EXCEL ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NBA and NAAC with "A+"and Recognized by UGC (2f &12B)
KOMARAPALAYAM - 637303

DEPARTMENT OF EEE REGULATION 2022
M.E –POWER ELECTRONICS AND DRIVES
Curriculum for Semesters – I, II, III & IV

I – SEMESTER									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course(s)									
22PMA104	Applied Mathematics for Electronics Engineers	FC	3	2	0	4	40	60	100
22PPE101	Power Semiconductor Devices	PC	3	0	0	3	40	60	100
22PPE102	Analysis of Electrical Machines	PC	3	0	0	3	40	60	100
22PPE103	Analysis and Design of Power Converters	PC	3	0	0	3	40	60	100
22PPEEXX	Professional Elective I	PE	3	0	0	3	40	60	100
22PPEEXX	Professional Elective II	PE	3	0	0	3	40	60	100
Practical Course									
22PPE104	Power Electronics Circuits Laboratory	PC	0	0	4	2	50	50	100
TOTAL			**18**	**2**	**4**	**21**	**290**	**350**	**700**

II- SEMESTER									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course(s)									
22PPE201	Analysis and Design of Inverters	PC	3	0	0	3	40	60	100
22PPE202	Solid State Drives	PC	3	0	0	3	40	60	100
22PPE203	Special Electrical Machines	PC	3	0	0	3	40	60	100
22PPE204	Electric Vehicles and Power Management	PC	3	0	0	3	40	60	100
22PPEEXX	Professional Elective-III	PE	3	0	0	3	40	60	100
22PPEEXX	Professional Elective IV	PE	3	0	0	3	40	60	100

Passed in Board of Studies Meeting (24.02.2022) Approved in Academic Council Meeting (09.03.2022)

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Practical Course									
22PPE205	Electrical Drives Laboratory	PC	0	0	4	2	50	50	100
22PPE206	Mini Project	EEC	0	0	4	2	50	50	100
		Total	**18**	**0**	**8**	**22**	**340**	**460**	**800**

III – SEMESTER

Code No.	**Course**	**Category**	**Periods / Week**				**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**FE**	**Total**
Theory Course(s)									
22PPE301	Research Methodology and Intellectual Property Rights	PC	3	0	0	3	40	60	100
22PPE302	Power Electronics for Renewable Energy Systems	PC	3	0	0	3	40	60	100
22PPEEXX	Professional Elective V	PE	3	0	0	3	40	60	100
Practical Course									
22PPE303	Project Work Phase- I	EEC	0	0	12	6	50	50	100
		Total	**9**	**0**	**12**	**15**	**170**	**230**	**400**

IV- SEMESTER

Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Practical Course									
22PPE401	Project Work Phase -II	EEC	0	0	24	12	50	50	100
		Total	**0**	**0**	**24**	**12**	**50**	**50**	**100**

LIST OF PROFESSIONAL ELECTIVES

Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
Semester I- Elective I									
22PPEE01	Soft Computing Techniques	PE	3	0	0	3	40	60	100
22PPEE02	Electromagnetic Field Computation and Modeling	PE	3	0	0	3	40	60	100
22PPEE03	Control System Design for Power Electronics	PE	3	0	0	3	40	60	100
Semester I- Elective II									
22PPEE11	Analog and Digital Controllers	PE	3	0	0	3	40	60	100
22PPEE12	Flexible AC Transmission Systems	PE	3	0	0	3	40	60	100

22PPEE13	Distributed Generation and Micro grid	PE	3	0	0	3	40	60	100
Semester II- Elective III									
22PPEE21	Modern Rectifiers and Resonant Converters	PE	3	0	0	3	40	60	100
22PPEE22	Computer Aided Simulation and Design of Power Electronics Systems	PE	3	0	0	3	40	60	100
22PPEE23	Field Programmable Gate Array Design	PE	3	0	0	3	40	60	100
Semester II- Elective IV									
22PPEE31	High Voltage Direct Current Transmission	PE	3	0	0	3	40	60	100
22PPEE32	Solar and Energy Storage Systems	PE	3	0	0	3	40	60	100
22PPEE33	Non Linear Control	PE	3	0	0	3	40	60	100
22PPEE34	Power Quality	PE	3	0	0	3	40	60	100

Semester III- Elective V									
22PPEE41	Wind Energy Conversion Systems	PE	3	0	0	3	40	60	100
22PPEE42	Energy Management and Auditing	PE	3	0	0	3	40	60	100
22PPEE43	Smart Grid	PE	3	0	0	3	40	60	100
22PPEE44	Electric Vehicles	PE	3	0	0	3	40	60	100

S. No	Category	CREDITS PER SEMESTER				Total Credit (AICTE)	Credits in %
		I	II	III	IV		
1.	FC	4				4	5.71%
2.	BS						
3.	ES						
4.	PC	11	14	6		31	44.28%
5.	PE	6	6	3		15	21.42%
6.	OE						
7.	EEC		2	6	12	20	28.57%
Total		21	22	15	12	70	100.00%

FC – Foundation Courses

BS - Basic Sciences

ES - Engineering Sciences

PC - Professional Core

PE - Professional Electives

OE - Open Electives

EEC - Employability Enhancement Courses

CA - Continuous Assessment

FE - Final Examination

Passed in Board of Studies Meeting (24.02.2022) Approved in Academic Council Meeting (09.03.2022)

Chairman – Board of Studies

I SEMESTER

22PMA104	Applied Mathematics For Electronics Engineers	L	T	P	C
		3	2	0	4
Nature of Course	Fundamental Core				
Pre requisites	Basic Engineering Mathematics				

Course Objectives

The course is intended to

1. The main objective of this course is to demonstrate various analytical skills in applied mathematics
2. Understand the extensive experience with the tactics of problem solving and logical thinking applicable for the students of electrical engineering.
3. Study performance of mathematical tools from a variety of mathematical areas, including matrix theory
4. Study identify, formulate, abstract, and solve problems in electrical engineering.
5. Study the calculus of variations, probability, linear programming and Fourier series.

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Apply various methods in matrix theory to solve system of linear equations	Apply
CO 2	Maximizing and minimizing the functional that occur in electrical engineering discipline	Apply
CO 3	Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable	Apply
CO 4	Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems	Apply
CO 5	Fourier series analysis and its uses in representing the power signals	Analyze

Course Contents

UNIT I MATRIX THEORY **12**

Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS **12**

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functional dependant on functions of several independent variables – variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random variable.

UNIT IV LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method - Two phase method - Transportation and Assignment models.

UNIT V FOURIER SERIES 12

Fourier trigonometric series : Periodic function as power signals – Convergence of series – Even and odd function : Cosine and sine series – Non periodic function : Extension to other intervals - Power signals : Exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm - Liouville systems – Generalized Fourier series.

Total : 60 Periods

Reference Books

1. Andrews L.C. and Phillips R.L., "Mathematical Techniques for Engineers and Scientists", Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
2. Bronson, R. "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. Elsgolc, L. D. "Calculus of Variations", Dover Publications, New York, 2019.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2019.
5. O'Neil, P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Taha, H.A., "Operations Research, An Introduction", 9th Edition, Pearson education, New Delhi, 2018.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	3	2									2		
CO 2	3	3	2									2		
CO 3	3	3	2									2		
CO 4	3	3	2									2		
CO 5	3	3	2									2		
	3-High				2-Medium				1-Low					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPE101	Power Semiconductor Devices	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamental of Power Semiconductor Devices				

Course Objectives

The course is intended to

1. Improve power semiconductor device structures for adjustable speed motor control applications.
2. Understand the static and dynamic characteristics of current controlled power semiconductor devices.
3. Understand the static and dynamic characteristics of voltage controlled power semiconductor devices.
4. Enable the students for the selection of devices for different power electronics applications.
5. Understand the control and firing circuit for different devices.

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Explain the basic principle and operation of Diode	Analyze
CO 2	Describe the principle and operation of current controlled transistors	Analyze
CO 3	Demonstrate the principle and operation of voltage controlled devices	Apply
CO 4	Design and analyze firing and control circuits	Analyze
CO 5	Comprehend various thermal protection devices	Apply

Course Contents

UNIT I INTRODUCTION **9**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

UNIT II CURRENT CONTROLLED DEVICES **9**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor- Basics

of GTO, MCT, FCT, RCT.

UNIT III VOLTAGE CONTROLLED DEVICES 9

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types,static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - and IGCT, New semiconductor materials for devices – Intelligent power modules- Integrated gate commutated thyristor (IGCT) - Comparison of all power devices.

UNIT IV FIRING AND PROTECTING CIRCUITS 9

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

UNIT V THERMAL PROTECTION 9

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device.

Total : 45 Periods

Reference Books

1. B.W Williams ‘Power Electronics Circuit Devices and Applications’ Third Edition, New Delhi, 2014.
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2018
3. MD Singh and K.B Khanchandani, “Power Electronics”, Tata McGraw Hill, 2017.
4. Mohan, Undeland and Robins, “Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2020.
5. Joseph Vithayathil, Power Electronics: Principles and Applications, Delhi, Tata McGraw- Hill, 2020.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	3	2									2		
CO 2	3	3	2									2		
CO 3	3	3	2									1		
CO 4	3	3	2									1		
CO 5	3	3	2									2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPE102	Analysis of Electrical Machines	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Design of Electrical Machines				

Course Objectives

The course is intended to

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

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Summarize the various electrical parameters in mathematical form.	Understand
CO 2	Analyze the dynamic characteristics of DC machines and also determine their voltage and Torque equations.	Analyze
CO 3	Compare the different types of reference frame theories and transformation relationships.	Apply
CO 4	Model and Analyze the performance of Induction machines	Analyze
CO 5	Examine the basic concepts of Synchronous Machines, equivalent circuit parameters and its modeling	Apply

Course Contents

UNIT I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9

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

UNIT II DC MACHINES **9**

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

UNIT III REFERENCE FRAME THEORY **9**

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

UNIT IV INDUCTION MACHINES **9**

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

UNIT V SYNCHRONOUS MACHINES **9**

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

Total : 45 Periods

Reference Books

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2020.
2. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2018.
3. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 8th Edition, 2018.
4. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, New Delhi, Prentice Hall of India, 2019.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2										1		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										1		
CO 5	3	2										2		
	3-High				2-Medium				1-Low					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand	10	10	10	20
Apply	10	10	10	20
Analyze	30	30	30	60
Evaluate				
Create				

22PPE103	Analysis and Design of Power Converters	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Basic Power Electronics				

Course Objectives

The course is intended to

1. Determine the operation and characteristics of controlled rectifiers.
2. Apply switching techniques and basic topologies of DC-DC switching regulators.
3. Introduce the design of power converter components.
4. Provide an in depth knowledge about resonant converters.
5. Comprehend the concepts of AC-AC power converters and their applications.

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Design and analyze various single phase and three phase power converters	Analyze
CO 2	Select and design dc-dc converter topologies for a broad range of power conversion applications	Apply
CO 3	Develop improved power converters for any stringent application requirements	Apply
CO 4	Analyze and design resonant converters	Analyze
CO 5	Examine the functions of various ac-ac converters	Analyze

Course Contents

UNIT I SINGLE PHASE & THREE PHASE CONVERTERS **9**

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

UNIT II DC-DC CONVERTERS **9**

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

UNIT III DESIGN OF POWER CONVERTER COMPONENTS **9**

Introduction to magnetic materials- hard and soft magnetic materials –types of cores , copper windings – Design of transformer –Inductor design equations –Examples of inductor design for buck/flyback converter-selection of output filter capacitors – selection of ratings for devices – input filter design.

UNIT IV RESONANT DC-DC CONVERTERS 9

Switching loss, hard switching, and basic principles of soft switching- classification of resonant converters- load resonant converters – series and parallel – resonant switch converters – operation and analysis of ZVS, ZCS converters comparison of ZCS/ZVS- Introduction to ZVT/ZCT PWM converters.

UNIT V AC-AC CONVERTERS 9

Principle of on-off and phase angle control – single phase ac voltage controller – analysis with R & RL load – Three phase ac voltage controller – principle of operation of cyclo converter – single phase and three phase cyclo converters – Introduction to matrix converters

Total : 45 Periods

Reference Books

1. Ned Mohan,T.MUndeland and W.P Robbin, “Power Electronics: converters, Application and design” John Wiley and sons.Wiley India edition, 2016.
2. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2019.
3. P.C. Sen, “Modern Power Electronics”, Wheeler Publishing Co, First Edition, New Delhi, 2018.
4. P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2013.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										1		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										1		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	20	20	20	40
Analyze	30	30	30	60
Evaluate				
Create				

22PPE104	Power Electronics Circuits Laboratory	L	T	P	C
		0	0	4	2
Nature of Course	Devices and Circuits				
Pre requisites	Fundamentals of Power Electronics				

Course Objectives

The course is intended to

1. Provide an insight on the switching behaviors of power electronic switches.
2. Make the students familiar with the digital tools used in generation of gate pulses for the power electronic switches.
3. Make the students capable of implementing analog interfacing as well as control circuits used in a closed-loop control for power electronic system
4. Make the students acquire knowledge on mathematical modeling of power electronic circuits and implementing the same using simulation tools.
5. Facilitate the students to design and fabricate a power converter circuits at appreciable voltage/power levels.

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Comprehensive understanding on the switching behavior of Power Electronic Switches Environments	Understand
CO 2	Comprehensive understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools	Understand
CO 3	Ability of the student to use microcontroller and its associated IDE* for power electronic applications	Understand
CO 4	Ability of the student to design and implement analog circuits for Power electronic control applications	Create
CO 5	Ability to design and fabricate a power converter circuit at an reasonable power level	Create

S.No	List of Experiments	CO Mapping	Revised Blooms Taxonomy
1	Study of switching characteristics of Power electronic switches with and without Snubber (i) IGBT (ii) MOSFET	CO1	Apply
2	Modeling and system simulation of basic electric circuits using MATLAB- SIMULINK/SCILAB	CO1	Apply
3	DC source fed resistive load and Resistive-inductive load.	CO4	Apply
4	DC source fed RLC load for different damping conditions	CO2	Apply

5	DC source fed DC motor load	CO5	Apply
6	Modeling and System simulation of basic power electronic circuits using MATLAB-SIMULINK/SCILAB	CO4	Apply

7	Three phase sine PWM inverter	CO5	Apply
8	Generation of PWM gate pulses with duty cycle control using PWM peripheral of microcontroller (TI-C2000 family/ PIC18)	CO4	Apply
9	Duty cycle control from IDE	CO3	Apply
10	Duty Cycle control using a POT connected to ADC peripheral in a standalone mode	CO4	Evaluate
11	Generation of Sine-PWM pulses for a three phase Voltage Source Inverter with control of modulation index using PWM peripheral of microcontroller (TI C2000 family/PIC 18)	CO4	Apply
12	Design of Driver Circuit using IR2110	CO4	Create

Total: 30 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2	3		3							1		
CO 2	3	2	3		3							1		
CO 3	3	2	3		3							1		
CO 4	3	2	3		3							1		
CO 5	3	2	3		2							1		
	3-High				**2-Medium**				**1-Low**					

Assessment based on Continuous and Final Examination			
Bloom's Level	**Continuous Assessment (50 Mark)** **(Attendance – 5 Marks)**		
	Rubric based Continuous Assessment [25 Mark]	**Model Examination [20Mark]**	**Final Examination [50Marks]**
Remember			
Understand			
Apply	40	40	40
Analyze	40	40	40
Evaluate	20	20	20
Create			

Passed in Board of Studies Meeting (24.02.2022)

Approved in Academic Council Meeting (09.03.2022)

Chairman – Board of Studies

II SEMESTER

22PPE201	Analysis and Design of Inverters	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Basic Power Electronics				

Course Objectives

The course is intended to

1. Provide the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation.
2. Equip with required skills to derive the criteria for the design of inverters for UPS, drives etc.
3. Analyze and comprehend the various operating modes of different configurations of inverters.
4. Design different single phase and three phase inverters.
5. Impart knowledge on multilevel inverters and modulation techniques

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Get expertise in the working modes and operation of inverters	Analyze
CO 2	Design single phase and three phase inverters	Apply
CO 3	Formulate and design the inverters for generic loads and machine loads	Apply
CO 4	Multilevel inverters and modulation techniques	Apply
CO 5	Analyze the various concept of inverter topology	Analyze

Course Contents

UNIT I SINGLE PHASE INVERTERS 9

Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated thyristor inverters

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – Application to drive system

UNIT III CURRENT SOURCE INVERTERS 9

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current

source inverter and voltage source inverters – PWM techniques for current source inverters.

UNIT IV MULTILEVEL & BOOST INVERTERS 9

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

UNIT V RESONANT INVERTERS AND POWER CONDITIONERS 9

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC - link inverters.-power line disturbances-power conditioners-UPS: offline UPS, online UPS.

Total : 45 Periods

Text Books

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2014.
2. Jai P.Agrawal, “Power Electronics Systems”, Pearson Education, Second Edition, 2012
3. BimalK.Bose “Modern Power Electronics and AC Drives”, Pearson Education, fourth Edition, 2013.

Reference Books

1. P.C. Sen, “Modern Power Electronics”, Wheeler Publishing Co, First Edition, New Delhi, 2018.
2. P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2013.
3. Philip T. krein, “Elements of Power Electronics” Oxford University Press -1998.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPE202	Solid State Drives	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of power Electronics and Electrical Machines				

Course Objectives

The course is intended to

1. Analyze the operation of controlled rectifier fed DC Drives
2. Study and analyze the operation chopper fed DC drives, both qualitatively and quantitatively.
3. Familiarize the students on the operation of VSI and CSI fed induction motor drives.
4. Understand the field oriented control of induction machines
5. Impart knowledge on the control of synchronous motor drives

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Analyze the performance of DC Motors using various converter control	Analyze
CO 2	Explain and calculate the performance of chopper controlled DC Drives in different quadrant.	Apply
CO 3	Apply the stator and rotor controlled techniques in Induction motor Drives	Apply
CO 4	Explain the performance of AC drives with Field Oriented Control and Direct Torque Control	Analyze
CO 5	Formulate the control schemes for synchronous motor drives.	Apply

Course Contents

UNIT I RECTIFIER CONTROL OF DC DRIVES 9

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter.

UNIT II CHOPPER CONTROL OF DC DRIVES 9

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

UNIT III CONTROL OF INDUCTION MOTOR DRIVES- STATOR SIDE AND ROTOR SIDE 9

AC voltage controller circuit – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed variable frequency drives – comparison Static rotor

resistance control - injection of voltage in the rotor circuit – static scherbius drives - power factor considerations – modified Kramer drives.

UNIT IV FIELD ORIENTED CONTROL OF INDUCTION MOTOR DRIVES 9

Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.

UNIT V SYNCHRONOUSMOTOR DRIVES 9

Wound field cylindrical rotor motor – Equivalent circuits – performance equations for operation from a voltage source – starting and braking - V curves - Self control-margin angle control-torque control-power factor control-Brushless excitation systems.

Total : 45 Periods

Reference Books

1. P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 2015.
2. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., New Jersy, 2018.
3. Gopal K.Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing House, New Delhi, Second Edition ,2019.
4. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education Asia 2002.
5. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2016.
6. VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2012.
7. W.Leonhard, “Control of Electrical Drives”, Narosa Publishing House, 2018.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										1		3
CO 2	3	2										1		3
CO 3	3	2										1		3
CO 4	3	2										1		3
CO 5	3	2										1		3
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPE203	Special Electrical Machines	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Electrical Machines				

Course Objectives

The course is intended to

1. Review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
2. Introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
3. Develop the control methods and operating principles of switched reluctance motors.
4. Introduce the concepts of stepper motors and its applications.
5. Understand the basic concepts of other special machines

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Analyze theoretically, the performance characteristics of PMBLDC	Analyze
CO 2	Infer the knowledge on construction and operation of permanent magnet synchronous motors	Understand
CO 3	Examine the function of Switched reluctance motor	Analyze
CO 4	Construct the principle and operation of stepper motors	Apply
CO 5	Ability to select a special Machine for a particular application	Apply

Course Contents

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS **9**

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics and control.

UNIT II PERMANENT MAGNET SYNCHROUNOUS MOTORS **9**

Principle of operation – EMF and Torque equations - Phasor diagram - Power controllers – Torque speed characteristics – Digital controllers – Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT III SWITCHED RELUCTANCE MOTORS **9**

Constructional features –Principle of operation- Torque prediction–Characteristics-Power controllers – Control of SRM drive- Sensorless operation of SRM – Applications.

UNIT IV STEPPER MOTORS **9**

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications.

UNIT V OTHER SPECIAL MACHINES **9**

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor Applications.

Total : 45 Periods

Text Books

1. T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Claredon press, London, 2013.
2. R.Krishnan, ' Switched Reluctance motor drives' , CRC press, 2017
3. T.Kenjo, 'Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2016.

Reference Books

1. R.Krishnan, ' Electric motor drives' , Prentice hall of India,2012.
2. D.P.Kothari and I.J.Nagrath, ' Electric machines', Tata Mc Graw hill publishing company, New Delhi, Third Edition, 2014.
3. Irving L.Kosow, "Electric Machinery and Transformers" Pearson Education, Second Edition, 2017.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	2	3	2											
CO 2	3	3	2											
CO 3	2	3	2											
CO 4	3	2	2											
CO 5	3	3	2											
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand	10	10		20
Apply	20	20	30	40
Analyze	20	20	20	40
Evaluate				
Create				

22PPE204	Electric Vehicles And Power Management	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Power Management System				

Course Objectives

The course is intended to

1. Understand the concept of electrical vehicles
2. Understand the concept of the operations
3. Understand the need for energy storage in hybrid vehicles
4. Provide knowledge about various possible energy storage technologies
5. Learners will understand the operation of Electric vehicles and various energy storage technologies for electrical vehicles

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Explain the basics of electric and hybrid electric vehicles and fundamentals	Understand
CO 2	Construct the architecture of EV and hybrid electric vehicles	Apply
CO 3	Analyze various electric drives suitable for electric vehicles	Analyze
CO 4	Discuss different energy storage technologies used for electric vehicles and their control.	Apply
CO 5	Generalize the characteristics of alternative energy storage systems	Apply

Course Contents

UNIT I ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

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

UNIT II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 9

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

UNIT III CONTROL OF DC AND AC DRIVES 9

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

UNIT IV BATTERY ENERGY STORAGE SYSTEM 9

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

UNIT V ALTERNATIVE ENERGY STORAGE SYSTEMS 9

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

Total : 45 Periods

Text Books

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Second Edition (2018).
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2019.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand	10			10
Apply	20	30	30	50
Analyze	20	20	20	40
Evaluate				
Create				

Passed in Board of Studies Meeting (24.02.2022)

Approved in Academic Council Meeting (09.03.2022)

Chairman – Board of Studies

22PPE205	Electrical Drives Laboratory	L	T	P	C
		0	0	4	2
Nature of Course	Devices and Circuits				
Pre requisites	Fundamentals of Power Electronics and Electrical Machines				

Course Objectives

The course is intended to

1. To design and analyze the various DC and AC drives
2. To generate the firing pulses for converters using digital processors
3. To generate the firing pulses for inverters using digital processors
4. Design of controllers for linear and nonlinear systems.
5. Implementation of closed loop system using hardware simulation

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	To learn about electrical drives system	Apply
CO 2	Ability to simulate different types of machines in a system	Apply
CO 3	Ability to simulate different types of converters in a system	Apply
CO 4	Analyze the performance of various electric drive systems	Analyze
CO 5	Ability to perform both hardware and software simulation	Apply

S.No	List of Experiments	CO Mapping	Revised Blooms Taxonomy
1	Speed control of Converter fed DC motor	CO1	Apply
2	Speed control of Chopper fed DC motor	CO1	Apply
3	V/f control of three-phase induction motor	CO4	Apply
4	Micro controller based speed control of Stepper motor	CO2	Apply
5	Speed control of BLDC motor	CO5	Apply
6	DSP based speed control of SRM motor	CO5	Apply
7	Voltage Regulation of three-phase Synchronous Generator	CO4	Apply
8	Cycloconverter fed Induction motor drives	CO3	Apply
9	Single phase Multi Level Inverter based induction motor drive	CO4	Apply
10	Study of power quality analyzer using FACT Controller	CO4	Apply

Total: 30 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2	3		3							1		
CO 2	3	2	3		3							1		
CO 3	3	2	3		3							1		
CO 4	3	2	3		3							1		
CO 5	3	2	3		2							1		
	3-High				**2-Medium**				**1-Low**					

Assessment based on Continuous and Final Examination			
Bloom's Level	**Continuous Assessment (50 Mark)** **(Attendance – 5 Marks)**		
	Rubric based Continuous Assessment [25 Mark]	**Model Examination [20Mark]**	**Final Examination [50Marks]**
Remember			
Understand	20	20	20
Apply	40	40	40
Analyze	40	40	40
Evaluate			
Create			

LIST OF PROFESSIONAL ELECTIVES I

SEMESTER – I

22PPEE01	Soft Computing Techniques	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Basic of NN,FLS,GA				

Course Objectives

The course is intended to

1. Expose the concepts of feed forward neural networks.
2. Provide adequate knowledge about feedback neural networks.
3. Teach about the concept of fuzziness involved in various systems.
4. Expose the ideas about genetic algorithm
5. Provide adequate knowledge about of FLC and NN toolbox

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	To know the basic ANN architectures, algorithms and their limitations.	Analyze
CO2	Able to know the different operations on the fuzzy sets	Apply
CO3	Expertise in the use of different ANN structures and online training algorithm.	Apply
CO4	Knowledgeable to use Fuzzy logic for modeling and control of non-linear systems.	Apply
CO5	Competent to use hybrid control schemes and P.S.O and support vector Regressive.	Apply

Course Contents

UNIT I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems -Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- Mc Culloch Pitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training- applications.

UNIT II ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY 9

Counter propagation network- architecture- functioning & characteristics of counter Propagation network- Hopfield/ Recurrent network configuration - stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance

Theory- Architecture- classifications- Implementation and training - Associative Memory.

UNIT III FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification inferencing and defuzzification- Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV GENETIC ALGORITHM 9

Evolutionary programs – Genetic algorithms, genetic programming and evolutionary programming - Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators - Optimization problems using GA-discrete and continuous - Single objective and multi-objective problems - Procedures in evolutionary programming.

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine- Evolutionary Programming-Particle Swarm Optimization - Case study – Familiarization of NN, FLC and ANFIS Tool Box.

Total : 45 Periods

Text Books:

1. Laurene V. Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson Education. Wiley India, 2018.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India, 2016.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2017.
4. T. Ross, “Fuzzy Logic with Engineering Applications”, Tata McGraw Hill, New Delhi, 2003.
5. Ethem Alpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, MIT Press, 2014.
6. Corinna Cortes and V. Vapnik, " Support - Vector Networks, Machine Learning ” 1995.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	3	2									2		
CO 2	3	3	2									2		
CO 3	3	3	2									2		
CO 4	3	3	2									2		
CO 5	3	3	2									2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyse	20	20	20	40
Evaluate				
Create				

22PPEE02	Electromagnetic Field Computation and Modeling	L	T	P	C
		3	2	0	4
Nature of Course	Professional Elective				
Pre requisites	Basic of Electromagnetic Theory				

Course Objectives

The course is intended to

1. To refresh the fundamentals of Electromagnetic Field Theory.
2. To provide foundation in formulation and computation of Electromagnetic Fields using analytical and numerical methods.
3. To impart in-depth knowledge on Finite Element Method in solving Electromagnetic field problems.
4. To introduce the concept of mathematical modeling and design of electrical apparatus.

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Analyze the concepts of electromagnetic	Analyze
CO 2	Formulate the basic of FEM	Apply
CO 3	The concepts in the design of rotating machines	Apply
CO 4	Formulate the FEM method	Apply
CO 5	Formulate the use of the package	Apply

Course Contents:

UNIT I INTRODUCTION 9

Review of basic field theory – Maxwell's equations – Constitutive relationships and Continuity equations – Laplace, Poisson and Helmholtz equation – principle of energy conversion – force/torque calculation.

UNIT II BASIC SOLUTION METHODS FOR FIELD EQUATIONS 9

Limitations of the conventional design procedure need for the field analysis based design, problem definition, boundary conditions, and solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

UNIT III FORMULATION OF FINITE ELEMENT METHOD (FEM) 9

Variational Formulation – Energy minimization – Discretization – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problems.

UNIT IV COMPUTATION OF BASIC QUANTITIES USING FEM PACKAGES 9

Basic quantities – Energy stored in Electric Field – Capacitance – Magnetic Field – Linked Flux –

Inductance – Force – Torque – Skin effect – Resistance.

UNIT V DESIGN APPLICATIONS **9**

Design of Insulators – Cylindrical magnetic actuators – Transformers – Rotating machines

Total : 45 Periods

Text Books:

1. Matthew. N.O. Sadiku, “Elements of Electromagnetics”, Fourth Edition, Oxford University Press, First Indian Edition 2017
2. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, “The analytical and numerical solution of Electric and magnetic fields”, John Wiley & Sons, 2021.
3. Nicola Biyanchi , “Electrical Machine analysis using Finite Elements”, Taylor and Francis Group, CRC Publishers, 2015.
4. Ethem Alpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, MIT Press, 2015.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										1		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										1		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyse	20	20	20	40
Evaluate				
Create				

22PPEE03	Control System Design for Power Electronics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Power Electronics				

Course Objectives

The course is intended to

1. To explore conceptual bridges between the fields of Control Systems and Power Electronics
2. To Study Control theories and techniques relevant to the design of feedback controllers in Power Electronics

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	To understand an overview on modern linear and nonlinear control strategies for power electronics devices	Analyze
CO 2	Model modern power electronic converters for industrial applications	Apply
CO 3	Design appropriate controllers for modern power electronics devices	Apply
CO 4	Analyze and control the linear parameters of power electronics	Analyze
CO 5	Analyze and control the nonlinear parameters of power electronics	Analyze

Course Contents:

UNIT I MODELLING OF DC-TO-DC POWER CONVERTERS 9

Modeling of Buck Converter , Boost Converter ,Buck-Boost Converter, Cuk Converter, Sepic Converter, Zeta Converter, Quadratic Buck Converter ,Double Buck-Boost Converter, Boost-Boost Converter General Mathematical Model for Power Electronics Devices.

UNIT II SLIDING MODE CONTROLLER DESIGN 9

Variable Structure Systems. Single Switch Regulated Systems Sliding Surfaces, Accessibility of the Sliding Surface Sliding Mode Control Implementation of Boost Converter ,Buck-Boost Converter, Cuk Converter, Sepic Converter, Zeta Converter, Quadratic Buck Converter ,Double Buck-Boost Converter, Boost-Boost Converter.

UNIT III APPROXIMATE LINEARIZATION CONTROLLER DESIGN 9

Linear Feedback Control, Pole Placement by Full State Feedback , Pole Placement Based on Observer Design ,Reduced Order Observers , Generalized Proportional Integral Controllers, Passivity Based Control , Sliding Mode Control Implementation of Buck Converter , Boost Converter ,Buck-Boost Converter

UNIT IV NONLINEAR CONTROLLER DESIGN 9

Feedback Linearization Isidori's Canonical Form, Input-Output Feedback Linearization, State Feedback Linearization, Passivity Based Control, Full Order Observers, Reduced.

UNIT V PREDICTIVE CONTROL OF POWER CONVERTERS 9

Basic Concepts, Theory, and Methods, Application of Predictive Control in Power Electronics, AC-DC-AC Converter System, Faults and Diagnosis Systems in Power Converters.

Total : 45 Periods

Text Books:

1. HeberttSira-Ramírez PhD, Ramón Silva-Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer 2018
2. Mahesh Patil, PankajRodey, "Control Systems for Power Electronics: A Practical Guide", Springer India, 2015.
3. Blaabjerg José Rodríguez, "Advanced and Intelligent Control in Power Electronics and Drives", Springer, 2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										1		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										1		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyse	20	20	20	40
Evaluate				
Create				

LIST OF PROFESSIONAL ELECTIVES - II

SEMESTER – I

22PPEE11	Analog and Digital Controllers	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Control System and Converter Control Methodologies				

Course Objectives

The course is intended to

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

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	To understand an overview on modern linear and nonlinear control strategies for power electronics devices	Analyze
CO 2	To model modern power electronic converters for industrial applications	Apply
CO 3	Design appropriate controllers for modern power electronics devices.	Apply
CO 4	Analyze and control the nonlinear parameters of power Electronics	Analyze
CO 5	Apply and control the nonlinear parameters of power electronics	Apply

Course Contents:

UNIT I CONTROL SYSTEM – OVERVIEW 9

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

UNIT II ANALOG CONTROLLERS 9

Major components of a controller – Op-Amp based PI and PID controller – Proportional, Integral and Differential gains in terms of Resistance and Capacitance, Error Amplifiers, PWM generator using Ramp or Triangular generator and comparator, and Driver, Voltage

mode controller design using UC3524, Peak Current mode controller design using UC3842, Average Current mode controller design using UC3854.

UNIT III DIGITAL CONTROLLERS 9

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

UNIT IV SIGNAL CONDITIONING, DRIVER, ISOLATION AND PROTECTION 9

Voltage feedback sensing circuits, Hall effect sensors and Shunts for current feedback sensing, Low offset Op-Amps for signal conditioning, Single and dual supply op-amps, Totem pole drivers, Need for isolated drivers, Optically isolated drivers, low side drivers, high side drivers with bootstrap power supply, Vce sat sensing, CT based Device current sensing and pulse blocking.

UNIT V CONTROLLER IMPLEMENTATION 9

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

Total : 45 Periods

Reference Books:

1. I.J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International Publishers,2016.
2. TI Application notes, Reference Manuals and Data Sheets.Agilent Data Sheets,2017.
3. Microchip Application notes, Reference Manuals and Data Sheets.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										1		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										1		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	

Understand	Tutorial class / Assignment	5	15
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE12	Flexible AC Transmission Systems	L	T	P	C
		3	0	0	3
Nature of Course	Fundamental Core				
Pre requisites	Modeling of Electrical Machines				

Course Objectives

The course is intended to

1. Emphasis the need for FACTS controllers.
2. Learn the characteristics, applications
3. Modeling of series and shunt FACTS controllers.
4. Analyze the interaction of different FACTS controller
5. Analyze the perform control coordination

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Analyze the operation of the compensator	Analyze
CO 2	Analyze the various emerging Facts controllers	Analyze
CO 3	To know about the genetic algorithm	Apply
CO 4	Facts its applications in power system.	Apply
CO 5	Facts controller coordination	Apply

Course Contents:

UNIT I INTRODUCTION **9**

Review of basics of power transmission networks-control of power flow in AC transmission line Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

UNIT II STATIC VAR COMPENSATOR (SVC) **9**

Configuration of SVC- voltage regulation by SVC- Modeling of SVC for load flow analysis modeling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

UNIT III THYRISTOR AND GTO THYRISTOR CONTROLLED SERIES CAPACITORS (TCSC and GCSC) **9**

Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of

TCSC-GCSC – modeling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)- Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- modeling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)- modeling of UPFC and IPFC for load flow and transient stability studies – Applications.

UNIT V CONTROLLERS AND THEIR COORDINATION 9

FACTS Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

Total : 45 Periods

Reference Books:

1. A.T.John, “Flexible AC Transmission System”, Institution of Electrical and Electronic Engineers (IEEE), 2017.
2. NarainG.Hingorani, Laszio. Gyugyl, “Understanding FACTS Concepts and Technology of Flexible AC Transmission System”, Standard Publishers, Delhi 2016.
3. V. K.Sood, “HVDC and FACTS controllers- Applications of Static Converters in Power System”, 2014.
4. Mohan Mathur, R., Rajiv. K. Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc, 2018.
5. K.R.Padiyar,” FACTS Controllers in Power Transmission and Distribution”, New Age International(P) Ltd., Publishers New Delhi, Reprint 2019.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										1		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										1		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE13	Distributed Generation and Microgrid	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Distributed generation				

Course Objectives

The course is intended to

1. To illustrate the concept of distributed generation
2. To analyze the impact of grid integration.
3. To study concept of Micro grid and its configuration

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Learners will attain knowledge on the various schemes of conventional and nonconventional power generation.	Analyze
CO 2	Learners will have knowledge on the topologies and energy sources of distributed generation	Apply
CO 3	Learners will understand the fundamental concept of Microgrid	Apply

Course Contents:

UNIT I INTRODUCTION **9**

Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

UNIT II DISTRIBUTED GENERATIONS (DG) **9**

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

UNIT III IMPACT OF GRID INTEGRATION **9**

Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT IV BASICS OF A MICROGRID **9**

Concept and definition of micro grid, micro grid drivers and benefits, review of sources of micro grids, typical structure and configuration of a micro grid, AC and DC micro grids, Power Electronics interfaces in DC and AC micro grids.

UNIT V CONTROL AND OPERATION OF MICROGRID **9**

Modes of operation and control of micro grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, micro grid communication infrastructure, Power quality issues in micro grids, regulatory standards, Micro grid economics, Introduction to smart micro grids.

Total : 45 Periods

Reference Books:

1. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling Control and Applications", IEEE John Wiley Publications, 2015.,
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2016
3. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi,2019
4. J.F. Manwell, J.G. McGowan "Wind Energy Explained, theory design and applications", Wiley publication 2017.
5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, 2017.
6. John Twidell and Tony Weir, "Renewable Energy Resources" Tyalor and Francis Publications, Second edition 2016.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										1		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										1		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

LIST OF PROFESSIONAL ELECTIVES - III

SEMESTER - II

22PPEE21	Modern Rectifiers and Resonant Converters	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Basic Power system and Power Electronics				

Course Objectives

The course is intended to

1. To gain knowledge about the harmonics standards and operation of rectifiers in CCM & DCM.
2. To analyze and design power factor correction rectifiers for UPS applications.
3. To know the operation of resonant converters for SMPS applications.
4. To carry out dynamic analysis of DC- DC Converters
5. To introduce the source current shaping methods for rectifiers

Course Outcomes:

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	To concept of various types of rectifiers	Apply
CO 2	Simulate and design the operation of resonant converter and its importance	Apply
CO 3	Identify the importance of linear system, state space model, PI controller	Analyze
CO 4	Design the DC power supplies using advanced techniques	Apply
CO 5	Analyze the standards for supply current harmonics and it significance	Analyze

Course Contents:

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS 9

Average power-RMS value of waveform–Effect of Power factor-. current and voltage harmonics – Effect of source and load impedance - AC line current harmonic standards IEC1000-IEEE 519- CCM and DCM operation of single phase full wave rectifier- Behaviour of full wave rectifier for large and small values of capacitance - CCM and DCM operation of three phase full wave rectifier- 12 pulse converters - Harmonic trap filters.

UNIT II PULSE WIDTH MODULATED RECTIFIERS 9

Properties of Ideal single phase rectifiers-Realization of nearly ideal rectifier-. Single-phase converter systems incorporating ideal rectifiers - Losses and efficiency in CCM high quality rectifiers -single-phase PWM rectifier -PWM concepts - device selection for rectifiers - IGBT based PWM rectifier, comparison with SCR based converters with respect to harmonic content - applications of rectifiers.

UNIT III RESONANT CONVERTERS **9**

Soft Switching - classification of resonant converters - Quasi resonant converters- basics of ZVS and ZCS- half wave and full wave operation (qualitative treatment) - multi resonant converters - operation and analysis of ZVS and ZCS multi resonant converter - zero voltage transition PWM converters -zero current transition PWM converters

UNIT IV DYNAMIC ANALYSIS OF SWITCHING CONVERTERS **9**

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter and an ideal Cuk Converter. Pulse Width modulation - Voltage Mode PWM Scheme - Current Mode PWM Scheme - design of PI controller.

UNIT V SOURCE CURRENT SHAPING OF RECTIFIERS **9**

Need for current shaping - power factor - functions of current shaper - input current shaping methods - passive shaping methods -input inductor filter - resonant input filter - active methods - boost rectifier employing peak current control - average current control - Hysteresis control- Nonlinear carrier control.

Total : 45 Periods

Reference Books:

1 Robert W. Erickson and Dragon Maksimovic, “Fundamentals of Power Electronics”, Second Edition, Springer science and Business media, 2016.
2 William Shepherd and Li zhang, “Power Converters Circuits”, MarceldEkkerin,C, 2015.
3 Simon Ang and Alejandro Oliva, “Power Switching Converters”, Taylor & Francis Group, 2016.
4 Andrzej M. Trzynadlowski, " Introduction To Modern Power Electronics", John Wiley & Sons, 2016.
5 Marian.K.Kazimierczuk and DariuszCzarkowski, “Resonant Power Converters”, John Wiley & Sons limited, 2016.
6 Keng C .Wu, “Switch Mode Power Converters – Design and Analysis” Elseveir academic press, 2016.
7 Abraham I.Pressman, Keith Billings and Taylor Morey, “ Switching Power Supply Design” McGraw-Hill ,2019
8 V.Ramanarayanan, “Course Material on Switched Mode Power Conversion” IISC, Banglore, 2017.
9 Christophe P. Basso, Switch-Mode Power Supplies, McGraw-Hill ,2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2										2		
CO 2	3	2										1		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										1		
	3-High				2-Medium				1-Low					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE22	Computer Aided Simulation and Design of Power Electronics Systems	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Basic Power system and Power Electronics				

Course Objectives

The course is intended to

1. Gain knowledge about the model/simulate various types of power semiconductors, power electronics converters.
2. Analyze and design power electronics converters their role in monitoring, controlling and conversion

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Choose suitable software package for power electronic circuits analysis	Apply
CO 2	Understand the principle of controlled devices and model various semiconductor devices in Pspice environment	Analyze
CO 3	Apply the simulation model for Rectifier in SIMULINK and PSIM environment	Apply
CO 4	Apply the simulation model for chopper in SIMULINK and PSIM environment	Apply
CO 5	Apply the simulation model for inverter in SIMULINK and PSIM environment	Apply

Course Contents:

UNIT I INTRODUCTION **9**

Review of power electronic software simulation tools, PSPICE, PSIM- Importance of simulation – Challenges in simulation - PSpice : File formats - Description of circuit elements - Circuit description – Output variables - Dot commands. PSIM : elements of psim - power circuit and control circuit component – circuit schematic design using simcad - simcoupler – Magnet plugins – waveform process using simview. MATLAB and Simulink : Toolboxes of MATLAB - Programming and file processing in MATLAB – Model definition and model analysis using SIMULINK - S-Functions - Converting S Functions to blocks.

UNIT II MODELING AND SIMULATION OF POWER ELECTRONIC DEVICES **9**

Model,Statement,Characteristics and Parameters of Diode , BJT,MOSFET,IGBT and GTO using PSpice , PSIM and MATLAB.

UNIT III SIMULATION OF AC/DC CONVERTERS 9

Diode rectifiers -Controlled rectifiers- Single-Phase Half-Wave Controlled Rectifier -Single-Phase Full-Wave Controlled Rectifier-Three-Phase Full-Wave Controlled Rectifier Simulation Using PSPICE, PSIM and Simscape MATLAB Analysis.

UNIT IV SIMULATION OF DC/DC CONVERTERS 9

DC Switch – BJT and MOSFET based Choppers buck and boost Using PSPICE, PSIM and Sims cape MATLAB Analysis

UNIT V SIMULATION OF DC/AC CONVERTERS 9

Pulse-Width-Modulated Inverters - Single-Phase Half-Bridge and Full-Bridge Inverter-Single-Phase Full-Bridge Inverter with PWM and SPWM -Three-Phase Bridge Inverter using Electrical Circuit Simulation Using PSPICE, PSIM and Simscape MATLAB Analysis.

Total : 45 Periods

Reference Books:

1. Muhammad H. Rashid, “SPICE for Power Electronics and Electric Power”, 3rd Edition, Taylor & Francis, 2005.
2. M. Godoy Simoes, Felix A. Farret, “Modeling Power Electronics and Interfacing Energy Conversion Systems”, IEEE press, Wiley publications,2017 .
3. Partha S. Mallick, “MATLAB and SIMULINK: Introduction to Applications”, 4th Edition,Scitech Publications (India), 2011.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE23	ASIC AND FPGA DESIGN	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of multiprocessor and multicomputer systems & Architecture				

Course Objectives

The course is intended to

1. Study the design flow of different types of ASIC.
2. Familiarize the different types of programming technologies and logic devices.
3. Learn the architecture of different types of FPGA.
4. Gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC.
5. Analyze the synthesis, Simulation and testing of systems.

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	An ability to understand the operations of multiprocessor and multicomputer systems	Analyze
CO 2	Analyze the various advanced processor technology, pipelining and scalable architectures	Analyze
CO 3	Know the working of superscalar pipeline, cache memory organization	Analyze
CO 4	Apply the principles of multithreading, multithread architecture, static and dynamic data flow.	Apply
CO 5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design	Apply

Course Contents:

UNIT I OVERVIEW OF ASIC AND PLD **9**

Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs – PLA –PAL. Gate Arrays – CPLDs and FPGAs

UNIT II ASIC PHYSICAL DESIGN **9**

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning - placement – Routing: global routing - detailed routing - special routing - circuit extraction – DRC.

UNIT III LOGIC SYNTHESIS, SIMULATION AND TESTING 9

Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language -PLA tools -EDIF- CFI design representation. Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation - automatic test pattern generation.

UNIT IV FPGA 9

Field Programmable gate arrays- Logic blocks, routing architecture, Design flow technology - mapping for FPGAs, Xilinx XC4000 - ALTERA's FLEX 8000/10000, ACTEL's ACT-1,2,3 and their speed performance.

Case studies: Altera MAX 5000 and 7000 - Altera MAX 9000 – Spartan II and Virtex II FPGAs - Apex and Cyclone FPGAs

UNIT V SOC DESIGN 9

Design Methodologies – Processes and Flows - Embedded software development for SOC – Techniques for SOC Testing – Configurable SOC – Hardware / Software co-design Case studies: Digital camera, Bluetooth radio / modem, SDRAM and USB.

Total : 45 Periods

Reference Books:

1. M.J.S .Smith, "Application Specific Integrated Circuits, Addison -Wesley Longman Inc., 2017.
2. S. Trimberger, Field Programmable Gate Array Technology, Edr, Kluwer Academic Publications, 1994.
3. John V.Oldfield, Richard C Dore, Field Programmable Gate Arrays, Wiley Publications 1995.
4. P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall, 2015.
5. Parag.K.Lala, Digital System Design using Programmable Logic Devices , BSP, 2013.
6. S. Brown, R. Francis, J. Rose, Z. Vransic, Field Programmable Gate Array, Kluwer Pubin, 2018.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

LIST OF PROFESSIONAL ELECTIVES - IV

SEMESTER - II

22PPEE31	High Voltage Direct Current Transmission	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Power System				

Course Objectives

The course is intended to

1. To impart knowledge on operation, modeling and control of HVDC link.
2. To perform steady state analysis of AC/DC system.
3. To expose various HVDC simulators.

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Analyze the synthesis, power transmission	Analyze
CO 2	Apply different high performance control system	Apply
CO 3	Design multiple terminals and testing	Apply
CO 4	Design the Power flow analysis	Apply
CO 5	Discuss the design HVDC	Analyze

Course Contents:

UNIT I DC POWER TRANSMISSION TECHNOLOGY **9**

Introduction - Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system - Planning for HVDC transmission – Modern trends in DC transmission – DC breakers – Cables, VSC based HVDC.

UNIT II THYRISTOR BASED HVDC CONVERTERS AND HVDC SYSTEM CONTROL **9**

Pulse number, choice of converter configuration – Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters. General principles of DC link control – Converter control characteristics – System control hierarchy - Firing angle control – Current and extinction angle control – Generation of harmonics and filtering - power control – Higher level controllers-Valve tests.

UNIT III MULTITERMINAL DC SYSTEMS **9**

Introduction – Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

UNIT IV POWER FLOW ANALYSIS IN AC/DC SYSTEMS **9**

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow - Solution of AC-DC power flow – Unified, Sequential and Substitution of power injection method.

UNIT V SIMULATION OF HVDC SYSTEMS **9**

Introduction – DC LINK Modelling , Converter Modeling and State Space Analysis , Philosophy and tools – HVDC system simulation, Online and OFF line simulators — Dynamic interactions between DC and AC systems.

Total : 45 Periods

Reference Books:

1 P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2017.
2 K.R.Padiyar, , “HVDC Power Transmission Systems”, New Age International (P) Ltd., New Delhi, 2012
3 J.Arrillaga, , “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 2017.
4 Erich Uhlmann, “ Power Transmission by Direct Current”, BS Publications, 2014.
5 V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, , Kluwer Academic Publishers APRIL 2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Passed in Board of Studies Meeting (24.02.2022) Approved in Academic Council Meeting (09.03.2022)

Chairman – Board of Studies

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE32	Solar and Energy Storage Systems	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals system for Solar and battery				

Course Objectives

The course is intended to

1. To understand the fundamentals of solar modules.
2. To Study about PV system design and their applications
3. To Deal with grid connected PV systems
4. To Discuss about different energy storage systems

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Students will develop more understanding on solar energy storage Systems	Apply
CO 2	Students will develop basic knowledge on standalone PV system	Analyze
CO 3	Students will understand the issues in grid connected PV systems	Analyze
CO 4	Students will study about the modeling of different energy storage systems and their performances	Apply
CO 5	Students will attain more on different applications of solar energy	Apply

Course Contents:

UNIT I INTRODUCTION **9**

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

UNIT II STAND ALONE PV SYSTEM **9**

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

UNIT III GRID CONNECTED PV SYSTEMS **9**

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

UNIT IV ENERGY STORAGE SYSTEMS **9**

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage

UNIT V APPLICATIONS **9**

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

Telecommunications.

Total : 45 Periods

Text Books:

1. Solanki C.S., "Solar Photovoltaics: Fundamentals, Technologies And Applications", PHI Learning Pvt. Ltd.,2015.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, "Applied Photovoltaics", 2017,Earthscan, UK.
3. Eduardo Lorenzo G. Araujo, "Solar electricity engineering of photovoltaic systems", Progensa,2016.
4. Frank S. Barnes & Jonah G. Levine, "Large Energy storage Systems Handbook", CRC Press, 2017.
5. McNeils, Frenkel, Desai, "Solar & Wind Energy Technologies", Wiley Eastern, 2016.
6. S.P. Sukhatme , "Solar Energy", Tata McGraw Hill,2017.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	2										2		
CO 2	3	2										2		
CO 3	3	2										2		
CO 4	3	2										2		
CO 5	3	2										2		
	3-High				**2-Medium**				**1-Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE34	NON LINEAR CONTROL	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Control System				

Course Objectives

The course is intended to

1. To impart knowledge on phase plane analysis of non-linear systems.
2. To educate on representing systems in state variable form
3. To educate on stability analysis of systems using Lyapunov's theory.
4. To educate on stability analysis of systems using Lyapunov's theory.
5. To introduce the concept of sliding mode control.

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Analyze the synthesis, Simulation and testing of systems	Analyze
CO 2	Apply the concepts of non-linear control system	Apply
CO 3	Analyze the stability of the system	Analyze
CO 4	Illustrate the sliding mode control	Analyze
CO 5	Illustrate the implementation in MATLAB.	Apply

Course Contents:

UNIT I PHASE PLANE ANALYSIS 9

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits-Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems-Existence of Limit Cycles. simulation of phase portraits in MATLAB.

UNIT II DESCRIBING FUNCTION 9

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions-Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles. simulation of limit cycles in MATLAB.

UNIT III LYAPUNOV THEORY 9

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunov's Direct Method-Positive definite Functions and Lyapunov Functions-Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunov's Direct Method-

Krasovski's Method-Variable Gradient Method-Physically – Control Design based on Lyapunov's Direct Method.

UNIT IV FEEDBACK LINEARIZATION **9**

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation-Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non- Minimum-Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design. Simulation of tracking problems in MATLAB.

UNIT V SLIDING MODE CONTROL **9**

Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in MATLAB.

Total : 45 Periods

Text Books:

1. J A E Slotine and W Li, Applied Nonlinear control, PHI, 2014.
2. K. P. Mohandas, Modern Control Engineering, Sanguine, India, 2016.
3. S H Zak, “Systems and control”, Oxford University Press, 2013.
4. Torkel Glad and Lennart Ljung, “Control Theory – Multivariable and Nonlinear Methods”,Taylor& Francis, 2012.
5. G. J. Thaler, “Automatic control systems”, Jaico publishers, 2016.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
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CO 1	3	2										2		
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Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE)**			**Final Examinations (FE)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**60**
Remember				
Understand				
Apply	30	30	30	60
Analyze	20	20	20	40
Evaluate				
Create				

22PPEE34	Power Quality	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of Electrical Engineering				

Course Objectives

The course is intended to

1. To understand the various power quality issues.
2. To understand the concept of power and power factor in single phase and three phase Systems supplying nonlinear 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.
5. To understand the active compensation techniques used for load voltage regulation.

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Formulate, design and simulate power supplies for generic load.	Apply
CO 2	Infer harmonic analysis on power supplies and drive systems.	Analyze
CO 3	Ability to understand and design load compensation methods useful for mitigating power quality problems.	Apply
CO 4	Ability to formulate, design and simulate power supplies for machine loads.	Apply
CO 5	Conduct load tests on power supplies and drive systems	Apply

Course Contents

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 – Power quality standards.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM **9**

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

UNIT III CONVENTIONAL LOAD COMPENSATION METHODS **9**

Principle of Load compensation and Voltage regulation – Classical load balancing problem: Open loop balancing – Closed loop balancing, Current balancing – Harmonic reduction and voltage sag

reduction – Analysis of unbalance – instantaneous real and reactive powers – Extraction of fundamental sequence component.

UNIT IV LOAD COMPENSATION USING DSTATCOM 9

Compensating single phase loads – Ideal three phase shunt compensator structure – Generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM 9

Rectifier supported Dynamic Voltage Restorer – DC Capacitor supported DVR – DVR Structure – voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

Total : 45 Periods

Text Books

1 ArindamGhosh “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2012
2 R.C. Duggan, Mark.F.McGranaghan,SuryaSantoas and H.WayneBeaty, “Electrical Power System Quality”, McGraw-Hill, 2014.

Reference Books

1. Jos Arrillaga and Neville R. Watson ,“ Power system harmonics”,Wiley,2013.
2. Derek A. Paice , “Power Electronics Converter Harmonics :Multipulse Methods for Clean Power”,Wiley,2017.
3. Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Systems and Electrical Machines,Elseveir academic publications,2021.press

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Chairman – Board of Studies

Summative Assessment				
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Apply	30	30	30	60
Analyze	20	20	20	40
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