Output feedback design - design examples.							
L:45, T:0, P:0, Total: 45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	M. Gopal, "Digital Control and State Variable Methods", Tata Mcgraw Hill, Second Edition, 2003.						
2.	B. C. Kuo, "Digital Control Systems", Oxford University Press, 2 nd Indian Edition, 2007.						
3.	K. Ogata, "Discrete Time Control Systems", Prentice Hall, Second Edition, 1995						
4.	G. F. Frankin, J. D. Powel, and M. L. Workman. "Digital Control of Dynamic Systems", Addison-Wesley, 1998. Pearson Education, Asia, Third Edition, 2000.						
5.	K. J. Astrom and B. Wittenmark, "Computer Controlled Systems - Theory and Design", Prentice Hall, Third Edition, 1997.						

E-RESOURCES:

1. <https://nptel.ac.in/courses/108103008>

COURSE OUTCOMES (COs):**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Understand the representation and modelling of discrete-time systems.	PO1, PO3	PSO1, PSO2
CO2	Obtain time response of discrete-time systems and analyse stability of discrete-time system.	PO1, PO3	PSO1, PSO2
CO3	Design of digital control system using classical methods.	PO1, PO3	PSO1, PSO2
CO4	Analyse of digital control system using state-space models.	PO1, PO3	PSO1, PSO2
CO5	Design of digital control system using advanced methods.	PO1, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	2	3	2
CO2	3	-	2	3	2
CO3	3	-	2	3	2
CO4	3	-	2	3	2
CO5	3	-	2	3	2

Activities:

1. Simulation of Modelling, Analysis, and design of controllers in digital control system (CO3)
2. Technical Seminar Presentation (CO5)

Rubrics for evaluation: CO3 - Simulation Activity

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	System Modelling	20	discrete transfer function or state-space model are clearly defined	Defines system model with minor errors	Incorrectly formulates the digital system
2.	Simulation Implementation	30	Simulation is done and properly implemented	Simulation is done, but minor error in implementation	Simulations and implementation are incomplete
3.	Interpretation of results	20	System performances are clearly interpreted	basic system behaviour is interpreted but limited justification	unclear interpretation

4.	Report presentation	10	Report is clear and well structured	Report is structured, but needs improvement	Poorly structured report
	Total	100			

Rubrics for evaluation: CO5 - Technical Seminar Presentation

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Knowledge	30	Clearly explains digital control principles and theoretical concepts	Satisfactory grasp of foundational digital control concepts	Insufficient technical knowledge
2.	Mathematical Modelling and / System analysis	30	Formulates accurate mathematical models, state-space model, or pulse transfer functions with precise physical interpretation	Develops accurate mathematical models but provides limited analysis of system's behaviour	Presents incorrect mathematical models
3.	Evidence of self-learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	22				11	2
CO2	22				11	2
CO3	16	10	40		33	3
CO4		28			14	2
CO5		22		40	31	3
Total	60	60	40	40	100	

26PEE03	MODERN RECTIFIERS AND RESONANT CONVERTERS		SEMESTER			II	
Prerequisites			Category	ES(PE)	Credits	3	
Power Electronics			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To impart knowledge on the design of pulse width modulated rectifiers and its supply current control strategies.						
2.	To introduce the concept of resonant converters and focuses on the dynamic analysis of DC-DC converters.						
3.	To introduce the control techniques applied for DC-DC converter						
UNIT - I		PWM Rectifiers					9
Pulse width modulation rectifiers – Properties of ideal rectifiers – Realization of near ideal rectifiers – CCM and DCM boost converter – Losses and efficiency in CCM highquality rectifiers – Device selection for rectifiers.							
UNIT - II		Source Current Shaping of Rectifiers					9
Need for current shaping – power factor – input current shaping methods – passive shaping methods – active methods – boost rectifier employing peak current control – average current control – Hysteresis control – Nonlinear carrier control – Sensor less current control.							
UNIT - III		Quasi Resonant DC-DC Converters					9
Introduction to Soft Switching – Difference between hard switched and soft switched converters – classification of resonant converters – Basics of ZVS and ZCS – operation and analysis of ZVS buck and boost converter – operation and analysis of ZCS buck and boost converter – Design of ZVS/ZCS (buck/boost) converters							
UNIT - IV		Class-D Resonant Converters					9
Introduction – Basic operation of Class-D series resonant converter- parallel resonant converter – series-parallel resonant converter – CLL resonant converter – LLC resonant converter.							
UNIT - V		Dynamic Analysis of Switching Converters					9
State Space Averaging – Steps involved in State Space Average Model – State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck-Boost Converter – Pulse Width modulation – Voltage Mode PWM-Scheme – Current Mode PWM Scheme.							
L:45, T:0, P:0, Total: 45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:	
1.	Robert W. Erickson and Dragon Maksimovic, 'Fundamentals of Power Electronics', Second Edition, Springer science and Business media, 2001. 2. Marian.K. Kazimierczuk and DariuszCzarkowski, 'Resonant Power Converters', John Wiley & Sons limited, 2011.
2.	Simon Ang and Alejandro Oliva, 'Power Switching Converters', Taylor & Francis Group, 2010
3.	John G. Kassakian, Martin F. Schlecht, George C. Verghese, 'Principles of Power Electronics', Pearson, India, New Delhi, 2010.
4.	IssaBatarseh, Ahmad Harb, 'Power Electronics – Circuit Analysis and Design', Second edition, 2018.
5.	KengC.Wu, 'Switch Mode Power Converters – Design and Analysis', Elsevier academic press, 2006.
6.	Mohan, Undeland and Robins, 'Power Electronics – Concepts, Applications and Design', Wiley, 2007

E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee02

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the operating principles, characteristics, and performance of PWM rectifiers and source current shaping techniques.	PO1	PSO1
CO2	Analyze power factor correction methods and control strategies employed in high-quality rectifier systems.	PO1, PO3	PSO1
CO3	Analyze the operation, design, and performance of quasi-resonant and Class-D resonant DC-DC converters.	PO1, PO3	PSO1, PSO2
CO4	Study and simulate PWM rectifiers, resonant converters, and DC-DC converter control techniques using MATLAB or open-source simulation software through self-learning activities and interpret the findings while considering practical engineering applications.	PO1, PO2, PO3	PSO1, PSO2
CO5	Study the applications of modern rectifiers and resonant converters in power electronic systems through self-learning activities and present the findings while considering societal, environmental, and economic impacts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2			2	
CO2	2		2	2	
CO3	1		2	2	1
CO4	1	2	2	3	2
CO5	1	2	3	3	2

Activities:					
1.	Perform simulation and performance analysis of PWM rectifiers, ZVS/ZCS converters, LLC resonant converters, or PWM-controlled DC-DC converters using MATLAB/Simulink or open-source simulation software tools.				
2.	Analyze the application of modern rectifiers and resonant converters in renewable energy systems, electric vehicle chargers, switched-mode power supplies, and industrial power conversion systems through case studies, self-learning activities, and technical presentations.				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Problem formulation and converter system modeling	20	Correctly formulates the problem with appropriate converter model and parameters	Formulates the problem with minor errors in model selection	Basic formulation with incomplete or incorrect parameters
2.	Development of simulation model and generation of results	30	Simulation executed correctly with accurate outputs and performance metrics	Simulation completed with minor errors in outputs/results	Simulation partially completed with inadequate outputs
3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis
4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Understanding of rectifier and resonant converter applications	20	Demonstrates strong understanding with relevant industrial applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts

3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE04	POWER ELECTRONIC CONVERTER DYNAMICS AND CONTROL		SEMESTER		II
Prerequisites		Category	ES(PE)	Credits	3
Power Electronics, Control System		Hours/ Semester	L	T	P
			45	0	0
TH					
45					
COURSE OBJECTIVES					
1.	To understand the operation and applications of power electronic converters , including isolated and non-isolated converter systems.				
2.	To learn the steady-state behavior and modeling of power converters for analyzing their performance and losses.				
3.	To study the dynamic characteristics of power converters using mathematical models and frequency-domain analysis techniques.				
4.	To understand Pulse Width Modulation (PWM) techniques and control methods used in converters, inverters, and rectifiers.				
5.	To gain knowledge of analog and digital controller implementation and advanced control techniques for efficient converter operation.				
UNIT – I	INTRODUCTION				9
Overview of basic and advanced Power electronic converters, various applications, basics of utility power conversion, isolated and non-isolated converter circuits, types of power converter models.					
UNIT – II	STEADY STATE MODELING AND ANALYSIS				9
Steady state converter analysis, Steady state modeling of the power converters, DC transformer model, loss modeling.					
UNIT– III	DYNAMIC MODELING AND ANALYSIS				9
Dynamic modeling of the power converters, AC modeling of converters, state-space averaging, Transfer functions and frequency domain analysis, Extra Element Theorem.					
UNIT – IV	PULSE WIDTH MODULATION & CONTROL				9
Pulse Width Modulation (PWM) control of power converters, voltage source and current source inverters, feedback control design, voltage mode and current mode control, control of inverters and rectifiers					
UNIT – V	CONTROLLER IMPLEMENTATION				9
Analog and digital implementation of the controllers, advanced analysis and control techniques applied to power electronics converters.					
L:45, T:0, P:0, Total: 45 Hours					
Weightage:					
Continuous Assessment 40%					
End Semester Examinations 60%					

REFERENCE BOOKS:					
1.	"Fundamentals of Power Electronics", Robert W. Erickson and Dragan Maksimovic, Springer, 3rd Edition, 2020.				
2.	"Power Electronics: Converters, Applications and Design", Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley & Sons, 3rd Edition, 2003.				
3.	"Modeling and Control of Power Electronics Converter System for Power Quality Improvements", Shailendra Jain, Pramod Agarwal, CRC Press, 2018.				
4.	Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid, Pearson Education, 4th Edition, 2014.				
5.	Digital Control of High-Frequency Switched-Mode Power Converters, Luca Corradini, Dragan Maksimović, Paolo Mattavelli, Regan Zane, IEEE Press-Wiley, 2015.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the operating principles, characteristics, modeling approaches, modulation techniques, and controller implementation methods used in power electronic converters.	PO1, PO3	PSO1, PSO2		
CO2	Applying steady-state and dynamic modeling techniques to determine the performance, transfer characteristics, and control requirements of power converters.	PO1, PO3	PSO1, PSO2		
CO3	Analyzing power converter systems using PWM strategies, feedback control methods, frequency-domain techniques, and converter models to evaluate system behavior and stability.	PO1, PO3	PSO1, PSO2		
CO4	Evaluating and comparing different converter topologies, modulation schemes, and control strategies through simulation studies for specific power electronic applications.	PO1, PO2, PO3	PSO1, PSO2		
CO5	Designing, simulating, and presenting a controlled power converter system using appropriate analog/digital control techniques to meet specified performance requirements.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1	1	-	2	2	1
CO2	2	-	3	3	2
CO3	3	-	3	3	2
CO4	3	2	3	3	3
CO5	3	3	3	3	3
Activities:					
1.	Technical Seminar / Report (CO4) (Self-learning Activity)				
2.	Simulation(CO5)(Self-learning Activity)				

Rubrics for evaluation:CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identification of Converter Topology / Control Technique	30	Identifies and justifies an appropriate and advanced converter topology/control strategy	Identifies a suitable topology/control strategy with limited justification	Identifies a basic topology/control strategy with minimal understanding
2.	Comparative Analysis and Evaluation	30	Comprehensive comparison with clear performance evaluation and conclusions	Adequate comparison with moderate analysis	Basic comparison with limited evaluation
3.	Resources Referred	20	Referred journals, books, and technical standards	Referred conference papers and technical articles	Referred open-access/web resources only
4.	Seminar / Report Presentation	20	Presentation/report is clear, well-structured, and technically sound	Presentation/report is structured but needs improvement	Poorly structured presentation/report with limited clarity
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Converter Design and Modeling	30	Correctly designs and models the converter meeting all specifications	Designs the converter with minor errors	Basic converter model with significant limitations
2.	Implementation of Control Strategy	30	Effectively implements and validates the selected control technique	Implements the control technique with moderate effectiveness	Basic implementation with limited validation
3.	Simulation Results and Analysis	20	Thorough analysis of waveforms and performance parameters with justified conclusions	Adequate analysis of results	Limited analysis and interpretation of results
4.	Documentation / Demonstration	20	Documentation and demonstration are clear, organized, and technically accurate	Documentation/demo nstration is adequate but needs improvement	Poor documentation/demon stration with limited technical explanation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Strength = 3 (if percentage >20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PEE05	DESIGN OF POWER CONVERTERS		SEMESTER			II
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the design and operation of uncontrolled and controlled rectifier circuits.					
2.	To study the design and analysis of inverter and DC-DC converter circuits.					
3.	To learn the selection of power semiconductor devices, filters and magnetic components for power converters.					
4.	To understand gate driver circuits, protection methods and thermal management techniques used in power converters.					
5.	To study the control strategies and industrial applications of power converters in modern electrical systems.					
UNIT – I	DESIGN OF UNCONTROLLED RECTIFIERS					9
Selection of Rectifier topology – Pulse number – Power output - Selection of Diode – Voltage and Current Ratings – Selection of DC Filter – Design and Selection of Inductor and Capacitor with practical considerations.						
UNIT – II	DESIGN OF CONTROLLED RECTIFIERS					9
Selection of Rectifier topology - Pulse number – Power output – Reactive Power Requirements - Selection of SCR – Voltage and Current Ratings - Selection of DC Filter – Design and Selection of Inductor and Capacitor – Triggering Sequence and Sequence control for improved power factor operation.						
UNIT– III	DESIGN OF SWITCH MODE INVERTERS					9
Selection of inverter topology – Power output – Harmonics – Reactive Power Requirements - Selection of Power Devices – Voltage and Current Ratings - Selection of output Filter – Design and Selection of Inductor and Capacitor – Different control strategy for various requirements.						
UNIT – IV	DESIGN OF SWITCH MODE DC-DC CONVERTERS					9
Selection of converter topology – Power output – Performance parameters - Selection of Power Devices – Voltage and Current Ratings - Selection of Filter – Design and Selection of Inductor, Capacitor and ferrite transformers. Control strategies for various requirements.						
UNIT – V	DRIVERS, PROTECTION AND APPLICATIONS OF POWER CONVERTER					9
Gate driver requirements and basic driver circuits for MOSFETs and IGBTs – Isolation techniques – Snubber circuits and converter protection methods – Thermal management and heat sink design – Over current and over voltage protection – Introduction to EMI and filtering – Applications of power converters in UPS, motor drives, battery chargers, renewable energy systems, induction heating and electric welding.						
L:45, T:0, P:0, Total: 45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	M.H.Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, PHI 4th Edition, New Delhi, 2017.				
2.	Barry W. Williams - Principles and Elements of Power Electronics – Devices, Drivers, Applications and Passive Components, ISBN 978-0-9553384-0-3.				
E-RESOURCES:					
1.	https://onlinecourses.nptel.ac.in/noc22_ee33/preview-Design of Power Converters				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the operation, characteristics and design considerations of power semiconductor devices, rectifiers, inverters and DC-DC converters.		--	--	
CO2	Apply the principles of power electronics to analyze and design uncontrolled rectifiers, controlled rectifiers, inverters and DC-DC converters for various applications.		PO1, PO3	PSO1	
CO3	Analyze the performance of power converters with respect to harmonics, reactive power, switching losses, thermal effects and converter control strategies.		PO1, PO2, PO3	PSO1, PSO2	
CO4	Analyze and simulate power converter circuits, gate driver circuits and protection methods using modern software tools and interpret the obtained results.		PO1, PO2	PSO1	
CO5	Study industrial applications of power converters including renewable energy systems, electric vehicle charging systems and motor drives through self-learning activities, technical seminars and case studies.		PO2, PO3	PSO2	
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3		3	3	
CO3	2		3	3	
CO4	3		3	2	3
CO5	2	2	3	2	3
Activities:					
1.	Design and simulation of DC-DC converters and inverter circuits using MATLAB/PSIM/LTspice. (CO4)(Self-learning Activity)				
2.	Design study and case analysis of power converter applications in renewable energy systems and electric vehicle charging systems. (CO5)(Self-learning Activity)				

Rubrics for evaluation:CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Converter design and parameter selection	25	Converter design and component selection are accurate and justified	Minor errors in design calculations	Incomplete or incorrect design.
2.	Simulation implementation and waveforms	30	Simulation completed successfully with accurate waveforms and results	Simulation completed with minor errors	Incomplete simulation and waveforms
3.	Performance analysis and interpretation	25	Results clearly analyzed and interpreted with proper justification	Partial analysis and interpretation	Poor or unclear interpretation
4.	Report presentation and documentation	20	Report is clear, structured and technically well presented	Report requires minor improvement	Poorly organized report
	Total	100			

Rubrics for evaluation:CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding of converter application	25	Clearly explains converter operation and application requirements	Minor gaps in explanation	Limited understanding
2.	Design study and technical analysis	30	Detailed technical analysis with proper converter selection and justification	Moderate technical analysis	Limited technical content
3.	Use of references and self-learning	25	Uses relevant journals, standards and technical resources	Limited supporting references	Very limited references
4.	Presentation and communication	20	Presentation is clear, structured and technically effective	Presentation needs improvement	Poor presentation and communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Strength = 3 (if percentage >20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26PEE06	POWER QUALITY AND CUSTOM POWER DEVICES		SEMESTER			II	
Prerequisites			Category	ES(PE)	Credits		3
Analysis of Power Converters			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the different power quality issues and IEEE standards with recommended practices.						
2.	To understand the concept of power and power factor in single phase and three phase systems supplying non-linear loads						
3.	To understand the conventional compensation techniques used for power factor correction and load voltage regulation.						
4.	To understand the active compensation techniques used for power factor correction and load voltage regulation.						
UNIT - I		INTRODUCTION					9
Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Nonlinear and unbalanced loads. DC offset in loads, Notching in load voltage, Disturbance in supply voltage –need of monitoring -international power quality standards (IEEE Standards) and recommended practices.							
UNIT - II		ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM					9
Single phase circuits: single phase sinusoidal voltage source supplying nonlinear loads – single phase non sinusoidal voltage source supplying nonlinear loads, Three phase circuits: three phase sinusoidal balanced system – instantaneous real and reactive powers for Three phase circuits– symmetrical components- three phase non-sinusoidal balanced system- unbalanced and non-sinusoidal three phase system- Harmonic sources from commercial loads: SMPS-fluorescent lighting-ASD, Harmonic sources from Industrial loads: three-phase power converter- arcing devices, saturable devices							
UNIT - III		FUNDAMENTAL THEORY OF LOAD COMPENSATION					9
Principle of load compensation – some practical aspects of compensator used as voltage regulator-Phase balancing and power factor correction of unbalanced load- a generalized approach for load compensation using symmetrical components, generating reference currents using instantaneous PQ theory.							
UNIT - IV		REALISATION AND CONTROL OF DSTATCOM					9
DSTATCOM structure- control of DSTATCOM connected to stiff source- DSTATCOM connected to weak supply point-DSTATCOM current control through phasor-DSTATCOM in Voltage control mode.							
UNIT - V		SERIES COMPENSATION USING DVRAND UPQC					9
Rectifier supported DVR – DC Capacitor supported DVR – Operating principle-characteristics for different load power factor and feeder resistance- mathematical description to compute DVR voltage – transient operation of DVR – realization of DVR using voltage source inverter- maximum compensation capacity of the DVR without real power support from DC-Link.							
Unified power quality conditioner: Configuration - Types, structure and control characteristics.							
L:45, T:0, P:0, Total: 45 Hours							

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Arindam Ghosh and Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2.	R. C. Dugan, Mark F McGranaghan, Surya Santoso, H.W. Beaty, "Electrical Power Systems Quality", McGraw Hill Publishers, New York, Second Edition, 2009.
3.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", John Wiley & Sons, 2015
4.	Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Systems and Electrical Machines, Elsevier academic press publications, 2011
5.	G.T. Heydt, "Electric Power Quality", McGraw-Hill Professional, 2007.
6.	Ahmed F. Zobaa, Shady H.E. Abdel Aleem and Murat E. Balci, "Power System Harmonics - Analysis, Effects, and Mitigation Solutions for Power Quality Improvement", Intec open 2018.

E-RESOURCES:

1.	https://nptel.ac.in/courses/108105066/16
2.	https://nptel.ac.in/courses/112107240/29
3.	https://nptel.ac.in/courses/108107114/35
4.	https://www.researchgate.net/publication/228413035_Harmonic_distortion_caused_by_compact_fluorescent_lights_on_electrical_networks
5.	https://www.researchgate.net/publication/273203160_Power_Conditioning_Using_Dynamic_Voltage_Restorers_under_Different_Voltage_Sag_Types/figures?lo=1

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Understand different types of power quality problems with their sources of generation.	PO1, PO3	PSO1, PSO2
CO2	Analyse the effect of harmonics on the single and three-phase circuits under non-sinusoidal and unbalanced load conditions.	PO1, PO3	PSO1, PSO2
CO3	Analyse the different types of load balancing problem in the power system.	PO1, PO3	PSO1, PSO2
CO4	Choose compensate system of DVR and DSTATECOM for voltage restoration, and load voltage regulation	PO1, PO3	PSO1, PSO2
CO5	Choose power quality conditioner for supply voltage restoration, and load voltage regulation.	PO1, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2		2	1	1
CO2	3		2	2	2
CO3	3		2	2	2
CO4	3		3	3	3
CO5	3		3	3	3

Activities:					
1.	Technical Seminar Presentation(CO2) / CaseStudy(CO2)				
2.	Assignment (CO4)				
Rubrics for evaluation:CO4 - Assignment					
Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Modelling and Operating Principles	20	DSTATCOM, and DVR, topology and operation principles are clearlydefined	Topology of DVR & DSTATCOM is defined, but theoperating principle isunclear	Major errors in device block diagrams.
2.	Control Strategy Realization	30	well explained control strategy and gate pulse generation	control strategy is explained but lacks of justification	Control scheme is incomplete
3.	Performance analysis andresults	20	System performance and results are clearly interpreted justified	Results are interpreted but limited justification	Unclear interpretation of results
4.	Assignment presentation	10	Reportisclear and well structured	report is structured,butneeds improvement	Poorlystructuredrep ort with missing sections.
	Total	100			
Rubrics for evaluation: CO2 – Technical Seminar Presentation					
Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Technical Content	20	Clearlyexplains thewaveform analysis and sequence components	Explanationneeds improvement	Limited understanding
2.	System Analysis and load conditions	20	Clearly explains the circuit under non-sinusoidal load/ supply.	Load and circuit analysis needs improvement	Poorly explained
3.	Effects on Equipment	20	Clearly discusses impacts of non-sinusoidal supply / unbalanced loads on power equipment	Discusses impacts on equipment	Fails to show how harmonics damage or degrade power equipment
4.	Solutions	20	Suggests right filters for the loads.	Mentions filters but cannot explain how they work.	no clear solutions

5.	Presentation and communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	22				11	2
C02	22		40		31	3
C03	16	10			13	2
C04		28		40	34	3
C05		22			11	2
Total	60	60	40	40	100	

26PEE07		MULTILEVEL INVERTERS			SEMESTER		II
Prerequisites				CATEGORY	ES(PE)	Credit	3
Power Electronics				Hours/ Semester	L	T	P
					45	0	0
Course Objectives:							
1.	To provide an in-depth understanding of various multilevel inverter (MLI) topologies, their modulation strategies, and practical applications in advanced power electronic systems						
UNIT - I		Review of two-level inverters					9
Review of Power circuits and working principle of: single-phase square-wave inverter, single-phase PWM inverter and three-phase PWM inverter. Review of the principle of sine-triangle PWM for single phase and three-phase two-level inverters. Review of concepts of blocking voltage and conduction current ratings of power switches in inverter, dv/dt stress, harmonic profile, total harmonic distortion (THD) and filtering components							
UNIT - II		Cascaded H-Bridge Multilevel Inverter					9
Working of a three-level H-bridge cell; realization of five-level inverter by cascading two H-bridge cells; advantages of multilevel inverters (MLIs) in terms of topological features (e.g. reduced blocking voltage) and waveform (e.g. reduced dv/dt stress); limitations of MLIs; advantages and limitations of CHBMLI; level-shifted and phase-shifted sine-triangle PWM for CHBMLI; selective harmonic elimination technique for CHBMLI; typical applications of CHBMLI.							
UNIT - III		Neutral Point Clamped MLIs					9
Power circuit and working principle of diode clamped MLI; level-shifted sine-triangle PWM and space vector PWM for diode clamped MLIs; advantages and limitations of diode clamped MLIs; power circuit and working principle of active neutral point clamped (ANPC) MLI; advantages and limitations of ANPC MLI; typical applications of neutral point clamped MLIs.							
UNIT - IV		Flying Capacitors based MLI					9
Power circuit and working principle of flying capacitors based MLI; study of redundant states, various mechanisms for voltage balancing of flying capacitors, level-shifted sine-triangle PWM and space vector PWM for diode clamped multilevel inverters; advantages and limitations of diode clamped MLIs; power circuit and working principle of active neutral point clamped (ANPC) MLI; advantages and limitations of ANPC MLI; typical applications of neutral point clamped MLIs.							
UNIT - V		Advanced MLIs					9
Power circuits and working principle of Modular Multilevel Converter (MMC), T-Type inverter, PackedU Cell (PUC) MLI and Nested Neutral Point Converter (NNPC); Basic principle of working of SwitchedCapacitors based MLIs (SCMLIs), advantages and limitations of SCMLIs; Typical applications of nonconventional MLIs							
L:45, T:0, P:0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:			
1.	"Multilevel Inverters" by Krishna Kumar Gupta and Pallavee Bhatnagar, Academic Press (Elsevier),ISBN 9780128124482 (2017)		
2.	"Modular Multilevel Converters" by Sixing Du, ApparaoDekka, Bin Wu and NavidZargari, Wiley-IEEE Press, ISBN 1119366305 (2018)		
3.	"High Power Converters and AC Drives" by Bin Wu and Mehdi Narimani, Wiley-IEEE Press, ISBN1119156033 (2017)		
4.	ErsanKabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press, 2021.		
5.	KengC.Wu, 'Switch Mode Power Converters – Design and Analysis', Elsevier academic press, 2006.		
6.	Iftekhar Maswood, DehghaniTafti, Advanced Multilevel Converters and Applications in GridIntegration, Wiley, 2018.		
7.	S. Ganesh Kumar, Marco Rivera Abarca, S. K. Patnaik, Power Converters, Drives and Controlsfor Sustainable Operations, Wiley, 2023		
E-RESOURCES:			
1.	Baker, R.H., "Switching circuit," U.S.Patent 4210826,1980. "Modular Multilevel Converters" bySixing Du, ApparaoDekka, Bin Wu and NavidZargari, Wiley-IEEE Press, ISBN 1119366305(2018)		
2.	Nabae, A.; Takahashi, I.; Akagi, H.;, "A neutral-point-clamped PWM inverter," in Conf. Rec.IEEE IAS Annual Meeting, Cincinnati, OH, vol. 3, pp. 761–766,Sep. 28–Oct. 3, 1980		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the operating principles, switching characteristics, harmonic performance, and modulation techniques of two-level inverters.	PO1, PO3	PSO1
CO2	Analyze the operation, modulation strategies, advantages, and limitations of Cascaded H-Bridge Multilevel Inverters (CHBMLIs).	PO1, PO3	PSO1
CO3	Analyze the operating principles, modulation techniques, and applications of Neutral Point Clamped, Flying Capacitor, and Advanced Multilevel Inverters.	PO1, PO3	PSO1, PSO2
CO4	Study and simulate the performance of multilevel inverter topologies and PWM techniques using MATLAB or open-source simulation software through self-learning activities and interpret the findings while considering practical engineering applications.	PO1, PO2, PO3	PSO1, PSO2
CO5	Study the applications of multilevel converters in renewable energy systems, electric drives, and grid integration through self-learning activities and present the findings while considering societal, environmental, and economic impacts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1		1	2	
CO2	2		2	2	
CO3	1		1	2	1
CO4	1	2	3	3	2
CO5	1	2	3	3	2

Activities:

1.	Perform simulation and performance analysis of Cascaded H-Bridge (CHB), Neutral Point Clamped (NPC), Flying Capacitor, Modular Multilevel Converters (MMC), or other multilevel inverter topologies using MATLAB/Simulink or open-source simulation software tools.
2.	Analyze the application of multilevel converters in renewable energy integration, medium-voltage motor drives, electric vehicles, smart grids, and industrial power systems through case studies, self-learning activities, and technical presentations.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Problem formulation and multilevel converter modelling	20	Correctly formulates the problem with appropriate converter model and parameters	Formulates the problem with minor errors in model selection	Basic formulation with incomplete or incorrect parameters
2.	Development of simulation model and generation of results	30	Simulation executed correctly with accurate outputs and performance metrics	Simulation completed with minor errors in outputs/results	Simulation partially completed with inadequate outputs
3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis
4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Understanding of multilevel converter applications and operating concepts	20	Demonstrates strong understanding with relevant industrial applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts
3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Weightage: Continuous Assessment 40% End Semester Examinations 60%					
REFERENCE BOOKS:					
1.	V.P. Kodali, "Engineering Electromagnetic Compatibility", S. Chand, 1996.				
2.	Henry W.Ott, "Noise reduction techniques in electronic systems", John Wiley & Sons, 1989.				
3.	Bernhard Keiser, "Principles of Electro-magnetic Compatibility", Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987.				
4.	Bridges. J.E, Milleta. J and Ricketts. L.W., "EMP Radiation and Protective techniques", John Wiley and sons, USA 1976.				
5.	William Duff G., & Donald White R. J, "Series on Electromagnetic Interference and Compatibility"				
6.	Weston David A., "Electromagnetic Compatibility, Principles and Applications", 1991.				
E-RESOURCES:					
1.	NPTEL Course - NPTEL EMI/EMC and Signal Integrity				
2.	NPTEL Course - NPTEL Electromagnetic Compatibility (EMC)				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the concepts of EMI/EMC, interference mechanisms, grounding, filtering, shielding, ESD, standards, and testing techniques used in power electronic systems.		PO1, PO3	PSO1, PSO2	
CO2	Apply EMI/EMC control techniques such as grounding, cabling, filtering, shielding, and protection methods in power converters and drives.		PO1, PO3	PSO1, PSO2	
CO3	Analyze EMI sources, coupling paths, emissions, shielding effectiveness, ESD effects, and EMC compliance issues in electrical and electronic systems.		PO1, PO2, PO3	PSO1, PSO2	
CO4	Perform EMI/EMC measurements, simulations, and testing to evaluate the performance of power electronic systems.		PO1, PO2, PO3	PSO1, PSO2	
CO5	Design EMC-compliant power electronic and drive systems to meet performance, safety, and regulatory requirements.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1	1	–	3	2	1
CO2	2	–	3	3	2
CO3	3	1	3	3	2
CO4	3	3	2	2	2
CO5	3	2	3	3	3

Activities:					
1.	Technical Seminar / Report (CO4) (Self-learning Activity)				
2.	Simulation (CO5) (Self-learning Activity)				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identification of Converter Topology / Control Technique	30	Identifies and justifies an appropriate and advanced converter topology/control strategy	Identifies a suitable topology/control strategy with limited justification	Identifies a basic topology/control strategy with minimal understanding
2.	Comparative Analysis and Evaluation	30	Comprehensive comparison with clear performance evaluation and conclusions	Adequate comparison with moderate analysis	Basic comparison with limited evaluation
3.	Resources Referred	20	Referred journals, books, and technical standards	Referred conference papers and technical articles	Referred open-access/web resources only
4.	Seminar / Report Presentation	20	Presentation/report is clear, well-structured, and technically sound	Presentation/report is structured but needs improvement	Poorly structured presentation/report with limited clarity
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Converter Design and Modelling	30	Correctly designs and models the converter meeting all specifications	Designs the converter with minor errors	Basic converter model with significant limitations
2.	Implementation of Control Strategy	30	Effectively implements and validates the selected control technique	Implements the control technique with moderate effectiveness	Basic implementation with limited validation
3.	Simulation Results and Analysis	20	Thorough analysis of waveforms and performance parameters with justified conclusions	Adequate analysis of results	Limited analysis and interpretation of results

4.	Documentation / Demonstration	20	Documentation and demonstration are clear, organized, and technically accurate	Documentation/demonstration is adequate but needs improvement	Poor documentation/demonstration with limited technical explanation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE09	DIGITAL SIMULATION OF POWER ELECTRONICS SYSTEM		SEMESTER			II	
Prerequisites			Category	ES(PE)	Credits	3	
Modelling of Electrical Machines Electrical Drives			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	Understand numerical methods for power electronic circuit analysis.						
2.	Model and simulate power semiconductor devices and associated circuits.						
3.	Apply state-space modelling techniques to electrical systems and drives.						
4.	Simulate power converters and DC drive systems for performance evaluation.						
5.	Analyze inverter-based AC drives using modern simulation tools.						
UNIT - I		NUMERICAL METHODS IN PASSIVE COMPONENTS					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.							
UNIT - II		SIMULATION AND MODELLING OF ACTIVE AND PASSIVECOMPONENTS					9
Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modelling 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		STATE SPACE MODELLING AND SIMULATION OF LINEARSYSTEMS					9
State space modelling and simulation of linear systems. Introduction to electrical machine modelling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.							
UNIT - IV		SIMULATION OF CONVERTERS AND DC DRIVES					9
Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self commutated devices- simulation of power factor correction schemes, 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		SIMULATION OF INVERTERS AND AC DRIVES					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.							
L:45, T:0, P:0, Total: 45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design, 3rd Edition, John Wiley & Sons, 2003.				
2.	Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, 2nd Edition, Springer, 2001.				
3.	IssaBatarseh, Power Electronic Circuits, John Wiley & Sons, 2004.				
4.	Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education, 2014.				
5.	Venkataraman B., Simulation of Power Electronic Circuits, Tata McGraw-Hill Education, 2007.				
E-RESOURCES:					
1.	MATLAB & Simulink Documentation				
2.	MathWorks Power Electronics Simulation Resources				
3.	NPTEL – Power Electronics Courses				
4.	MIT Open Course Ware – Power Electronics				
5.	IEEE Xplore Digital Library				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the principles of numerical methods, component modeling, state-space representation, power converters, and drive systems used in digital simulation of power electronic systems.	PO1, PO3	PSO1, PSO2		
CO2	Apply numerical methods and simulation tools to model and simulate power electronic devices, converters, inverters, and electrical drive systems.	PO1, PO2, PO3	PSO1, PSO2		
CO3	Analyze the transient and steady-state performance of simulated power electronic circuits, converters, and motor drive systems under various operating conditions.	PO1, PO2, PO3	PSO1, PSO2		
CO4	Evaluate and select appropriate simulation models, power electronic devices, control strategies, and drive configurations for specified engineering applications.	PO1, PO2, PO3	PSO1, PSO2		
CO5	Develop and validate simulation-based solutions for power electronic converters and electrical drive systems using industry-standard software tools such as MATLAB/Simulink.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1	1		3	2	1
CO2	2	1	3	3	2
CO3	3	1	3	3	2
CO4	3	2	3	3	2
CO5	3	3	3	3	3

Activities:

1.	CaseStudy/Technical Seminar Presentation on selection of appropriate simulation models, power electronic devices, control strategies, and drive configurations for specified engineering applications (CO4) (Independent study) (Self-learning Activity)
2.	Simulation-based solutions for power electronic converters and electrical drive systems using industry-standard software tools such as MATLAB/Simulink (CO5) (Self-learning Activity)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Problem Identification	25	Clearly identifies all system requirements and constraints	Identifies most requirements with minor omissions	Identifies basic requirements only
2.	Selection of Device/Model	35	Selects the most appropriate model/device with strong technical justification	Selects a suitable model/device with adequate justification	Selects a partially suitable model/device with limited justification
3.	Evaluation of Alternatives	25	Compares alternatives quantitatively and recommends the best solution	Compares alternatives with reasonable analysis	Limited comparison and analysis
4.	Technical Interpretation	15	Provides accurate conclusions supported by simulation results	Provides acceptable conclusions with minor gaps	Conclusions are basic and weakly supported
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Model Development	30	Develops a complete and optimized simulation model	Develops a functional simulation model with minor issues	Develops a basic model with noticeable deficiencies
2.	Software Implementation	25	Implements the model correctly with no errors	Implements the model with minor errors	Implements a partially functional model
3.	Validation of Results	25	Thoroughly validates results using theory/literature and explains deviations	Validates results with adequate comparison	Performs limited validation
4.	Documentation & Presentation	20	Presents professional-quality report with clear interpretation	Presents a well-organized report with acceptable interpretation	Presents a basic report with limited interpretation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Strength = 3 (if percentage >20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%)

26PEE10	MODELLING OF SWITCHED MODE POWER CONVERTERS		SEMESTER			II
Prerequisites		CATEGORY	ES(PE)	Credit		3
Power Electronics		Hours/ Semester	L	T	P	TH
		45	0	0	0	45
Course Objectives:						
1.	To understand the operation, analysis and design of isolated and non-isolated switched mode DC-DC converters under various operating conditions.					
2.	To develop mathematical models and design suitable controllers for SMPS converters using state-space averaging, transfer function and frequency response techniques.					
3.	To design magnetic components such as inductors and transformers for switched mode power supply applications and validate their performance through simulation and experimentation.					
UNIT - I	DESIGN OF CONVERTER CIRCUITS					9
Revision of Buck, Boost, Buck-boost and Cuk converters - Discontinuous conduction mode – Derivation of current ripple and voltage ripple formulae based on volt-sec balance and charge balance concepts - Design of critical inductance – Selection of capacitors.						
UNIT - II	PUSH-PULL AND FORWARD CONVERTER TOPOLOGIES					9
Push-Pull Topology: Basic Operation – Master/slave outputs - Flux imbalance -Power transformer design relations - Primary, secondary peak and RMS currents - output power and input voltage limitations -output filter design relations. Forward Converter Topology: Basic operation -Design relations – Slave output voltages -secondary load -freewheeling diode and inductor currents. Forward converter with unequal power and reset winding turns - power transformer design and output filter design						
UNIT - III	HALF AND FULL BRIDGE CONVERTER TOPOLOGIES					9
Half Bridge Converter Topology: Basic operation-Half bridge magnetic-output filter calculations, blocking capacitor to avoid flux imbalance- Half bridge leakage inductance problems. Full Bridge Converter Topology :Basic operation- Full Bridge magnetic –out put filter calculations– transformer primary blocking capacitor						
UNIT - IV	MODELLING CONTROL OF SMPS CONVERTERS					9
AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch modelling – Transfer function model for buck, boost, buck-boost and cuk converters – Input filters, Controller Design - Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost, buck- boost and cuk converters.						
UNIT - V	DESIGN OF MAGNETICS					9
Basic magnetic theory revision – Inductor design – Design of mutual inductance – Design of transformer for isolated topologies – Ferrite core table and selection of area product – wire table – selection of wire gauge – Amorphous core for filter application.						
L:45, T:0, P:0, Total: 45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:	
1.	Robert W. Erickson & Dragon Maksimovic "Fundamentals of Power Electronics", Second 2. Edition, 2001 Springer science and Business media
2.	John G. Kassakian, Martin F. Schlecht, George C. Verghese, "Principles of Power Electronics", Pearson, India, New Delhi, 2010. Philip T Krein "Elements of Power Electronics", Oxford University Press, 2017.
4.	Ned Mohan, "Power Electronics: A first course", John Wiley, 2012.
5.	Issa Batarseh, Ahmad Harb, "Power Electronics- Circuit Analysis and Design, Second edition.

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Analyze the operation and performance characteristics of non-isolated and isolated DC-DC converters under continuous and discontinuous conduction modes.	PO1	PSO1
CO2	Develop mathematical models and design control strategies for SMPS converters using state-space averaging, transfer function and frequency response techniques.	PO1, PO3	PSO1
CO3	Design magnetic components such as inductors and transformers for switched mode power supply applications based on converter specifications.	PO1, PO3	PSO1 PSO2
CO4	Simulate and verify the performance of DC-DC converter topologies and controller designs using software tools.	PO1, PO2, PO3	PSO1 PSO2
CO5	Perform magnetic core selection, winding design and experimental evaluation of SMPS magnetic components for practical converter applications.	PO1, PO2, PO3	PSO1 PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3			3	
CO2	3		3	3	
CO3	3		3	3	2
CO4	2	2	3	3	3
CO5	2	2	2	2	3

Activities:

1.	Simulate and verify the performance of DC-DC converter topologies and controller designs using software tools.
2.	Perform magnetic core selection, winding design and experimental evaluation of SMPS magnetic components for practical converter applications.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Circuit Modeling	20	Correct and complete converter model developed without error	Minor errors in modeling	Basic model developed with multiple correction

2.	Simulation Execution	30	Accurate simulation with proper parameters and waveforms	Simulation completed with minor deviations	Simulation partially verified
3.	Controller Design Analysis of Results	30	Proper controller tuning with stable response Clear interpretation of ripple, efficiency and response characteristics	Acceptable controller performance	Limited controller tuning accuracy
4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Core Selection	20	Appropriate core selected based on design requirements	Minor deviation in selection	Basic selection with limited justification
2.	Magnetic Design Calculations	30	Accurate calculations for inductance, turns and area product	Minor calculation errors	Partially correct calculations
3.	Wire Gauge & Winding Design	30	Proper wire gauge and winding arrangement selected	Minor errors in selection	Basic winding design completed
4.	Experimental Verification and Technical Presentation & Documentation	20	Experimental results closely match design expectations Well-organized report with clear technical explanation	Small deviation in results and good documentation with minor issue	Partial verification completed Basic documentation only
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

REFERENCE BOOKS:					
1.	Shady S Refaat, Omar Ellabban, SertacBayhan, Haitham Abu-Rub, FredeBlaaberg, and Misroslav M Begovic, "Smart Grid and Enabling Technologies", Wiley, 2021.				
2.	James Momoh, "Smart Grid Fundamentals of Design and Analysis", Wiley India, 2015.				
3.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, and Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, 2012.				
4.	Mini S Thomas, and John D McDonald, "Power System SCADA and Smart Grids", CRC Press, 2015.				
5.	S Misra, and S Bera, "Smart Grid Technology: A Cloud Computing and Data Management Approach", Cambridge University Press, 2018.				
E-RESOURCES:					
1.	NPTEL Online Course: Introduction to Smart Grid.				
2.	NPTEL Online Course: Smart Grid: Basics to Advanced Technologies.				
3.	IEEE Transactions on Smart Grid.				
4.	IEEE Smart Grid – Standards.				
5.	R. Bayindir, I. Colak, G. Fulli, and K. Demirtas, "Smart Grid Technologies and Applications", Renewable and Sustainable Energy Reviews, Vol.66, pp.499-516, 2016.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the advancements in integration of energy sources, measuring and control technologies, communication infrastructure and information security in smart grid.	--	--		
CO2	Apply the knowledge for enhancing smart grid operations through integration of renewable energy sources and energy storage devices in electric network.	PO3	PSO2		
CO3	Analyse the pertinency of bidirectional communication infrastructure and information security for smart electric power network.	PO3	PSO2		
CO4	As an individual, research the advancements on emerging technologies in transmission / distribution system in smart grid through self-learning activities and present the findings while considering utility and consumer benefits .	PO1, PO2	PSO2		
CO5	As an individual , study the communication protocols in modern power transmission / distribution system through self-learning activities and present a reportwhile considering societal and economic impacts .	PO1, PO2	PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3			3		3
CO4	1	2			3
CO5	1	2			3

Activities:

1. Technical Seminar / Report (CO4) (Self-learning Activity)

2. Technical Report(CO5)(Self-learning Activity)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the emerging technology	30	Identification of the latest technology in smart grid	The technology is identified, but it is not recent.	The technology is identified but it is conventional.
2.	Understanding the advancements in network operations	30	Familiar on changes in the network operations	Moderate knowledge in network operations	Less knowledge in network operations
3.	Resources Referred	20	Referred journals / books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorly structured presentation / report
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the communication protocol	30	Identification of the latest communication protocol implemented in smart grid	The technology is identified, but it is not recent.	The technology is identified but it is conventional.
2.	Understanding the bi-directional communication	30	Familiar on bi-directional data flow	Moderate knowledge in bi-directional data flow	Less knowledge in bi-directional data flow
3.	Resources Referred	20	Referred journals / books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorly structured presentation / report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

REFERENCE BOOKS:					
1.	H Lee Willis, and Walter G Scott, "Distributed Power Generation – Planning and Evaluation", Marcel Decker Press, 2000.				
2.	M Godoy Simoes, and Felix A Farret, "Renewable Energy Systems – Design and Analysis with Induction Generators", CRC Press, 2004.				
3.	M NandhiniGayathiri, and SanjeevikumarPadmanaban, "Electric Vehicles and Distributed Generation-Microgrid", River Publishers, 2025.				
4.	Robert Lasseter, and Paolo Piagi, "Microgrid: A Conceptual Solution", PESD 2004, June 2004.				
5.	John Twidell and Tony Weir, "Renewable Energy Resources", Taylor and Francis Publications, 2005.				
E-RESOURCES:					
1.	NPTEL Online Course: DC Microgrid and Control System.				
2.	NPTEL Online Course: Smart Grid: Basics to Advanced Technologies.				
3.	Class Central: An Introduction to AC Microgrids for Energy Control and Management.				
4.	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems, IEEE Std 1547-2003.				
5.	Clause-by-Clause Summary of Requirements in IEEE Standard 15472018.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the distributed generation technologies and microgrid operations.	--	--		
CO2	Apply the knowledge of standards for developing distributed generation systems and their installations in electric power network.	PO3	PSO2		
CO3	Analyse microgrid operations and adopt effective control strategies for enhancing microgrid operations.	PO3	PSO2		
CO4	As an individual, research the distributed energy resources installed in a regional electric network in India through self-learning activities and present a report while considering benefits of power companies and consumers.	PO1, PO2	PSO2		
CO5	As an individual, study the communication protocols implemented in microgrid through self-learning activities and present a reportwhile considering societal and economic impacts.	PO1, PO2	PSO2		
The Course Articulation Matrix (CAM)for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3			3		3
CO4	1	2			3
CO5	1	2			3
Activities:					
1.	Technical Seminar / Report (CO4) (Self-learning Activity)				
2.	Technical Report(CO5)(Self-learning Activity)				

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the regional electric network and distributed energy sources	30	Provided all technical data	Provided partial technical data	Technical data is not adequate
2.	Understanding the topology and operations	30	High knowledge on topology and operations	Moderate knowledge on topology and operations	Low knowledge on topology and operations
3.	Resources Referred	20	Referred journals / books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorlystructured presentation / report
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the communication protocol	30	Identification of the latest communication protocol implemented in microgrid	The technology is identified, but it is not recent	The technology is identified but it is conventional
2.	Understanding the information flow	30	Familiar on information flow	Moderate knowledge in information flow	Less knowledge in information flow
3.	Resources Referred	20	Referred journals / books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorlystructured presentation / report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE13		FACTS AND HVDC SYSTEM		SEMESTER		III	
Prerequisites			Category	ES(PE)	Credits		3
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the operation and control of static shunt compensators, specifically comparing the performance and applications of SVC and STATCOM in modern power systems.						
2.	To analyse the principles and control strategies of various static series compensation devices, including TCSC, SSSC, and phase angle regulators like TCPAR.						
3.	To explore the circuit arrangements and independent power flow control capabilities of combined controllers such as the Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC).						
4.	To perform a detailed analysis of HVDC converter topologies, including 6-pulse and 12-pulse bridges, and to identify abnormal operations such as commutation failure and arcbreak.						
5.	To study the control hierarchies and firing schemes for HVDC links, including the control of VSC-based systems and the functions of smoothing reactors for system protection.						
UNIT – I		STATIC SHUNT COMPENSATORS					9
Static versus passive VAR compensator-Static shunt compensators: SVC and STATCOM –Operation and control of TSC, TCR and STATCOM – Compensator control – Comparison between SVC and STATCOM.							
UNIT – II		STATIC SERIES COMPENSATORS					9
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.							
UNIT - III		COMBINED AND SPECIAL PURPOSE FACTS CONTROLLERS					9
SSR and its damping – Unified Power Flow Controller: Circuit arrangement, operation and control of UPFC – Basic principle of P and Q control – Independent real and reactive power flow control – Applications- Interline Power Flow Controller (IPFC): Basic operation, structure and applications.							
UNIT – IV		ANALYSIS OF HVDC CONVERTERS					9
Pulse number – Choice of best topology for HVDC – Analysis of six pulse bridge converter without overlap, and with overlap less than 60° – Equivalent circuit model – Analysis of 12 pulse bridge converters – Converter bridge characteristics – Abnormal operation: Arc back, Commutation failure, Arc through, Misfire.							
UNIT – V		CONTROL OF HVDC SYSTEMS					9
Basic principles of DC link control – Converter Control characteristics – System control Hierarchy – Converter firing control schemes – Current and extinction angle – Starting and stopping of DC link and power control – Higher level controllers – control of VSC based HVDC link – Controls for enhancement of AC system performance – Fault development and protection – Functions of smoothing reactors.							
L:45, T:0, P:0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:

1.	N G Hingorani, and L Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, 2001.
2.	K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
3.	Bjarne R Anderson, and Stig L Nilsson, "High Voltage DC Transmission Systems: HVDC", Springer Nature Switzerland, 2025.
4.	R Mohan Mathur, and Rajiv K Verma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", IEEE press, Wiley-Interscience Publications, 2002.
5.	X P Zhang, C Rehtanz, and B Pal, "Flexible AC Transmission Systems- Modelling and Control", Springer Verlag, Berlin, 2006.

E-RESOURCES:

1.	NPTEL Online Course: HVDC Transmission and FACTS.
2.	NPTEL Online Course: Advance Power Electronics.
3.	IET Power Engineering Journal: Flexible AC Transmission Systems.
4.	NPTEL Online Course: High Voltage DC Transmission.
5.	IEEE Power Engineering Society: Reactive Compensation Tutorial.

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamental principles, operational characteristics, and circuit arrangements of Static Shunt/Series compensators, combined FACTS controllers, and HVDC transmission systems.	--	--
CO2	Apply control strategies and mathematical models of devices like SVC, STATCOM, TCSC, and UPFC to regulate real and reactive power flow and improve the stability of modern power grids.	PO3	PSO2
CO3	Analyse the performance of 6-pulse and 12-pulse HVDC converters, the impact of abnormal operations like commutation failure, and the effectiveness of different firing control schemes for AC system enhancement.	PO3	PSO2
CO4	As an individual , demonstrate self-learning capabilities by delivering a technical presentation on contemporary advancements or case studies in FACTS and HVDC technology, utilizing academic references and industry standards .	PO1, PO2	PSO2
CO5	Conduct independent research to prepare a comprehensive technical report evaluating the integration of VSC-based HVDC links or combined controllers like IPFC in complex power networks.	PO1, PO2	PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3			3		3
CO4	1	2			3
CO5	1	2			3

Activities:

1. Technical Presentation (CO4) (Self-learning Activity)
2. Technical Report(CO5)(Self-learning Activity)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the advancements in FACTS and HVDC technology	30	Explained well the technical advancements	Partially explained the technical advancements	Explained the technical advancements in satisfactory level
2.	Understanding the impacts of implications	30	High knowledge on impacts in system operations	Moderate knowledge on impacts in system operations	Low knowledge on impacts in system operations
3.	Resources referred	20	Referred journals /books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation/ Reportisclear and well structured	Presentation / Report is structured, but needs improvement	Poorlystructured presentation / report
Total		100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding the grid integration	30	High level of understanding	Moderate level of understanding	Low level of understanding
2.	Impacts in system performance	30	Familiar with impacts in system performance	Partially familiar with impacts in system performance	Less familiar with impacts in system performance
3.	Resources referred	20	Referred journals /books/magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Reportisclear and well structured	Presentation / Report is structured, but needs improvement	Poorlystructured presentation / report
Total		100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE14	ADVANCED ELECTRICAL DRIVES FOR ELECTRIC VEHICLE		SEMESTER		III		
Prerequisites			CATEGORY	ES(PE)	Credit	3	
Power Electronics			Hours/ Semester	L	T	P	TH
			45	45	0	0	45
Course Objectives:							
1.	To introduce the electrical machines with control module for electric vehicle propulsion						
UNIT - I		Permanent Magnet Brushless Motor Drives					9
PM Brushless Machines : Structure and Principle of PM Brushless Machines, Inverters for PM Brushless, Switching Schemes for Brushless AC Operation, PM Brushless Motor Control, Application of PM Brushless Motor Drives in Electric vehicle							
UNIT - II		Switched Reluctance Motor Drives					9
System Configurations, Switched Reluctance Machine: Structure and Principle of operation, Switched Reluctance Motor Converter Topologies, Soft-Switching Switched Reluctance Motor Converter Topologies, Switched Reluctance Motor Control, Torque-Ripple Minimization Control, Switched Reluctance Motor Drives for Electric Vehicle, Application Examples of Switched Reluctance Motor Drives in Electric Vehicles							
UNIT - III		Magnetless Motor Drives					9
Synchronous Reluctance Motor Drives, Doubly-Salient DC Motor Drives, Flux-Switching DC Motor Drive, Axial-Flux Magnetless Motor Drives, Design Criteria of Advanced Magnetless Motor Drives for EVs, Design Examples of Advanced Magnetless Motor Drives for EVs, Potential Applications of Advanced Magnetless Motor Drives in EVs							
UNIT - IV		Vernier Permanent Magnet Motor Drives					9
System Configurations and Vernier Permanent Magnet Machines, Structure and Principle of Vernier Permanent Magnet Machines, Inverters for Vernier Permanent Magnet Motors, Vernier Permanent Magnet Motor Control, Design Examples of Vernier PM Motor Drives for EVs, Outer-Rotor Vernier PM Motor Drive, Outer-Rotor Flux-Controllable Vernier PM Motor Drive, Potential Applications of Vernier PM Motor Drives in EVs							
UNIT - V		Double-Rotor Electric Variable Transmission Systems					9
Double-Rotor Machines, Double-Rotor Electric Variable Transmission System (DR EVT) Structure and operation, Advanced Double-Rotor EVT Systems, PM DR EVT System, SR DR EVT System, Axial-Flux DR EVT System, Potential Applications of DR EVT Systems in HEVs							
L:45, T:0, P:0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	K. T. Chau, 'Electric Vehicle Machines and Drives: Design, Analysis and Application, Wiley-IEEE Press, 2015						
2.	Mary Murphy " Electric and Hybrid Vehicles: Principles, Design and Technology ", Larsen and Keller Education, 2019						
E-RESOURCES:							
1.	https://nptel.ac.in/courses/108104011						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mappin g PSOs
CO1	Explain the structure, principle of operation, and control techniques of Permanent Magnet Brushless Motor drives used in electric vehicles.	PO1	PSO1
CO2	Analyze the operation and converter topologies of Switched Reluctance Motor drives for electric vehicle applications.	PO1, PO3	PSO1
CO3	Describe the configuration, operation, and applications of magnetless motor drives and double-rotor electric variable transmission systems in electric vehicles.	PO1, PO3	PSO1, PSO2
CO4	Study and simulate the performance characteristics of advanced electric drives for electric vehicles using MATLAB or open-source simulation software through self-learning activities and interpret the findings while considering practical engineering applications.	PO1, PO2, PO3	PSO1, PSO2
CO5	Study advanced electric drive technologies and their applications in electric vehicles through self-learning activities and present the findings while considering societal, environmental, and economic impacts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1			1	
CO2	1		2	2	
CO3	1		2	2	2
CO4	1	2	3	1	2
CO5	1	2	3	1	2

Activities:

1.	Perform simulation and performance analysis of Permanent Magnet Brushless Motor drives, Switched Reluctance Motor drives, or Vernier PM motor drives using MATLAB/Simulink or open-source software tools.
2.	Analyze advanced electric drive technologies used in electric vehicles through case studies, self-learning activities, and technical presentations focusing on energy efficiency, sustainability, and practical applications.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Problem formulation and drive system modeling	20	Correctly formulates the problem with appropriate drive model and parameters	Formulates the problem with minor errors in model selection	Basic formulation with incomplete or incorrect parameters
2.	Development of simulation model and result generation	30	Simulation executed correctly with accurate results and waveforms	Simulation completed with minor errors in results/waveforms	Simulation partially completed with inadequate results
3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis

4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding of advanced electric drive concepts and EV applications	20	Demonstrates strong understanding with relevant EV applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts
3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE15	DESIGN OF MAGNETICS FOR POWER CONVERTERS			SEMESTER		III	
Prerequisites			CATEGORY	ES(PE)	Credit	3	
Solid state drives			Hours/ Semester	L	T	P	TH
				45	0	0	45
Course Objectives:							
1.	To provide a comprehensive understanding of magnetic circuits, magnetic materials, and the design principles of inductors and transformers used in power electronic applications.						
2.	To develop the ability to design and analyze high-frequency magnetic components by considering core selection, winding design, thermal constraints, and high-frequency effects.						
3.	To enable students to evaluate the performance of magnetic components through testing, measurement, and analysis of electrical and magnetic characteristics for efficient power electronic converter applications.						
UNIT - I		Fundamentals of Magnetic Circuits and Magnetic Materials					9
Basic magnetics theory: Review of basic magnetics-transformer modelling-loss mechanisms in magnetic devices-eddy currents in winding conductors-several types of magnetic devices and their B-H loops.							
UNIT - II		Design of Inductors for Power Electronic Applications					9
Inductor design: Introduction -magnet wire-wire insulation -restrictions on inductors-window utilization factor-temperature rise of inductors-mean turn length of inductors-area product method-inductor design for power electronic applications.							
UNIT - III		Design of High-Frequency Transformers					9
Transformer design: Introduction- area product method-optimum flux density-area product for sinusoidal voltages-high frequency transformer design for power electronic applications.							
UNIT - IV		High-Frequency Winding Effects and Magnetic Component Optimization					9
High frequency effects in the windings: skin effect factor -proximity effect factor -proximity effect factor for an arbitrary waveform-reducing proximity effects by interleaving the windings-leakage inductance in transformer windings.							
UNIT - V		Measurement and Testing of Magnetic Components					9
Measurements: measurement of inductance-B-H loop-losses in a transformer-capacitance in transformer windings.							
L:45, T:0, P:0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Robert W. Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics," Third edition, Springer.						
2.	Marian K. Kazimierczuk, "High-Frequency Magnetic Components," second edition, Wiley 2013.						
3.	W.G Hurley and W.H Wofle," Transformers and inductors for power electronics Theory, design, and applications," Wiley 2013.						
4.	Ned Mohan, Tore M. Underland and William P. Robbins, "Power Electronics; Converters, Applications and design," Third edition, Wiley 2007.						
5.	L.Umanand and S.R. Bhat," Design of magnetic components for switched mode power converters", New age international 1992.						
6.	V.Ramanarayanan," Course material on switched mode power conversion," Department of Electrical Engineering Indian Institute of Science Bangalore,2017.						

E-RESOURCE:

1. <https://nptel.ac.in/courses/117103148>

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Analyze magnetic circuits, magnetic materials, and design principles of inductors and transformers for power electronic applications.	PO2, PO3	PSO1, PSO2
CO2	Design high-frequency magnetic components by selecting appropriate core materials, winding configurations, and considering thermal and high-frequency effects.	PO3	PSO3
CO3	Evaluate the performance of magnetic components through testing, measurement, and analysis to ensure efficient and reliable operation in power electronic systems.	PO2, PO3	PSO2
CO4	Design, fabricate, and test a high-frequency inductor or transformer for a specified power electronic application, and evaluate its performance based on design specifications	PO2	PSO3
CO5	Conduct laboratory experiments to measure the magnetic and electrical characteristics of magnetic components, analyze the results, and prepare a technical report with design recommendations.	PO2, PO3	PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	-
CO2	3	3	3	3	2
CO3	2	3	2	2	3
CO4	2	2	3	3	2
CO5	2	3	2	2	3

Activities:

1. Design and Fabrication of a High-Frequency Magnetic Component.
2. Experimental Measurement and Performance Analysis of Magnetic Components.

Rubrics for evaluation:CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Design Calculations	20	Accurate and complete design calculations with proper justification	Minor errors in calculations	Basic calculations with limited justification
2.	Core & Material Selection	30	Appropriate selection with clear technical justification	Suitable selection with minor omissions	Acceptable selection with limited justification
3.	Fabrication & Testing	30	Component fabricated and tested successfully with excellent workmanship	Minor fabrication/testing issues	Functional with noticeable errors

4.	Performance Evaluation	10	Comprehensive analysis and comparison with design specifications	Good analysis with minor omissions	Basic analysis
5.	Technical Report & Presentation	10	Well-organized report with excellent presentation	Good report with minor errors	Average report
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Experimental Setup	20	Correct setup and safe handling of instruments	Minor setup errors	Requires guidance
2.	Measurement Accuracy	30	Measurements are accurate and properly recorded	Minor measurement errors	Acceptable measurements
3.	Data Analysis	30	Thorough analysis with valid interpretations	Good analysis with minor omissions	Basic analysis
4.	Conclusions & Recommendations	20	Logical conclusions with effective design recommendations	Appropriate conclusions	Limited conclusions
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE16	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the fundamental concepts of different grid interfaces and identify the technical issues, such as voltage control and harmonics, associated with integrating both small-scale and large-scale renewable energy generation into the grid.					
2.	To analyse various wind power conversion configurations and the control requirements for modern wind turbines, focusing on active/reactive power control and fault ride-through capabilities.					
3.	To explore different grid-connected PV system configurations, ranging from utility-scale central inverter plants to AC-module systems based on resonant converters.					
4.	To examine specific control strategies for PV systems, including Maximum Power Point Tracking (MPPT), voltage-oriented control for inverters, and anti-islanding detection methods.					
5.	To perform controllability and stability analysis of renewable systems, specifically focusing on wind turbines connected through L/LCL filters and PV systems connected to current source inverters.					
UNIT – I		INTRODUCTION				9
Different types of grid interfaces, Issues related to grid integration of small-scale generation: Protection issues, Voltage control, Harmonics control, Grid integration of large-scale renewable energy generation, interconnection standards and grid codes.						
UNIT – II		GRID INTEGRATION OF WIND ENERGY SYSTEMS				9
Wind power conversion configuration, Fixed speed wind turbine with direct grid connection using a soft starter, Partial-scale variable speed wind turbine with variable rotor resistance, Variable speed wind turbine with full-scale power converter, Requirements of modern wind power converters, Controls and grid requirements for modern wind turbines: Active power control, Reactive power control, Total harmonic distortion, Fault ride-through capability.						
UNIT– III		PHOTOVOLTAIC ENERGY CONVERSION SYSTEMS				9
Generic grid-connected PV energy conversion system, Grid-connected PV system configurations, Utility-scale PV plant based on central inverter configuration, Multilevel central inverter PV systems, Variants of the transformer less H-bridge string inverter for grid integration, multi-string PV grid configurations, AC-module PV system based on resonant H-bridge HF DC–DC converter and H-bridge inverter.						
UNIT – IV		CONTROL OF GRID-CONNECTED PV SYSTEMS				9
Maximum power point tracking control methods, DC–DC stage converter control, Grid-tied converter control: Voltage-oriented control for single phase and three-phase grid-tied PV inverters, Anti-islanding detection, Three-phase NPC and CHB multi-string topology for multi-megawatt PV application.						
UNIT – V		CONTROLLABILITY ANALYSIS OF GRID TIED RENEWABLE ENERGY SYSTEMS				9
Controllability of wind turbine connected through L filter to the grid, Controllability of wind turbine connected through LCL filter to the grid, Controllability and stability analysis of PV system connected to current source inverter.						
L:45, T:0, P:0, Total: 45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:

1.	Haitham Abu-Rub, Mariusz Malinowski, and Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation, and Industrial Applications", John Wiley & Sons Ltd, 2014.
2.	S Sumathi, L Ashok Kumar, and P Surekha, "Solar PV and Wind Energy Conversion Systems", Springer International Publishing AG Switzerland, 2015.
3.	M Kathiresh, A MahaboobSubahani, and G R Kanagachidambaresan, "Integration of Renewable Energy Sources with Smart Grid", Wiley, 2021.
4.	Majid Jamil, M Rizwan, and D P Kothari, "Grid Integration of Solar Photovoltaic Systems", CRC Press, 2017.
5.	Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley, 2019.

E-RESOURCES:

1.	Integration of Large-Scale Renewable Energy in the Bulk Power System: Good Practices from International Experiences, National Renewable Energy Laboratory.
2.	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems.
3.	IEEE Energy Conference and Exhibition: Power Electronics and Controls for Wind Turbine Systems.
4.	IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.
5.	NPTEL Online Course: Smart Grid: Basics to Advanced Technologies.

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping POs****Mapping PSOs**

CO1	Explain the operation of renewable energy resources and their impact on the electric network operations.	--	--
CO2	Apply knowledge of wind and photovoltaic energy conversion systems for seamless grid integration.	PO3	PSO2
CO3	Analyse the control schemes for grid connected renewable energy systems.	PO3	PSO2
CO4	As an individual , demonstrate self-learning capabilities by delivering a technical presentation on large scale integration of wind / photovoltaic system in India.	PO1, PO2	PSO2
CO5	Conduct independent research to prepare a comprehensive technical report evaluating the control schemes adopted in India for grid connected PV system.	PO1, PO2	PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3			3		3
CO4	1	2			3
CO5	1	2			3

Activities:

1.	Technical Presentation (CO4) (Self-learning Activity)
2.	Technical Report(CO5)(Self-learning Activity)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the advancements in FACTS and HVDC technology	30	Explained well the technical advancements	Partially explained the technical advancements	Explained the technical advancements in satisfactory level
2.	Understanding the impacts of implications	30	High knowledge on impacts in system operations	Moderate knowledge on impacts in system operations	Low knowledge on impacts in system operations
3.	Resources Referred	20	Referred journals /books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorly structured presentation / report
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding the grid integration	30	High level of understanding	Moderate level of understanding	Low level of understanding
2.	Impacts in system performance	30	Familiar with impacts in system performance	Partially familiar with impacts in system performance	Less familiar with impacts in system performance
3.	Resources Referred	20	Referred journals /books/magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorly structured presentation / report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE17	ENERGY STORAGE TECHNOLOGIES		SEMESTER			III
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the fundamental necessity for energy storage, including variations in energy demand and supply, transmission congestion, and the environmental and sustainability issues involved.					
2.	To analyse the performance indicators of energy storage systems, focusing on energy capture and discharge efficiency, cycle lifetime, safety risks, and environmental recycling considerations.					
3.	To compare various technology options and battery chemistries (specifically Lead Acid and Lithium) and evaluate their applications in fields like solar energy storage, automotive hybrid/electric vehicles, and waste heat recovery.					
4.	To explore the design and operation of advanced systems, including hydrogen fuel cells, flow batteries, and hybrid energy storage for managing peak and continuous power needs.					
UNIT – I		STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES				9
Storage needs – Variations in energy demand – Variations in energy supply – Interruptions in energy supply – Transmission congestion – Demand for portable energy-demand and scale requirements – Environmental and sustainability issues.						
UNIT – II		TECHNICAL METHODS OF STORAGE				9
Energy and Energy Transformations, Mechanical storage: Pumped hydroelectric, compressed air, flywheel- Electrochemical storage: Batteries, flywheels – Chemical storage: Hydrogen- Electrical and electromagnetic storage: Super capacitors, super conducting magnetic energy storage-Thermal storage: Sensible heat, Latent heat, Thermochemical storage.						
UNIT – III		PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS				9
Energy capture rate and efficiency – Discharge rate and efficiency – Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity – Ease of materials, recycling and recovery – Environmental consideration and recycling, Merits and demerits of different types of storage.						
UNIT – IV		APPLICATION CONSIDERATION				9
Comparing storage technologies – Technology options – Performance factors and metrics – Efficiency of energy systems – Energy recovery. Battery storage system: Introduction with focus on lead acid and Lithium – Chemistry of battery operation, power storage calculations, reversible reactions, Charging patterns. Battery management systems, System performance, Areas of application of energy storage: Waste heat recovery, Solar energy storage, Greenhouse heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles						
UNIT – V		HYDROGEN FUEL CELLS AND FLOW BATTERIES				9
Capacitors: properties, power calculations – Operation and design methods - Hybrid energy storage: Managing peak and continuous power needs, options - Level 1: (Hybrid power generation) Bacitor “Battery + Capacitor” Combinations: need, operation and merits; Level 2: (Hybrid power generation) Bacitor + Fuel cell or Flow battery operation-Applications: Storage for hybrid electric vehicles, Regenerative power, Capturing methods.						
L:45, T:0, P:0, Total: 45 Hours						

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	DetlefStolten, "Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", Wiley, 2010.
2.	Jiujun Zhang, Lei Zhang,Hansan Liu, and Andy Sun, Ru-Shi Liu, "Electrochemical Technologies for Energy Storage and Conversion", John Wiley and Sons, 2012.
3.	Francois Beguin and ElzbietaFrackowiak, "Super Capacitors", Wiley, 2013.
4.	Andreas Hauer, "Advances in Energy Storage", Latest Developments from R&D to the Market, Wiley, 2022.
5.	Jia'en Lin, "New Energy Technologies: Cases and Solutions", Springer, 2025.

E-RESOURCES:

1.	NPTEL Online Course: Energy Storage.
2.	Coursera: Energy Production, Distribution & Safety Battery.
3.	Coursera: Battery State of Health and Management Systems.
4.	IEEE Power and Energy Society.
5.	Journal of Power Source, Elsevier.

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping POs****Mapping PSOs**

CO1	Explain various energy storage technologies and their applications.	--	--
CO2	Apply knowledge of energy storage technologies for real-time applications.	PO3	PSO2
CO3	Analyse the energy storage systems through the performance indicators.	PO3	PSO2
CO4	As an individual , demonstrate self-learning capabilities by delivering a technical presentation on small-scale energy storage devices deployed in electric power networks in India.	PO1, PO2	PSO2
CO5	Conduct independent research to prepare a comprehensive technical report evaluating the role of energy storage systems in managing peak and light load situations.	PO1, PO2	PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3			3		3
CO4	1	2			3
CO5	1	2			3

Activities:

1.	Technical Presentation (CO4) (Self-learning Activity)
2.	Technical Report(CO5)(Self-learning Activity)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the small-scale energy storage technologies adopted in India	30	Explained well the energy storage technology	Partially explained the energy storage technology	Explained the energy storage technology in satisfactory level
2.	Understanding the impacts of implications	30	High knowledge on impacts in system operations	Moderate knowledge on impacts in system operations	Low knowledge on impacts in system operations
3.	Resources referred	20	Referred journals /books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Reportisclear and well structured	Presentation / Report is structured,but needs improvement	Poorlystructured presentation / report
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding the load management	30	High level of understanding	Moderate level of understanding	Low level of understanding
2.	Impacts in system performance	30	Familiar with impacts in system performance	Partially familiar with impacts in system performance	Less familiar with impacts in system performance
3.	Resources referred	20	Referred journals /books/magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Reportisclear and well structured	Presentation / Report is structured,but needs improvement	Poorlystructured presentation / report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

REFERENCE BOOKS:					
1.	Pethuru Raj, and Anupama C Mohan, "The Internet of Things – Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.				
2.	Raj Kamal, "Internet of Things Architecture and Design Principles", McGraw Hill Education (India) Private Limited, 2017.				
3.	Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things – Key applications and Protocols", John Wiley, 2012.				
4.	RabindraNath Shaw, Ankush Ghosh, SaadMakhilef, and Valentina Emilia Balas, "Applications of AI and IoT in Renewable Energy", Elsevier, 2022.				
5.	RajkumarBuyya and Amir VahidDastjerdi, "Internet of Things:Principles and Paradigms", Elsevier, 2016.				
E-RESOURCES:					
1.	NPTEL Online Course: Introduction to Internet of Things.				
2.	Coursera: IoT Communications.				
3.	WasedaX: IoT System Architecture: Design and Evaluation.				
4.	NPTEL Online Course: Foundation of Cloud IoT Edge ML.				
5.	Coursera: Master AWS IoT: Build, Automate & Deploy Smart Systems.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the structure and components of IoT system and its interfacing technologies.	--	--		
CO2	Apply the knowledge structure and components to design an appropriate system for the real-world applications.	PO3	PSO2		
CO3	Analyse the applicability of communication technologies and computing platform to develop an IoT smart system.	PO3	PSO2		
CO4	As an individual , demonstrate self-learning capabilities by delivering a technical presentation on modern communication protocols of IoT systems for electrical engineering applications.	PO1, PO2	PSO2		
CO5	Conduct independent research to prepare a comprehensive technical report on cloud computing platform employed in IoT smart system for electrical engineering applications.	PO1, PO2	PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3			3		3
CO4	1	2			3
CO5	1	2			3
Activities:					
1.	Technical Presentation (CO4) (Self-learning Activity)				
2.	Technical Report(CO5)(Self-learning Activity)				

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Identifying the communication protocols of IoT system	30	Explained well the communication protocols	Partially explained the communication protocols	Explained the communication protocol in satisfactory level
2.	Understanding the implementations of communication in IoT system	30	High knowledge on implementation	Moderate knowledge on implementation	Low knowledge on implementation
3.	Resources Referred	20	Referred journals /books/ magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorly structured presentation / report
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory (1)
1.	Understanding the cloud computing	30	High level of understanding	Moderate level of understanding	Low level of understanding
2.	Familiar of cloud computing tools and their implementations	30	Familiar with tools and their implementations	Partially familiar with tools and their implementations	Less familiar with tools and their implementations
3.	Resources Referred	20	Referred journals /books/magazines	Conference articles	Open access articles
4.	Seminar / Report presentation	20	Presentation / Report is clear and well structured	Presentation / Report is structured, but needs improvement	Poorly structured presentation / report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	10	

26PEE19	ARTIFICIAL INTELLIGENCE FOR POWER ELECTRONICS		SEMESTER			III	
Prerequisites			CATEGORY	ES(PE)	Credit		3
Power Electronics, Power systems			Hours/ Semester	L	T	P	TH
				45	0	0	45
Course Objectives:							
1.	Industrial Applications & AI Integration in Power Electronics						
UNIT - I	Introduction to Artificial Intelligence for Power Electronics						9
Introduction to Artificial Intelligence – History and evolution of AI – Types of AI – Machine Learning, Deep Learning and Reinforcement Learning – AI workflow for engineering applications – Data acquisition, preprocessing and feature extraction – Performance evaluation metrics – Introduction to AI tools (Python, MATLAB, TensorFlow, Scikit-learn) – Scope of AI in Power Electronics, Electric Drives, Renewable Energy Systems and Smart Grid Applications.							
UNIT - II	AI Techniques and Intelligent Optimization Methods						9
Artificial Neural Networks (ANN) – Fuzzy Logic Systems – Genetic Algorithms (GA) – Particle Swarm Optimization (PSO) – Reinforcement Learning (RL) – Support Vector Machine (SVM) – Decision Trees – Model training, validation and testing – Selection of suitable AI techniques for converter control and optimization.							
UNIT - III	AI Applications in Power Electronic Converters and Electric Drives						9
Review of DC-DC converters, Rectifiers and Inverters – AI-based converter modelling – Intelligent PWM techniques – AI-assisted converter parameter optimization – AI-based controller tuning (PID, Fuzzy PID, ANN Controller) – AI for Electric Drives – BLDC, PMSM and Induction Motor drives – Torque ripple minimization – Efficiency optimization – Sensorless control – Electric Vehicle applications.							
UNIT - IV	AI for Fault Diagnosis, Predictive Maintenance and Condition Monitoring						9
Condition monitoring of power electronic converters – Data acquisition from voltage, current and temperature sensors – Feature extraction techniques – AI-based fault diagnosis of semiconductor switches, capacitors and gate drivers – Predictive maintenance using Machine Learning – Remaining Useful Life (RUL) estimation – Digital Twin concept – MATLAB/Python based case studies.							
UNIT - V	Renewable Integration & Smart Grids						9
AI for Solar PV Maximum Power Point Tracking (MPPT) – Wind Energy Conversion Systems – Battery Management Systems (BMS) – Energy Storage Systems – AI-based Energy Management in Hybrid Electric Vehicles – Smart Grid applications – Microgrid energy optimization – AI-enabled power quality improvement – Future trends: Edge AI, Explainable AI (XAI), Digital Twin, Autonomous Power Electronics.							
L:45, T:0, P:0, Total: 45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Rashid, M.H. - Power Electronics: Circuits, Devices & Applications, Princeton Publications,2021						
2.	Hu, W., Zhang, G., Zhang, Z., Blaabjerg, F., et al. – AI for Power Electronics and Renewable Energy Systems (IET, 2024)						
3.	AhteshamulHaque, Azra Malik, SaadMekhilef, - AI for Power Electronics, Wiley IEEE Publictions,2025						
E-RESOURCES:							
1.	Zhao, S., Blaabjerg, F., & Wang, H. – "Overview of AI Applications for Power Electronics," IEEE Trans. Power Electronics, Apr 2021						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the applications of power electronic converters in industrial systems such as SMPS, UPS, static switches, solid-state relays, and motor drives.	PO1, PO3	PSO1
CO2	Analyze the role of artificial intelligence techniques in electric drives and power electronic converter performance optimization.	PO1, PO3	PSO1
CO3	Apply AI algorithms such as Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms (GA), and Reinforcement Learning for converter control, optimization, and fault detection.	PO1, PO3	PSO1, PSO2
CO4	Study and simulate AI-based control, monitoring, and optimization techniques for power electronic converters using MATLAB or open-source software through self-learning activities and interpret the findings while considering practical engineering applications.	PO1, PO2, PO3	PSO1, PSO2
CO5	Study the applications of artificial intelligence in condition monitoring, renewable energy integration, and smart grid systems through self-learning activities and present the findings while considering societal, environmental, and economic impacts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1		1	2	
CO2	2		2	2	
CO3	1		2	2	2
CO4	1	3	2	3	2
CO5	1	3	3	3	2

Activities:

1.	Perform simulation and analysis of AI-based converter control, motor drive optimization, fault detection, or condition monitoring systems using MATLAB/Simulink, Python, or open-source AI tools.
2.	Analyze AI applications in renewable energy systems, smart grids, predictive maintenance, and power quality enhancement through case studies, self-learning activities, and technical presentations.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Problem formulation and AI model selection	20	Correctly formulates the problem with appropriate AI technique and system parameters	Formulates the problem with minor errors in AI model selection	Basic formulation with incomplete or incorrect parameters
2.	Development of simulation model and generation of results	30	Simulation executed correctly with accurate outputs and performance metrics	Simulation completed with minor errors in outputs/results	Simulation partially completed with inadequate outputs

3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis
4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: CO5

Sl. No	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Understanding of AI applications in power electronics and energy systems	20	Demonstrates strong understanding with relevant industrial applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts
3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	10			10	2
CO2	20	20			20	2
CO3	30	30			30	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

26PEE20	POWER ELECTRONICS DRIVES FOR ELECTRIC VEHICLE			SEMESTER		III
Prerequisites			CATEGORY	ES(PE)	Credit	3
Power Electronics			Hours/ Semester	L	T	P
				45	0	0
TH						
45						
Course Objectives:						
1.	To study the characteristics of motors used Electric Vehicle					
2.	To understand the design of dc and ac drives used in Electric Vehicle					
UNIT - I	EV Motors Characteristics					9
Requirement of EV motors, Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Comparison of EV motors, Basics of DC Motor, Torque speed characteristics, DC Motor dynamics, Field Weakening Control, Four quadrant operation						
UNIT - II	Design Of DC Drives					9
Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits.						
UNIT - III	Inverter Fed AC Drives					9
Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations. Problems and strategies.						
UNIT - IV	Permanent Magnet AC Motors and Control					9
BLDC dynamic modelling, torque equations, BLDC control methods, machine sizing, current, voltage and speed limits, extending constant power speed range, current control methods- Application of hall current sensor in PM AC motors.						
UNIT - V	PWM Techniques					9
Sinusoidal PWM, Injection of third order harmonics, Space Vector Modulation, Dead time & compensation Encoders, Resolvers, R/D Converters.						
L:45, T:0, P:0, Total: 45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	K. T. Chau, 'Electric Vehicle Machines and Drives: Design, Analysis and Application, Wiley-IEEE Press, 2015					
2.	Mary Murphy " Electric and Hybrid Vehicles: Principles, Design and Technology ", Larsen and Keller Education, 2019					
3.	B.K. Bose, "Power Electronics and Motor Drives", Elsevier 2015					
4.	R. Krishnan, " Electric Motor Drives Modelling Analysis and Control", Prentice -Hall of India2001.					
5.	P.S. Bhimra," Generalized Theory of Electrical Machines", Khanna Publisher.					
E-RESOURCES:						
1.	https://nptel.ac.in/courses/108107715					

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the characteristics, operating principles, and performance requirements of motors used in electric vehicles.	PO1	PSO1
CO2	Analyze the operation and control of DC drives and converter-fed DC motor drives used in electric vehicle applications.	PO1, PO3	PSO1
CO3	Explain inverter-fed AC drives, PWM techniques, and speed control methods used for AC motor control in electric vehicles.	PO1, PO3	PSO1
CO4	Study and simulate the operation and control of DC drives, inverter-fed AC drives, and permanent magnet AC motors using MATLAB or open-source simulation software through self-learning activities and interpret the findings while considering practical engineering applications.	PO1, PO2, PO3	PSO1 PSO2
CO5	Study modern power converter techniques, PWM methods, and sensor-based motor control applications in electric vehicles through self-learning activities and present the findings while considering societal, environmental, and economic impacts.	PO1, PO2, PO3	PSO1 PSO2

The Course Articulation Matrix (CAM) for defined COs

CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1			2	
CO2	2		2	2	
CO3	1		2	2	2
CO4	1	3	2	3	2
CO5	1	3	3	3	2

Activities:

1.	Perform simulation and performance analysis of DC drives, inverter-fed AC drives, or BLDC motor control techniques using MATLAB/Simulink or open-source software tools.
2.	Analyze PWM techniques, inverter configurations, and sensor-based control methods used in electric vehicles through case studies, self-learning activities, and technical presentations.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Problem formulation and drive system modelling	20	Correctly formulates the problem with appropriate drive model and parameters	Formulates the problem with minor errors in model selection	Basic formulation with incomplete or incorrect parameters
2.	Development of simulation model and generation of results	30	Simulation executed correctly with accurate outputs and waveforms	Simulation completed with minor errors in outputs/waveforms	Simulation partially completed with inadequate outputs
3.	Analysis and interpretation of simulation results	30	Clearly interprets results with proper engineering justification	Provides acceptable interpretation with limited explanation	Gives basic interpretation with insufficient analysis

4.	Report preparation and presentation	20	Well-organized report with effective presentation and documentation	Report is adequate with minor presentation issues	Report lacks clarity and proper organization
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (3)	Good(2)	Satisfactory(1)
1.	Understanding of PWM, inverter, and sensor control concepts	20	Demonstrates strong understanding with relevant EV applications	Demonstrates moderate understanding with limited applications	Demonstrates basic understanding with minimal applications
2.	Case study analysis considering societal, environmental, and economic impacts	30	Provides detailed analysis with clear societal/environmental/economic considerations	Provides acceptable analysis with partial consideration of impacts	Provides basic analysis with minimal consideration of impacts
3.	Evidence of self-learning and independent study	30	Shows extensive self-learning with additional references and insights	Shows moderate self-learning with adequate references	Shows limited self-learning with minimal references
4.	Presentation, communication, and documentation skills	20	Presents ideas clearly with effective communication and documentation	Presentation is understandable with minor communication issues	Presentation lacks clarity and effective communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	10	10			10	2
C02	20	20			20	2
C03	30	30			30	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

26AC001	ENGLISH FOR RESEARCH PAPER WRITING M.E. (Common to all Branches)			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
Basic proficiency in English and familiarity with academic and technical writing.			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To develop awareness of the importance of English in academic and research communication.						
2.	To familiarize learners with the structure and organization of research papers.						
3.	To improve learners’ ability to use appropriate academic language and expressions in research writing.						
4.	To help learners avoid common language errors and improve the quality of their research papers.						
5.	To enable learners to write and present research work using accepted academic conventions.						
UNIT - I		FUNDAMENTALS OF RESEARCH AND ACADEMIC WRITING					6
Research and its significance. Purpose, characteristics, and structure of a research paper. Types of research publications. Identifying research problems and defining objectives. Features of academic English, including formal and objective style. Academic vocabulary, clear and concise sentence construction, and avoidance of redundancy and common grammatical errors. Selection of appropriate journals and conferences for publication.							
UNIT - II		LANGUAGE PATTERNS IN RESEARCH WRITING					6
Common phrases for introducing research problems, stating objectives, describing methods, and presenting results. Use of active and passive voice. Appropriate tense forms in research writing. Cohesion and coherence through linking words and transitions.							
UNIT - III		IMPROVING RESEARCH WRITING					6
Hedging in academic writing. Paraphrasing and summarizing techniques. Plagiarism and ethical writing practices. Identifying and correcting common language mistakes. Editing and proof reading strategies.							
UNIT - IV		REVIEW WRITING AND REVIEW OF LITERATURE					6
Purpose and structure of review articles. Review of Literature (RoL): literature search, synthesis of findings, and identification of research gaps. Citation practices and avoidance of plagiarism. Practical exercises in organizing literature and drafting literature review sections.							
UNIT - V		WRITING RESEARCH PAPER SECTIONS					6
Writing effective titles, abstracts, introductions and conclusions. Presenting findings and discussions clearly. Language for oral presentation of research. Useful phrase banks for different sections of a research paper and research presentations.							
L:30, Total:30 Hours							
Weightage: Continuous Assessment - 100%							

REFERENCE BOOKS:

1.	Wallwork, Adrian. English for Writing Research Papers. 3 rd ed., Springer, 2023.
2.	Swales, John M., and Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills. 4 th ed., University of Michigan Press, 2020.
3.	Glasman-Deal, Hilary. Science Research Writing for Non-Native Speakers of English. 2 nd ed., Imperial College Press, 2020.
4.	Cargill, Margaret, and Patrick O'Connor. Writing Scientific Research Articles: Strategy and Steps. 3 rd ed., Wiley-Blackwell, 2021.
5.	Day, Robert A., Barbara Gastel, and Michelle Prince. How to Write and Publish a Scientific Paper. 9 th ed., Greenwood, 2022.

E-RESOURCES:

1.	Author Academy – https://authoracademy.springernature.com
2.	Researcher Academy – https://researcheracademy.elsevier.com
3.	Learn English (British Council) - https://learnenglish.britishcouncil.org/skills/writing
4.	Academic Phrase bank – https://www.phrasebank.manchester.ac.uk
5.	Committee on Publication Ethics (COPE) – https://publicationethics.org

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the significance of research communication and describe the structure, purpose, and types of research publications.	PO1, PO2	
CO2	Apply appropriate academic vocabulary, sentence structures, and language conventions in research writing.	PO1, PO2	
CO3	Use academic language patterns, cohesive devices, and appropriate grammatical structures to communicate research ideas effectively.	PO1, PO2	
CO4	Analyze research papers to identify writing styles, language patterns, and common grammatical error	PO1, PO2	
CO5	Demonstrate ethical research writing practices through effective paraphrasing, citation, referencing, and avoidance of plagiarism.	PO1, PO2	

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2			
CO2	3	3			
CO3	2	3			
CO4	2	3			
CO5	3	3			

Activities:

1.	(i) Assignment 1: Research Paper Analysis and Language Evaluation Select a published research paper from your discipline and analyze its structure, purpose, and major components. Evaluate the use of academic vocabulary, sentence structures, language patterns, cohesive devices, and grammatical conventions. Comment on the effectiveness of the writing and identify areas for improvement. (ii) Assignment 2: Academic Rewriting and Editing Choose a technical text or an excerpt from a research article and revise it using appropriate academic vocabulary, formal style, cohesive devices, and correct grammatical structures. Explain the revisions made and discuss how they improve the quality and clarity of research communication. (iii) Assignment 3: Review of Literature and Research Gap Identification Select a research topic related to your specialization and review at least five recent research articles. Summarize the major findings using appropriate academic language and transitions, compare the studies, identify research gaps, and present the review in a coherent academic format. (iv) Assignment 4: Analysis of Research Writing Conventions Analyze two published research papers from your discipline and compare their writing conventions, language patterns, organization, and presentation of research findings. Examine the use of academic expressions, cohesion, citation practices, and ethical writing principles. Suggest improvements where necessary.
2.	PRESENTATION: (i) Presentation 1: Ethical Issues in Research Writing Discuss plagiarism, self-plagiarism, authorship issues, citation ethics, and the responsibilities of researchers in academic publishing. Illustrate the discussion with examples from published research articles and explain strategies for maintaining academic integrity. (ii) Presentation 2: Paraphrasing, Citation, and Referencing in Research Writing Present effective techniques for paraphrasing and summarizing research literature. Demonstrate the use of citation and referencing styles commonly adopted in academic publications and discuss methods for avoiding plagiarism. (iii) Presentation 3: Review of Literature and Research Gap Identification Select a research topic from your area of specialization and present a brief review of relevant literature. Summarize key findings from published studies, compare their contributions, identify research gaps, and explain how ethical citation practices are followed in the review process. (iv) Presentation 4: Presenting Research Paper Sections Prepare and present the title, abstract, introduction, methodology, findings, and conclusion of a selected research paper. Highlight the language conventions, organization, and presentation strategies used for effective research communication. (v) Presentation 5: Research Conference and Poster Presentation Design and deliver a short conference-style or poster presentation based on a research article or review paper. Demonstrate effective presentation techniques, audience engagement, response to questions, and adherence to ethical practices in reporting and acknowledging sources.

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding and Application of Concepts	25	Shows excellent understanding of the topic	Shows good understanding with minor gaps	Shows basic understanding with several gaps

2.	Analysis and Critical Observation	25	Presents clear and relevant analysis	Adequate analysis with minor omissions	Limited analysis and observations
3.	Organization, Clarity and Coherence	25	Well-organized and easy to follow	Generally organized with minor issues	Organization is weak or inconsistent
4.	Academic Language and Accuracy	25	Accurate academic language with minimal errors	Few language errors that do not affect clarity	Frequent language errors but meaning is understandable
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Assignment	Presentation	Percentage allocation	Mapping Strength
CO1	25		12.5	2
CO2	25		12.5	2
CO3	25		12.5	2
CO4	25		12.5	2
CO5		50	50	3
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26AC002		DISASTER MANAGEMENT		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To have a critical understanding of key concepts in disaster risk reduction and humanitarian response and critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations and evaluate the strengths and weaknesses of disaster management approaches. Planning and programming in different countries, particularly their home country or the countries they work in.						
UNIT - I		INTRODUCTION					6
Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Disaster Prone Areas in India: Study of Seismic Zones; Area 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.							
L: 30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							

REFERENCE BOOKS:

- | | |
|----|---|
| 1. | R. Nishith, Singh AK 2012 Disaster Management in India: Perspectives, issues and strategies New Royal Book Company, Lucknow |
| 2. | Sahni, PardeepEt.Al. (Eds.) 2002 Disaster Mitigation Experiences and Reflections. Prentice Hall Of India, New Delhi |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs****CO1**

Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2

Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3

develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

CO4

Critically understand the strengths and weaknesses of disaster management approaches

26AC003	SANSKRIT FOR TECHNICAL KNOWLEDGE			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning Sanskrit to improve brain functioning. Learning Sanskrit to develop logic in mathematics, science & other subjects enhances the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.						
UNIT - I	ALPHABETS						10
Alphabets in Sanskrit –Past/Present/Future Tense –Simple Sentences							
UNIT - II	LITERATURE						10
Order –Introduction of roots –Technical information about Sanskrit Literature							
UNIT - III	CONCEPTS						10
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	"AbhyasaPustakam"- Dr.Vishwas, Samskrita- Bharati Publication, New Delhi						
2.	"Tech Yourself Sanskrit" PrathamaDeeksha-Vempatikutumbshastri,Rashtriya Sanskrit Sansthan, New Delhi Publication						
3.	India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Understanding basic Sanskrit language.						
CO2	Ancient Sanskrit literature about science & technology can be understood.						
CO3	Being a logical language will help to develop logic in students						

26AC004		VALUE EDUCATION		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To understand the Importance of value education and self-development. To imbibe good values in students and also know about the importance of character.						
UNIT - I		BASIC VALUES					7
Values and self-development- Social values and individual attitudes-Work ethics, Indian vision of Humanism Moral and Non Moralvaluation-Standards and principles-Value judgments.							
UNIT - II		CONFIDENCE					7
Importance of cultivation of values- Sense of Duty-Devotion-Self-reliance-Confidence-Concentration-Truthfulness-CleanlinesHonesty-Humanity-Power of faith-National Unity-Patriotism-Love for nature-Discipline.							
UNIT - III		PERSONALITY DEVELOPMENT					8
Personality and Behavior Development-Soul and Scientific attitude - Positive – Thinking - Integrity and discipline -Punctuality – Love and Kindness - Avoid fault Thinking - Free from anger - Dignity of labor - 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 - IV		LOVE AND COMPASSION					8
Character and Competence –Holy books Vs. Blind faith –Self –management and Good health – Science of reincarnation –Equality – Non Violence –Humility -Role of Women –All religions and same message –Mind your Mind –Self -control –Honesty –Studying effectively.							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	Chakraborty, S.K. "Values and Ethics for Organization Theory and Practice", Oxford University Press, New Delhi, 1998.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Knowledge of self-development.						
CO2	Learn the importance of Human values.						
CO3	Developing the overall personality.						

26AC005		CONSTITUTION OF INDIA		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.						
UNIT - I		HISTORY OF MAKING OF INDIAN CONSTITUTION					5
History, Drafting Committee (Composition & working)							
UNIT - II		PHILOSOPHY OF THE INDIAN CONSTITUTION					5
Preamble, Salient Features							
UNIT - III		CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES					5
Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and education rights, right to constitutional remedies, directive principles of state policy, fundamental duties.							
UNIT - IV		ORGANS OF GOVERNANCE					5
Parliament, composition, qualifications and disqualifications, powers and functions, executive, president, governor, council of ministers, judiciary, appointment and transfer of judges, qualifications, powers and functions.							
UNIT - V		LOCAL ADMINISTRATION					5
Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zila panchayat. Elected officials and their roles, CEO zila panchayat: position and role. Block level: organizational hierarchy (different departments), village level: role of elected and appointed officials, importance of grass root democracy.							
UNIT - VI		ELECTION COMMISSION					5
Election Commission: role and functioning. Chief election commissioner and election commissioners. State election commission: role and functioning. Institute and bodies for the welfare of SC/ST/OBC and women.							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	The Constitution of India, 1950 (Bare Act), Government Publication						
2.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.						
3.	M. P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.						
4.	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics		
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.		
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution		
CO4	Discuss the passage of the Hindu Code Bill of 1956		

26AC006		PEDAGOGY STUDIES			SEMESTER			I/II
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers. 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
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 follow-up 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.								
L: 30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								

REFERENCE BOOKS:			
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 math 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.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?		
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?		
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?		

26AC007		STRESS MANAGEMENT BY YOGA			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To create a healthy, strong willed and intelligent young society through yoga practices							
UNIT - I		PHYSICAL AND MENTAL HEALTH						6
Pain and disease - free life, Simplified Physical Exercise- Pranayama. Concentration on Pituitary gland- Practical, Goal fixing								
UNIT - II		REJUVENATION OF LIFE FORCE AND WILL POWER						6
Principle of kayakalpa yoga, mind, life force and Biomagnetism, Practical, Concentration on Muladhara- Practical, Analysis of thought –Will power								
UNIT - III		DEVELOPMENT OF VIRTUES						6
Activation of Dormant Brain cells- Practical, Moralization of dezire and its classification, Neutralization of Anger, Results of anger								
UNIT - IV		STREAM LINING OF MIND						6
Definition of Mind-Worries, Eradication of Worries. The science behind blessings. Blessing techniques. Benefits, five basic duties								
UNIT - V		CAUSE AND EFFECT SYSTEM						6
Law of nature, Hereditary Imprints, Fivefold and Two-fold culture, good values and Resolution for world peace								
L: 30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								
REFERENCE BOOKS:								
1.	"Thirukkural" , Pearls of Inspiration, Translation by Rajaram, Publisher :RUPA							
2.	"Bharathiyar Poems", Amazon Asia – Pacific Holdings Private Limited							
3.	"Yoga for Humane Excellence" ,Vethathiri Maharishi, Vision for Wisdom, Vethathiri Publications							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					Mapping POs		Mapping PSOs	
CO1	Maintain good Physical health.							
CO2	Develop will power.							
CO3	Take quick and right decisions.							
CO4	Maintain good relationship with everyone around them his creating a Health Society							

26AC008	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To learn to achieve the highest goal happily,						
2.	To become a person with stable mind, pleasing personality and determination,						
3.	To awaken wisdom in students.						
UNIT - I	NEETISATAKAM – HOLISTICS DEVELOPMENT OF PERSONALITY						6
Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)							
UNIT - II	NEETISATAKAM — HOLISTIC DEVELOPMENT OF PERSONALITY (CONT'D)						6
Verses 52, 53, 59 (don'ts) - Verses 71.73.75 & 78 (do's) - Approach to day to day works and duties.							
UNIT - III	INTRODUCTION TO BHAGAVADGEETHA FOR PERSONALITY DEVELOPMENT						6
Shrimad Bhagavadgeetha: Chapter 2 — Verses 41, 47, 48 - Chapter 3 — Verses 13,21,27,35 - Chapter 6 - Verses 5,13,17,23,35 - Chapter 18 - Verses 45,40,48 Chapter - 6: Verses 5, 13, 17, 23, 35; Chapter - 18: Verses 45, 46, 48							
UNIT - IV	STATEMENTS OF BASIC KNOWLEDGE - SHRIMAD BHAGAVADGEETHA						6
Chapter 2- Verses 56, 62,68 - Chapter 12 — Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.							
UNIT - V	ROLE OF BHAGAVADGEETHA IN THE PRESENT SCENARIO						6
Chapter 2 — Verses 17 - Chapter 3 — Verses 36, 37, 42 - Chapter 4 — Verses 18, 38, 39 - Chapter 18 — Verses 37, 38, 63.							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	“Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata						
2.	Bhartrihari’s Three Sataskam (Niti- Sringar – Vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.						

E-RESOURCES:			
1.	NTPEL: http://nptel.ac.in/downloads/109104115		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
C01	Develop their personality and achieve their highest goal of life.		
C02	Lead the nation and mankind to peace and prosperity.		
C03	Practice emotional self-regulation.		
C04	Develop a positive approach to work and duties.		
C05	Develop a versatile personality.		

26AC009	SUSTAINABLE DEVELOPMENT GOALS		SEMESTER			I/II
PREREQUISITES		Category	AC	Credits		0
		Hours/ Semester	L	T	P	TCP
			30	0	0	30
COURSE OBJECTIVES						
1.	To understand the concepts of Sustainable Development Goals					
2.	To study sustainability assessment methods, education for sustainable development					
3.	To analyze the problems and solution in environmental management.					
4.	To analyze the issues related to resource utilization.					
5.	To explore knowledge about life cycle assessment.					
UNIT - I	INTRODUCTION TO SUSTAINABLE DEVELOPMENT					6
Need and Importance of Sustainable Development - Historical & Policy perspectives of Sustainable Development - Sustainable Development: World and India Perspective - Introduction to 17 SDGs - Specific learning objectives for different SDGs - Challenges & strategies of attaining SDGs in developed and developing nations.						
UNIT - II	SDG QUALITY EDUCATION					6
Focus of NEP-2020 on SDG - Education for Sustainable Development - Berlin Declaration 2021 on ESD - Integration of ESD - Tools, Systems, and Innovation for Sustainability - Measuring Sustainability.						
UNIT - III	SUSTAINABLE COMMUNITIES AND RESOURCE CONSERVATION					6
Circular economy (basic model of reuse, recycle, and reduce) - Rural & urban Problems & Challenges - Sustainable production and consumption - Renewable energy - Health & Hygiene, water, sanitation & water management - Waste Management.						
UNIT - IV	CLIMATE CHANGE, ENERGY AND SUSTAINABLE DEVELOPMENT					6
The greenhouse effect: Causes and Consequences - Climate Change: A Threat to Sustainable Development - Adaptation to Current and Future Climate Regimes - Consequences: crop failure - Solutions technology and lifestyle changes - Mitigating Climate Change.						
UNIT - V	SUSTAINABLE BUSINESS PRACTICES					6
Corporate Social Responsibility - Sustainable products and services - Business and Environment - Corporations and Ecological Sustainability - Life Cycle Assessment: LCA Overview and Application - World peace and justice: United nations goals for peace and justice - World Government for peace.						
L:30, Total:30 Hours						
Weightage:						
Continuous Assessment - 100%						

REFERENCE BOOKS:	
1.	Onyeka Osuji, "Corporate Social Responsibility in Developing and Emerging Markets", Cambridge, 2022.
2.	Ram Kumar, Ch Lakshmi, Sandee, Janaki, "Smart Cities for Sustainable Development", Springer Switzerland, 2022.
3.	Surender Kumar and Shunsuke Managi, "The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)", Springer Switzerland, 2009.
4.	Sushma Goyal, "Management of Resources for Sustainable Devpt", The Orient Blackswan, 2016.
5.	S. Ramaswamy Sathis G. Kumar, "Energy, Environment and Sustainable Development: Issues and Policies", Regal Publications, 2009.
E-RESOURCES:	
1.	https://www.un.org/sustainabledevelopment/
2.	https://www.aiu.ac.in/documents/AIU_Publications/UN-SDG goals
3.	https://www.unesco.org/en/education-sustainable-development
4.	https://onlinecourses.nptel.ac.in/noc23_hs57/preview
5.	https://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted-unesco-esd-conference-17-19
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to	
CO1	Explain the concepts of Sustainable Development and United Nations Sustainable Development Goals (SDGs), sustainability assessment methods, and their significance in national and global contexts.
CO2	Apply the challenges related to resource utilization, circular economy, renewable energy, sustainable production and consumption, environmental management, climate change, and their impact on society and sustainable development.
CO3	Analyze the sustainable business practices, corporate social responsibility, ecological sustainability, life cycle assessment, and global initiatives for achieving environmental protection, social equity, peace, and sustainable growth.
CO4	Design and develop a sustainability assessment project, case study, field survey, or community-based solution for a selected SDG.
CO5	Demonstrate professional competency through technical seminar presentations/group discussions, or preparation of technical reports on emerging trends, innovations, policies, and best practices related to SDG.