

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY**KUNIAMUTHUR, COIMBATORE.641 008.****CURRICULUM DEVELOPMENT CELL****CURRICULUM DESIGN FOR M.E. – PED COURSE****SEMESTER 1:**

S.NO	CATEGORY	SUB CODE	SUB NAME	L	T	P	C	MAX MARKS
1	FCBS	17MM104	Advanced Mathematics for Electrical Engineers	3	2	0	4	100
2	PC	17PE101	Modeling and Analysis of Electrical Machines	3	2	0	4	100
3	PC	17PE102	Analysis of Power Converters	3	2	0	4	100
4	PC	17PE103	Analysis of Inverters	3	0	0	3	100
5	PE	17PE0XX	PE - 1	3	0	0	3	100
6	PE	17PE0XX	PE - 2	3	0	0	3	100
7	PC Lab	17PE111	Power Electronics Simulation Laboratory	0	0	3	2	100
Total				18	6	3	23	700

Semester 2:

S.NO	CATEGORY	SUB CODE	SUB NAME	L	T	P	C	MAX MARKS
1	PC	17PE201	Solid State DC drives	3	2	0	4	100
2	PC	17PE202	Solid State AC drives	3	2	0	4	100
3	PC	17PE203	System Theory	3	2	0	4	100
4	PE	17PE0XX	PE - 3	3	0	0	3	100
5	PE	17PE0XX	PE - 4	3	0	0	3	100
6	PSC	17PE0ZZ	PSC - I	3	0	0	3	100
7	PC Lab	17PE211	Power Electronics and Drives Laboratory	0	0	3	2	100
8	*****	17PE212	Technical Seminar	0	0	2	1	100
Total				18	6	5	24	800

FCBS - Foundation Compulsory Basic Science

PC - Programme Core

PSC - Programme Soft Core

PE - Programme Elective

Semester 3:

S.N O	CATEGORY	SUB CODE	SUB NAME	L	T	P	C	MAX MARKS
1	PSC	17PE0ZZ	PSC - II	3	0	0	3	100
2	PE	17PE0XX	PE – 5	3	0	0	3	100
3	PE	17PE0XX	PE - 6	3	0	0	3	100
4	Project	17PE311	Project Work– Phase I / Internship	0	0	12	6	100
5	*****	17PE312	Comprehensive Viva – Voce (Objective type Test & Viva (External))	0	0	2	1	100
Total				9	0	14	16	500

Semester 4:

S.NO	CATEGORY	SUB CODE	SUB NAME	L	T	P	C	MAX MARKS
1	Project	17PE411	Project Work – Phase II	0	0	24	12	100
Total				0	0	24	12	100

FCBS - Foundation Compulsory Basic Science

PC - Programme Core

PSC - Programme Soft Core

PE - Programme Elective

Programme Elective Groups:

S.No	Group Name	Subject Code	List of Subjects
1	Power Electronics	17PE001	Advanced Power Semiconductor Devices
		17PE004	Flexible AC Transmission systems
		17PE003	Applications of Power Electronics in Power Systems
2	Power Systems	17PE002	Simulation of Power Electronic circuits with MATLAB in power system
		17PE005	High Voltage Direct Current Transmission
		17PE006	Smart Grid
3	Renewable Energy	17PE007	Power Electronics for Renewable Energy Systems
		17PE008	Wind Energy Conversion Systems
		17PE009	Solar Energy Generation and Utilization
4	Soft Computing Techniques	17PE010	Soft Computing tools applied in Electrical Engineering
		17PE011	PLC & SCADA
		17PE012	Advanced Control Systems
5	Embedded Systems	17PE013	Embedded Control of Electrical Drives
		17PE014	Digital Signal Processing using MATLAB and Wavelets
		17PE015	Real Time Operating Systems
6	Research	17PE016	Optimization Techniques
		17CC014	Research Methodology
		17PE017	Industrial Automation And Control

Programme Soft Core Group (PSC):

S.No	Subject Code	Subject Name
1	17PE081	Special Electrical Machines
2	17PE082	Computer Aided Design of Power Electronics Circuits
3	17PE083	VLSI Design
4	17PE084	DSP Controller for Power Electronics Applications
5	17PE085	Advanced Microprocessors and Microcontrollers

Note :

1. Programme Electives (PE) must be framed by having 5 domains, each possessing 3 subjects. Students should get specialized in any two domains.
2. List of subjects must be given in Programme Soft Core (PSC), so that students can choose any 2 subjects.
3. Students can earn extra credits by doing certification courses.

Curriculum Structure - Sample

S.No	Category Name	Actual Credit Break Up
1	Foundation Compulsory Basic Science (FCBS)	4
2	Programme Core(PC)	23
3	Programme Elective(PE)	18
4	Programme Core(PC) Lab	4
5	Programme Soft Core(PSC)	6
6	Project	18
7	Comprehensive Viva – Voce	2
	Total	75

Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE101	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	3	0	0	3

1. **Course pre-requisites** : DC Machines and Transformers
Synchronous and Induction Machines
2. **Course learning objectives** :
 - i. To impart knowledge on Electromagnetic Energy conversion.
 - ii. To understand the concept of Reference frame theory.
 - iii. To analyze about the dynamic performance of DC machines.
 - iv. To apply reference frame theory on Induction machines.
 - v. To apply reference frame theory on Synchronous machines.
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 3 – 75 % Descriptive & 25% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION									
	General expression of stored magnetic energy, co-energy and force/ torque	A	1	3	U	9	4	3	1	
	Example using single and doubly excited system	A	1	3	U		4	3	2	
	Calculation of air gap mmf and per phase machine inductance using physical machine data	A	2	3	U		3	2	3	
II	REFERENCE FRAME THEORY									
	Static and rotating reference frames – transformation of variables – reference frames	A	3	2	R	9	5	4	3	
	Transformation between reference frames – transformation of a balanced set	A	3	2	R		5	4	3	
	Balanced steady state phasor and voltage equations	A	3	3	A		5	4	3	

	Variables observed from several frames of reference	A	3	2	A		5	4	3	
III	DC MACHINES									
	Voltage and torque equations	A	10	3	R	9	3	3	2	
	Dynamic characteristics of permanent magnet and shunt DC motors	A	10	3	AP		5	4	2	
	State equations - solution of dynamic characteristic by Laplace transformation	A	10	3	A		4	4	2	
IV	INDUCTION MACHINES									
	Voltage and torque equations	A	6	1	R	9	4	2	1	
	Transformation for rotor circuits – Voltage and torque equations in reference frame variables	A	6	2	AP		4	1	2	
	Analysis of steady state operation – Free acceleration characteristics	A	6	2	A		4	1	1	
	Dynamic performance for load and torque variations – Dynamic performance for three phase fault	A	6	3	A		4	1	2	
	Computer simulation in arbitrary reference frame	A	6	1	C		5	4	3	
V	SYNCHRONOUS MACHINES									
	Voltage and Torque Equation	A	5	1	R	9	5	5	2	
	Voltage Equation in arbitrary reference frame and rotor reference frame – Park equations - Rotor angle	A	5	2	AP		4	4	2	
	Steady state analysis – Dynamic performances for torque variations	A	5	2	A		3	1	2	
	Dynamic performance for three phase fault – Transient stability limit – Critical clearing time	A	5	3	A		5	5	5	
	Computer simulation	A	5	1	C		5	5	4	

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Paul C.Krause, OlegWasyzcuk, Scott S, Sudhoff, “Analysis of Electric Machinery and Drive Systems”, IEEE Press, Second Edition, 2002
- B. Charles Kingsley, A.E. Fitzgerald Jr. and Stephen D. Umans, ‘Electric Machinery’, Tata McGraw-Hill, Fifth Edition, 2002.

REFERENCE BOOKS

- C. R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control”, Prentice Hall of India, 2002
- D. Samuel Seely, “Electromechanical Energy Conversion”, Tata McGraw Hill Publishing Company, 1962.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I		3					3
UNIT II	2			2			4
UNIT III	1		1	1			3
UNIT IV	1		1	2		1	5
UNIT V	1		1	2		1	5
TOTAL							20

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	0	15	0	0	0	0	15
UNIT II	10	0	0	10	0	0	20
UNIT III	5	0	5	5	0	0	15
UNIT IV	5	0	5	10	0	5	25
UNIT V	5	0	5	10	0	5	25
TOTAL	25	15	15	35	0	10	100
Lower Order Thinking (%)				55%			
Higher Order Thinking (%)				45%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: know about Electromagnetic Energy conversion

CO2: understand the concept of Reference frame theory

CO3: analyze about DC machines with dynamic performance

CO4: apply reference frame theory on Induction machines.

CO5: apply reference frame theory on Synchronous machines.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√		√		
CO2	√	√		√		
CO3	√		√	√		
CO4	√	√		√	√	
CO5		√	√		√	√

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√		√√		√					√		√
CO2	√√	√√	√√		√		√	√		√	√	√
CO3	√√			√		√	√	√	√√		√	
CO4	√√	√√	√	√√		√√		√√				√√
CO5	√√		√√				√√		√√		√√	

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√	√	√	√
CO2	√√	√		√	√	√		√		√	√	√
CO3	√√		√			√	√		√	√	√	√
CO4		√√		√	√		√	√				
CO5	√√		√			√	√			√	√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√		√
CO2	√√		√	√	√
CO3		√			
CO4	√		√	√	√
CO5	√√		√	√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE102	ANALYSIS OF POWER CONVERTER	3	0	0	3

1. **Course pre-requisites** : Power Electronics
2. **Course learning objectives** :
 - i. To provide the electrical circuit concepts behind the different working modes of power Converters.
 - ii. To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
 - iii. To analyze and comprehend the various operating modes of different configurations of Power converters.
 - iv. To design different power converters namely AC to DC, DC to DC and AC to AC converters.
3. **Expected Level of Output** : Analysis Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 3 –50% Descriptive & 50% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	SINGLE PHASE RECTIFIER									
	Static Characteristics of power diode, SCR and GTO, Half controlled and fully controlled converters with R-L, R-L-E loads and free wheeling diodes	A	2 & 5	5	U,A,Ap	9	5	4	4	
	Continuous and discontinuous modes of operation - inverter operation	F	6		U,A		5	4	4	
	Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor	F	3	1	U,A		5	4	4	
	Effect of source impedance and overlap-reactive power and power balance in converter circuits	F	6	3	U,A		5	4	4	
THREE PHASE RECTIFIER										

II	Semi and fully controlled converter with R, R-L, R-L-E - loads and free wheeling diodes	A,F	5,6	5	U,A,Ap	9	5	4	4
	Inverter operation and its limit – performance parameters	F	6	2	U,A		5	4	4
	Effect of source impedance and overlap – 12 pulse converter	F	6	2	U,A		5	4	4
DC-DC CONVERTERS									
III	Principles of step-down and step-up converters	B,F	8,7	1	U	9	5	4	4
	Analysis of buck, boost, buck-boost converters	B,F	8,7	3	A,Ap		5	4	4
	Cuk Converters	B,F	8,7	2	A,Ap		5	4	4
	Time ratio and current limit control- Full bridge converter	B,F	8,7	1	U		5	4	4
	Resonant converters	A,B	9,12	1	U,A,Ap		5	4	4
	Quasi resonant converters	A,B	9,12	1	U,A,Ap		5	4	4
AC VOLTAGE CONTROLLERS									
IV	Static Characteristics of TRIAC	B,F	11,9	1	U,A	9	5	4	4
	Principle of phase control: single phase controllers	B,F	11,9	2	U,Ap		5	4	4
	Three phase controllers	B,F	11,9	2	U,Ap		5	4	4
	Various configurations	B,F	11,9	2	U		5	4	4
	Analysis with R and R-L loads	B,F	11,9	2	A		5	4	4
CYCLOCONVERTERS									
V	Principle of operation – Single phase Dual converters	B,F	10,10	1	U,A,Ap	9	5	4	4
	Three-phase Dual converters	B,F	11,9	1	U,A,Ap		5	4	4
	Single phase Cyclo-Converters	B,F	11,9	2	U,A,Ap		5	4	4
	Three phase Cyclo-Converters	B,F	11,9	2	U,A,Ap		5	4	4
	Power factor Control	F	13	1	U,A		5	4	4
	Introduction to Matrix converters			2	U		5	4	4

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Ned Mohan, T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" Wiley India edition, 2006.

B. M.D.Sungh and K.B.Kanchandani, "Power Electronics", Tata McgGraw Hill, 2012

REFERENCE BOOKS

C. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pierson Prentice Hall India, New Delhi, 2010.

D. E. P.C Sen., "Modern Power Electronics ", Wheeler publishing Co, First Edition,

New Delhi-1998.

E. P.S.Bimbra, "Power Electronics", Khanna Publishers, Fourth Edition, 2012.

F. Power Electronics by Vedam Subramanyam, New Age International publishers, New Delhi Second Edition, 2006

WEB RESOURCES

[http://www.nptel.ac.in/courses/Webcourse-contents/IITKharagpur/Power Electronics/PDF](http://www.nptel.ac.in/courses/Webcourse-contents/IITKharagpur/Power_Electronics/PDF)

8. Assessing Level of Bloom’s Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	0	4	1	4	0	0	9
UNIT II	0	3	1	3	0	0	7
UNIT III	0	4	4	4	0	0	12
UNIT IV	0	4	2	2	0	0	8
UNIT V	0	6	4	5	0	0	15
TOTAL							51

9. Weightage of Bloom’s Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	0	7.84	1.96	7.84	0	0	17.64
UNIT II	0	5.88	1.96	5.88	0	0	13.72
UNIT III	0	7.84	7.84	7.84	0	0	23.52
UNIT IV	0	7.84	3.92	3.92	0	0	15.68
UNIT V	0	11.76	7.84	8.20	0	0	27.8
TOTAL	0	41.16	23.52	33.68	0	0	98.36
Lower Order Thinking (%)				64.68 %			
Higher Order Thinking (%)				33.68%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Know static and dynamic characteristics of power electronic devices

CO2: Analyze the RMS, Average values of output voltage and current of the single and three phase rectifiers and they can also be able to calculate performance parameters

CO3: Analyze DC Chopper operation

CO4: Analyze AC Voltage controller operation

CO5: Analyze Cyclo converters operation

11. Mapping course outcome with Bloom’s Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√		√	√		
CO2		√	√	√		
CO3		√	√	√		
CO4		√	√	√		
CO5		√	√	√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√√	√√	√√	√					√		√
CO2	√√	√√	√√	√√	√		√		√	√		√
CO3	√√	√√	√√	√√	√		√		√	√		√
CO4	√√	√√	√√	√√	√					√		√
CO5	√√	√√	√√	√√	√		√		√	√		√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√√		√√			√√	√√	√	√	√
CO2	√√	√√	√√		√√			√√	√√	√	√	√
CO3	√√	√√	√√		√√			√√	√√	√	√	√
CO4	√√	√√	√√		√√			√√	√√	√	√	√
CO5	√√	√√	√√		√√			√√	√√	√	√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√√	√	√	√
CO2	√√	√√	√	√	√
CO3	√√	√√	√	√	√
CO4	√√	√√	√	√	√
CO5	√√	√√	√	√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE103	ANALYSIS OF INVERTERS	3	0	0	3

1. **Course pre-requisites** : Power Electronics

2. **Course learning objectives** :

- i. To provide the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation.
- ii. To equip with required skills to derive the criteria for the design of power converters for UPS Drives etc.,
- iii. To study the working of advanced types of inverters such as multilevel inverters and resonant inverters.
- iv. Ability to analyze and comprehend the various operating modes of different configurations of power converters.
- v. Ability to design different single phase and three phase inverters.

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : Electrical & Electronics Engineering

5. **Nature of the Course** : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	SINGLE PHASE INVERTERS									
	Introduction to self commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters	A	6	4	U	12	5	5	4	
	Performance parameters –Voltage control of single phase inverters using various PWM techniques	A	6	3	U,C		5	5	4	
	Various harmonic elimination techniques	A	6	2	R,U		5	4	3	
	Forced commutated Thyristor inverters- Design of UPS	A	6,10	3	U,AP,C		5	4	3	
THREE PHASE VOLTAGE SOURCE INVERTERS										

II	180 degree and 120 degree conduction mode inverters with star and delta connected loads	A	6	3	R,U,A	9	5	4	3
	Voltage control of three phase inverters	A	6	2	U		5	4	3
	Single, multi pulse, sinusoidal, space vector modulation techniques	A,E	6,8	2	U,A		5	5	4
	Application to drive system	A	6	2	R,U		5	5	5
III	CURRENT SOURCE INVERTERS								
	Operation of six-step thyristor inverter – Inverter operation modes	E	8	3	R,U,C	9	5	5	3
	Load – Commutated inverters – Auto Sequential Current Source Inverter (ASCI)	E	8	1	R,U		5	4	3
	Current pulsations – Comparison of current source inverter and voltage source inverters	A	6	2	R,U		5	5	3
	PWM techniques for current source inverters.	A	6	3	R,U,AP		5	4	4
IV	MULTILEVEL & BOOST INVERTERS								
	Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel inverters	A	9	3	R,U,A	9	5	5	3
	Comparison of multilevel inverters application of multilevel inverters	A	9	2	R,U,A		5	4	5
	PWM techniques for MLI	A	6	2	R,U,A		5	5	3
	Boost Inverter-Basic Principle	A	6	2	R,U,C		5	5	3
V	RESONANT INVERTERS								
	Series and parallel resonant inverters - Voltage control of resonant inverters	A	11	2	R,U,C	6	5	5	3
	Class E resonant inverter	A	11	2	R,U		5	4	3
	Resonant DC – link inverters.	A	11	2	R,U		5	4	2

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2013.
 B. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, 2006

REFERENCE BOOKS

- C. Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design", John Wiley and sons.Inc, Newyork, Reprint 2009
 D. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, Second Edition, 2002.
 E. P.S.Bimbira, "Power Electronics", Khanna Publishers, Eleventh Edition, 2012

WEB RESOURCES

<http://www.nptel.ac.in/courses/Webcourse-contents/IITKharagpur/Power Electronics/PDF>

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	4	1	0	0	2	8
UNIT II	2	4	0	2	0	0	8
UNIT III	4	4	1	0	0	1	10
UNIT IV	4	4	0	3	0	1	12
UNIT V	3	3	0	0	0	1	7
TOTAL							45

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	2.22	8.88	2.22	0	0	4.44	17.76
UNIT II	4.44	8.88	0	4.44	0	0	17.76
UNIT III	8.88	8.88	2.22	0	0	2.22	22.2
UNIT IV	8.88	8.88	0	6.66	0	2.22	26.64
UNIT V	6.66	6.66	0	0	0	2.22	15.54
TOTAL	31.08	42.18	4.44	11.1	0	11.1	100
Lower Order Thinking (%)				78%			
Higher Order Thinking (%)				22%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand the characteristics of power diodes and power handling capability of switching devices

CO2: Understand the static and dynamic characteristics of current controlled power semiconductor devices

CO3: Understand the static and dynamic characteristics of voltage controlled power semiconductor devices

CO4: Enable the students for the selection of firing and protection circuit for different power semiconductor switches

CO5: Understand the methods of thermal protection for different semiconductor devices.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√	√			√
CO2	√	√√		√		
CO3	√√	√√	√	√		√
CO4	√√	√√	√	√√		√
CO5	√√	√				√

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√					√		√	√	√	√
CO2	√√	√	√√	√	√		√	√		√	√	√
CO3	√√	√	√√	√			√	√		√	√	√
CO4	√√	√	√			√√	√√	√	√		√	√
CO5	√√	√	√	√		√	√	√		√	√	√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√		√	√	√	√		√	√	√	
CO2	√√	√√		√	√	√	√		√		√	√
CO3	√√	√√		√	√	√	√	√	√		√	
CO4	√√	√√		√	√	√	√		√	√		√
CO5	√√	√√		√	√	√	√		√	√		

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√		√
CO2	√√			√	
CO3	√√			√	
CO4	√√		√	√	√
CO5	√√			√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE111	POWER ELECTRONICS SIMULATION LABORATORY	0	0	3	2

1. **Course pre-requisites** : NIL

2. **Course learning objectives** :

- i. To understand and verify the results of single and three phase semi and fully controlled converters
- ii. To know the concept of dual converter and to verify the results
- iii. To know the single and three phase inverter operation and to verify the results
- iv. To verify the operation of AC voltage controller and cyclo converter circuits with lamp load and motor load.

3. **Expected Level of Output** : **Practical**

4. **Department Offered** : Electrical and Electronics Engineering

5. **Nature of the Course** : Group 5 - Practical

Continuous Internal Assessment (CIA) : **40 Marks**

Semester End Examination (SEE) : **60 Marks**

6. **List of Experiments:**

1. Simulation of Single phase Semi controlled converter
2. a) R Load. b) RL load. c) RLE (Motor) Load
3. Simulation of Single phase fully controlled converter.
 - a) R Load. b) RL load. c) RLE (Motor) Load
4. Simulation of Three phase semi controlled converter
5. Simulation of Three phase fully controlled converter
6. Simulation of Single phase Dual converter
7. Simulation of Single phase full bridge Inverter
8. Simulation of Single phase half bridge Inverter
9. Simulation of Three phase full bridge inverter.
10. a) 180 degree mode operation b) 120 degree mode operation
11. Simulation of single phase AC Voltage Controller.
12. a) Lamp load b) Motor load
13. 10. Simulation of Three phase AC Voltage Controller.
14. a) Lamp load b) Motor load
15. 11. Simulation of PWM inverters
16. a) Sinusoidal PWM b) Square PWM

7. **Expected outcome of the course:**

Students will be able to

CO1: Verify the results of converter output and they can calculate RMS and Average values of output voltage and current

CO2: Calculate frequency and output voltage and current of inverter

CO3: Analyze the performance of motor with ac voltage controller and cycloconverters

Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE201	SOLID STATE DC DRIVES	3	0	0	3

1. **Course pre-requisites** : Power Electronics, DC machines, Analysis of Power Converters, Control Systems
2. **Course learning objectives** :
 - i. To study the fundamentals of motors and mechanical systems
 - ii. To study about converter control of DC motor drive
 - iii. To study about chopper control of DC motor drive
 - iv. To study about closed loop control of DC motor drive
 - v. To Study about Digital control of DC motor drive
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 3 – 60% Descriptive & 40% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS									
I	DC motor- Types, Induced emf, speed-torque relations	A	2	1	R	9	4	4	2
	Speed control- Ward Leonard control , Constant torque and constant horse power operation	A	2	1	R		5	5	3
	Introduction to high speed drives and modern drives, Characteristics of mechanical system, Dynamic equations	A	1	2	U		5	5	3
	Components of torque, types of load , Requirements of drives characteristics	A	2	2	R		5	5	3
	Multi-quadrant operation; Drive elements	A	2	2	U		5	5	3
	Types of motor duty and selection of motor rating	A	2	1	U		5	5	3
	CONVERTER CONTROL								

II	Principle of phase control – Fundamental relations	A	3	1	AP	9	4	4	2
	Analysis of series and separately excited DC motor with single-phase converters	A	3	2	A		3	3	3
	Analysis of series and separately excited DC motor with three phase converter	A	3	2	A		5	5	4
	Performance characteristics - Continuous and discontinuous armature current operations	A	3	1	A		4	4	3
	Current ripple and its effect on performance, Operation with freewheeling diode	A	3	1	A		5	4	4
	Implementation of braking schemes	A	3	1	AP		3	3	3
	Drive employing dual converter	A	3	1	AP		4	3	2
CHOPPER CONTROL									
III	Introduction to time ratio control and frequency modulation	A	4	1	AP	9	5	4	3
	Class A, B chopper controlled DC motor performance analysis	A	4	1	A		5	4	4
	Class C, D chopper controlled DC motor performance analysis	A	4	2	A		5	4	4
	Class E chopper controlled DC motor performance analysis - multi-quadrant control	A	4	2	A		4	3	3
	Chopper based implementation of braking schemes	A	4	2	A		3	3	3
	Multi-phase chopper	A	4	1	U				
CLOSED LOOP CONTROL									
IV	Modeling of drive elements – Equivalent circuit	A	2	1	R	9	3	3	3
	Transfer function of self, separately excited DC motors	A	2	2	E		4	3	3
	Linear Transfer function model of power converters	A	2	1	E		5	4	3
	Transfer function of Sensing and feedback elements	A	2	1	E		5	5	5
	Closed loop speed control – Current and speed loops	A	5	1	AP		5	4	4
	P, PI and PID controllers – Response comparison	A	5	2	AP		5	4	4
	Simulation of converter and chopper fed DC drive	B	4	1	C		5	4	4
DIGITAL CONTROL OF DC DRIVE									

V	Phase Locked Loop control	B	3	1	A	9	4	4	4
	Micro-computer control of DC drives	E	5	2	AP		5	4	4
	Program flow chart for constant horse power	B	4	2	E		4	3	2
	Load disturbed operations	B	4	2	A		5	4	4
	Speed detection and gate firing	A	5	2	U		5	4	4

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc, NewYersy 1989.

B. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

REFERENCE BOOKS

C. Gobal K.Dubey, “Fundamentals of Electrical Drives”, Alpha Science International, II Edition, 2002.

D. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education (Singapore) Ltd., New Delhi, 2003.

E. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	3	3	0	0	0	0	6
UNIT II	0	0	3	4	0	0	7
UNIT III	0	1	1	4	0	0	6
UNIT IV	1	0	2	0	3	1	7
UNIT V	0	1	1	2	1	0	5
TOTAL							31

9. Weight age of Bloom's Taxonomy in the Syllabus:

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	9.67	9.67	0	0	0	0	19.35
UNIT II	0	0	9.67	12.9	0	0	22.58
UNIT III	0	3.22	3.22	12.9	0	0	19.35
UNIT IV	3.22	0	6.45	0	9.67	3.22	22.58
UNIT V	0	3.22	3.22	6.45	3.22	0	16.13
TOTAL	12.89	16.11	22.56	32.25	12.89	3.22	99.99
Lower Order Thinking (%)				51.56%			

Higher Order Thinking (%)	48.36%
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10. Expected outcome of the course:

On completion of the course the student will be

CO1: know about fundamentals of motors and mechanical systems

CO2: able to design converter control of DC motor drive

CO3: able to design chopper control of DC motor drive

CO4: able to design closed loop control of DC motor drive

CO5: know about Digital control of DC motor drive

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√	√			
CO2			√	√	√	
CO3		√	√	√	√	
CO4		√	√	√		
CO5	√	√	√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√√	√√	√√	√				√	√		√
CO2	√√	√√		√	√	√					√	√
CO3	√	√√			√	√			√		√	√
CO4	√	√√		√	√	√					√	√
CO5	√	√	√						√	√		√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√			√
CO2	√√				√	√					√	
CO3	√√					√				√		
CO4		√√		√	√					√		√
CO5		√√	√		√				√		√	

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	
CO2	√√				√
CO3			√	√	
CO4	√√		√	√	√√
CO5			√√		√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PFK202	SOLID STATE AC DRIVES	3	1	0	4

1. **Course pre-requisites** : Ac Machines, Power Electronics ,Analysis of power Converter, Control system

2. **Course learning objectives** :
- To understand various operating regions of the induction motor drives.
 - To study and analyze the operation of VSI & CSI fed induction motor control.
 - To understand the speed control of induction motor drive from the rotor side.
 - To understand the field oriented control of induction machine.
 - To understand the control of synchronous motor drives.

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** :EEE

5. **Nature of the Course** : C. Group 3 :70% Descriptive & 30% Analytical

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
INTRODUCTION TO INDUCTION MOTORS									
I	Steady state performance equations – Rotating magnetic field – Torque production, Equivalent circuit	A	6	3	R,A	9	4	4	4
	Variable voltage, constant frequency operation – Variable frequency operation, constant Volt/Hz operation	A	6	3	U, C		4	4	5
	Drive operating regions, variable stator current operation, different braking methods.	A	6	3	U,A		4	4	4
VSI AND CSI FED INDUCTION MOTOR DRIVES									
	AC voltage controller circuit	A	6	1	U,A	9	5	4	4
	Step inverter voltage control	A	6	2	R,A		5	4	4
	Closed loop variable frequency PWM	A	6	3	U,A		5	4	5

II	inverter with dynamic braking								
	CSI fed IM variable frequency drives comparison	A	6	3	R,A		4	3	4
ROTOR CONTROLLED INDUCTION MOTOR DRIVES									
III	Static rotor resistance control	A	6	2	U,A	9	4	4	4
	Injection of voltage in the rotor circuit	A	6	2	U,A		3	4	4
	Static scherbius drive	A	6	2	A		4	3	5
	Power factor considerations – Modified Kramer drives	A	6	3	Ap,A		4	4	5
VECTOR CONTROLLED INDUCTION MOTOR DRIVES									
IV	Field oriented control of induction machines – Theory	D	8	2	U,A	9	4	3	4
	DC drive analogy – Direct and Indirect methods – Flux vector estimation	D	8	2	B,A		4	4	4
	Direct torque control of Induction Machines	D	8	2	E,Ap		4	4	5
	Torque expression with stator and rotor fluxes, DTC control strategy	D	8	3	U,A		4	3	5
SYNCHRONOUS MOTOR DRIVES									
V	Wound field cylindrical rotor motor	A	7	2	U,C	9	4	3	4
	Equivalent circuits – Performance equations of operation from a voltage source	A	7	3	U,A		4	4	4
	Power factor control and V curves	A	7	1	U,A		3	4	5
	Starting and braking, self control – Load commutated Synchronous motor drives	A	7	2	U,A		4	3	5
	Brush and Brushless excitation	A	7	1	U,A		4	4	4

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Gobat. K.Dubey, “Fundamentals of Electrical Drives”, Alpha Science International, II Edition, 2002.

B. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003

REFERENCE BOOKS

C. W.Leonhard, “Control of Electrical Drives”, Narosa Publishing House, 1992.

D. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education (Singapore) Ltd., New Delhi, 2003

E.Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw Hill, 1994.

WEB RESOURCES

B. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	0	2	0	0	5
UNIT II	2	1	0	4	0	0	7
UNIT III	0	2	1	4	0	0	7
UNIT IV	0	2	1	3	1	0	7
UNIT V	0	5	0	4	0	1	10
TOTAL							36

C. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	2.7	5.5	0	5.5	0	0	13.7
UNIT II	5.5	2.7	0	11.1	0	0	19.3
UNIT III	0	5.5	2.7	11.1	0	0	19.3
UNIT IV	0	5.5	2.7	8.3	2.7	0	19.3
UNIT V	0	13.8	0	11.1	0	2.7	27.6
TOTAL							
Lower Order Thinking (%)				100 %			
Higher Order Thinking (%)				NIL			

D. Expected outcome of the course:

Upon successful completion of this course, the student will be:

- CO1:** able to understand various operating regions of the induction motor drives.
- CO2:** able to study and analyze the operation of VSI & CSI fed induction motor control.
- CO3:** able to understand the speed control of induction motor drive from the rotor side.
- CO4:** able to understand the field oriented control of induction machine.
- CO5:** able to understand the control of synchronous motor drives.

E. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√√		√		
CO2	√√	√		√√		
CO3		√	√	√√		
CO4		√	√	√√	√	
CO5		√√		√√		√

F. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√	√				√					√√
CO2	√√	√√	√	√	√				√	√		√
CO3	√√	√√	√	√	√	√					√	
CO4	√√	√√	√	√	√	√				√		√
CO5	√√	√√	√	√	√	√				√		√

G. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√			√
CO2	√√				√	√					√	
CO3	√√					√				√		
CO4		√√		√	√					√		√
CO5		√√	√		√				√		√	

H. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	
CO2	√√				√
CO3		√		√	
CO4	√√		√	√	√√
CO5		√√			√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE203	SYSTEM THEORY	3	1	0	4

1. **Course pre-requisites** : Control Systems
2. **Course learning objectives** :
 - i. To understand the basic concepts of state variable representation.
 - ii. To understand the concepts of discrete time state model.
 - iii. To acquire the knowledge about controllability and observability
 - iv. To analyze the stability of linear and non linear systems.
 - v. To understand the concepts of model control
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 2 – 100% Analytical

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	STATE VARIABLE REPRESENTATION									
	Introduction-Concept of State-State equation for Dynamic Systems	A	2	3	U	12	5	5	2	
	Time invariance and linearity-No uniqueness of state model-State Diagrams	A	2	2	AP		5	5	0	
	Physical System and State Assignment - Solution of State Equation	A	3	2	A		5	5	1	
	Existence and uniqueness of solutions to Continuous-time state equations- Evaluation of matrix exponential	A	3	2	E		5	4	1	
	System modes-Role of Eigen values and Eigenvectors	A	4	3	R		5	3	0	
DISCRETE TIME STATE MODEL										
II	Introduction – Discrete Time State Model	A	5	3	U	12	5	2	0	
	Sample and Hold Digital Equivalent – Methods of Discretization – Sampling Effects	A	5	3	AP		4	0	0	
	Discrete Time State Model – Conversion from Continuous Time State Models – Discrete Time State Transition Matrix	A	5	4	AP		5	4	1	
	Solution Space of State Equation	A	5	2	A		4	2	0	
III	CONTROLLABILITY AND OBSERVABILITY									
	Introduction - Controllability and	A,B	6,11	3	U	12	5	5	0	

	Observability								
	Stabilizability and Detectability-Test for Continuous time Systems	A,B	6,11	3	R		4	2	0
	Time varying and Time invariant case-Output Controllability	A,B	7,11	3	A		5	4	1
	Reducibility-System Realizations	A,B	7,11	3	R		4	1	0
	STABILITY								
IV	Introduction-Equilibrium Points-Stability in the sense of Lyapunov	A	8	3	U	12	5	3	1
	BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems	A	8	3	AP		4	2	1
	The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems	A	8	2	R		5	3	1
	Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems	A	8	2	A		4	2	0
	Krasovskii and Variable-Gradient Method	A	8	2	R		5	3	1
	CONTROL MODEL								
V	Introduction-Controllable and Observable Companion Forms	A,B	9,12	3	U	12	5	4	0
	SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability	A,B	9,12	3	R		5	3	1
	Pole Placement by State Feedback for both SISO and MIMO Systems	A,B	9,12	3	A		5	4	0
	Full Order and Reduced Order Observers	A,B	9,12	3	A		5	4	0

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Gopal.M, “Modern Control System Theory”, New Age International, 2014.

B. Ogatta.K, “Modern Control Engineering”, PHI, 2009.

REFERENCE BOOKS

C. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999.

D. Roy Choudhury.D, “Modern Control Systems”, New Age International, 2005.

E. John J. DAzzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2008.

F. Bubnicki.Z, “Modern Control Theory”, Springer, 2010.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	1	1	1	1	0	5
UNIT II	0	1	2	1	0	0	4
UNIT III	2	1	0	1	0	0	4
UNIT IV	2	1	1	1	0	0	5
UNIT V	1	1	0	2	0	0	4
TOTAL							22

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	4.54	4.54	4.54	4.54	4.54	0	22.7
UNIT II	0	4.54	9.09	4.54	0	0	18.17
UNIT III	9.09	4.54	0	4.54	0	0	18.17
UNIT IV	9.09	4.54	4.54	4.54	0	0	22.71
UNIT V	4.54	4.54	0	9.09	0	0	18.17
TOTAL	27.26	22.7	18.17	27.25	4.54	0	99.92
Lower Order Thinking (%)				68.13 %			
Higher Order Thinking (%)				31.79 %			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

- CO1: Students understood the basic concepts of state variable representation.
- CO2: Students understood the concepts of discrete time state model.
- CO3: Students acquired the knowledge in controllability and observability.
- CO4: Students able to analyze the stability of linear and non linear systems.
- CO5: Students understood the concepts of model control

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√	√	√	√	
CO2		√	√√	√		
CO3	√√	√		√		
CO4	√√	√	√	√		
CO5	√	√		√√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√√	√				√			√	√	√
CO2	√√	√√			√		√	√		√	√	√
CO3	√√	√√			√√	√	√	√		√	√	
CO4	√√	√√			√√	√						√
CO5	√√	√√		√		√				√		

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√			√		√				√	√
CO2	√√				√		√				√	√
CO3	√√	√			√		√				√	√
CO4	√√		√	√	√		√	√			√	√
CO5	√√	√			√		√				√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√		√	
CO2	√√	√		√	√
CO3	√√	√		√	
CO4	√√	√	√	√	√
CO5	√√	√	√	√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE211	POWER ELECTRONICS & DRIVES LABORATORY	0	0	3	2

1. **Course pre-requisites** : Power Electronics

2. **Course learning objectives** :

- i. To know the DC motor performance with dual converter and chopper.
- ii. To understand the Vector controlled induction motor and verify their performance.
- iii. Implementation of IGBT based PWM and SVPWM inverter.
- iv. To control the speed of BLDC and SRM motor by DSP controller.

3. **Expected Level of Output** : Practical

4. **Department Offered** : Electrical and Electronics Engineering

5. **Nature of the Course** : Group 5 - Practical

Continuous Internal Assessment (CIA): 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **List of Experiments:**

1. Dual Converter Fed DC Motor Drive
2. Chopper Fed DC Drive
3. DSP controlled AC drive
4. Performance study of Stator Voltage Controlled Induction Motor Drive
5. Vector Controlled Induction Motor Drive
6. IGBT Based Three Phase PWM Inverter
7. IGBT Based Three Phase SVPWM Inverter
8. DSP based speed control of BLDC motor
9. DSP based speed control of SRM motor
10. IGBT based single phase inverters
11. Speed control of DC motor using three phase fully controlled converter
12. Single phase cycloconverters

7. **Expected outcome of the course:**

Students can able to

- CO1: Know the performance of dual converter fed DC motor
- CO2: Control the speed of induction motor by Vector control method
- CO3: Implement IGBT based inverter
- CO4: Vary the speed of BLDC and SRM motor by DSP controller
- CO5: Know the operation of cycloconverters

Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE001	ADVANCED POWER SEMICONDUCTOR DEVICES	3	0	0	3

1. **Course pre-requisites** : Power Electronics

2. **Course learning objectives** :

- i. To understand the characteristics of power diodes and power handling capability of switching devices
- ii. To understand the static and dynamic characteristics of current controlled power semiconductor devices
- iii. To understand the static and dynamic characteristics of voltage controlled power semiconductor devices
- iv. To enable the students for the selection of firing and protection circuit for different power semiconductor switches
- v. To understand the methods of thermal protection for different semiconductor devices.

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : Electrical & Electronics Engineering

5. **Nature of the Course** : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION									
	Power switching devices overview – Attributes of an ideal switch, application requirements	E	1	3	U	9	5	4	4	
	Power handling capability – (SOA) Device selection strategy	E	1	2	U		5	5	4	
	On-state and switching losses – EMI due to switching	C	20	1	R		4	2	2	
Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.	C	20	3	U,AP	5		2	2		
CURRENT CONTROLLED DEVICES										

II	BJT's – Construction, static and dynamic characteristics; Negative temperature coefficient and secondary breakdown	E	1.5	3	R,U	9	5	1	3
	Power Darlington - Thyristors – Physical and electrical principle underlying operating mode,	E	1.5, 1.8	2	U		5	3	3
	Two transistor analogy –Gate and switching characteristics; converter grade and inverter grade and other types	A	7	2	U		4	2	4
	series and parallel operation; comparison of BJT and Thyristor	A	7	1	R,U		5	2	5
	Steady state and dynamic models of BJT & Thyristor.	A	7	1	R,U		4	2	1
VOLTAGE CONTROLLED DEVICES									
III	Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types	E,C	1.6, 22	3	R,U	9	5	5	3
	Static and switching characteristics,	C	22	1	R,U		5	4	2
	Steady state and dynamic models of MOSFET and IGBTs	A	4	2	R,U,A		5	5	2
	Basics of GTO, MCT, FCT, RCT and IGCT.	A	7	3	R,U,A		5	4	1
FIRING AND PROTECTING CIRCUITS									
IV	Necessity of isolation, pulse transformer, opto coupler	A	17	3	R,U,A	9	4	5	1
	Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT	A	17	2	U,A		5	4	5
	Over voltage, over current and gate protections	A	17	2	U,A		5	5	3
	Design of snubbers	C	27	2	U,AP		5	5	3
THERMAL PROTECTION									
V	Heat transfer – conduction, convection and radiation	C	29	2	R,AP	9	5	5	2
	Cooling – liquid cooling, vapour – phase cooling	B	11	2	R,U		4	4	2
	Guidance for heat sink selection – Thermal resistance and impedance	C	29	2	R,U		5	4	2
	Electrical analogy of thermal components, heat sink types and design – Mounting types.	B	11	3	R,U		5	5	4

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2013.
- B. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.

REFERENCE BOOKS

- C. Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design", John Wiley and sons.Inc, Newyork, Reprint 2009
- D. B.W. Williams, Power Electronics: Devices, Drivers, Applications and Passive Components, New York, McGraw-Hill, 1992.
- E. Joseph Vithayathil, Power Electronics: Principles and Applications, Delhi, Tata McGraw-Hill, 2010.

WEB RESOURCES

<http://www.nptel.ac.in/courses/Webcourse-contents/IITKharagpur/Power Electronics/PDF/>

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	3	1	0	0	0	5
UNIT II	3	5	0	0	0	0	8
UNIT III	4	4	0	2	0	0	10
UNIT IV	1	4	1	3	0	0	9
UNIT V	4	3	1	0	0	0	8
TOTAL							40

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	2.5	7.5	2.5	0	0	0	12.5
UNIT II	7.5	12.5	0	0	0	0	20
UNIT III	10	10	0	5	0	0	25
UNIT IV	2.5	10	2.5	7.5	0	0	22.5
UNIT V	10	7.5	2.5	0	0	0	20
TOTAL	32.5	47.5	7.5	12.5	0	0	100
Lower Order Thinking (%)				87.5%			
Higher Order Thinking (%)				12.5%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand the characteristics of power diodes and power handling capability of switching devices

CO2: Understand the static and dynamic characteristics of current controlled power semiconductor devices

CO3: Understand the static and dynamic characteristics of voltage controlled power semiconductor devices

CO4: Enable the students for the selection of firing and protection circuit for different power semiconductor switches

CO5: Understand the methods of thermal protection for different semiconductor devices

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√	√			
CO2	√	√√				
CO3	√	√√		√		
CO4	√	√√	√		√√	

CO5	√√	√	√			
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12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√						√		√	√	√	√
CO2	√√		√√	√			√	√		√	√	√
CO3	√√		√√	√			√	√		√	√	√
CO4	√√		√			√√	√√	√			√	√
CO5	√√		√	√		√	√	√		√	√	√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√		√	√	√	√		√	√	√	
CO2	√√	√√		√	√	√	√	√	√		√	
CO3	√√	√√	√	√	√	√	√	√	√		√	√
CO4	√√	√√		√	√	√	√	√	√	√		√
CO5	√√	√√		√	√	√	√		√	√		

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√		
CO2	√√	√		√	
CO3	√√	√	√	√	
CO4	√√	√		√	√
CO5	√√	√		√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE002	Simulation of Power Electronic circuits with MATLAB in Power System	3	0	0	3

1. **Course pre-requisites** : Power Electronics, Control Systems

2. **Course learning objectives** :

- i. To know the tool boxes and programming of files in MATLAB
- ii. To design different power converters namely AC to DC, DC to DC and AC to AC converters.
- iii. To know about Walsh Domain Operational Method of System
- iv. To equip with required skills to derive the criteria for the design of Single-Input Single-Output Systems from basic fundamentals.
- v. To design different power converters namely AC to DC converter using Walsh function

3. **Expected Level of Output** : Analysis Level

4. **Department Offered** : Electrical and Electronics Engineering

5. **Nature of the Course** : Group 3 –20% Descriptive & 40%Analytical & Group 4 – 40%Programming

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	MATLAB AND SIMULINK						9	4	3	4
	Toolboxes of MATLAB	A	1-7	2	R					
	Programming and File processing in MATLAB	A,D		2	U					
	Model Definition and model analysis using SIMULINK	A,D		2	U,A					
	S Functions – Converting S-Functions to block	A,D		3	U,Ap	4	3	4		
	Simulation using MATLAB						9	4	3	4
	Diode Rectifiers – Controlled Rectifiers –	A	2,3	3	A, Ap`					
	AC Voltage Controllers– Dc choppers	A	4	2	A, Ap					

II	PWM inverters – Voltage and Current Source Inverts	A	7	2	A, Ap		4	3	4
	Zero Current Switching and Zero Voltage Switching Inverts	A	7	2	A, Ap		4	3	4
WALSH DOMAIN OPERATIONAL METHOD OF SYSTEM ANALYSIS									
III	Introduction to Walsh Function - Rademacher and Walsh Functions - Applications of Walsh Functions	B	1	3	U,A	9	4	3	4
	Time Scaling of Operational Matrices - Philosophy of the Proposed Walsh Domain Operational Technique	B	2	2	U,A		4	3	4
	Analysis of a First-Order System with Step Input	B	2	2	A		4	3	4
	Oscillatory Phenomenon in Walsh Domain System Analysis	B	2	2	A		4	3	4
ANALYSIS OF PULSE-FED SINGLE-INPUT SINGLE-OUTPUT SYSTEMS									
IV	Analysis of a First-Order System	B	3	3	A	9	4	3	4
	Analysis of a Second-Order System	B	3	3	A		4	3	4
	Pulse-Width Modulated Chopper System	B	3	3	A		4	3	4
ANALYSIS OF CONTROLLED RECTIFIER CIRCUITS									
V	Representation of a Sine Wave by Walsh Functions	B	4	2	A,Ap	9	4	3	4
	Conventional Analysis of Half-Wave Controlled Rectifier	B	4	2	A,Ap		4	3	4
	Walsh Domain Analysis of Half-Wave Controlled Rectifier	B	4	2	A,Ap		4	3	4
	Walsh Domain Analysis of Full-Wave Controlled Rectifier	B	4	3	A,Ap		4	3	4

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Randall Shaffer, “Fundamentals Of Power Electronics With Matlab Hardcover “ Firewall Media, 2010

B. D.Anish Deb, Suchismita Ghosh, ”Power Electronic Systems: Walsh Analysis with MATLAB” CRC Press 2014

REFERENCE BOOKS

CO1	√	√	√	√	√					√		√
CO2	√	√	√	√	√		√		√	√		√
CO3	√	√	√	√	√		√		√	√		√
CO4	√	√	√	√	√					√		√
CO5	√	√	√	√	√		√		√	√		√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√		√			√	√	√	√	√
CO2	√	√	√		√			√	√	√	√	√
CO3	√	√	√		√			√	√	√	√	√
CO4	√	√	√		√			√	√	√	√	√
CO5	√	√	√		√			√	√	√	√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√	√	√	√
CO2	√	√	√	√	√
CO3	√	√	√	√	√
CO4	√	√	√	√	√
CO5	√	√	√	√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE003	APPLICATIONS OF POWER ELECTRONICS IN POWER SYSTEMS	3	0	0	3

- Course pre-requisites** : Power Electronics, Power Systems
- Course learning objectives** :
 - To impart knowledge on different types of converter configurations.
 - To study the different Applications of converters in HVDC systems
 - To design and analyze the different types of protection schemes for converters.
 - To design and chose the best circuit for power system.
 - To impart knowledge on compensation by a series capacitor.
- Expected Level of Output** : Conceptual Level
- Department Offered** : Electrical and Electronics Engineering
- Nature of the Course** : Group 1 – 100 % Descriptive
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
- Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION						7	3	1	2
	High Power drives for Power systems controllers	B	1,2	3	R					
	Characteristics	B	2	2	U					
	Configuration for Large power control	A	4	2	A					
II	SINGLE PHASE AND THREE PHASE CONVERTERS						10	3	2	3
	Properties – Current and voltage harmonics Effect of source and load impedance	A	8	3	R , U					
	Choice of best circuit for power systems- Converter Control - Gate Control	A	3,4	2	A,AP					
	Basic means of Control – Control characteristics – Stability of control – Reactive power control - Applications of	A	4	3	A,E					

	converters in HVDC system								
	Static VAR control - Source of reactive power – Harmonics and filters	A	8	2	U, A		3	3	2
III	HVDC								
	HVDC configurations, components of HVDC system: Converter, transformer, smoothing reactor, harmonic filter. Reactive power support	B	7	3	R	11	3	2	3
	Operation of 6-pulse controlled rectifier in inverting mode of operation. Operation of 12-pulse converter. Control of HVDC system	A	3	3	U & AP		4	2	3
	Rectifier and inverter characteristics, mode stabilization, current control, voltage dependent current order limit, combined rectifier-inverter characteristics, valve blocking and by-passing	D	4	3	A		4	2	2
	Limitations HVDC system using line commutated converters, modern HVDC system - HVDC light	D	1	2	A		3	2	2
IV	REACTIVE POWER COMPENSATION								
	Introduction, methods of Var generation, analysis of uncompensated AC line, Passive reactive power compensation	A	7	2	R, U, A	9	4	3	2
	Compensation by a series capacitor connected at the midpoint of the line, Effect on Power Transfer capacity	A	7	2	U, A		3	2	2
	Compensation by STATCOM and SSSC, Fixed capacitor-Thyristor controlled reactor (FC TCR)	D	11	3	U, A		3	2	3
Thyristor-switched capacitor- Thyristor controlled reactor (TSC-TCR), static var compensators	D	11	3	U	3		2	3	
V	STATIC APPLICATIONS								
	Static excitation of synchronous generators	B	9	2	U, A	8	3	2	1
	Solid state tap changers for transformer	B	6	2	U, A		3	2	1
	UPS Systems	E	11	2	U, E		3	1	1
Induction furnace control	E	30	2	U, A	3		1	1	

Bloom's Legends:

R-Remembering

A-Analyzing

U-Understanding

C-Creating

AP-Applying

E – Evaluating

7. TEXT BOOKS

- A. K.R. Padiyar, HVDC Power Transmission System – Technology and System Interaction, New Delhi, New Age International, 2002.
- B. Ned Mohan, Electric power system, New York, John Wiley and Sons, 2012.

REFERENCE BOOKS

- C. S. Kamakshiah, V. Kamaraj , HVDC Transmission, New Delhi, Tata Mc Graw-Hill Education Pvt Ltd, 2011
- D. B. Ned Mohan, Power electronic converters Applications and Design, New York, John Wiley and Sons, 2013.
- E. Mohd. Hasan Ali, Bin Wu, Roger A. Dougal, An Overview of SMES Applications in Power and Energy Systems, IEEE Transactions on Sustainable Energy, vol. 1, no. 1, April 2010.

WEB RESOURCES

[nptel.ac.in/ High Voltage DC Transmission/ Industrial drives](http://nptel.ac.in/High%20Voltage%20DC%20Transmission/Industrial%20drives)

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	1	0	1	0	0	3
UNIT II	1	0	1	3	2	0	7
UNIT III	1	1	1	2	0	0	5
UNIT IV	1	4	0	3	0	0	8
UNIT V	0	4	0	3	1	0	8
TOTAL							31

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	3.225	3.225	0	3.225	0	0	9.675
UNIT II	3.225	0	3.225	9.68	6.45	0	22.58
UNIT III	3.225	3.225	3.225	6.45	0	0	16.125
UNIT IV	3.225	12.9	0	9.68	0	0	25.805
UNIT V	0	12.9	0	9.68	3.225	0	25.805
TOTAL	12.9	32.25	6.45	38.715	9.675	0	100
Lower Order Thinking (%)				52			
Higher Order Thinking (%)				48			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand and remember the types of converter configuration.

CO2: Applying the knowledge to chose the best circuit for power system.

CO3: Execute the different control methods.

CO4: Applying the knowledge to design and analyze the different types of protection schemes for converters.

CO5: Understand and remember the different Applications of converters in HVDC systems

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√√	√√		√		
CO2		√	√√	√	√	
CO3	√		√	√	√√	
CO4	√	√		√		
CO5	√	√		√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√						√		√	√		√
CO2	√	√	√	√√	√	√	√	√	√	√	√	√
CO3		√		√	√	√	√		√	√	√	√
CO4	√	√	√√	√	√	√	√	√	√			
CO5			√	√	√	√					√	√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		√	√	√	√		√	√	√	√	√	
CO2	√	√	√√	√	√			√	√	√	√	
CO3					√√			√		√	√	√
CO4	√	√√	√		√	√		√	√	√	√	
CO5		√	√		√			√	√	√	√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√	√	√	
CO2	√	√√	√		√
CO3	√	√√	√		√
CO4	√	√√	√		√
CO5	√	√	√	√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE004	FLEXIBLE AC TRANSMISSION SYSTEMS	3	0	0	3

- Course pre-requisites** : Power System Generation, Transmission, Distribution & Analysis
- Course learning objectives** :
 - To understand the concepts of FACTS
 - To expose the students to the applications of FACTS controllers in power systems
 - To learn about shunt & series compensation schemes
 - To make the students' learn the simulation of FACTS Controllers
 - To understand the phenomenon of SSR & its mitigation
- Expected Level of Output** : Conceptual Level
- Department Offered** : Electrical & Electronics Engineering
- Nature of the Course** : Group 1 – 100 % Descriptive
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
- Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION									
	Introduction	A	1	2	U	9	5	4	3	
	Electrical Transmission Network– Necessity	A	1	1	U		5	5	3	
	Power Flow in AC system & Relative importance of controllable parameter	A	1	2	U		4	4	2	
Opportunities for FACTS, Possible benefits for FACTS Technology & Types of FACTS Controllers	A	1	4	U	5		5	3		
II	STATIC VAR COMPENSATION									
	Need for compensation – introduction to shunt & series compensation	A	2	2	U	9	5	5	3	
	Objectives of shunt & series compensation	A	2	2	R,U		4	3	2	
Configuration & Operating characteristics – Thyristor Controlled Reactor (TCR), Thyristor Switched Capacitor (TSC)	A	2,3	3	A	5		4	2		

	Comparison of TCR & TSC	A	2,3	2	U		5	4	4	
III	SERIES COMPENSATION									
	Variable Impedance Type Series Compensation	A	7	2	U	9	4	5	3	
	Thyristor Switched Series Capacitor (TSSC) & Thyristor Controlled Series Capacitor (TCSC)	A	7	3	A		5	5	3	
	Basic operating control schemes for TSSC & TCSC	A	7	4	A		5	5	3	
IV	STATIC VOLTAGE PHASE ANGLE REGULATOR									
	Objectives of voltage and phase angle regulators	A, C	5	2	U,R	9	4	5	3	
	TCVR Model and characteristics	A, C	5	3	A		5	5	4	
	Approaches to Thyristor – Controlled Voltage and Phase Angle Regulator	A, C	5	3	A		5	5	3	
TCPAR Model	A, C	5	1	A		4	3	2		
V	SECOND GENERATION FACTS CONTROLLERS									
	STATCOM – Introduction, Circuit model, Principle of operation	A	10	2	A	9	4	4	2	
	Introduction to Unified Power Flow Controller (UPFC) , Basic operating principles and control structure of UPFC	A	10	2	A		5	4	2	
	Introduction to sub synchronous resonance , SSR mitigation by FACTS controllers & NGH – SSR damping scheme	A	8	2	U		5	4	2	
Simulation and study of FACTS under dynamic conditions	D,E	-	3	C	4		5	4		

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. R. Mohan Mathur and Rajiv K. Varma, “Thyristor Based FACTS Controller for Electrical Transmission Systems”, Wiley Interscience Publications, 2002.
- B. K.R. Padiyar, “FACTS Controllers for Power Transmission and Distribution” New Age International Publishers, 2007.

REFERENCE BOOKS

- C. Narain G.Hingorani, Laszlo Gyugyi, “Understanding FACTS concept and Technology”, Standard Publisher, Delhi, 2001.
- D. Gyugyi L., “Unified power flow control concept for flexible AC transmission “, IEEE Proc-C Vol.139, No.4, July 1992.
- E. Einar V.Larsen, Juan J. Sanchez-Gasca, Joe H.Chow, “ Concepts for design of FACTS Controllers to damp power swings “, IEEE Trans on Power Systems, Vol.10, No.2, May 1995.

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	0	4	0	0	0	0	4
UNIT II	1	3	0	1	0	0	5
UNIT III	0	1	0	2	0	0	3
UNIT IV	1	1	0	3	0	0	5
UNIT V	0	1	0	2	0	1	4
TOTAL							21

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	0	19.05	0	0	0	0	19.05
UNIT II	4.76	14.29	0	4.76	0	0	23.81
UNIT III	0	4.76	0	9.52	0	0	14.28
UNIT IV	4.76	4.76	0	14.29	0	0	23.81
UNIT V	0	4.76	0	9.52	0	4.76	19.04
TOTAL	9.52	47.62	0	38.09	0	4.76	100
Lower Order Thinking (%)				100 %			
Higher Order Thinking (%)				NIL			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand and analyze the concept of FACTS.

CO2: To understand the various types of compensation schemes.

CO3: Implement various FACTS controllers.

CO4: Applying the knowledge gained to simulate various FACTS controllers.

CO5: Understand about the phenomena of sub synchronous resonance

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1		√√		√		
CO2		√				
CO3			√√	√		√
CO4			√√			√
CO5		√√				

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√											
CO2		√										
CO3			√	√	√						√	
CO4			√	√	√						√√	
CO5	√											

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√√									√	
CO2	√											
CO3	√		√√		√						√√	√
CO4	√	√√		√√	√						√√	
CO5	√	√√									√	

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√√		√√	
CO2	√	√√		√	
CO3	√	√√			
CO4		√	√	√√	√
CO5	√	√√		√√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE005	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	3	0	0	3

1. **Course pre-requisites** : Analysis of Power Converters, Analysis of Inverters

2. **Course learning objectives** :
- To understand the concept of DC transmission systems.
 - To analyze the control strategies in a DC transmission.
 - To model and analyze the power flow concept in DC transmission systems.
 - Apply the knowledge to overcome the DC transmission problems.
 - To Analyze the DC transmission system and their problems by simulation techniques

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : EEE

5. **Nature of the Course** : A. Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
DC POWER TRANSMISSION TECHNOLOGY									
I	Introduction - Comparison of AC and DC transmission – Application of DC transmission	A	1	1	R, U	6	5	4	4
	Description of DC transmission system –	A	1	1	U		4	3	3
	Planning for HVDC transmission	A	1	1	E		4	3	1
	Modern trends in DC transmission – DC breakers	A	1	1	A		4	3	1
	Operating problems	A	1	1	A		4	2	0
	HVDC transmission based on voltage source converters.	A	1	1	E		4	1	3
	ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL								
	Pulse number, choice of converter configuration	A	2	2	U	12	4	3	2
	Simplified analysis of Graetz circuit	A	2	1	A		3	1	0

II	Converter bridge characteristics – characteristics of a twelve pulse converter.	A	3	2	A	9	3	1	1
	Detailed Analysis of converters	A	3	1	A		4	2	2
	General principles of DC link control	A	4	1	U		4	3	1
	Converter control characteristics	A	4	1	A		4	3	2
	System control hierarchy - Firing angle control –	A	4	1	U,A		5	3	3
	Current and extinction angle control –	A	4	1	U,A		4	3	2
	Generation of harmonics and filtering -	A	4	1	U,E		4	2	2
	power control – Higher level controllers	A	4	1	U,A		4	2	1
MULTITERMINAL DC SYSTEMS									
III	Introduction	A	9	1	R	9	5	3	0
	Potential applications of MTDC systems	A	9	2	A		4	3	2
	Types of MTDC systems	A	9	2	U, Ap		5	3	1
	Control and protection of MTDC systems	A	9	2	A, Ap		5	2	1
	Study of MTDC systems	A	9	2	A		5	3	0
POWER FLOW ANALYSIS IN AC/DC SYSTEMS									
IV	Per unit system for DC Quantities	A	10	1	U	9	5	4	3
	Modeling of DC links	A	10	2	A		5	4	4
	Solution of DC load flow	A	10	2	A		5	3	1
	Solution of AC-DC power flow	A	10	2	A		5	3	1
	Case studies	A	10	2	AP		5	3	0
SIMULATION OF HVDC SYSTEMS									
V	Introduction	A	11	1	U	9	5	5	0
	System simulation: Philosophy and tools	A	11	2	A, AP		4	3	1
	HVDC system simulation	A	11	2	A, C		5	3	2
	Modeling of HVDC systems for digital dynamic simulation	A	11	2	A, E		4	3	2
	Dynamic in traction between DC and AC systems.	A	11	2	A, E		4	2	0

Bloom's Legends:**R**-Remembering**U**-Understanding**AP**-Applying**A**-Analyzing**C**-Creating**E** – Evaluating**7. TEXT BOOKS**

- A. K.R.Padiyar , “HVDC Power Transmission Systems”, New Age International (P) Ltd., New Delhi, 2012.
- B. Kamakshaiha S, Kamaraju V, ”HVDC transmission”, Tata McGraw Hill edu.pvt.ltd, 2011.

REFERENCE BOOKS

- C. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
- D. Erich Uhlmann, “Power Transmission by Direct Current”, BS Publications, 2004.
- E. V.K.Sood, HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004, Kluwer Academic Publishers.

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	0	2	2	0	7
UNIT II	0	6	0	7	1	0	14
UNIT III	1	1	2	3	0	0	7
UNIT IV	0	1	1	3	0	0	5
UNIT V	0	1	1	4	2	1	9
						TOTAL	42

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	2.38	4.76	0	4.76	4.76	0	16.66
UNIT II	0	14.29	0	16.67	2.38	0	33.34
UNIT III	2.38	2.38	4.76	7.14	0	0	16.66
UNIT IV	0	2.38	2.38	7.14	0	0	11.9
UNIT V	0	2.38	2.38	9.52	4.76	2.38	21.42
TOTAL	4.76	26.19	9.52	45.23	11.9	2.38	100
Lower Order Thinking (%)				40.47%			
Higher Order Thinking (%)				59.51%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand about the DC transmission system.

CO2: Apply knowledge to find the solution of the power flow problems.

CO3: Create and evaluate long distance DC transmission.

CO4: Applying the knowledge gained about the DC transmission to analyze about it.

CO5: To Analyze the DC transmission system and their problems by simulation techniques.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√				
CO2		√		√		

CO3			√	√√	√√		
CO4			√				
CO5					√√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√		√		√					√		√
CO2	√√	√√			√		√	√		√	√	√
CO3	√√	√√				√	√	√			√	
CO4	√√		√	√√								
CO5	√√	√√				√	√	√			√	√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√		√				√	√
CO2	√√				√	√√	√√				√	√
CO3	√√						√	√	√	√		
CO4		√√		√	√			√				
CO5	√√	√√	√						√	√		

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4
CO1	√√	√	√	
CO2	√√			
CO3		√		
CO4			√	
CO5	√√	√	√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE006	SMART GRID	3	0	0	3

1. **Course pre-requisites** : NIL
2. **Course learning objectives** :
 - i. To Study about Smart Grid technologies
 - ii. To familiarize the power quality management issues in Smart Grid
 - iii. To familiarize the high performance computing for Smart Grid applications
 - iv. To study the new concepts of smart meters and advanced metering infrastructure
 - v. To understand the need of smart grids
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : ELECTRICAL AND ELECTRONICS ENGINEERING
5. **Nature of the Course** : Group 1 – 100 % Descriptive
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION TO SMART GRID									
	Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits	6		3	R,U	9	4	4	4	
	Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid	6		2	U		3	3	2	
	Present development & International policies in Smart Grid,	6		2	A		3	2	2	
Diverse perspectives from experts and global Smart Grid initiatives.	6		2	R	3		2	2		
	SMART GRID TECHNOLOGIES									
	Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation	3		3	R		4	4	3	
	Transmission systems: EMS, FACTS and	3		3	U,A		3	3	3	

II	HVDC, Wide area monitoring, Protection and control								
	Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV)	3		4	U,A		4	4	3
SMART METERS AND ADVANCED METERING INFRASTRUCTURE									
III	Introduction to Smart Meters			2	R		5	4	3
	Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid	1		4	U,A		4	4	4
	Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.	1		3	U,A		4	4	3
POWER QUALITY MANAGEMENT IN SMART GRID									
IV	Power Quality & EMC in Smart Grid	2		2	R,U		4	3	4
	Power Quality issues of Grid connected Renewable Energy Sources	2		3	U		4	2	2
	Power Quality Conditioners for Smart Grid	2		2	U,A		4	3	2
	Web based Power Quality monitoring, Power Quality Audit.	2		3	U,A		4	3	3
HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS									
V	Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL	5		5	U,R		3	2	2
	IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter	5							
	Cyber Security for Smart Grid	4		2	U,A		3	3	3

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. REFERENCE BOOKS

WEB RESOURCES

- 1." Ramyar Rashed Mohassel, Alan Fung, Farah Mohammadi, Kaamran Raahemifar" A survey on Advanced Metering Infrastructure Electrical Power and Energy Systems 63 (2014) 473–484
2. "E. Prathibha A.Manjunath *Dept. of EEE, VTU university* "An Overview of Power Quality Issues in Smart Grid" International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163 Volume 1 Issue 10 (November 2014)
3. "Vehbi C. Gungör, *Member, IEEE*, Dilan Sahin, Taskin Kocak, Salih Ergüt,

Concettina Buccella, *Senior Member, IEEE*, Carlo Cecati, *Fellow, IEEE*, and Gerhard P. Hancke, *Senior Member, IEEE*” Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011

4.“Ye Yan, Yi Qian, Hamid Sharif and David Tipper” A Survey on Cyber Security for Smart Grid Communications IEEE Communications Surveys & Tutorials, Vol. 14, No. 4, Fourth Quarter 2012

5.” Murat Kuzlu, Manisa Pipattanasomporn, Saifur Rahman” Communication network requirements for major smart grid applications in HAN, NAN and WAN journal homepage: www.elsevier.com/locate/comnet

6. www.wikipedia.org

8. Assessing Level of Bloom’s Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	1	0	0	0	4
UNIT II	1	3	2	0	0	0	6
UNIT III	1	3	1	0	0	0	5
UNIT IV	1	3	1	0	0	0	5
UNIT V	1	2	1	0	0	0	4
TOTAL							24

9. Weightages of Bloom’s Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	4.16	8.33	4.16	0	0	0	16.65
UNIT II	4.16	12.5	8.33	0	0	0	24.99
UNIT III	4.16	12.5	4.16	0	0	0	20.82
UNIT IV	4.16	12.5	4.16	0	0	0	20.82
UNIT V	4.16	8.33	4.16	0	0	0	16.65
TOTAL	20.8	54.16	24.97	0	0	0	99.93
Lower Order Thinking (%)				99.93			
Higher Order Thinking (%)				0.07			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand about Smart Grid technologies, different smart meters and advanced metering infrastructure

CO2: Familiarize with the technologies of smart grid

CO3: Understand the concept of smart meters

CO4: Familiarize with power quality management

CO5: Will know the security system for smart grid

11. Mapping course outcome with Bloom’s Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√√		√			
CO2	√	√√				
CO3	√√	√				
CO4			√√			
CO5	√		√√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√		√√	√	√√		√	√	√		√
CO2	√√	√	√√		√		√	√		√	√	√
CO3	√√	√√				√	√	√			√	
CO4	√√		√	√√					√√			√
CO5	√√	√		√	√√		√√				√	

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√	√	√√	√	√√	√	√		√	√
CO2	√√	√√	√	√√	√	√						√
CO3	√√	√√	√√	√	√	√	√	√√	√	√		√
CO4	√√	√√	√	√	√		√				√	
CO5	√	√√	√√	√√	√	√√	√√	√	√√	√		√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	√
CO2	√√		√		√
CO3	√√	√		√	√
CO4	√√		√		√
CO5	√√	√	√√	√	√√

√√	Strongly agreed	√	Moderately agreed

Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE007	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	0	0	3

1. **Course pre-requisites** : Power Electronics, Power Generation Systems & AC Machines

2. **Course learning objectives** :

- i. To expose the students to the applications of power electronics in power systems
- ii. To understand the concepts of machines for renewable energy sources
- iii. To understand & design the PV systems
- iv. To understand & design the wind energy systems
- v. To understand & implement the concepts of wind and solar power systems

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : M.E. (Power Electronics and Drives)

5. **Nature of the Course** : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION									
	Environmental aspects of electric energy conversion	A,C	2,1	1	A	9	1	1	0	
	Impacts of renewable energy generation on environment	C	1	1	A		1	1	0	
	Qualitative study of renewable energy resources: Solar	C,D	4,5,6,1	1	U		2	4	5	
	Qualitative study of renewable energy resources: Wind	C,D	7,2	1	U		2	4	5	
	Qualitative study of renewable energy resources: Ocean	C,D	10,1	1	U	2	0	2		
	Qualitative study of renewable energy resources: Bio Mass	C,D	8,3	1	U	2	1	1		
	Qualitative study of renewable energy resources: Fuel Cell	C	12	1	U	2	1	1		
	Qualitative study of renewable energy resources: Hybrid renewable energy systems	A,C,D	28,7,5	2	U	2	4	4		
ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION										
	Review of reference theory fundamentals	B	6	2	R	9	5	2	4	

II	Principle of operation and analysis: Induction Generator	B	6	4	A		5	2	5
	Principle of operation and analysis: Synchronous Generator	B	6	3	A		4	2	4
ANALYSIS OF PV SYSTEMS									
III	Solar: Block diagram of solar photo voltaic system	A	27,28	2	A	9	5	5	4
	Principle of operation - Stand alone system	A	27,28	2	A		3	5	4
	Principle of operation - Grid connected system	A	27,28	2	A		3	5	4
	Selection of inverter - battery and array sizing	A	27,28	2	A		2	2	5
	Types of converters in PV system.	A	227,8	1	C		2	4	5
ANALYSIS OF WIND SYSTEMS									
IV	Stand alone operation of fixed speed wind energy conversion systems	A	28	2	U	9	4	2	0
	Stand alone operation of variable speed wind energy conversion systems	A	28	2	U		5	2	0
	Grid connection system and its issues	A	28	1	R		1	0	0
	Grid integrated with PMSG Based WECS	A	28	1	A		4	1	2
	Grid integrated with SCIG Based WECS	A	28	1	A		4	1	2
	Grid integrated with DFIG Based WECS	A	28	1	A		4	1	2
	Types of inverters in wind system	A	28	1	C		3	1	5
CASE STUDIES IN RENEWABLE ENERGY SOURCES									
V	Case studies of Wind - Maximum Power Point Tracking (MPPT) Techniques	A	28	2	AP	9	5	2	5
	Case studies of Solar - Maximum Power Point Tracking (MPPT) Techniques	A	27,28	3	AP		5	2	5
	Case studies of Solar - Inverter technologies	A	27,28	1	A		5	2	5
	Case studies of Solar - Converter technologies	A	27,28	1	A		5	2	5
	Case studies of Wind - Inverter technologies	A	28	1	A		5	3	5
	Case studies of Wind - Converter technologies	A	28,30	1	A		5	3	5

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Muhammad H. Rashid, "Power Electronics Handbook", Elsevier, 2011.

B. S N Bard, D Kastha, S Banerjee, "Wind Electrical Systems", Oxford University Press, 2012.

REFERENCE BOOKS

C. B H Khan, "Non-Conventional Energy Resources", the McGraw Hill Companies – 2nd edition 2009.

D. G D Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 2011.

E. Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, John Wiley & Sons, 2011.

WEB RESOURCES

8. Assessing Level of Bloom’s Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	0	6	0	2	0	0	8
UNIT II	1	0	0	2	0	0	3
UNIT III	0	0	0	4	0	1	5
UNIT IV	1	2	0	3	0	1	7
UNIT V	0	0	2	4	0	0	6
TOTAL							29

9. Weight age of Bloom’s Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	0	20.69	0	6.89	0	0	27.59
UNIT II	3.44	0	0	6.89	0	0	10.33
UNIT III	0	0	0	13.79	0	3.44	17.23
UNIT IV	3.44	6.89	0	10.34	0	3.44	24.11
UNIT V	0	0	6.89	13.79	0	0	20.68
TOTAL	6.88	27.58	6.89	51.70	0	6.88	100
Lower Order Thinking (%)				41.35%			
Higher Order Thinking (%)				58.58%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand the concepts of renewable energy systems.

CO2: Understand the concepts of different types of Electrical Machines employed for Renewable Energy Conversion Systems.

CO3: Understand the concepts of Standalone, Grid connected PV Systems.

CO4: Understand the concepts of Standalone, Grid connected Wind Systems.

CO5: Design a system, component or process to meet desired needs.

11. Mapping course outcome with Bloom’s Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1		√		√		
CO2	√			√		
CO3		√		√		√
CO4		√		√		√
CO5			√	√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√		√		√					√		√
CO2	√√		√√		√		√	√		√	√	√
CO3	√√					√	√	√			√	
CO4			√	√√					√√			
CO5		√√			√			√√	√			√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√		√	√	√				√	√		√
CO2	√√	√	√		√		√	√			√	√
CO3	√					√	√	√				
CO4			√	√					√		√√	
CO5	√	√√			√	√		√	√	√		

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	
CO2	√				√
CO3		√	√		
CO4		√		√	
CO5	√				√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE008	WIND ENERGY CONVERSION SYSTEMS	3	0	0	3

1. Course pre-requisites : i) Renewable energy systems
ii) Power Electronics
iii) Power Electronics for Renewable energy systems
2. Course learning objectives :
i. To understand the role of Wind Energy Conversion Systems in the power generation.
ii. To apply the types of Wind turbines.
iii. To apply efficient generator models in fixed speed wind energy systems.
iv. To model and analyze the variable speed systems in wind energy systems.
v. To analyze the grid connected systems.
3. Expected Level of Output : Conceptual Level
4. Department Offered : Electrical and Electronic Engineering
5. Nature of the Course : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. Course Input :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION									
	Components of WECS	A,B	1,2	1	U	9	5	5	0	
	WECS schemes	A	1,2	2	R		4	5	2	
	Power obtained from wind	A	2	1	A		5	4	0	
	Simple momentum theory	A	2	1	AP		4	4	0	
	Power coefficient	A,B	2,4	1	AP		5	4	0	
	Sabinin's theory	A,B	2,4	1	A		4	2	3	
	Aerodynamics of Wind turbine	A,B	2,4	2	A		4	2	4	
WIND TURBINES										
	Horizontal Axis Wind Turbine	A,B	3,7	1	U	9	5	5	0	

II	Vertical Axis Wind Turbine	A,B	3	1	U	9	5	5	0
	Power developed- Thrust-Efficiency	A,B	3	1	U		5	4	2
	Rotor selection- Rotor design consideration- Tip speed ratio	A,B	3	2	AP		5	4	0
	No. of Blades-Blade profile- Power Regulation	A,B	7,5,9	1	R		4	4	1
	Yaw control-Pitch angle control- Stall control	A,B	7,5,9	1	R		5	5	0
	Schemes for maximum power extraction	A,B	7,5,9	2	A		5	5	4
FIXED SPEED SYSTEMS									
III	Generating Systems- Constant speed constant frequency systems	B	8	2	U	9	4	4	0
	Choice of Generators-Deciding factors- Synchronous Generator-Squirrel Cage Induction Generator	B	8	2	U		5	4	0
	Model of Wind Speed	A	9	1	R		5	5	4
	Model wind turbine rotor	A	9,17	1	R		5	5	5
	Drive Train model	A,B	9,6	2	A		5	5	3
	Generator model for Steady state and Transient stability analysis	B	10	1	U		4	3	0
VARIABLE SPEED SYSTEMS									
IV	Need of variable speed systems	B	8	1	U	9	4	4	0
	Power-wind speed characteristics	B	8	2	AP		5	4	0
	Variable speed constant frequency systems synchronous generator	B	8	2	U		4	5	1
	DFIG	B	8	1	A		5	5	4
	PMSG	B	8	2	A		5	5	4
	Variable speed generators modeling	B	8	1	AP		4	4	0
GRID CONNECTED SYSTEMS									
	Stand alone WECS system	B	8	2	U	9	4	5	4
	Grid Connected WECS system	B	10	2	U		4	5	4
	Grid connection Issues	A,B	7,10	1	A		3	1	0

V	Machine side controllers	A,B	10	1	R	5	4	0
	Grid side controllers	B	10	1	R	5	4	0
	WECS in various countries	B	10	1	R	2	1	1
	Fault ride through technique in Wind Energy System. (Beyond Syllabus)	B	8	1	U	4	3	3

Bloom's Legends:

R-Remembering

U-Understanding

AP-Appling

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Hau, Erich, "Wind Turbines Fundamentals, Technologies, Application, Economics", Springer Publications, Third Edition, 2013.
- B. Alois Schaffarczyk, "Understanding Wind Power Technology: Theory, Deployment and Optimization", Wiley Publications, 2014.

REFERENCE BOOKS

- C. Gasch, Robert, Twele, Jochen, "Wind Power Plants- Fundamentals, Design, Construction and Operation", Springer Publications, Second Edition, 2012.
- D. Tony Burton, Nick Jenkins, David Sharpe, Ervin Bossanyi, "Wind Energy Handbook", John Wiley & Sons, Ltd, Second Edition, 2011.
- E. Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro, "Power Conversion and Control of Wind Energy System", Wiley Publications, 2011.

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	1	2	2	0	0	6
UNIT II	2	3	1	1	0	0	7
UNIT III	2	3	0	1	0	0	6
UNIT IV	0	2	2	2	0	0	6
UNIT V	3	3	1	0	0	0	7
TOTAL							32

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	3.125	3.125	6.25	6.25	0	0	18.75
UNIT II	6.25	9.375	3.125	3.125	0	0	21.875
UNIT III	6.25	9.375	0	3.125	0	0	18.75
UNIT IV	0	6.25	6.25	6.25	0	0	18.75
UNIT V	9.375	9.375	3.125	0	0	0	21.875
TOTAL	25	37.5	18.75	18.75	0	0	100
Lower Order Thinking (%)				100 %			
Higher Order Thinking (%)				NIL			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand the importance of Wind Energy Conversion Systems.

CO2: Analyze the types of wind turbines.

CO3: Acquire the knowledge in various generator models.

CO4: Analyze the variable speed systems in wind energy systems.

CO5: Examine the concepts in grid connected system.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√	√			
CO2		√		√		
CO3			√√	√		
CO4		√		√		
CO5			√		√	

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1		√√	√	√								√
CO2		√√	√√	√					√		√	
CO3	√√					√	√	√			√	
CO4	√√		√	√√								
CO5												

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√		√	√
CO2	√√				√	√					√	√
CO3	√√	√	√	√	√	√					√	
CO4	√	√√	√	√							√	
CO5	√	√	√	√	√	√	√				√	

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	
CO2	√√	√	√	√	
CO3	√	√√	√	√	
CO4	√	√	√	√	
CO5	√	√	√	√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE009	SOLAR ENERGY GENERATION AND UTILIZATION	3	0	0	3

1. **Course pre-requisites** : Basics of renewable energy and solar energy
2. **Course learning objectives** :
 - i. To provide an introduction of solar thermal power generating systems, principles, materials and theories.
 - ii. To provide an introduction of solar photovoltaic power generating systems, principles, materials and theories
 - iii. To learn the fundamental concepts of solar energy radiation, its measurement and collecting instruments
 - iv. To study about approaches for the storage of solar energy
 - v. To learn about the areas of solar energy application
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 3 – 75% Descriptive & 25% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	SOLAR THERMAL POWER GENERATION									
	Solar Parabolic trough - Solar parabolic dish	A	10	3	U,AP	9	2	4	3	
		D	3							
	Solar tower concepts-Tower design - Heliostat type	A	10	3	U,AP		2	4	3	
		D	3							
Performance study, site selection and land requirement for the above technologies	A	2	3	R	1		1	1		
II	SOLAR PHOTOVOLTAIC POWER GENERATION									
	Solar PV technologies overview - Stationary and concentrated PV	A	9	3	U,AP	9	2	4	1	
		B	6							
	Standalone systems	A	9	2	U		2	3	2	
	Grid connected systems	A	9	2	U		2	3	2	
	Site selection and land requirements	A	2	1	R		1	1	1	
Environmental considerations	A	2	1	R	1		1	1		
	SOLAR RADIATION MEASUREMENT									
	Solar radiation and modeling	B	3	1	U,AP	9	1	4	0	
	Empirical equations for predicting the	B	3	2	U,AP		3	3	0	

III	availability of solar radiation								
	Measurement of global, direct and diffuse radiation	C	2	1	R		1	2	1
	Standard radiation scale-Measurement of solar radiation	A	1	2	R		2	2	1
		C	2						
	Solar energy measuring instruments – Pyranometer	C	3	1	R,U		3	1	0
	Pyrheliometer	C	3	1	R,U		3	1	0
Sunshine recorder	C	3	1	R,U		3	1	0	
SOLAR ENERGY STORAGE									
IV	Types of Energy Storage- thermal storage	B	7	3	R,U	9	1	3	2
	Electrical Storage	B	7	2	R,U		1	3	2
	Chemical Storage	B	7	2	R,U		1	2	1
	Hydro-storage	B	7	2	R,U		1	2	1
SOLAR ENERGY APPLICATIONS									
V	Introduction and principle of operation of solar cooling	E	2	1	R,U	9	2	1	0
	Building Heating: Passive and Hybrid Methods	E	2	1	R,U		2	1	0
	Solar air heater	B	5	1	R,U		2	1	0
	Solar water heater	E	2	1	R,U		2	1	0
	Solar distillation	E	2	1	R,U		2	1	0
	Solar pond	E	2	1	R,U		2	1	0
		B	8						
	Solar thermal power generation	E	2	2	R,U		2	1	0
		A	10						
Greenhouse	D	2	1	R,U	2	1	0		

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Soteris A. Kalogirou, 'Solar Energy Engineering: Processes and Systems', 2009

B. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co., 3rd Edition, 2008.

REFERENCE BOOKS

C. Solar and Infrared Radiation Measurements (Energy and the Environment) June,2012

D. Electricity Generation using Solar Thermal Technology, the Wikipedia community books

E. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman,4th Edition, April 2013.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	2	0	0	0	5
UNIT II	2	3	1	0	0	0	6
UNIT III	5	5	2	0	0	0	12
UNIT IV	4	4	0	0	0	0	8

UNIT V	8	8	0	0	0	0	16
TOTAL							47

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	2.1	4.25	4.25	0	0	0	10.6
UNIT II	4.25	6.38	2.1	0	0	0	12.73
UNIT III	10.63	10.63	4.25	0	0	0	25.51
UNIT IV	8.51	8.51	0	0	0	0	17.02
UNIT V	17.02	17.02	0	0	0	0	34.04
TOTAL	42.51	46.72	10.6	0	0	0	100
Lower Order Thinking (%)				100 %			
Higher Order Thinking (%)				NIL			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able:

CO1: To provide an introduction of solar thermal power generating systems, principles, materials and theories.

CO2: To provide an introduction of solar photovoltaic power generating systems, principles, materials and theories

CO3: To learn the fundamental concepts of solar energy radiation, its measurement and collecting instruments

CO4: To study about approaches for the storage of solar energy

CO5: To learn about the areas of solar energy application

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√				
CO2	√	√				
CO3	√	√				
CO4		√	√			
CO5			√√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√					√					√	√
CO2	√					√					√	√
CO3	√		√		√						√	√
CO4	√√	√				√√					√√	√
CO5	√√	√	√√			√√					√√	√√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√				√			√			√	√
CO2	√				√			√			√	√

C03	√	√√			√			√		√	√	√
C04	√		√					√		√	√	√
C05	√	√√	√√		√			√√	√	√√	√√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
C01				√	√
C02				√	√
C03		√		√	√
C04				√	√
C05	√√	√		√	√√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE010	SOFT COMPUTING TOOLS APPLIED IN ELECTRICAL ENGINEERING	3	0	0	3

1. **Course pre-requisites** : Control system

2. **Course learning objectives** :

- i. To expose the concepts of feed forward neural networks.
- ii. To provide adequate knowledge about feed back neural networks.
- iii. To teach about the concept of fuzziness involved in various systems.
- iv. To expose the ideas about genetic algorithm
- v. To provide adequate knowledge about of FLC and NN toolbox

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : EEE

5. **Nature of the Course** : Group 3– 70 % Descriptive & 30% Analytical

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS									
	Introduction of Soft Computing-Soft computing vs hard computing-Variou types of soft computing techniques-Applications of soft computing	A	1	2	U	9	5	5	3	
	Neuron-Nerve structure and Synapse-Artificial Neuron and its model - Activation functions - Neural network architecture -Single layer and Multilayer feed forward networks	A	1	3	U		5	5	2	
	McCullochPitts neuron model - Perceptron model – Adaline and Madaline - Multilayer perception model - Back propagation learning methods	A	1	2	R		5	2	1	
	Effect of learning rule coefficient - back	A	6	2	A		5	2	1	

	propagation algorithm - Factors affecting Back propagation training - Applications									
II	ARTIFICIAL NEURAL NETWORKS									
	Counter propagation network – Architecture - Functioning & Characteristics of counter -Propagation Network	A	4	2	U	9	5	3	1	
	Hopfield/ Recurrent network – Configuration - Stability constraints - Associative memory and characteristics - Limitations and applications - Hopfield v/s Boltzmann machine	A	3	3	U		5	1	1	
	Adaptive Resonance Theory – Architecture – Classifications	A	5	2	U		5	1	1	
	Implementation and training - Associative Memory	A	3	2	AP		5	1	1	
III	FUZZY LOGIC SYSTEM									
	Introduction to crisp sets and fuzzy sets - Basic fuzzy set operation and approximate reasoning	B	2	3	A	9	5	2	2	
	Introduction to fuzzy logic modeling and control – Fuzzification – Inferencing and defuzzification - Fuzzy knowledge and rule bases - Fuzzy modeling and control schemes for nonlinear systems	B	4	3	A		5	2	2	
Self organizing fuzzy logic control - Fuzzy logic control for nonlinear time delay system	B	8	3	A	5		1	2		
IV	GENETIC ALGORITHM									
	Basic concept of Genetic algorithm and detail algorithmic steps - Adjustment of free Parameters	D	1	3	A	9	3	1	1	
	Solution of typical control problems using genetic algorithm	D	3	3	U		3	1	1	
Concept on some other search techniques like Tabu Search and Ant Colony Search techniques for solving optimization problems	D	3	3	A	3		1	1		
V	APPLICATIONS									
	GA application to power system optimization problem - Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab - Neural Network toolbox	D	6	3	AP	9	5	2	0	
	Stability analysis of Neural Network interconnection systems	A	5	1	AP		5	2	0	
Implementation of fuzzy logic controller using Matlab Fuzzy logic toolbox - Stability analysis of fuzzy control systems	B	13	5	AP	5		2	0		

Bloom's Legends:**R**-Remembering**U**-Understanding**AP**-Applying**A**-Analyzing**C**-Creating**E** – Evaluating**7. REFERENCE BOOKS**

- A.** Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education, 2012.
- B.** Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India, 2009.
- C.** Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
- D.** David E. Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009
- E.** W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.

WEB RESOURCES**8. Assessing Level of Bloom's Taxonomy in Numbers:**

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	0	1	0	0	4
UNIT II	0	3	1	0	0	0	4
UNIT III	0	0	0	3	0	0	3
UNIT IV	0	1	0	2	0	0	3
UNIT V	0	0	3	0	0	0	3
TOTAL							17

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	5.88	11.76	0	5.88	0	0	23.52
UNIT II	0	17.64	5.88	0	0	0	23.52
UNIT III	0	0	0	17.64	0	0	17.64
UNIT IV	0	5.88	0	11.76	0	0	17.64
UNIT V	0	0	17.64	0	0	0	17.64
TOTAL	5.88	35.28	23.52	35.28	0	0	100
Lower Order Thinking (%)				64.68%			
Higher Order Thinking (%)				35.28%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand the concepts of feed forward neural networks.

CO2: Understand about feedback neural networks.

CO3: Understand about the concept of fuzziness involved in various systems.

CO4: Understand ideas about genetic algorithm.

CO5: Understand about FLC and NN toolbox.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√				
CO2		√	√			
CO3		√	√	√		
CO4			√	√		
CO5			√	√		√

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√			√		√		√	√	√		
CO2	√			√		√		√	√	√		
CO3	√			√		√		√	√	√		
CO4	√			√		√		√	√	√		
CO5	√			√		√		√	√	√		

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√		√√		√√				√√			
CO2		√√			√√		√√		√√			√√
CO3		√√		√√				√√				√√
CO4		√√		√√			√√	√√		√√	√√	
CO5		√√		√√			√√	√√		√√	√√	

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√√	√√	√√	
CO2	√√	√√	√√	√√	
CO3	√√	√√	√√	√√	√√
CO4	√√	√√	√√	√√	√√
CO5	√√	√√	√√	√√	√√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE011	PLC AND SCADA	3	0	0	3

1. **Course pre-requisites** :NIL
2. **Course learning objectives** :
 - i. To learn the basics about PLC and SCADA.
 - ii. To have an idea about programming languages and program control functions.
 - iii. To learn the ladder logic programming using corresponding functions.
 - iv. To know the basics of SCADA and its hardware, software.
 - v. To have a knowledge about communication protocols in SCADA.
3. **Expected Level of Output** :Understanding and creating
4. **Department Offered** :Electrical and Electronics Engineering
5. **Nature of the Course** :C. Group 3 – 80% Descriptive & 20% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** :60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLERS									
I	Definition and History of PLC –Parts of PLC-Principle of operation- modifying the operation	A,B	1,1	2	U	9	5	4	1
	PLC Advantages and Disadvantages - Manufacturing and assembly Processes	B	1	2	R		5	4	1
	Overall PLC System Architecture- PLC CPU, Solid state Memory, the processor, Input and Output Modules, Power supplies.	A,B	2,1	3	U		4	3	2
	Programming Languages: Ladder Diagram, Function Block Diagram, Instruction List, Structured Text and Sequential Function Charts	A,B	5,3	2	A		5	4	1
PROGRAMMING OF PLC									
II	Basics:Relay-Type instructions, instruction addressing, Branch instructions, internal relay instructions, EXAMINE IF CLOSED and EXAMINE IF OPEN instructions.	A	5	2	AP	9	5	5	0
	Fundamentals of Logic, Timer and Counter	A,B	4,7,8,	3	E		5	3	1

	Instructions		3						
	Arithmetic and Comparison Functions, SKIP and MCR function,	A,B	10,11 4	2	E		5	2	2
	Sequencer and Shift Register instructions.	A	12	2	A		5	2	2
	NETWORKING OF PLCs								
III	Levels of Industrial Control -Types of Networking – Remote I/O Expansion - Cell Control by PLC	B	7	3	R	9	5	5	2
	PLC installation, troubleshooting and maintenance	A,B	13,8	2	U		5	4	0
	Data acquisition System: Components and its functions	A	14	1	U		5	5	0
	Networks Basics: Introduction to Field Bus and Process Bus – Control Networks and Device Networks – Ethernet	D	5,11, 15	3	U		5	5	2
	SCADA								
IV	Introduction- Brief history- Principles of modern SCADA system	C	1	3	R	9	4	4	0
	SCADA Hardware – SCADA software-system implementation	C	2	2	U		5	4	2
	Remote terminal units, the master station: Local area network	C	2	2	A		5	4	1
	System reliability - Availability – Communication architecture	C	2	2	U		5	3	1
	FUNCTIONS AND PROTOCOLS OF SCADA								
V	The components of a SCADA system - SCADA software package: Redundancy, System response time, Expandability of the system	C	3	2	U	9	5	4	1
	Introduction to protocols - High level data link control (HDLC) protocol - Error detection - Distributed network protocol	C	3	2	U		5	4	1
	New technologies in SCADA systems – Ethernet - types of Ethernet- TCP/IP protocols	C	3,5	2	A		4	4	2
	Troubleshooting and Maintenance-Specifications of system	C	8,9	3	U		5	3	0

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Frank D. Petruzella, Programmable Logic Controllers”, Tata McGraw-Hill, New Delhi, 2011.

B. John W. Webb and Ronald A. Reis, “Programmable logic controllers: Principles and Applications”, Prentice Hall India, New Delhi, 2009.

C. David Bailey, Edwin Right, “Practical SCADA for Industry”, Newnes (Elsevier), Mumbai, 2003.

REFERENCE BOOKS

D. Sunit Kumar Sen, “Fieldbus and Networking in Process Automation”, CRC Press, 2014.

E. Peng Zhang, “Advanced Industrial Control Technology”, Elsevier, 2010.

F. William Bolton, “Programmable Logic Controllers”, Newnes, 2006.

WEB RESOURCES

8. Assessing Level of Bloom’s Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	0	1	0	0	4
UNIT II	0	0	1	1	2	0	4
UNIT III	1	3	0	0	0	0	4
UNIT IV	1	2	0	1	0	0	4
UNIT V	0	3	0	1	0	0	4
TOTAL							20

9. Weightage of Bloom’s Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	5	10	0	5	0	0	20
UNIT II	0	0	5	5	10	0	20
UNIT III	5	15	0	0	0	0	20
UNIT IV	5	10	0	5	0	0	20
UNIT V	0	15	0	5	0	0	20
TOTAL	15	50	5	20	10	0	100
Lower Order Thinking (%)				70 %			
Higher Order Thinking (%)				30%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: To learn the basics of Programmable Logic Controller

CO2: To understand and execute the ladder logic programming

CO3: To understand the networking concepts of PLC

CO4: To learn about the hardware and software of SCADA

CO5: To know the new technologies in SCADA

11. Mapping course outcome with Bloom’s Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√				
CO2		√	√	√	√	√
CO3	√	√				
CO4	√	√				
CO5	√		√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1							√	√				
CO2	√√	√√	√√	√	√		√		√√		√	√
CO3	√√		√		√	√	√		√	√	√	√
CO4	√			√		√		√				
CO5			√		√		√		√	√		√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		√		√	√	√	√		√	√		
CO2	√	√√	√√	√	√	√	√√	√	√	√	√	√
CO3	√	√	√	√		√	√	√			√	√
CO4				√	√		√	√			√	
CO5	√		√	√			√		√		√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1			√		
CO2	√√	√√		√	√
CO3	√√	√	√		√
CO4			√		
CO5	√√	√	√	√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE012	ADVANCED CONTROL SYSTEM	3	0	0	3

1. **Course pre-requisites** : Control System
2. **Course learning objectives** :
 - i. To learn the design and performance of Controllers
 - ii. To have an idea about representing the system in State-space model
 - iii. To obtain the knowledge about system identification
 - iv. To Study the adaptive control and its techniques
 - v. To gain knowledge about estimation of systems through filters
3. **Expected Level of Output** : Analyzing and Evaluating
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : C. Group 3 60% Descriptive & 40% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	ROBUST PID CONTROL									
	Introduction - Control structures and Performance measures	A	8	2	U	9	5	4	3	
	Design of PID controllers with Frequency-Response approach and Computational Optimization Approach	A,B	8,5	3	AP		5	3	4	
	Modifications of PID control schemes	B	8	2	A		5	2	3	
	Two-Degree of Freedom control	B	8	2	A		5	2	2	
II	STATE SPACE ANALYSIS									
	Limitations of conventional control theory - Concepts of state, State variables and state model	A	10	2	U	9	5	5	2	
	State space representations - State Transition Matrix	A,B	10,9	2	A		5	4	2	
	Transfer function from state model - Solution of State equations	B	9	3	E		5	3	1	
	Controllability and Observability	A,B	10,9	2	AP		5	3	1	
Pole placement by state feedback	A,B	10,10	2	A						

SYSTEM IDENTIFICATION									
III	Models of LTI systems: Linear Models - State space Models	C	2	2	R	9	5	4	2
	Output Error model - Model sets	C	4	2	U		5	3	1
	Structures and Identifiability	C	5	2	U		5	3	2
	Models for Time-varying and Non-linear systems	C,F	5	3	U		5	3	2
ADAPTIVE CONTROL									
IV	Introduction – Uses – Auto tuning – Self Tuning Regulators (STR)	D	3,4,8	2	U	9	5	3	1
	Model Reference Adaptive Control (MRAC)	D	5	2	A		5	3	2
	Types of STR and MRAC	D	4,5	3	A		4	3	1
	Different approaches to self tuning regulators	D	7,9	2	U		5	3	1
STATE ESTIMATION									
V	Estimation of continuous linear systems	E,I	1, 1,7	2	U	9	5	3	1
	Wiener Hopf Integral equation	J,I	4,16	3	A		5	3	1
	Continuous Kalman filter	E	2	2	U		5	3	1

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Benjamin C Kuo, "Automatic Control Systems", John Wiley & Sons, Inc., Delhi, 2010.
- B. Katsuhiko Ogata, "Modern Control Engineering", Pearson's Education, Fifth Edition, New Jersey, 2010.
- C. Ljung L, "System Identification: Theory for the user", Prentice Hall, New Jersey, 1999.
- D. Astrom and Wittenmark, "Adaptive Control", Dover Publications, 2008.
- E. Arthur G O Mutambara, "Decentralized Estimation and Control for Multisensory Systems", CRC, 1998.

REFERENCE BOOKS

- F. GP RAO, L.Sivakumar, "Piecewise linear system identification via Walsh functions", International Journal of Systems Science, Vol.13, Iss 5, P.No 525-530, 1982.
- G. Eykhoff P, "System Identification Parameter and State Estimation", John Wiley and Sons, London, 1974.
- H. Narendra and Annasamy, "Stable Adaptive Control Systems", Dover Publications, 2005.
- I. Kailath T, Hassibi B and Sayed A H, "Linear Estimation", Prentice Hall of India, New Delhi, 2000.
- J. Arthur Gelb, "Applied Optimal Estimation", The MIT Press, London, 2001.

WEB RESOURCES

K. <http://nptel.ac.in/courses/108103007/>

L. <http://nptel.ac.in/courses/108101037/>

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	0	1	1	2	0	0	4

UNIT II	0	1	1	2	1	0	4
UNIT III	1	3	0	0	0	0	4
UNIT IV	0	2	0	2	0	0	4
UNIT V	0	2	0	1	0	0	4
TOTAL							20

9. Weightage of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	0	5	5	10	0	0	20
UNIT II	0	5	5	10	5	0	20
UNIT III	5	15	0	0	0	0	20
UNIT IV	0	10	0	10	0	0	20
UNIT V	0	10	0	5	0	0	20
TOTAL	5	45	10	35	5	0	100
Lower Order Thinking (%)				60 %			
Higher Order Thinking (%)				40%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: To obtain the knowledge about controllers and its tuning methods

CO2: To get an idea about state space model and its analysis

CO3: To learn about model identification.

CO4: To learn about adaptive control techniques

CO5: To understand the concepts of optimal filters

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1		√	√	√		
CO2		√	√			
CO3	√	√				
CO4	√	√				
CO5		√	√	√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1			√	√	√	√	√	√	√	√		
CO2	√√	√√	√√	√	√		√		√	√	√	√
CO3	√		√		√	√	√			√	√	√
CO4			√	√	√	√		√	√			
CO5	√	√	√	√	√	√	√		√	√		√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√√	√	√	√	√√	√	√√	√
CO2	√	√√	√√		√		√		√	√		

CO3	√				√	√	√			√	√	
CO4			√	√	√		√	√	√			√
CO5	√	√		√	√√		√		√√	√	√√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√√	√√
CO2	√	√√		√√	
CO3	√		√		
CO4	√		√		√
CO5	√√	√	√	√√	√√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE013	EMBEDDED CONTROL OF ELECTRICAL DRIVES	3	0	0	3

1. **Course pre-requisites** : Machines, Power Electronics , Embedded Systems
2. **Course learning objectives** :
 - i. To study the Architecture of PIC 16C7X Microcontroller
 - ii. To understand the various peripherals of PIC 16C7X
 - iii. To study the C2XX DSP CPU and Instruction Set
 - iv. To understand the various peripherals of signal processors
 - v. To understand the applications of PIC and Signal Processors
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 3 – 75 % Descriptive & 25% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	PIC 16C7X MICROCONTROLLER						9	4	3	1
	Architecture memory organization	A	1	2	R	4		3	2	
	Addressing modes	A	2	2	R	4		2	3	
	Instruction set	A	2	2	U	3		2	2	
	Programming techniques simple programs	A	2	3	U					
II	PERIPHERALS OF PIC 16C7X						9	4	3	2
	Timers , Interrupts	A	6	3	AP	4		3	2	
	I/O ports , I 2C bus for peripheral chip access	A	7,9	3	A	4		3	2	
	A/D converter , UART	A	10,11	3	U	4	3	2		
	C2XX DSP CPU and Instruction Set									

III	Introduction - System configuration registers	B	2	2	R	9	4	3	2
	Memory Addressing modes	B	2	2	R		4	4	2
	Instruction set	B	2	2	U		4	4	2
	Programming techniques – simple programs	B	2	3	U	3	2	2	
PERIPHERALS OF SIGNAL PROCESSORS									
IV	General purpose Input/output (GPIO) Functionality	B	3	2	R	9	4	2	1
	Interrupts, A/D converter	B	4,5	2	AP		4	2	2
	Event Managers (EVA, EVB)	B	6	3	A		4	2	1
	PWM signal generation	B	6	2	C		4	2	2
APPLICATIONS OF PIC AND SIGNAL PROCESSORS									
V	Voltage regulation of DC-DC converters- Stepper motor and DC motor control	B	7	2	AP	9	5	5	2
	Clarke's and parks transformation	B	10	2	AP		4	4	2
	Space vector PWM	B	11	2	A		4	3	2
	Control of Induction Motors and PMSM	B	12, 13	3	A		5	5	2

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. John B.Peatman , 'Design with PIC Microcontrollers,' Pearson Education, Asia 2004
- B. Hamid A.Toliyat, Steven Campbell, 'DSP based electromechanical motion control', CRC Press, 2003

REFERENCES

- C. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" Prentice Hall of India, 2002
- D. Ion Boldea & S.A.Nasar "ELECTRIC DRIVES", CRC Press, 2006

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	2	2					4
UNIT II		1	1	1			3
UNIT III	2	2					4
UNIT IV	1		1	1		1	4

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		√√	√√				√√				√	√
CO2	√√	√√	√√	√	√		√√				√	√
CO3		√√	√√				√√				√	√
CO4	√√	√√	√√	√	√		√√				√	√
CO5	√√	√√	√√	√	√		√√				√	√

15. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√			√√	
CO2	√√	√√		√√	
CO3	√√			√√	
CO4	√√	√√		√√	
CO5	√√	√√	√	√√	√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE014	DIGITAL SIGNAL PROCESSING USING MATLAB AND WAVELETS	3	0	0	3

1. **Course pre-requisites** : 11UBK651 - Digital Signal Processing
2. **Course learning objectives** :
 - i. Introduce to advanced DSP and MATLAB.
 - ii. To help students to understand the Estimation of spectrum analysis.
 - iii. To understand various design strategies of FIR and IIR filter.
 - iv. To introduce the concepts of wavelet based signal processing.
 - v. To help students to apply real time applications.
3. **Expected Level of Output** : Realistic Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : C. Group 3 –50% Descriptive & 50% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
INTRODUCTION TO DSP AND MATLAB									
I	Sampling and representation of discrete signals and systems.	A,B	5,9	3	U	9	3	2	5
	Amplitude and time quantization & Difference equations	A,B	5,9	2	R		2	1	4
	Impulse, frequency and phase responses	A,B	5,9	2	R		3	1	3
	Introduction to DSP simulation software on the PC (MATLAB)	A,B	5,1	2	U,E		5	5	4
SPECTRUM ESTIMATION									
II	Estimation of spectra from finite duration signals – Non-Parametric Methods – Correlation Method	B,C,D	5,6	3	R	11	2	2	3
	Periodogram Estimator – Performance Analysis of Estimators – Unbiased,	B,C,D	5,6	2	R		3	1	3

	Consistent Estimators								
	Modified Periodogram – Bartlett and Welch methods – Blackman – Tukey method - Parametric Methods	B,C,D	6,7	3	R		3	2	3
	AR, MA, and ARMA model based spectral estimation – Parameter Estimation –Yule-Walker equations – Solutions using Durbins algorithm	B,C,D	6,7	3	R		3	2	3
	DIGITAL FILTERS								
III	FIR and IIR digital filter structures - Properties	A,B,F	3,6	3	U	8	4	4	4
	Overview of some design techniques for digital filters	A,B,F	3,7	3	U		5	4	4
	Frequency transformations from prototype filters & Sources of error in filter design	A,B,F	3,8	2	U,A		4	4	4
	WAVELET BASED SIGNAL PROCESSING								
IV	Introduction of wavelet transform, uncertainty, wavelet analysis	A	9	3	U,A	9	4	2	3
	Multiresolution analysis	A	9	1	U		3	2	3
	Continuous wavelet transform – Properties - Mother wavelet – Redundancy	A	9	3	U,A		4	3	3
	Discrete wavelet transform – Frequency domain – Subband coding – Matrix interpretation	A	9	2	U		4	3	4
	APPLICATIONS								
V	Image compression, Image segmentation, Noise reduction & Discontinuity detection in ECG signal	A	10	3	AP,E	8	5	3	3
	Performing the 2D Discrete Wavelet Transform on an image	A	10	2	AP,E		5	4	2
	Wavelet Transform with Matrices - Filter Design	A	10	2	AP,E		5	4	2
	Frequency Magnitude Response of Sound	A	10	1	AP,E		5	2	3

Bloom's Legends:

R-Remembering

A-Analyzing

U-Understanding

C-Creating

AP-Applying

E – Evaluating

7. TEXT BOOKS

- A. Micheal weeks., digital signal processing using matlab with wavelets, george state university, 2007.
- B. Vinay k ingle.john g proakis., essentials of digital signal processing using matlab, cengage learning, 2012.

REFERENCE BOOKS

- C. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, New Jersey, John Wiley and Sons, 2002.
- D. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing, New Delhi, Pearson Education, 2002.
- E. John G. Proakis, Algorithms for Statistical Signal Processing, New Delhi, Pearson Education, 2002.
- F. Robert j.shilling., Sandra l.harris., fundamentals of digital signal processing using matlab, USA, cengage learning, 2010.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	2	2	0	0	1	0	5
UNIT II	4	0	0	0	0	0	4
UNIT III	0	3	0	1	0	0	4
UNIT IV	0	4	0	2	0	0	6
UNIT V	0	0	4	0	4	0	8
TOTAL							27

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	7.41	7.41	0	0	3.70	0	18.52
UNIT II	14.81	0	0	0	0	0	14.81
UNIT III	0	11.11	0	3.70	0	0	14.81
UNIT IV	0	14.81	0	7.41	0	0	22.22
UNIT V	0	0	14.81	0	14.81	0	29.62
TOTAL	22.22	33.33	14.81	11.11	18.51	0	100
Lower Order Thinking (%)				70 %			
Higher Order Thinking (%)				30 %			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand and remember the concept of DSP and MATLAB.

CO2: Students will be able to design System for estimation, Spectral Estimation and also able to perform wave formation Analysis of the System

CO3: optimize & matched filters for best performance.

CO4: Understand the different wavelet transforms.

CO5: use MATLAB real time applications & to write small programs in MATLAB

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√√	√√			√	
CO2	√√					
CO3		√√		√		
CO4		√√		√		
CO5			√√		√√	

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√		√	√	√						
CO2	√	√√	√									
CO3	√	√	√√	√								
CO4	√	√	√	√√								
CO5			√	√	√√	√						

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√										√	√
CO2	√	√√	√√								√	√
CO3	√	√√	√√								√	√
CO4	√	√√	√√								√	√
CO5								√√			√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√	√		
CO2	√	√		√	
CO3		√√		√	
CO4		√√		√	
CO5		√√	√√		

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE015	REAL TIME OPERATING SYSTEMS	3	0	0	3

1. **Course pre-requisites** : Communication Engineering, Embedded Systems

2. **Course learning objectives** :

- i. To study issues related to the design and analysis of systems with real-time constraints.
- ii. To learn the features of Real time OS.
- iii. To study the various Uniprocessor and Multiprocessor scheduling mechanisms.
- iv. To learn about various real time communication protocols.
- v. To study the difference between traditional and real time databases

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : Electrical and Electronics Engineering

5. **Nature of the Course** : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
INTRODUCTION TO REAL-TIME COMPUTING									
I	Introduction to real time computing - Concepts	A,B	1	1	R	9	3	3	2
	Example of real-time applications – Structure of a real time system	A,B	1	2	AP		5	4	2
	Characterization of real time systems and tasks	A,B	2	3	A		4	4	2
	Performance measures	A	2	3	R		4	3	1
TASK ASSIGNMENT AND SCHEDULING									
II	Task allocation algorithms, Time services	A,B,C	3	2	U	9	4	3	1
	Single-processor and Multiprocessor task scheduling, Scheduling Mechanisms Communication and Synchronization	A,B,C	3	3	U		4	3	2
	Clock-driven and priority based scheduling algorithms, Fault tolerant scheduling	A,B,C	3	3	R		3	2	2
		A,B,C	3	1	A		3	2	2

III	REAL-TIME COMMUNICATION								
	Threads and Tasks ,Protocols	A,B	6	1	U	9	5	4	3
	Contention-based, token-based, polled bus, deadline based protocol	A,B	6	3	R		4	4	2
	Fault tolerant routing	A,B	6,7	3	A		5	3	3
	RTP and RTCP.	A,B	6,7	2	U		4	4	2
IV	REAL-TIME DATABASES								
	Transaction priorities and aborts	A	5	2	U	9	4	2	1
	Concurrency control issues	A	5	2	U		4	2	2
	Scheduling algorithms	A	3,5	2	R		4	3	1
Two-phase approach to improve predictability	A	5	3	A	4		2	2	
V	PROGRAMMING LANGUAGES AND TOOLS								
	Hierarchical decomposition	A,C	4	2	U	9	3	2	1
	Run-time error handling	A,C	4	2	U		3	2	1
	Overloading - Timing specification	A,C	4	3	A		3	2	1
Recent trends and developments.	A,C	4	2	R	3		3	1	

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. C.M. Krishna, Kang G. Shin – “ Real Time Systems”, International Edition, McGraw Hill Companies, Inc., New York, 2010
- B. Raj Kamal “ Embedded computer systems”, Tata McGraw-Hill Education, 2008

REFERENCE BOOKS

- C. Jane W.S. Liu, Real-Time Systems, Pearson Education India, 2000.
- D. Philip A. Laplante and Seppo J. Ovaska, “Real-Time Systems Design and Analysis: Tools for the Practitioner” IV Edition IEEE Press, Wiley. 2011.
- E. Qing Li, Caroline Yao “Real-Time Systems Design and Analysis” John Wiley & Sons, 2004.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	2	0	1	1	0	0	4
UNIT II	1	2	0	1	0	0	4
UNIT III	1	2	0	1	0	0	4
UNIT IV	1	2	0	1	0	0	4
UNIT V	1	2	0	1	0	0	4
TOTAL							20

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√	√		
CO2	√√	√√		√	√√
CO3		√√	√√		√√
CO4			√√	√√	
CO5	√√		√		√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE016	OPTIMIZATION TECHNIQUES	3	0	0	3

1. **Course pre-requisites** : Engineering Mathematics ,Control systems
2. **Course learning objectives** :
 - i. To acquaint engineering students with mathematical optimization methods
 - ii. To study about unconstrained optimization techniques
 - iii. To study about constrained optimization techniques
 - iv. Introduce methods that are used in modern control system for Engineering Applications
 - v. To introduce state of art techniques for solving practical optimization problems
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 3 – 70% Descriptive & 30% Analytical
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
CLASSICAL OPTIMIZATION TECHNIQUES									
I	Introduction- Single-Variable optimization	A	2	1	R	9	4	4	2
	Multivariable optimization with no constraints	A	2	1	R		5	5	3
	Multivariable optimization with Equality constraints	A	2	2	R		5	5	3
	Multivariable optimization with inequality	A	2	2	R		5	5	3
	Convex Programming Problem	A	2	1	U		5	5	3
	Dynamic Programming & gradient method, Calculus of variation	A	9	2	U		5	5	3
UNCONSTRAINED OPTIMIZATION TECHNIQUES									
	Introduction to Optimum design	A	7	1	U	9	4	4	2
	General principles of optimization	A	7	1	U		3	3	3

II	Problem formulation & their classifications	A	7	1	A	9	5	5	4
	Single variable and multivariable optimization	A	7	2	A		4	4	3
	Techniques of unconstrained minimization	A	7	1	A		5	4	4
	Golden section, Random, pattern and gradient search methods	A	7	2	A		3	3	3
	Interpolation methods	A	7	1	A		4	3	2
CONSTRAINED OPTIMIZATION TECHNIQUES									
III	Optimization with equality and inequality constraints	A	8	2	AP	9	5	4	3
	Direct methods	A	8	2	A		5	4	4
	Indirect methods using penalty functions	A	8	2	A		5	4	4
	Lagrange Multipliers	A	8	2	A		4	3	3
	Geometric Programming	A	8	1	A		3	3	3
MULTI OBJECTIVE OPTIMIZATION									
IV	Weighted Sum of Squares method	A	9	2	A	9	3	3	3
	Epsilon constrains method	A	9	2	A		4	3	3
	Goal attainment	A	9	2	A		5	4	3
	Examples	A	9	1	E		5	5	5
	Introduction to Optimal control and Dynamic optimization	A	9	2	U		5	4	4
ADVANCED OPTIMIZATION TECHNIQUES									
V	Multi stage Optimization	A	12	2	A	9	4	4	4
	Dynamic Programming	A	12	1	A		5	4	4
	Stochastic programming; Multi objective optimization	A	12	2	E		4	3	2
	Genetic algorithms and Simulated Annealing techniques	A	12	2	E		5	4	4
	Neural network & Fuzzy logic principles in Optimization	A	12	2	E		5	4	4

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Engineering Optimization-Theory and Practice, Singiresu S. Rao, 3rd/e, New Age International (P) Limited, Publishers, 2013.

B. Allen J.Wood , Bruce F.Wollenberg “Power Generation ,operation and control”, 3rd/e, John

Wiley and sons, 2014.

REFERENCE BOOKS

C. Kalyanmoy Deb, “ Optimization for engineering design: algorithms and examples”, New Delhi Prentice Hall of India, 2012.

D. Singiresu S Rao, Engineering optimization: theory and practice, 3rd/e, New Delhi New Age International Publishers, 2013.

WEB RESOURCES

8. Assessing Level of Bloom’s Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	4	2	0	0	0	0	6
UNIT II	0	2	0	5	0	0	7
UNIT III	0	0	1	4	0	0	5
UNIT IV	0	1	0	3	1	0	5
UNIT V	0	0	0	2	3	0	5
TOTAL							28

9. Weight age of Bloom’s Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	14.28	7.14	0	0	0	0	21.42
UNIT II	0	7.14	0	17.86	0	0	25
UNIT III	0	0	3.57	14.28	0	0	17.85
UNIT IV	0	3.57	0	10.71	3.57	0	17.85
UNIT V	0	0	0	7.14	10.71	0	17.85
TOTAL	14.28	17.85	3.57	49.98	14.28	0	99.96
Lower Order Thinking (%)				35.70%			
Higher Order Thinking (%)				64.26%			

10. Expected outcome of the course:

On completion of the course the student will be able to

CO1: Solve practical Optimization problem in Engineering using both classical methods and soft computing techniques.

CO2: apply knowledge on unconstrained optimization problems

CO3: apply knowledge on constrained optimization problems

CO4: an ability to apply knowledge of mathematics, science, and engineering

CO5: an ability to use the techniques, skills, and modern engineering tools necessary for Engineering practice.

11. Mapping course outcome with Bloom’s Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1			√			
CO2			√	√		
CO3		√				
CO4						√

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√√	√√	√√	√				√	√		√
CO2	√√	√√		√	√	√					√	√
CO3	√	√√			√	√					√	√
CO4	√	√√		√	√	√					√	√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√			
CO2	√√				√	√					√√	
CO3	√√		√√			√			√√	√√		
CO4		√√	√√	√	√				√√		√√	√√
CO5			√√					√√				

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	
CO2	√√				
CO3		√		√	√√
CO4	√√		√	√	√√
CO5		√√		√√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE017	INDUSTRIAL AUTOMATION AND CONTROL	3	0	0	3

1. **Course pre-requisites** : Control systems

2. **Course learning objectives** :
- To learn about basics of automation systems
 - To learn about types of controllers
 - To know about sequence and supervisory control
 - To know about operation management systems
 - To know about industrial communication systems

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : Electrical and Electronics Engineering

5. **Nature of the Course** : Group 3 – 70% Descriptive & 30% Analytical

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	INTRODUCTION									
	Structure & Components Industrial Automation systems	A	2	2	R	9	4	4	2	
	Architectural levels of Industrial controls	A	2	2	R		5	5	3	
	Servomotors, Stepper motors,	A	11	2	R		5	5	3	
	Process I/O systems. Local & Remote I/O systems	A	2	3	U		5	5	3	
II	CONTROLLERS									
	Different types of controllers, Single loop and Multiloop controllers and their tuning, Direct controllers and their tuning	B	4	3	U	9	4	4	2	
	Direct Digital Controllers, Software implementation of Multiloop Controllers	B	4	3	U		3	3	1	

	Distributed Control Systems	B	4	3	A		4	2	2	
III	SEQUENCE CONTROL & SUPERVISORY CONTROLLERS									
	Programmable Logic Controllers, Relay Ladder Logic Programming	B	2	2	U	9	4	3	2	
	Functionally of Supervisory Control Level	B	3	2	AP		4	2	2	
	Process Optimization, Recipe Management Material Tracking	B	5	3	A		4	3	2	
	Man-machine interfaces	B	5	2	A		4	3	2	
IV	PROCESS OPERATION MANAGEMENT SYSTEMS									
	Overview of process operation management systems order	A	13	3	AP	9	3	3	3	
	Inventory management	A	13	3	AP		4	3	3	
	Process scheduling, quality management	A	13	3	A		5	4	3	
V	INDUSTRIAL COMMUNICATION SYSTEMS									
	Characteristic features of industrial networks	A	16	3	AP	9	4	4	4	
	Low level networks and their features, Field bus architecture	A	16	3	A		5	4	4	
	Performance aspects of Industrial Automation Systems	A	16	3	A		4	3	2	

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Thomas E Kissell - Industrial electronics : applications for programmable controllers, instrumentation and process control, and electrical machines and motor PHI learning private limited 2009
- B. George L Batten, Programmable controllers : hardware software and applications, McGraw Hill Book Company,2009

REFERENCE BOOKS

C. Liptak B.G (ED)-Process Control H andbook,vol-2 Chilton book Co.

D. Noltinc - Handbook for Instrumentation Engineers.

E. Bollinger J.G and Duffie N.A-Computer control of machines and processes, Reading M A, Addison-Wesley, 1988.

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	3	1					4
UNIT II		2		1			3
UNIT III		1	1	2			4
UNIT IV			2	1			3
UNIT V			1	2			3
TOTAL							17

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	17.64	5.88					23.52
UNIT II		11.76		5.88			17.64
UNIT III		5.88	5.88	11.76			23.52
UNIT IV			11.76	5.88			17.64
UNIT V			5.88	11.76			17.64
TOTAL	17.64	23.52	23.52	35.28			99.96
Lower Order Thinking (%)				64.68%			
Higher Order Thinking (%)				35.28%			

10. Expected outcome of the course:

On completion of the course the student will be able to

CO1: know about basics of automation systems.

CO2: know about types of controllers

CO3: apply knowledge on Sequel and supervisory control

CO4: an ability to apply knowledge on operation management systems

CO5: an ability to apply knowledge on industrial communication systems

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1		√				
CO2			√	√		
CO3		√				
CO4				√		
CO5		√	√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√√	√√	√√	√				√	√		√
CO2	√√	√√		√	√	√					√	√
CO3	√	√√			√	√					√	√
CO4	√	√√		√	√	√					√	√
CO5	√√	√√	√√	√	√	√						

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√			
CO2	√√				√	√					√√	
CO3	√√		√√			√			√√	√√		
CO4		√√	√√	√	√				√√		√√	√√
CO5			√√					√√				

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√	√	
CO2	√√				
CO3		√		√	√√
CO4	√√		√	√	√√
CO5		√√		√√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE081	SPECIAL ELECTRICAL MACHINES	3	0	0	3

1. **Course pre-requisites** : DC Machines and Transformers
Synchronous and Induction Machines

2. **Course learning objectives** :

- i. To impart knowledge on phase diagram, use of phase diagram and application of Synchronous reluctance motors
- ii. To understand the construction and applications of stepper motor
- iii. To obtain knowledge on Switched Reluctance Motors and its practical applications
- iv. To impart knowledge on Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- v. To understand the Construction, principle of operation and performance of permanent magnet synchronous motors

3. **Expected Level of Output** : Conceptual Level

4. **Department Offered** : Electrical and Electronics Engineering

5. **Nature of the Course** : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors						
						F1	F2	F3	F4			
I	STEPPING MOTOR						9					
	Constructional features – Principle of operation – Modes of excitation	B	2	1	U	4					3	1
	Torque production in variable reluctance stepping motor	B	2	2	U	4					3	2
	Dynamic characteristics	B	2	2	R	3					2	0
	Drive systems and circuit for open loop control	B	2	2	A	3					2	1
	Closed loop control of stepping motor	B	2,3	2	U,R	3					1	1
	SWITCHED RELUCTANCE MOTORS						9					
	Constructional features	C	1	1	U	1					1	0

II	Principle of operation	C	1	2	R	9	3	1	1
	Torque equation	C	2	1	A		2	2	0
	Power controllers	C	3,4	2	U		4	4	1
	Characteristics	C	4	1	R		5	3	1
	Control microprocessor based controller	C	8	1	U,R		5	5	5
SYNCHRONOUS RELUCTANCE MOTORS									
III	Constructional features: axial and radial air gap Motors	A,C	2,3	2	R	9	3	3	2
	Operating principle –Reluctance torque	A,C	2,3	3	AP		5	4	2
	Phasor diagram	A,C	3,4	2	A		4	4	2
	Motor characteristics	A,C	3,4	2	R		4	3	1
PERMANENT MAGNET SYNCHRONOUS MOTORS									
IV	Principle of operation –EMF	A	6	2	U	9	4	2	1
	Power input and torque expressions	A	6	2	E		4	1	2
	Phasor diagram –Power controller	A	6	2	R		4	1	1
	Torque speed characteristics-Self control	A	6	1	A		4	1	2
	Vector control –Current control schemes	A	6	2	U		2	1	1
PERMANENT MAGNET BRUSHLESS DC MOTORS									
V	Commutation in DC motors, Difference between mechanical and electronic commutators	A	5	2	U	9	5	5	2
	Hall sensors, Optical sensors - Multiphase Brushless motor	A	5	2	E		4	4	2
	Square wave permanent magnet brushless motor drives –Torque and emf equation	A	5	2	A		3	1	2
	Torque speed characteristics-Controllers Microprocessors based controller	A	5	3	R,U		5	5	5

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. REFERENCES

- A. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives”, Clarendon Press, Oxford, 1989.
- B. Kenjo, T, “Stepping motors and their microprocessor control”, Clarendon Press, Oxford 1989.
- C. R.Krishnan, “Switched Reluctance Motors Drives: Modelling, Simulation, Analysis Design and Applications”, CRC Press, New York, 2001.

TEXT BOOKS

- D. D.P.Kothari and I.J.Nagrath “Electric machines” Tata McGraw-Hill Education, 2010.
E. K. Venkataratnam “Special Electric Machines” Universities Press, 2009.

WEB RESOURCES

8. Assessing Level of Bloom’s Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	2	3	0	1	0	0	6
UNIT II	3	3	0	1	0	0	7
UNIT III	2	0	1	1	0	0	4
UNIT IV	1	2	0	1	1	0	5
UNIT V	1	2	0	1	1	0	5
TOTAL							27

9. Weight age of Bloom’s Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	7.6	11.2	0	3.6	0	0	22.4
UNIT II	11.2	11.2	0	3.6	0	0	26
UNIT III	7.6	0	3.6	3.6	0	0	14.8
UNIT IV	3.6	7.6	0	3.6	3.6	0	18.4
UNIT V	3.6	7.6	0	3.6	3.6	0	18.4
TOTAL	33.7	37.7	3.6	17.8	7.2	0	100
Lower Order Thinking (%)				100 %			
Higher Order Thinking (%)				NIL			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

- CO1. List the different motors and its properties
- CO2. Understand the construction and working of different types of motor
- CO3. Understand the phase diagrams and power controllers
- CO4. Understand the application of motors
- CO5. Understand the basic Principle of different types of motor

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√		√		
CO2	√	√		√		
CO3	√		√	√		
CO4	√	√		√	√	
CO5	√√	√	√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√		√√		√					√		√
CO2	√√	√√	√√		√		√	√		√	√	√
CO3	√√			√		√	√	√	√√		√	
CO4	√√	√√	√	√√		√√		√√				√√
CO5			√√		√√							

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√		√	
CO2	√√	√		√	√	√		√		√		√
CO3	√√		√			√	√		√			
CO4		√√		√	√		√	√		√	√	
CO5	√				√	√√			√			√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√	√		
CO2	√√		√	√	
CO3		√		√	√
CO4	√		√	√	√
CO5		√	√	√√	

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE082	COMPUTER AIDED DESIGN OF POWER ELECTRONICS CIRCUITS	3	0	0	3

1. **Course pre-requisites** : Power Electronics
2. **Course learning objectives** :
 - i. To learn the basics about the simulation.
 - ii. To study issues related to the design and analysis of power electronics systems
 - iii. To learn the recent trends of computer simulation
 - iv. To analyze the various time domain
 - v. To study the simulation of various power electronic circuits
3. **Expected Level of Output** : Conceptual Level
4. **Department Offered** : Electrical and Electronics Engineering
5. **Nature of the Course** : Group 1 – 100 % Descriptive
Continuous Internal Assessment (CIA) : 40 Marks
Semester End Examination (SEE) : 60 Marks
6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors						
						F1	F2	F3	F4			
I	INTRODUCTION						9					
	Importance of simulation	A,B	1	1	U	3					2	3
	General purpose circuit analysis	A,B	1	2	AP	4					5	2
	Methods of analysis of power electronic systems	A,B	2	3	E	4					4	2
	Review of power electronic devices and circuits	A	2	3	R	4					1	3
II	ADVANCED TECHNIQUES IN SIMULATION						9					
	Analysis of power electronic systems in a sequential manner	A,B	3	2	U	4					3	1
	Coupled and decoupled systems	A,B	3	3	E	4					2	3
	Various algorithms for computing steady state solution in power electronic systems	A,B	3	3	R	3					2	2

	Future trends in computer simulation	A,B	3	1	AP		2	3	2	
III	MODELING OF POWER ELCTRONIC DEVICES									
	Introduction – AC sweep and DC sweep analysis	A	6	1	U	9	5	3	4	
	Transients and the time domain analysis	A	6	3	R		4	2	4	
	Fourier series and harmonic components, BJT, FET, MOSFET	A	6,7	3	A		5	3	3	
	Model- Amplifiers and Oscillator, Non-linear devices	A	6,7	2	U		4	2	4	
IV	SIMULATION OF CIRCUITS									
	Introduction – Schematic capture and libraries	A	5	3	U	9	4	2	1	
	Time domain analysis	A	5	2	U		4	2	2	
	System level integration and analysis	A	3,5	2	R		4	1	3	
	Monte Carlo analysis – Sensitivity/stress analysis – Fourier analysis.	A	5	2	A		4	2	2	
V	CASE STUDIES									
	Simulation of Converters, Choppers, Inverters	A,B	4	3	U	9	3	2	1	
	AC voltage controllers, and Cycloconverters feeding	A,B	4	2	U		3	1	2	
	R, R-L, and R-L-E loads	A,B	4	2	A		2	3	1	
	Computation of performance parameters: harmonics, power factor, angle of overlap	A,B	4	2	R		3	3	1	

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Rashid, M., Simulation of Power Electronic Circuits using pSPICE, PHI, 2006.
- B. M.M.Shah, Design of Electronic Circuits and Computer Aided Design,1993

REFERENCE BOOKS

- C. Rajagopalan, V. “Computer Aided Analysis of Power Electronic systems”-Marcell – Dekker Inc., 1987.
- D. John Keown “Microsim, Pspice and circuit analysis”-Prentice Hall Inc., 1998.
- E. M. S. JAMIL ASGHAR , Power electronics, 2004.

WEB RESOURCES

8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	1	1	0	1	0	4
UNIT II	1	1	1	0	1	0	4
UNIT III	1	2	0	1	0	0	4
UNIT IV	1	2	0	1	0	0	4

UNIT V	1	2	0	1	0	0	4
TOTAL							20

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	5	5	5	0	5	0	20
UNIT II	5	5	5	0	5	0	20
UNIT III	5	10	0	5	0	0	20
UNIT IV	5	10	0	5	0	0	20
UNIT V	5	10	0	5	0	0	20
TOTAL	25	40	10	15	10	0	100
Lower Order Thinking (%)				75 %			
Higher Order Thinking (%)				25%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Knowledge about time domain analysis.

CO2: Ability to learn future trends of computer simulation

CO3: Knowledge about power electronics circuits.

CO4: Ability to develop various power electronic circuits simulation.

CO5: Ability to develop a model for power electronic devices.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√		√	√√	
CO2		√√				
CO3	√	√	√√	√	√√	
CO4	√√	√				
CO5	√	√		√	√√	√√

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√		√√		√	√				√		√
CO2	√√		√		√		√	√	√√	√	√	√
CO3	√			√√		√	√	√			√	
CO4	√		√	√√					√			
CO5	√√		√		√		√	√	√√	√	√	√

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	√√	√√	√		√	√		√	√	√√		√
CO2	√√	√		√√	√√	√√	√√		√		√√	
CO3	√√					√	√	√√				
CO4		√√		√	√√		√		√		√	
CO5	√√	√		√√	√√	√√	√√		√	√		√√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√	√		√
CO2	√√	√√		√√	
CO3	√	√√	√		√√
CO4			√√	√√	
CO5	√√	√√		√√	√√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE083	VLSI DESIGN	3	0	0	3

1. **Course pre-requisites** :Basic electron devices

2. **Course learning objectives** :
- To introduce MOS theory and manufacturing Technology.
 - To study inverter, logic gates and stick diagrams for layout design
 - To analyze the characteristics and performance of circuits.
 - To understand the design of VLSI system components circuits.
 - To design digital circuits using Verilog HDL

3. **Expected Level of Output** :Conceptual Level

4. **Department Offered** :Electrical and Electronics Engineering

5. **Nature of the Course** :Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) :60 Marks

6. **Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors						
						F1	F2	F3	F4			
I	MOS TRANSISTOR THEORY AND PROCESS TECHNOLOGY						9					
	NMOS and PMOS transistors -Threshold voltage , Body effect	A	1	3	R&U	5					4	3
	Design equations , Second order effects	A	2	2	R&U	3					3	1
	MOS models and small signal AC characteristics	A	2	2	U	1					0	0
	Basic CMOS technology.	A	3	2	U	2					0	0
II	INVERTERS AND LOGIC GATES						9					
	NMOS and CMOS Inverters, Stick diagram, Inverter ratio	B	2.6, 3.2	3	U&Ap	4					3	2
	DC and transient characteristics , switching times, Super buffers	B	3	2	U	2					0	1
	Driving large capacitance loads, CMOS logic structures, Transmission gates	A	2	2	U	4					2	2

	Static CMOS design , Dynamic CMOS design	A	5	2	R&U		4	2	1	
III	CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION									
	Resistance estimation, Capacitance estimation & Inductance	A	4.2-4.4	3	U	9	1	0	1	
	Switching characteristics, Transistor sizing	A	4.5	2	A		2	0	1	
	Power dissipation and design margining	A	5	2	U		3	0	0	
	Charge sharing, Scaling,	A	5	2	A		2	0	0	
IV	VLSI SYSTEM COMPONENTS CIRCUITS									
	Multiplexers ,Decoders , comparators	C	11.1-11.3	2	C	9	4	0	0	
	Priority encoders , Shift registers	C	11.4-11.5	2	C		4	0	0	
	Arithmetic circuits -Ripple carry adders, Carry look ahead adders	C	12.1-12.3	3	C		3	0	0	
	High-speed adders ,Multipliers	C	12.4-12.5	2	C		3	0	0	
V	VERILOG HARDWARE DESCRIPTION LANGUAGE									
	Overview of digital design with Verilog HDL	D	1.1-1.6	2	Ap	9	3	0	0	
	Hierarchical modeling concepts	D	2.1-2.7	2	Ap		3	0	0	
	Modules and port Definitions. Gate level Modeling	D	4.1-4.2,5	2	Ap		3	0	0	
	Data flow modeling - Behavioral modeling	D	6-7	3	Ap		3	0	0	

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

A. Neil H E Weste; David Harris; Ayan Banerjee, "CMOS VLSI design: a circuits and systems perspective", Pearson Education, 2009

B. Douglas A Pucknell., "Kamran Eshraghian., "Basic VLSI Design", Prentice Hall of India Publication, 3rd Edition, 2011.

REFERENCE BOOKS

C. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc., 2012.

D. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd edition, 2013

E. Eshraghian K Pucknell Da, "Essentials of VLSI Circuits and System", 2013

WEB RESOURCES

8. www.cdeep.iitb.ac.in/nptel/Electrical%20.../VLSI%20Design/TOC.htm

9. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	2	4	0	0	0	0	6
UNIT II	1	4	1	0	0	0	6
UNIT III	0	2	0	2	0	0	4
UNIT IV	0	0	0	0	0	4	4
UNIT V	0	0	4	0	0	0	4
TOTAL							24

10. Weightage of Bloom's Taxonomy in the Syllabus (%)

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	8.3	16.6	0	0	0	0	24.9
UNIT II	4.2	16.6	4.2	0	0	0	25.0
UNIT III	0	8.3	0	8.3	0	0	16.6
UNIT IV	0	0	0	0	0	16.6	16.6
UNIT V	0	0	16.6	0	0	0	16.6
TOTAL	12.5	41.5	20.8	8.3	0	16.6	100
Lower Order Thinking (%)				75%			
Higher Order Thinking (%)				25%			

11. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand the basic concepts of MOS circuits.

CO2: To have good knowledge and practice about the logic gates.

CO3: To analyze the characteristics and performance of the circuits.

CO4: Able to create the system component circuits.

CO5: Able to design the basic models using verilog hardware description language.

12. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√				
CO2		√	√			
CO3		√		√		
CO4						√
CO5			√			

13. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√√	√√	√√	√√	√					√	
CO2	√√	√√	√√	√√	√√	√					√	
CO3	√√	√√	√√	√√	√√	√					√	
CO4	√√	√√	√√	√√	√√	√					√	
CO5	√√	√√	√√	√√	√√	√					√	

14. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	√√	√√	√√	√	√						√	√

C02	√√	√√	√√	√	√						√	√
C03	√√	√√	√√	√	√						√	√
C04	√√	√√	√√	√	√						√√	√√
C05	√√	√√	√√	√	√						√√	√√

15. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
C01	√	√√	√	√√	√
C02	√	√√	√	√√	√
C03	√	√√	√	√√	√
C04	√	√√	√	√√	√
C05	√	√√	√	√√	√

√√ | Strongly agreed | √ | Moderately agreed

Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE084	DSP CONTROLLERS IN POWER ELECTRONICS APPLICATIONS	3	0	0	3

- Course pre-requisites : Digital Signal processing, HDL programming, Embedded systems, Electric drives and control ,VLSI
- Course learning objectives :
 - To learn the basics about DSP controllers
 - To learn the application of digital controllers in electric drives.
 - To obtain knowledge on CPLD, FPGA and their implementation using HDL.
 - To acquire knowledge on the applications of embedded system components.
 - To gain knowledge on FPGA Implementation
- Expected Level of Output : Conceptual Level
- Department Offered : Electrical and Electronics Engineering
- Nature of the Course : Group 1 – 100 % Descriptive

Continuous Internal Assessment (CIA) : 40 Marks

Semester End Examination (SEE) : 60 Marks

- Course Input :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors			
						F1	F2	F3	F4
INTRODUCTION TO THE C2XX DSP CORE									
I	Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core	A	1	3	U	9	5	4	2
	Mapping external devices to the C2xx core peripherals and Peripheral Interface	A	1	2	U		5	5	2
	System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes	A	2	2	R		4	2	0
	Assembly Programming using C2xx DSP, Instruction Set, Software Tools	A	2	2	C		5	5	0
MULTIPLEXING AND INTERRUPT CONCEPTS									
	Pin Multiplexing (MUX) and General Purpose I/O Overview,	A	3	3	U	9	5	5	4

II	Multiplexing and General Purpose I/O Control Registers	A	3	3	U		5	3	5
	Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers	A	4	2	AP		4	4	4
	Initializing and Servicing Interrupts in Software	A	4	1	C		5	3	5
PERIPHERAL DEVICES									
III	ADC Overview , Operation of the ADC in the DSP	A	5	2	AP	9	5	5	3
	Overview of the Event manager (EV), Event Manager Interrupts	A	5	2	U		5	5	2
	General Purpose (GP) Timers, Compare Units, Capture Units And Quadrature Enclosed Pulse (QEP) Circuitry	A	5	2	R		5	5	4
	General Event Manager Information	A	6	3	U		5	5	5
INTRODUCTION TO FIELD PROGRAMMABLE GATE ARRAYS									
IV	Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA	B	1	3	R	9	4	5	0
	Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/output Block (IOB) – Programmable Interconnect Point (PIP)	B	1	2	AP		5	4	5
	Xilinx 4000 series – HDL programming	B	3	2	C		5	5	5
	overview of Spartan 3E and Virtex II pro FPGA boards- case study	B	4	2	U		5	5	3
INTERFACING USING DSP PROCESSOR									
V	Controlled Rectifier, Switched Mode Power Converters	A	9	2	C	9	5	5	2
	PWM Inverters	A	9	2	C		4	4	2
	DC motor control	A,B	9,4	2	U		3	1	2

Bloom's Legends:

R-Remembering

U-Understanding

AP-Applying

A-Analyzing

C-Creating

E – Evaluating

7. TEXT BOOKS

- A. Hamid.A.Toliyat and Steven G.Campbell “ DSP Based Electro Mechanical Motion Control “ CRC Press New York , 2004
- B. Wayne Wolf,” FPGA based system design “, Prentice hall, 2004

REFERENCE BOOKS

C."Digital Signal Processing in Power Electronics Control Circuits" By Krzysztof Sozanski, Springer-Verlad, London 2013

D."Integrated Power Electronic Converters and Digital Control" Ali Emadi, Alireza Khaligh, Zhong Nie, Young Joo Lee, 2008

E."Advanced Power Electronics Converters: PWM Converters Processing AC Voltages" Euzeli dos Santos, Edison R. da Silva ,2011

8 Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	1	2	0	0	0	1	4
UNIT II	0	2	1	1	0	0	4
UNIT III	1	2	0	1	0	0	4
UNIT IV	2	0	1	0	1	1	4
UNIT V	0	1	1	0	0	1	4
TOTAL							20

9.Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	5	10	0	0	0	5	20
UNIT II	0	10	5	5	0	0	20
UNIT III	5	10	0	5	0	0	20
UNIT IV	10	5	5	0	0	5	25
UNIT V	0	5	5	0	0	5	15
TOTAL	20	40	15	10	0	15	100
Lower Order Thinking (%)				75 %			
Higher Order Thinking (%)				25%			

10.Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: Understand and remember the concept DSP Controllers

CO2: To remember the application of digital controllers in electric drives.

CO3: To obtain knowledge on CPLD, FPGA and their implementation using HDL.

CO4: To understand the applications of embedded system components.

CO5: To gain knowledge on FPGA Implementation.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√	√		√		
CO2		√√				
CO3	√√	√√	√√	√		
CO4	√√	√				
CO5	√		√√			

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√		√√		√	√√				√		√
CO2	√√		√√		√		√	√	√√	√	√	√
CO3	√√					√	√	√			√	
CO4	√√		√	√√					√√			
CO5	√		√					√				

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√		√	√		√	√	√		√
CO2	√√	√√		√√	√	√√	√√		√		√	
CO3	√√					√	√			√		
CO4		√√		√	√√		√		√			√
CO5												√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√	√	√		
CO2	√√	√√		√	√√
CO3		√√	√√		√√
CO4			√√	√√	
CO5	√√		√		√

√√	Strongly agreed	√	Moderately agreed
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Course Code	Course Name	Contact Hours			
		L	T	P	C
17PE085	Advanced Microprocessors And Microcontrollers	3	0	0	3

- Course pre-requisites** : Microprocessor and microcontroller.
- Course learning objectives** :
 - To familiarize the fundamental concepts of microprocessor architecture.
 - To gain knowledge about high performance CISC architecture- PENTIUM.
 - To gain knowledge about ARM microcontroller architecture.
 - To study about MOTOROLA Microcontrollers viz. 68HC11.
 - To gain knowledge about PIC microcontroller
- Expected Level of Output** : Conceptual Level
- Department Offered** : Electrical and Electronics Engineering.
- Nature of the Course** : Group 7 – 75% Descriptive and 25% programming
- Continuous Internal Assessment (CIA)** : 40 Marks
- Semester End Examination (SEE)** : 60 Marks
- Course Input** :

Unit No	Name Of The Topic	Text / Ref Books	Chapter No	Instructional Hours	Level of Bloom's Taxonomy	Course Assessment Factors				
						F1	F2	F3	F4	
I	OVERVIEW									
	Generic Architecture--Instruction Set – Data formats –Addressing modes – Memory hierarchy – Register file	A	1,2,3	4	R	9	5	4	2	
	Cache – Virtual memory and paging – Segmentation- pipelining –The instruction pipeline – Pipeline hazards – Instruction level parallelism – Reduced	A	4,5	3	U		5	5	2	
	Instruction set –Computer principles – RISC versus CISC.	A	6	2	R		4	5	2	
HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM										
	CPU Architecture- Bus Operations – Pipelining – Branch predication – Floating point unit	A,B	8,2	2	U	9	5	5	4	
	Operating Modes –Paging – Multitasking –	A,B	8,5	2	U		5	4	5	

II	Exception and Interrupts								
	Instruction set – Addressing modes	B	2,3	3	R		4	4	4
	Programming the Pentium processor	B	6	2	C		5	4	3
HIGH PERFORMANCE RISC ARCHITECTURE – ARM									
III	Organization of CPU – Bus architecture – Memory management unit	C	1,2,3	2	U	9	5	5	3
	ARM instruction set- Thumb Instruction set- addressing modes	C	5	5	AP		5	5	2
	Programming the ARM processor.6	C	6	4	C		5	5	4
MOTOROLA 68HC11 MICROCONTROLLERS									
IV	Instruction set addressing modes – operating modes- Interrupt system	A	11	5	R	9	4	5	2
	RTC-Serial Communication Interface – A/D Converter PWM and UART	A	12,13	3	U		5	4	5
PIC MICROCONTROLLER									
V	CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing	F	2,5,6,9	3	U	9	5	5	2
	UART- A/D Converter –PWM	F	10	3	U		4	4	2
	Introduction to C-Compilers	F	11	3	A		4		2

Bloom’s Legends:

R-Remembering

A-Analyzing

U-Understanding

C-Creating

AP-Applying

E – Evaluating

7. TEXT BOOKS

- A. Daniel Tabak, ‘‘Advanced Microprocessors’’ McGraw Hill.Inc., 1995
- B. James L. Antonakos, ‘‘The Pentium Microprocessor ‘’ Pearson Education, 2006.
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8. Assessing Level of Bloom's Taxonomy in Numbers:

	R	U	AP	A	E	C	TOTAL
UNIT I	2	1	1	0	0	0	3
UNIT II	1	2	1	0	0	1	4
UNIT III	0	1	0	1	0	1	3
UNIT IV	1	1	2	0	0	0	2
UNIT V	0	2	1	0	1	0	3
TOTAL							15

9. Weight age of Bloom's Taxonomy in the Syllabus

	R	U	AP	A	E	C	TOTAL (%)
UNIT I	13.33	6.66	0	0	0	0	19.98%
UNIT II	6.66	13.33	0	0	0	6.66	26.65%
UNIT III	0	6.66	6.66	0	0	6.66	19.98%
UNIT IV	6.66	6.66	0	0	0	0	13.33%
UNIT V	0	13.33	0	6.66	0	0	19.98%
TOTAL	26.65	46.58	6.66	6.66	0	13.33	99.97%
Lower Order Thinking (%)				80 %			
Higher Order Thinking (%)				20%			

10. Expected outcome of the course:

Upon successful completion of this course, the student will be able to:

CO1: To familiarize the fundamental concepts of microprocessor architecture.

CO2: To gain knowledge about high performance CISC architectures.

CO3: To gain knowledge about high performance RISC architectures.

CO4: To study about MOTOROLA Microcontrollers viz. 68HC11

CO5: To study about PIC Microcontrollers.

11. Mapping course outcome with Bloom's Taxonomy LOT and HOT:

	R	U	AP	A	E	C
CO1	√		√√			
CO2	√	√√				√
CO3		√	√√			√
CO4	√	√√				
CO5		√√		√		

12. Mapping Course outcome with graduate attributes:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO1	√√	√	√		√	√			√			√
CO2	√√	√	√√		√				√			√
CO3	√√	√	√		√				√			√
CO4	√√	√	√√	√√					√			√
CO5	√√	√	√	√	√				√			

13. Mapping course outcome with programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√√	√√	√	√	√			√	√		√	√
CO2	√√	√√	√	√	√						√	√
CO3	√√	√√	√	√	√			√			√	√
CO4	√√	√√	√	√	√				√		√	√
CO5	√√	√√	√	√	√			√	√		√	√

14. Mapping with Programme Educational Objectives:

	PEO1	PEO2	PEO3	PEO4	PEO5
CO1	√√	√√		√	
CO2	√√	√√		√	
CO3	√√	√√		√	
CO4	√√	√√		√	
CO5	√√	√√		√	

√√	Strongly agreed	√	Moderately agreed
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