DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Periyar Nagar, Vallam, Thanjavur - 613 403, Tamil Nadu, India
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PERIYAR MANIAMMAI UNIVERSITY
Under Sec. 3 of UGC Act, 1956
NAAC ACCREDITED

Curriculum and Syllabus

for

M.Tech

Power Electronics and Drives

(Two Year Full Time)

Regulation 2015

(Based on OBE)

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VISION

To become a leader in providing education and training in the field of Electrical and Electronics Engineering to the aspiring graduates to be competent in their profession.

MISSION

- To develop innovative, competent, efficient disciplined and quality Electrical and Electronics Engineers.
- To enrich knowledge and encourage the students to become Entrepreneurs.
- To produce Engineers who can participate in Technical Advancement and Social enlistment of the country and to meet the growing global challenges.
- To prosper in Academic Activities by continual improvement in Teaching methods, Laboratory facilities and Research activities.
- To develop consultancy for various industries.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Design and develop innovative products and services in the field of Power Electronics & Drives
PEO2	Keep abreast with the latest technology and toolset.
PEO3	Communicate effectively to propagate ideas and promote teamwork
PEO4	Attain intellectual leadership skills to cater to the changing needs of power industry, academia, society and environment

Mapping of Mission (MS) with Program Educational Objectives (PEOs)

	PEO1	PEO2	PEO3	PEO4
MS1	2	1	2	2
MS2	2	2	1	1
MS3	1	2	2	2
MS4	1	2	1	1
MS5	2	1	2	2

1 - Slightly 2 - Supportive 3 - Highly related

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GRADUATE ATTRIBUTES:

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping of Program Educational Objectives (PEOs) with Graduate Attributes (GAs)

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA 12
PEO1	3	3	3	2	3	2	2	1	2	1	3	3
PEO2	1	1	2	2	3	2	2	1	1	-	-	3
PEO3	-	-	-	-	-	1	-	-	3	3	2	2
PEO4	2	3	3	3	3	3	2	1	-	-	-	3

1- Slightly 2 – Supportive 3 – Highly related

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PROGRAMME OUTCOMES (POs)

1. Design and develop power electronic circuits and drive systems
2. Deliver technological solutions in the field of power electronics and drives by assimilating advances in allied disciplines
3. Simulate and experiment in the field of power electronics and drives using modern tools
4. Design renewable energy systems to protect environment and ecosystems
5. Practice professional ethics with social sensitivity
6. Develop innovative and entrepreneurial solutions
7. Develop an attitude to learn with self motivation
8. Communicate effectively at all levels and demonstrate leadership qualities
9. Pursue research to enhance the existing pool of knowledge

Mapping of Program Educational Objectives (PEOs) with Program Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
PEO 1	3	3	3	3	-	3	1	1	3
PEO 2	2	2	2	2	-	-	3	-	3
PEO 3	1	1	1	2	2	2	1	3	2
PEO 4	3	3	3	3	2	3	1	2	3

1- Slightly 2 - Supportive 3 - Highly related

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Mapping of Program Outcomes (POs) with Graduate Attributes (GAs)

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA 12
PO1	3	2	2	1	1	2	1	1	1	2	2	1
PO2	2	3	3	2	1	2	1	1	2	1	1	2
PO3	2	2	2	3	3	1	2	1	1	2	1	2
PO4	2	2	3	3	1	2	1	1	2	2	1	2
PO5	2	1	3	2	3	3	3	2	2	3	1	2
PO6	3	2	2	1	1	2	1	1	1	2	2	1
PO7	2	2	1	1	2	3	2	3	2	1	2	2
PO8	2	1	1	2	1	3	2	2	2	3	1	2
PO9	2	1	1	2	3	3	2	2	3	3	1	3

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CURRICULUM 2015

SEMESTER I

Code No.	Course Title	L	T	P	C	HRS
YPE 101	Applied Mathematics for Electrical Engineers	3	1	0	4	5
YPE 102	Analysis and Design of Inverters	3	1	0	4	5
YPE 103	Advanced Power Semiconductor Devices and Protection	3	0	1	4	5
YPE 104	Digital Simulation of Power Electronics Systems	3	0	1	4	5
YPE 105	Analysis of Power Converters	3	1	0	4	5
YPE ****	Elective – 1	3	0	0	3	3
		18	**3**	**2**	**23**	**28**

SEMESTER II

Code No.	Course Title	L	T	P	C	HRS
YPE 201	Analysis of Electrical Machines	3	0	0	3	5
YPE 202	Solid State AC Drives	3	1	0	4	5
YPE 203	Solid State DC Drives	3	0	1	4	5
YPE 204	Power Quality	3	1	0	4	5
YPE ****	Elective – II	3	0	0	3	3
YPE ****	Elective – III	3	0	0	3	3
YST 207	Communication Skills	1	0	1	2	3
YST 208	Mini Project (if YPE 204 option is core only)	0	0	1	1	2
		19	**2**	**3**	**24**	**29**

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SEMESTER III

Code No.	Course Title	L	T	P	C	HRS
YPE 301	Project Work - Phase I	0	0	8	8	16
	MOOC-I *	0	0	0	0	0
	MOOC-II *	0	0	0	0	0
		0	**0**	**8**	**8**	**16**

*** Non credit**

SEMESTER IV

Code No.	Course Title	L	T	P	C	HRS
YPE 401	Project Work - Phase II	0	0	15	15	30
		0	**0**	**15**	**15**	**30**

OVER ALL CREDITS =70

ELECTIVE GROUP - 1:

Code No.	Course Title	L	T	P	C	HRS
106A	Power Electronics for Renewable Energy Systems	3	0	0	3	3
106B	Microcontroller Based System Design	3	0	0	3	3
106C	System Theory	3	0	0	3	3
106D	Electro Magnetic Interferences and Harmonic Elimination	3	0	0	3	3
106E	Non-Linear Dynamics for Power Electronics Circuits	3	0	0	3	3

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ELECTIVE GROUP - 2:

Code No.	Course Title	L	T	P	C	HRS
205A	Smart Grid	3	0	0	3	3
205B	Energy Auditing Conservation and Management	3	0	0	3	3
205C	Special Electrical Machines	3	0	0	3	3
205D	Static VAR Controllers and Harmonic Filtering	3	0	0	3	3
205E	Wind Energy Conversion Systems	3	0	0	3	3

ELECTIVE GROUP - 3:

Code No.	Course Title	L	T	P	C	HRS
206A	Soft Computing Techniques	3	0	0	3	3
206B	Flexible AC Transmission Systems	3	0	0	3	3
206C	Computer Aided Design of Electrical Machines	3	0	0	3	3
206D	Solar and Energy Storage Systems	3	0	0	3	3
206E	Application of MEMS Technology	3	0	0	3	3

Note:

1. HOD concerned has to provide options for selecting the relevant MOOC courses which are offered.
2. The credit distribution is followed as per the guidelines given by AICTE/UGC.

Course type	Credits				Contact Hours			
	L	T	P	Total	L	T	P	Total
Lecture course	3	0	0	3	3	0	0	3
Lecture + Practical course	3	0	1	4	3	0	2	5
Lecture + Tutorial course	3	1	0	4	3	2	0	5
	2	1	0	3	2	2	0	4
Lecture + Tutorial + Practical course	3	1	1	5	3	2	2	7

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Department	Electrical and Electronics Engineering	Course Code		255	Sub. Code		YPE 101	Sub. Name	Applied Mathematics for Electrical Engineers
Year	I	Semester		1	Regulation		2015	Max Mark	100
MODE OF EVALUATION & WEIGHTAGE (%)					Hours/ Week				Credit
CA 1	CA 2	CA 3	CA 4	Total	L	T		P	4
					3	1		0	
40%	10%	20%	30%	100%	L = 45; T=15 Total = 60 hrs				
Objective (s)	To develop the ability to apply the concepts of Matrix theory and Linear programming in Electrical Engineering problems. To achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems. To familiarize the students in calculus of variations and solve problems using Fourier transforms associated with engineering applications.								
Unit - 1	MATRIX THEORY								12 hours
	The Cholesky decomposition - Generalized Eigen vectors, Canonical basis - QR factorization - Least squares method - Singular value decomposition								
Unit - 2	CALCULUS OF VARIATIONS								12 hours
	Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.								
Unit - 3	ONE DIMENSIONAL RANDOM VARIABLES								12 hours
	Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.								
Unit - 4	LINEAR PROGRAMMING								12 hours
	Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models								
Unit - 5	FOURIER SERIES								12 hours
	Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals - Power signals: Exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm-Liouville systems – Generalized Fourier series.								

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Reference Books:	
1.	Richard Bronson, “Matrix Operation”, Schaum’s outline series, 2nd Edition, McGraw Hill, 2011.
2.	Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3.	Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes, Academic Press, (An imprint of Elsevier), 2010.
4.	Taha, H.A., “Operations Research, An introduction”, 10th edition, Pearson education, New Delhi, 2010.
5.	Andrews L.C. and Phillips R.L., Mathematical Techniques for Engineers and Scientists, Prentice Hall of India Pvt.Ltd., New Delhi, 2005.

YPE101 – Applied Mathematics for Electrical Engineers
Course Outcomes (COs)

At the end of the course, the students will be able to

1. Ability to provide the students with outstanding educational skills that will enable them to integrate undergraduate fundamentals with advanced knowledge to solve Complex power electronics problems
2. Ability to get the idea of optimization and the applications
3. Ability to apply the optimization ideas to solve the functional.

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Department	Electrical and Electronics Engineering	**Course Code**		255	**Sub. Code**		YPE 102	**Sub. Name**	**Analysis and Design of Inverters**
Year	I	**Semester**		1	**Regulation**		2015	**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**				**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**		4
					3	1	0		
40%	10%	20%	30%	100%	**L = 45; T=15 Total = 60 hrs**				

Objective (s)	To Provide the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation. To equip with required skills to derive the criteria for the design of power inverters for UPS, Drives etc., To give Ability to analyse and comprehend the various operating modes of different configurations of power inverters.	
Unit - 1	**SINGLE PHASE INVERTERS**	**12 hours**
	Introduction to self commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated Thyristor inverters – Design of UPS	
Unit - 2	**THREE PHASE VOLTAGE SOURCE INVERTERS**	**09 hours**
	180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – Application to drive system	
Unit - 3	**CURRENT SOURCE INVERTERS**	**09 hours**
	Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters – PWM techniques for current source inverters.	
Unit - 4	**MULTILEVEL & BOOST INVERTERS**	**09 hours**
	Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI – Single phase & Three phase Impedance source inverters .	
Unit - 5	**RESONANT INVERTERS**	**06 hours**
	Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices	

Reference Books:	
1.	Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
2.	Jai P.Agrawal, “Power Electronics Systems”, Pearson Education, Second Edition, 2002.
3.	Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education, Second Edition, 2003.
4.	Ned Mohan,T.M Undeland and W.P Robbin, “Power Electronics: converters, Application and design” John Wiley and sons.Wiley India edition, 2006.
5.	P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003.

YPE102 – Analysis and Design of Inverters
Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Design** their Inverter based on their requirement
2. **Identify** and **Apply** the various modes of inverters
3. **Analyse** the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation
4. **Analyse** and comprehend the various operating modes of different configurations of power converters

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Department	Electrical & Electronics Engineering	Course Code	255	Sub. Code	YPE 103	Sub. Name	Advanced Power Semiconductor Devices and Protection
Year	I	**Semester**	I	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					Hours / Week			Credit
CA1	**CA2**	**CA3**	**CA4 (End Sem)**	**Total**	**L**	**T**	**P**	4
					3	0	1	
15%	15%	20%	50%	100%	**L = 45; T = 0; P= 15;**			**Total = 60hrs**

Objective (s)	To improve power semiconductor device structures for adjustable speed motor control applications. To understand the static and dynamic characteristics of current controlled power semiconductor devices understand the static and dynamic characteristics of voltage controlled power semiconductor devices To enable the students for the selection of devices for different power electronics applications To understand the control and firing circuit for different devices.	
Unit - 1	**INTRODUCTION**	**09 hours**
Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability ; Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, switching characteristics – rating.		
Unit - 2	**CURRENT CONTROLLED DEVICES**	**09 hours**
BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor.		
Unit - 3	**VOLTAGE CONTROLLED DEVICES**	**09 hours**
Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.		
Unit - 4	**FIRING AND PROTECTING CIRCUITS**	**09 hours**
Necessity of isolation, pulse transformer, opto-coupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.		
Unit - 5	**THERMAL PROTECTION**	**09 hours**
Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types.		

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Text Books:	
1.	M.D. Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
2.	B.W Williams 'Power Electronics Circuit Devices and Applications.
3.	Ned Mohan, T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons. Wiley India edition, 2006.
Reference Books:	
1.	Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2.	Mohan, Undeland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.
3.	Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.

YPE 103 - Advanced Power Semiconductor Devices and Protection
Course Outcomes (COs)

At the end of the course, the students will be able to

1. To **know** the various power semiconductor devices and its characteristics.
2. To use the thyristor models for industrial applications.
3. **Understand** the characteristics of current controlled devices.
4. **Know** the basic principle and operation of voltage controlled devices.
5. Realize the operation of firing and protection circuits.
6. Able to **describe and analysis** of various power electronic circuit used in various applications

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epartment	Electrical & Electronics Engineering	**Course Code**	255	**Sub. Code**	**YPE 103**	**Sub. Name**	**Advanced Power Semiconductor Devices And Protection**
Year	**I**	**Semester**	I	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Credit**				**Hours/ Week**			
CIA 1	**CIA 2**	**EA 1**	**EA 2**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	1	4	3	0	2	5
30%	30%	20%	20%	100%	**L = 45; T = 0; P = 15; Total = 60 hrs**							

Objective (s)	To provide better understanding of power electronics devices Characteristics and converter performance for various loads

POWER ELECTRONICS DEVICES AND CIRCUITS LABORATORY

Name of the Experiments:

1. Switching characteristics of SCR.
2. Switching characteristics of TRIAC.
3. Switching characteristics of MOSFET.
4. Switching characteristics of IGBT.
5. Single phase semi converter with R-L and R-L-E (Motor)loads
6. Single phase full converter with R-L and R-L-E (Motor) loads.
7. MOSFET/ IGBT based Choppers.

YPE 103 Power Electronics Devices And Circuits Laboratory
Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Understand** I-V Characteristics Power semiconductor devices.
2. **Analyse** the various types of firing schemes.
3. **Able to Know** the converter performance for various types of loads
4. **Analyse** and **design** DC / DC converter circuits.
5. **Able to Know** about the PWM circuit.
6. **Learn** the performance of single and three phase converter .

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Department	Electrical and Electronics Engineering	**Course Code**		255	**Sub. Code**	YPE 104	**Sub. Name**	**Digital Simulation of Power Electronic Systems**
Year	I	**Semester**		I	**Regulation**	2015	**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**			**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	4
					3	0	1	
15%	15%	20%	50%	100%	**L = 45; T = 0; P = 30;**			**Total = 75 hrs**
Objective (s)	This course prepares students to work professionally in the area of power and power related fields. Students should be able to apply knowledge of mathematics and engineering, and identify numerical models to solve power and power electronics engineering problems.							
Unit - 1	**INTRODUCTION**							**09 hours**
	Principal of modelling power semiconductor devices – Macro models versus micro models – Thyristor model – Semiconductor device modelled as R,RL and RLC combinations – Systematic model of formulating State Equations-Computer Solution of State Equations – Explicit Integration Method – Implicit Integration Method.							
Unit - 2	**PSPICE**							**09 hours**
	Principal of modelling power semiconductor devices – Macro models versus micro models – Thyristor model – Semiconductor device modelled as R,RL and RLC combinations – Systematic model of formulating State Equations-Computer Solution of State Equations – Explicit Integration Method – Implicit Integration Method.							
Unit - 3	**MATLAB and SIMULINK**							**09 hours**
	Toolboxes of MATLAB - Programming and file processing in MATLAB – Model definition and model analysis using SIMULINK - S-Functions - Converting S - Functions to blocks.							
Unit - 4	**SIMULATION USING PSPICE, MATLAB and SIMULINK**							**09 hours**
	Diode rectifiers -Controlled rectifiers - AC voltage controllers - DC choppers – PWM inverters – Voltage source and current source inverters - Resonant pulse inverters -Zero current switching and Zero voltage switching inverters.							
Unit - 5	**SIMULATION OF DRIVES**							**09 hours**
	Simulation of speed control schemes for DC motors – Rectifier fed DC motors – Chopper fed DC motors – VSI and CSI fed AC motors – PWM Inverter – DC link inverter.							

Text Books:	
1.	V. Rajagopalan, "Computer Aided Analysis of Power Electronic Systems" – CRC Press, 1987.
2.	M. H. Rashid, "Introduction to PSpice using OrCAD for circuits and electronics", Pearson/Prentice Hall, 2004.
Reference Books:	
1.	E. Ramshaw, D. C, Schuuram, "PSpice Simulation of Power Electronics Circuits – An introductory Guide", Springer, New York, 1996.
2.	Chee-Mun Ong, "Dynamic Simulation of Electric Machinery: Using MATLAB/ Simulink", Prentice Hall, New Jersey, 1998.
3.	Ned Mohan, "Power Electronics: Computer Simulation Analysis and Education using PSPICE", Minnesota Power Electronics Research and Education, USA, 1992.
4.	Simulink Reference Manual, Math works, USA.
5.	"The PSpice User's Guide", Microsim Corporation, California, 1996.

YPE104 –Digital Simulation of Power Electronic Systems
Course Outcomes (COs)

At the end of the course, the students will be able to

1. To **formulate** state equations and solve state equations by explicit and implicit integration method.
2. To **know** the SPICE models of power electronic devices such as power diode, thyristor, BJT, MOSFET, IGBT.
3. To **know** programming and file processing, model analysis aspect of MATLAB/SIMULINK.
4. Able to **describe and analysis** of various power electronic circuits using PSPICE
5. Able to **describe and analysis** of various power electronic circuit using MATLAB/SIMULINK.
6. To **develop** Simulation model for DC and AC drives in MATLAB/SIMULINK environment.

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Department	Electrical and Electronics Engineering	**Course Code**	255	**Sub. Code**		YPE104		**Sub. Name**	Digital Simulation of Power Electronic Systems		
Year	I	**Semester**	I	**Regulation**		2015		**Max Mark**	100		
MODE OF EVALUATION & WEIGHTAGE (%)				**Credit Hours/ Week**							
CIA 1	**CIA 2**	**EA 1**	**EA 2**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	1	4	3	0	2	5
30%	30%	20%	20%	100%	**L = 45; T = 0; P = 30; Total = 75hrs**							
Objective (s)	To provide better understanding of power electronics system through digital simulation											

POWER ELECTRONICS SIMULATION LABORATORY

Name of the Experiments:

1. Simulation of Single phase semi converter with R, RL and RLE loads.
2. Simulation of Single phase full-converter with R, RL and RLE loads.
3. Simulation of three phase Semi and Full converter.
4. Simulation of MOSFET, IGBT based CLASS A, B, C, D, E Choppers.
5. Simulation of Single Phase dual converter fed R, RL and RLE loads.
6. Simulation of single phase IGBT based PWM inverter.
7. Simulation of single phase semi converter fed DC drives.
8. Simulation of three phase semi converter fed DC drives.
9. Simulation of single phase full converter fed DC drives
10. Simulation of closed loop control of chopper fed DC motor.
11. Simulation of single phase AC voltage controller fed AC drives

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YPE104 Power Electronics Simulation Laboratory Course Outcomes (COs)
At the end of the course, the students will be able to
1. **Understand** basic operation of various power semiconductor devices and passive components. 2. **Understand** the basic principle of switching circuits. 3. **Analyse** and **design** an AC/DC rectifier circuit. 4. **Analyse** and **design** DC/DC converter circuits. 5. **Analyse** DC/AC inverter circuit. 6. **Learn** the requirements imposed by electric drives (dc and ac) on converters and **synthesize** these converters using the building block approach.

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Department	Electrical and Electronics Engineering	**Course Code**	255	**Sub. Code**	YPE 105	**Sub. Name**	**Analysis of Power Converters**
Year	I	**Semester**	1	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**			**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	
					3	1	0	4
40%	10%	20%	30%	100%	**L = 45; T=15 Total = 60 hrs**			

Objective (s)	• To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation • To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals. • To analyze and comprehend the various operating modes of different configurations of power converters. • To design different power converters namely AC to DC, DC to DC and AC to AC converters.	
Unit - 1	**SINGLE PHASE AC-DC CONVERTER**	**09 hours**
	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 – continuous and discontinuous modes of operation - inverter operation –Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap-reactive power and power balance in converter circuits	
Unit - 2	**THREE PHASE AC-DC CONVERTER**	**09 hours**
	Semi and fully controlled converter with R, R-L, R-L-E - loads and free wheeling diodes – inverter operation and its limit – performance parameters – effect of source impedance and over lap – 12 pulse converter.	
Unit - 3	**DC-DC CONVERTERS**	**09 hours**
	Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters – PWM techniques for current source inverters.	
Unit - 4	**AC VOLTAGE CONTROLLERS**	**09 hours**
	Static Characteristics of TRIAC- Principle of phase control: single phase and three phase controllers – various configurations – analysis with R and R-L loads.	
Unit - 5	**CYCLOCONVERTERS**	**09 hours**
	Principle of operation – Single phase and Three-phase Dual converters - Single phase and three phase cyclo-converters – power factor Control – Introduction to matrix converters.	

Reference Books:	
1.	Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
2.	Jai P.Agrawal, “Power Electronics Systems”, Pearson Education, Second Edition, 2002.
3.	Power Electronics by Vedam Subramanyam, New Age International publishers, New Delhi Second Edition, 2006
4.	Ned Mohan,T.M Undeland and W.P Robbin, “Power Electronics: converters, Application and design” John Wiley and sons.Wiley India edition, 2006.
5.	P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003.

YPE105 – Analysis of Power Converters **Course Outcomes (COs)**
At the end of the course, the students will be able to
1. **review** knowledge about fundamental concepts and techniques used in power electronics. 2. **analyze** various single phase and three phase power converter circuits and understand their applications. 3. **identify** basic requirements for power electronics based design application 4. **understand** the use of power converters in commercial and industrial applications

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

YPE101 – Applied Mathematics for Electrical Engineers

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	-	2	-	-	1	-	-	1
CO2	1	2	1	3	1	-	-	-	2
CO3	-	-	2	-	-	1	2	-	1
CO4	1	1	2	2	1	-	-	-	2

1- Slightly 2 – Supportive 3 – Highly related

YPE102 – Analysis and Design of Inverters

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	-	2	-	-	1	-	-	1
CO2	1	2	1	3	1	-	-	-	2
CO3	-	-	2	-	-	1	2	-	1
CO4	1	1	2	2	1	-	-	-	2

1- Slightly 2 – Supportive 3 – Highly related

YPE 103 Advanced Power Semiconductor Devices And Protection (Theory)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	1	1	2	-	-	-	-
CO2	2	2	2	2	2	-	-	-	1
CO3	3	3	3	2	2	-	-	-	1
CO4	2	3	2	2	1	-	-	-	-
CO5	2	2	2	3	3	-	-	-	1
CO6	2	1	2	3	2	-	-	-	-

1- Slightly 2 – Supportive 3 – Highly related

YPE 103 – Advanced Power Semiconductor Devices and Protection (Lab)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	-	-	2	-	-	-	-
CO2	1	3	-	2	-	-	-	-	-
CO3	1	2	-	3	-	-	-	-	-
CO4	1	3	-	-	-	-	-	-	-
CO5	3	1	-	-	2	-	-	-	-
CO6	2	3	-	-	1	-	-	-	-
CO7	3	2	-	-	2	-	-	-	-

1- Slightly 2 – Supportive 3 – Highly related

YPE 104 – Digital Simulation of Power Electronics System (Theory)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	1	2	-	-	-	-
CO2	2	3	2	2	2	-	-	-	1
CO3	2	3	3	2	2	-	-	-	1
CO4	2	3	2	2	3	-	-	-	-
CO5	2	2	2	3	3	-	-	-	1
CO6	2	3	2	3	2	-	-	-	-
CO7	2	2	3	3	2	-	-	-	-
CO8	1	2	2	2	2	-	-	-	-

1- Slightly 2 – Supportive 3 – Highly related

YPE 104 – Digital Simulation Power Electronics System (Lab)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	-	-	2	-	-	-	-
CO2	1	3	-	2	-	-	-	-	-
CO3	2	2	-	3	-	-	-	-	-
CO4	1	3	-	-	-	-	-	-	-
CO5	3	2	-	-	2	-	-	-	-
CO6	2	3	-	-	1	-	-	-	-
CO7	3	2	-	-	2	-	-	-	-

1- Slightly 2 – Supportive 3 – Highly related

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YPE105 – Analysis of Power Converters

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	-	2	-	-	-	-	-	-
CO2	1	2	1	3	1	-	-	-	2
CO3	-	-	-	-	-	1	2	-	1
CO4	1	1	2	2	1	-	-	-	2

1- Slightly 2 – Supportive 3 – Highly related

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Department	Electrical and Electronics Engineering		**Course Code**	255	**Sub. Code**		YPE 203	**Sub. Name**	Solid State DC Drives
Year	I		**Semester**	II	**Regulation**		2015	**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE (%)					**Hours / Week**				**Credit**
CA1	**CA2**	**CA3**	**CA4 (End Sem)**	**Total**	**L**	**T**	**P**		4
					3	0	1		
40%	10%	20%	30%	100%	**L = 45; T = 0; P= 30; Total = 75 hrs**				
Objective (s)	To understand steady state operation and transient dynamics of a motor load system To study and analyze the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively. To analyze and design the current and speed controllers for a closed loop solid state DC motor drive. To understand the implementation of control algorithms using microcontrollers and phase locked loop.								
Unit - 1	**DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS**								**09 hours**
DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation - Introduction to high speed drives and modern drives. Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics - stability of drives – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.									
Unit - 2	**CONVERTER CONTROL**								**09 hours**
Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with free wheeling diode; Implementation of braking schemes; Drive employing dual converter.									
Unit - 3	**CHOPPER CONTROL**								**09 hours**
Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Multi-phase chopper; Related problems									
Unit - 4	**CLOSED LOOP CONTROL**								**09 hours**
Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed d.c drive.									

Unit - 5	**DIGITAL CONTROL OF D.C DRIVE**	**09 hours**
Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant horse power and load disturbed operations; Speed detection and current sensing circuits.		
Text Books:		
1.	Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., New Yersy, 1989.	
2.	R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.	
Reference Books:		
1.	Gobal K.Dubey, “Fundamentals of Electrical Drives”, Narosal Publishing House, New Delhi, Second Edition, 2009.	
2.	Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.	
3.	P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 1981.	

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<table>
<tr><td>Department</td><td>Electrical and Electronics Engineering</td><td>Course Code</td><td>255</td><td colspan="2">Sub. Code</td><td>YPE 203</td><td>Sub. Name</td><td>Solid State DC Drives</td></tr>
<tr><td>Year</td><td colspan="2">I</td><td>Semester</td><td>II</td><td>Regulation</td><td>2015</td><td>Max Mark</td><td>100</td></tr>
<tr><td colspan="5">MODE OF EVALUATION & WEIGHTAGE (%)</td><td colspan="3">Hours / Week</td><td>Credit</td></tr>
<tr><td rowspan="2">CA1</td><td rowspan="2">CA2</td><td rowspan="2">CA3</td><td rowspan="2">CA4 (End Sem)</td><td rowspan="2">Total</td><td>L</td><td>T</td><td>P</td><td rowspan="2">4</td></tr>
<tr><td>3</td><td>0</td><td>1</td></tr>
<tr><td>40%</td><td>10%</td><td>20%</td><td>30%</td><td>100%</td><td colspan="4">L = 45; T = 0; P= 30; Total = 75 hrs</td></tr>
<tr><td>Objective (s)</td><td colspan="8">To understand steady state operation and transient dynamics of a motor load system
To study and analyze the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively. To analyze and design the current and speed controllers for a closed loop solid state DC motor drive. To understand the implementation of control algorithms using microcontrollers and phase locked loop.</td></tr>
</table>

POWER ELECTRONICS DRIVES LABORATORY

LIST OF EXPERIMENTS

1. Single phase semi- converter fed DC drive.
2. Single phase full converter fed DC drive
3. Three phase Half controlled rectifier fed dc drive
4. Three phase fully controlled rectifier fed dc drive.
5. Chopper fed DC drives.
6. Speed control of three-phase induction motor using PWM inverter.
7. DSP based closed loop drive for induction motor
8. DSP based Speed control of Brush Less DC motor.
9. DSP based Switched Reluctance Motor Drive.
10. Three phase AC voltage controller fed AC Drive
11. Mini Projects (Related above Experiments)

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YPE 203 - Solid State DC Drives Course Outcomes (COs)
At the end of the course, the students will be able to
1. **Know** the basic concept of steady state operation and transient dynamics of a motor load system 2. **Design** , **Analyze** and **operate** with various controlled rectifier fed DC drive. 3. **Design**, **Analyze** and **operate** with various chopper fed DC drive 4. **Analyze** and **Design** the current and speed controllers for a closed loop solid state DC motor drives. 5. **Design** , **Analyze** and **operate** with inverter fed induction motor drives. 6. **Generate** the gating pulses using micro controller and FPGA 7. **Analyze** the speed control of Stepper motor, BLDC motor and SRM. 8. **Design, simulate** and **analyze** the closed loop control of converter and chopper fed dc drives.

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Department	Electrical & Electronics Engineering	**Course Code**	255	**Sub. Code**	YPE 204	**Sub. Name**	**Power Quality**
Year	I	**Semester**	II	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Credit**				**Hours/ Week**			
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	0	3	3	0	0	3
15%	15%	20%	50%	100%	**L = 45; T = 0; P = 0; Total = 45 hrs**							

Objective (s)	To impart the Basic knowledge of Power quality issues. To understand the idea about voltage sag. To understand the analysis in harmonics. To describe the fundamentals of filtering. To know about the power factor. To understand the power quality monitoring.	
Unit - 1	**INTRODUCTION**	**09 hours**
	Definition of Electric Power Quality- Description of poor power quality events. Power Quality phenomena – Basic terminologies – various events in Power Quality – Causes for reduction in Power Quality — Power Quality Standards and power quality strategy.	
Unit - 2	**VOLTAGE SAG**	**09 hours**
	Sources of sags – estimating voltage sag performance, sag severities – voltage sag due to induction motor starting - mitigation of voltage sags - effect on adjustable AC Drives, DC drives, computers and consumer electronics.	
Unit - 3	**HARMONICS**	**09 hours**
	Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics - evaluation of Harmonic distortion - devices for controlling harmonic distortion.	
Unit - 4	**FILTERING AND POWER FACTOR IMPROVEMENT**	**09 hours**
	Power factor improvement- Passive Compensation. Passive Filtering Active Harmonic Filtering-Shunt Injection Filter for single phase, three-phase three-wire and three-phase four-wire systems static VAR compensators-SVC and STATCOM.	
Unit - 5	**POWER QUALITY MONITORING**	**09 hours**
	Monitoring considerations - monitoring and diagnostic techniques for various power quality problems - modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - power line disturbance analyzer – Quality measurement equipment - harmonic / flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring	

Text Books:	
1.	Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.WayneBeaty, "Electrical Power Systems Quality" McGraw Hill,2003
2.	C. Sankaran, "Power Quality" CRC Press.
3.	Alexander Kusko "Power Quality in Electrical Systems" The McGraw-Hill Companies, Inc.
4.	Ewald F. Fuchs and Mohammad A.S. Masoum" Power Quality in Power Systems and Electrical Machines"
Reference Books:	
1.	Silvester and Ferrari, "Finite for Electrical Engineers", Cambridge University Press, 1983
2.	S.R.H.Hoole, Computer – Aided, Analysis and Design of Electromagnetic Devices, Elsevier, New York, Amsterdam, London, 1989
3.	D.A.Lowther and P.P Silvester, "Computer Aided Design in Magnetics", Springer Verlag, New York, 1956
4.	S.J Salon, "Finite Element Analysis of Electrical Machines", Kluwer Academic Publishers, London, 1995

YPE 204 – Power Quality
Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Understand** the fundamentals and working principle of power quality.
2. **Use** the measuring instruments to **measure** the electrical parameters **Record** the harmonics value in harmonics.
3. **Indentify** the various types of filters.
4. Gain the knowledge in the measuring instruments and **analyze** the various power quality Monitoring systems.
5. **Compare** the power quality strategy.
6. **Analysis** power line disturbance.
7. **Collect** the various power quality problems

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

YPE203 – Solid State DC Drives

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	-	2	-	-	1	-	-	1
CO2	1	2	1	3	1	-	-	-	2
CO3	-	-	2	-	-	1	2	-	1
CO4	1	1	2	2	1	-	-	-	2
CO5	1	-	2	-	-	1	-	-	1
CO6	1	2	1	3	1	-	-	-	2
CO7	-	-	2	-	-	1	2	-	1
CO8	1	1	2	2	1	-	-	-	2

1- Slightly 2 – Supportive 3 – Highly related

YPE204 – Power Quality

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	-	2	-	-	1	-	-	1
CO2	1	2	1	3	1	-	-	-	2
CO3	-	-	2	-	-	1	2	-	1
CO4	1	1	2	2	1	-	-	-	2
CO5	1	-	2	-	-	1	-	-	1
CO6	1	2	1	3	1	-	-	-	2
CO7	-	-	2	-	-	1	2	-	1

1- Slightly 2 – Supportive 3 – Highly related

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Department	Electrical & Electronics Engineering	**Course Code**	255	**Sub. Code**	YPE 106A	**Sub. Name**	**Power Electronics for Renewable Energy Systems**
Year	I	**Semester**	I	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Credit**				**Hours/ Week**			
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	0	3	3	0	0	3
15%	15%	20%	50%	100%	**L = 45; T = 00; P = 00;**				**Total = 45 hrs**			

Objective (s)	To Provide knowledge about the standalone and grid connected renewable energy systems. To equip with required skills to derive the criteria for the design of power converters for renewable energy applications. To analyze and comprehend the various operating modes of wind electrical generators and solar energy systems	
Unit- 1	**INTRODUCTION**	**10 hours**
	Trends in energy consumption - World energy scenario - Energy source and their availability – Conventional and renewable sources - Need to develop new energy technologies- MNRE Rules and Regulations-TEDA-Wind and solar survey in India and World.	
Unit- 2	**ELECTRICALMACHINESFOR RENEWABLEENERGYCONVERSION**	**08 hours**
	Review of reference theory fundamentals-principle of operation and analysis: Induction Generator (IG), Permanent Magnet Synchronous Generator (PMSG), squirrel cage induction generator (SCIG)and Doubly Fed Induction Generator (DFIG).	
Unit- 3	**POWER CONVERTERS**	**10 hours**
	Solar: Block diagram of solar photo voltaic system, line commutated converters (inversion-mode) -Maximum power point tracking – Applications – Water pumping – Street lighting, battery sizing, array sizing. Wind: three phase AC voltage controllers- AC-DC-AC converters, Grid Interactive Inverters-matrix converters.	
Unit- 4	**ANALYSISOFWINDAND PVSYSTEMS**	**08 hours**
	Standaloneoperationoffixedandvariablespeedwindenergyconversionsystemsand solar energy conversion system based on PV system -Inter connections with Grid - Power conditioning schemes.	
Unit- 5	**HYBRID RENEWABLEENERGYSYSTEMS**	**09 hours**
	Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Power converters for distributed power systems- Storage - Reliability evolution	

Text Books:	
1.	S. Rao and Parulekar, Energy Technology – Non Conventional, Renewable and Conventional, New Delhi, Khanna Publishers, 1999.
2.	Mukund R. Patel, Wind and Solar Power System, New York, CRC Press LLC, 1999.
3.	Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design, New Jersey, John Wiley and Sons, 2003.
4.	S.N.Bhadra,D.Kastha,&S.Banerjee “Wind Electrical Systems ”,OxfordUniversity Press,2009
Reference Books:	
1.	Rashid. M.H “power Electronics Handbook”, Academicpress, 2001.
2.	Rai. G.D,“ Nonconventional Energy Sources”, Khanna publishes, 1993
3.	Gray, L.Johnson, “Wind energy system”, prentice hall linc, 1995.
4.	Non-conventional Energy sources B.H. Khan Tata McGraw-hill Publishing Company, New Delhi.

YPE 106A – Power Electronics for Renewable Energy Systems
Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Understand** the fundamentals of renewable energy systems.
2. **Explained** the operation of various electrical machines for renewable energy conversion.
3. **Analyze** the different power conversion systems employed in renewable energy.
4. **Review** the Grid connected solar and wind power generation systems.
5. **Identify** the DC / AC converters employed for hybrid energy systems.

Gain the knowledge about the controllers **design** for hybrid systems.

6. **Discuss** the hybrid renewable energy systems.

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Department	Electrical & Electronics Engineering	**Course Code**	255	**Sub. Code**	YPE 106B	**Sub. Name**	**Microcontroller Based System Design**
Year	I	**Semester**	I	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Credit**				**Hours/ Week**			
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	0	3	3	0	0	3
40%	10%	20%	30%	100%	**L = 45; T = 0; P = 0; Total = 45 Hrs**							

Objective (s)	To expose the students to the fundamentals of microcontroller based system design. To teach I/O and RTOS role on microcontroller. To impart knowledge on PIC Microcontroller based system design. To introduce Microchip PIC 8 bit peripheral system Design. To give case study experiences for microcontroller based applications.	
Unit - 1	**8051 ARCHITECTURE**	**09 hours**
	Architecture – memory organization – addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication.	
Unit - 2	**8051 PROGRAMMING**	**09 hours**
	Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming Interrupt Programming – RTOS for 8051 – RTOS Lite – Full RTOS – Task creation and run – LCD digital clock/thermometer using Full RTOS.	
Unit - 3	**PIC MICROCONTROLLER**	**09 hours**
	Architecture – memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, MP-LAB IDE.	
Unit - 4	**PERIPHERAL OF PIC MICROCONTROLLER**	**09 hours**
	Timers – Interrupts, I/O ports- I^2C bus-A/D converter-UART- CCP modules -ADC, DAC and Sensor Interfacing –Flash and EEPROM memories.	
Unit - 5	**SYSTEM DESIGN – CASE STUDY**	**09 hours**
	Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Stand alone Data Acquisition System.	

Reference Books:	
1.	Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008
2.	John Iovine, ‘PIC Microcontroller Project Book ’, McGraw Hill 2000.
3.	Myke Predko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001**.**
4.	Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2005.
5.	Rajkamal, “Microcontrollers-Architecture, Programming, Interfacing & System Design”, 2ed, Pearson, 2012.
6.	I Scott Mackenzie and Raphael C.W. Phan, “The Micro controller”, Pearson, Fourth edition 2012.

YPE106B Microcontroller Based System Design

Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Define** and differentiate between microprocessor and microcontroller.
2. **Discuss** the various types of peripheral located in the Embedded controllers.
3. **Understand** the concept of Interfacing of various systems.
4. **Develope** a controller model for the different electrical systems automation application.
5. **Design** & verification of Standalone Systems.

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Department	Electrical and Electronics Engineering	**Course Code**		255	**Sub. Code**	YPE 106C		**Sub. Name**	**System Theory**
Year	I	**Semester**		I	**Regulation**	2015		**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**				**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**		**P**	3
					3	0		0	
40%	10%	20%	30%	100%	**L = 45; T = 0; P = 0; Total = 45 hrs**				
Objective (s)	To educate on modeling and representing systems in state variable form and educate on solving linear and non-linear state equations. To illustrate the role of controllability and observabilit and understand on stability analysis of systems using Lyapunov's theory. To educate on modal concepts and design of state and output feedback controllers and estimators								
Unit - 1	**STATE VARIABLE REPRESENTATION**								**09 hours**
	Introduction-Concept of State-State equation for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model-State Diagrams - Physical System and State Assignment.								
Unit - 2	**SOLUTION OF STATE EQUATIONS**								**09 hours**
	Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes- Role of Eigenvalues and Eigenvectors, Discrete time state equations- Jordan canonical form								
Unit - 3	**CONTROLLABILITY AND OBSERVABILITY**								**09 hours**
	Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations								
Unit - 4	**STABILTY**								**09 hours**
	Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.								
Unit - 5	**SISO and MIMO Systems**								**09 hours**
	Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers..								

Text Books:	
1.	M. Goal, ‘Digital Control and State Variable Methods’, Tata McGraw-Hill, 1997.
2.	John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999.
3.	Benjamin C. Kuo, “Digital Control Systems”. Oxford University Press, 1992.
4.	D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005.
Reference Books:	
1.	R.C.Dorf and R.H.Bishop, ‘Modern Control Systems’, Addison-Wesley, 1995. (MATLAB Reference)
2.	Nagrath, I.J. and Gopal, M., ‘Control System Engineering’, Wiley Eastern, Reprint 1995
3.	K. Ogata, “Modern Control Engineering” 2nd Edition, Prentice Hall India, New Delhi, 1992.
4.	A. Johnson and H. Moradi, New Identifications and Design Methods, Springer -Verlag, 2005.

YPE 106C System Theroy **Course Outcomes (COs)**
At the end of the course, the students will be able to
1. **Define** and differentiation between linear and nonlinear control systems. 2. **Develope** a mathematical model for the different mechanical, electrical and electromechanical 3. **Discuss** of Lyapunov BIBO Stability, Krasovskii and Variable-Gradiant Method. 4. **Understand** of optical and adaptive control systems & also verification of controllability and observability of control Systems. 5. **Design** & verification of compensated circuits/systems for uncompensated circuits/systems

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Department	Electrical and Electronics Engineering	**Course Code**	255	**Sub. Code**	YPE 106D	**Sub. Name**	Electro Magnetic Interferences and Harmonic Elimination
Year	I	**Semester**	I	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Hours / Week**			**Credit**
CA1	**CA2**	**CA3**	**CA4 (End Sem)**	**Total**	**L**	**T**	**P**	3
					3	0	0	
40%	10%	20%	30%	100%	**L = 45; T = 00; P= 0;**			**Total = 45 hrs**

Objective (s)	To get the knowledge about Electro Magnetic Interferences and Harmonic Elimination. To get in-depth idea about EMI Measurements, Power system Harmonics, Harmonic Elimination and sources of harmonics.	
Unit - 1	**INTRODUCTION**	**09 hours**
	Introduction Sources of EMI- EMI and EMC with examples- Classification of EMI/EMC - power quality - voltage quality - overview of power quality phenomena - classification of power quality issues - power quality measures and standards-THD-TIF-DIN-C-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and recommended practices.	
Unit - 2	**ELETROMAGNETIC INTERFERERS AND MEASUREMENTS**	**09 hours**
	CE, RE, CS, RS, Units of Parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression. Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection technique open area site, shielded anechoic chamber, TEM cell.	
Unit - 3	**POWER SYSTEM HARMONICS**	**09 hours**
	Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.	

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Unit - 4	**HARMONICS ELIMINATION**	**09 hours**
	Passive Harmonic Filtering. Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling. Three-phase four-wire shunt active filters. Hybrid Filtering using Shunt Active Filters. Series Active Filtering in Harmonic Cancellation Mode.	
Unit - 5	**SOURCES AND EFFECTS OF HARMANICS**	**09 hours**
	Current Harmonics - Sources of Harmonics in Distribution Systems and Ill Effects, Series Active Filtering in Harmonic Cancellation Mode. Series Active Filtering in Harmonic Isolation Mode . Dynamic Voltage Restorer and its control . Power Quality Conditioner.	
Text Books:		
1.	Prasad Kodali.V, “Engineering Electromagnetic Compatibility”, S. Chand & Co, New Delhi 2000.	
2.	Clayton R. Paul, “Introduction to Electromagnetic compatibility”, Wiley & Sons 1992	
Reference Books:		
1.	Reactive Power Control in Electric Systems by T.J.E Miller	
2.	Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems by N.G. Hingorani & L. Gyugyi IEEE Press, 2000.	
3.	Electric Power Quality by G.T.Heydt	
4.	Understanding Power Quality Problems by Math H. Bollen J.Arrillaga, .Power System Quality Assessment., John wiley, 2000	

YPE 106D – Electro Magnetic Interferences and Harmonic Elimination
Course Outcomes (COs)

At the end of the course, the students will be able to

1. Learn and **understand** the sources of power quality issues and its results.
2. Use the measuring techniques to **measure** the various EMIs.
3. **Discuss** and distinguish the various Power system harmonics.
4. **Analyze** the harmonics and **design** the concern filters**.**
5. **Understand** the sources of harmonics and leading to justify its effects

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Department	Electrical and Electronics Engineering	**Course Code**	255	**Sub. Code**	YPE 106E	**Sub. Name**	**Non Linear Dynamics for Power Electronic Circuits**
Year	I	**Semester**	I	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**			**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	3
					3	0	0	
40%	10%	20%	30%	100%	**L = 45; T = 0; P = 0;**			**Total = 45 hrs**

Objective (s)	To understand the non linear behavior of power electronic converters. To understand the techniques for investigation on non linear behavior of power electronic converters. To analyse the non linear phenomena in DC to DC converters. To analyse the non linear phenomena in AC and DC Drives. To introduce the control techniques for control of non linear behavior in power electronic systems.	
Unit – 1	**BASICS OF NONLINEAR DYNAMICS**	**09 hours**
	Basics of Nonlinear Dynamics: System, state and state space model, Vector field- Modeling of Linear, nonlinear and Linearized systems, Attractors , chaos, Poincare map, Dynamics of Discrete time system, Lyapunov Exponent, Bifurcations, Bifurcations of smooth map, Bifurcations in piece wise smooth maps, border crossing and border collision bifurcation.	
Unit – 2	**TECHNIQUES FOR INVESTIGATION OF NONLINEAR PHENOMENA**	**09 hours**
	Techniques for experimental investigation, Techniques for numerical investigation, Computation of averages under chaos, Computations of spectral peaks, Computation of the bifurcation and analyzing stability.	
Unit - 3	**NONLINEAR PHENOMENA IN DC-DC CONVERTERS**	**09 hours**
	Border collision in the Current Mode controlled Boost Converter, Bifurcation and chaos in the Voltage controlled Buck Converter with latch, Bifurcation and chaos in the Voltage controlled Buck Converter without latch, Bifurcation and chaos in Cuk Converter. Nonlinear phenomenon in the inverter under tolerance band control	
Unit - 4	**NONLINEAR PHENOMENA IN DRIVES**	**09 hours**
	Nonlinear Phenomenon in Current controlled and voltage controlled DC Drives, Nonlinear Phenomenon in PMSM Drives.	
Unit - 5	**CONTROL OF CHAOS**	**09 hours**
	Hysteresis control, Sliding mode and switching surface control, OGY Method, Pyragas method, Time Delay control. Application of the techniques to the Power electronics circuit and drives.	

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Reference Books:	
1.	George C. Vargheese, July 2001 Wiley – IEEE Press S Banerjee, Nonlinear Phenomena in Power Electronics, IEEE Press.
2.	Steven H Strogatz, Nonlinear Dynamics and Chaos, Westview Press
3.	C.K.TSE Complex Behaviour of Switching Power Converters, CRC Press, 2003

YPE 106E Non Linear Dynamics for Power Electronic Circuits **Course Outcomes (COs)**
At the end of the course, the students will be able to
1. Ability to **understand**, model and simulate chaotic behavior in power electronic systems. 2. Ability to **mitigate** chaotic behavior noticed in power converters. 3. **Discuss** of **Techniques** for investigation of nonlinear phenomena. 4. **Analyse** the non linear phenomena in DC to DC converters.

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Department	Electrical & Electronics Engineering	Course Code	255	Sub. Code	YPE 205A	Sub. Name	Smart Grid
Year	I	**Semester**	II	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					Credit				Hours/ Week			
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	0	3	3	0	0	3
15%	15%	20%	50%	100%	**L = 45; T = 0; P = 0; Total = 45 hrs**							

Objective (s)	The objectives of this course are to Study about Smart Grid technologies, different smart meters and advanced metering infrastructure; to familiarize the power quality management issues in Smart Grid; to familiarize the high performance computing for Smart Grid applications	
Unit- 1	**INTRODUCTION TO SMART GRID**	**09 hours**
	Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives	
Unit- 2	**SMART GRID TECHNOLOGIES**	**09 hours**
	Smart energy resources,Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and 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).	
Unit- 3	**SMART METERS AND ADVANCED METERING INFRASTRUCTURE**	**09 hours**
	Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits,AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.	
Unit- 4	**POWER QUALITY MANAGEMENT IN SMART GRID**	**09 hours**
	Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.	
Unit- 5	**HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS**	**09 hours**
	Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.	

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Text Books:	
1.	Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, Wiley
2.	Stuart Borlase “Smart Grid :Infrastructure, Technology and Solutions”,CRC Press2012.
3.	Yang Xiao, Communication and Networking in Smart Grids, CRC press, 2012
Reference Books:	
1.	Nouredine Hadjsaïd and Jean-Claude SabonnadièreSmart, SmartGrids, ISTE Ltd. 2012.
2.	Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
3.	Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – TheNew and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grids.

YPE 205A – Smart Grid
Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Describe** the paradigm shift between traditional power transmission and distribution and smart power grids verbally and in writing.
2. **Understand and describe** drivers, challenges and benefits to the integration of renewable and distributed generation into large power grids.
3. Describe and **assess** smart grid technologies that enhance transmission and distribution systems.
4. **Study** current implementations of smart grid technologies and/or policies using regional data sources.
5. **Work effectively** in project teams using appropriate communication skills in order to present information about smart grid industry practices and community engagement.

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Department	Electrical & Electronics Engineering		**Course Code**	255	**Sub. Code**	YPE 205B	**Sub. Name**	Energy Auditing Conservation and Management
Year	I		**Semester**	II	**Regulation**	2015	**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE (%)					**Hours / Week**			**Credit**
CA1	**CA2**	**CA3**	**CA4 (End Sem)**	**Total**	**L**	**T**	**P**	3
					3	0	0	
40%	10%	20%	30%	100%	**L = 45; T = 00; P= 0;**			**Total = 45 hrs**
Objective (s)	To provide the knowledge on energy audit and to study the different energy audit instruments. To give idea about different energy efficiency machineries to selection of equipments for energy conservation. To analyze the different methodologies for minimum loss power distribution system.							
Unit - 1	**ENERGY AUDITING AND MEASURING INSTRUMENTS**							**09 hours**
Introduction - System approach and End use approach to efficient use of Electricity; Electricity tariff types; Energy auditing: Types and objectives-audit instruments- ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models-Case study.								
Unit - 2	**ENERGY EFFICIENCY IN ELECTRICAL MACHINES**							**09 hours**
Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis- Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors. Methods of power factor improvements, location of power factor correction equipment's.								
Unit - 3	**POWER DISTRIBUTION AND MEASUREMENT**							**09 hours**
Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study. Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance case study; Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study.								

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Unit - 4	ENERGY CONSERVATION MEASURES	09 hours
Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study; Electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage .Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- software's- EMS		
Unit - 5	ENERGY MANAGEMENT IN DRIVES AND DOMESTIC SYSTEMS	09 hours
Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Optimal operation and Storage; Case study Lighting- Energy efficient light sources- Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study.		

Text Books:	
1.	Smith CB Energy management Principles, Pergamom Press, New York, 1981.
2.	Albert Thumann, "Handbook of Energy Audits", Fairmont Pr; 5th edition, 1998.
Reference Books:	
1.	Giovanni Petrecca, "Industrial Energy Management:Principles and Applications" The Kluwer international series -207,(1999)
2.	Anthony J. Pansini, Kenneth D. Smalling, "Guide to Electric Load Management" Pennwell Pub; (1998)
3.	Howard E. Jordan, "Energy-Efficient Electric Motors and Their Applications" Plenum Pub MCorp; 2nd edition (1994)
4.	Turner, Wayne C. "Energy Management Handbook"., Lilburn, The Fairmont Press, 2001

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YPE 205B Energy Auditing Conservation and Management **Course Outcomes (COs)**
At the end of the course, the students will be able to
1. **Understand** the need for energy audit , types and methodologies of energy audit. 2. **Study** the different energy efficiency control techniques for improving the efficiency in power system 3. **Practice** the power management system in a distribution network to minimize the peak demand. 4. **Understand** the different lighting schemes and variable speed drive system for optimal operation of the electrical system. 5. **Compare** different methods of power factor improvement for reducing the losses in a distribution system. 6. **Analyze optimal** operation in cogeneration plant and to improve heat recovery schemes for minimum loss in a thermal system.

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<table>
<tr><td>Department</td><td>Electrical & Electronics Engineering</td><td>Course Code</td><td colspan="2">255</td><td colspan="4">Sub. Code</td><td colspan="2">YPE 205C</td><td>Sub. Name</td><td colspan="3">Special Electrical Machines</td></tr>
<tr><td>Year</td><td>I</td><td>Semester</td><td colspan="2">II</td><td colspan="4">Regulation</td><td colspan="2">2015</td><td>Max Mark</td><td colspan="3">100</td></tr>
<tr><td colspan="5">MODE OF EVALUATION & WEIGHTAGE (%)</td><td colspan="4">Credit</td><td colspan="6">Hours/ Week</td></tr>
<tr><td rowspan="2">CA 1</td><td rowspan="2">CA 2</td><td rowspan="2">CA 3</td><td rowspan="2">CA 4</td><td rowspan="2">Total</td><td>L</td><td>T</td><td>P</td><td>Total</td><td>L</td><td>T</td><td>P</td><td colspan="3">Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td><td>0</td><td>0</td><td colspan="3">3</td></tr>
<tr><td>15%</td><td>15%</td><td>20%</td><td>50%</td><td>100%</td><td colspan="10">L = 45; T = 0; P = 0; Total = 45 hrs</td></tr>
<tr><td>Objective (s)</td><td colspan="14">To impart the Basic knowledge of synchronous reluctance motor. To understand the concepts of working principles and construction of stepping motors and switched reluctance motor. To impart the knowledge of permanent magnet brushless AC and DC motor.</td></tr>
<tr><td>Unit – 1</td><td colspan="12">SYNCHRONOUS RELUCTANCE MOTORS</td><td colspan="2">09 hours</td></tr>
<tr><td></td><td colspan="14">Constructional features – types – axial and radial air gap motors – operating principle – reluctance – phasordiagram - characteristics – Vernier motor.</td></tr>
<tr><td>Unit –2</td><td colspan="12">STEPPING MOTORS</td><td colspan="2">09 hours</td></tr>
<tr><td></td><td colspan="14">Constructional features – principle of operation – variable reluctance motor – Hybrid motor – single and Multi stack configurations – theory of torque predictions – linear and non-linear analysis – characteristics –closed loop control - drive circuits.</td></tr>
<tr><td>Unit –3</td><td colspan="12">SWITCHED RELUCTANCE MOTORS</td><td colspan="2">09 hours</td></tr>
<tr><td></td><td colspan="14">Constructional features – principle of operation – torque prediction – power controllers – Nonlinear analysis – Microprocessor based control –closed loop control - characteristics.</td></tr>
<tr><td>Unit –4</td><td colspan="12">PERMANENT MAGNET BRUSHLESS DC MOTORS</td><td colspan="2">09 hours</td></tr>
<tr><td></td><td colspan="14">Principle of operation –EMF and Torque equations – Types of Power Controllers – Torque Speed characteristics – Commutation logic - Control.</td></tr>
<tr><td>Unit –5</td><td colspan="12">PERMANENT MAGNET SYNCHRONOUS MOTORS</td><td colspan="2">09 hours</td></tr>
<tr><td></td><td colspan="14">Principle of operation – EMF and torque equations – reactance – phasor diagram – power controllers - converter - volt-ampere requirements – torque speed characteristics - microprocessor based control.</td></tr>
</table>

Text Books:	
1.	Miller, T.J.E., 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
2.	Aearnley, P.P., 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus, London, 1982.
3.	P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus, London, 1982.
4.	R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design andApplication', CRC Press, New York, 2001.
Reference Books:	
1.	Kenjo, T., 'Stepping Motors and their Microprocessor Controls', Clarendon Press London, 1984.
2.	Kenjo, T., and Nagamori, S., 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
3.	K. Dhayalini, 'Special Electrical Machines', Anuradha Publications.
4.	S.Albert Alexander,J.Gnanavadivel, "Special Electrical Machines", Anuradha Publications.

YPE 205C –Special Electrical Machines **Course Outcomes (COs)**
At the end of the course, the students will be able to
1. **Able** to know the construction and working of synchronous motor. 2. **Describe** the construction and working of stepping motor. 3. **Analyze** the control and performance of stepping motor. 4. **Understand** the construction, working and performance of switched reluctance motor. 5. **Illustrate** the different types of power controllers of switched reluctance motor 6. **Explain** the construction and working of permanent magnet dc and synchronous motor 7. **Handle** the microprocessors based control using Permanent magnet synchronous motor.

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Department	Power Electronics and Drives	**Course Code**	255	**Sub. Code**	**YPE 205D**	**Sub. Name**	**Static Var Controllers and Harmonic filtering**
Year	I	**Semester**	II	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE(%)					**Hours / Week**			**Credit**
CA1	**CA2**	**CA3**	**CA4 (End Sem)**	**Total**	**L**	**T**	**P**	4
					3	0	0	
40%	10%	20%	30%	100%	**L = 45; T = 00; P= 0;**			**Total = 45 hrs**

Objective (s)	To emphasis the fundamentals for load compensation.To learn the characteristics, applications of series and shunt FACTS controllers. To analyze the power quality issues and harmonics.	
Unit - 1	**INTRODUCTION**	**09 hours**
Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems, Reactive Power Compensation and Dynamic Performance of Transmission Systems. Power Qulity Issues. Sags, Sweels, Unbalance, Flicker, Distortion, Current Harmonics.		
Unit - 2	**VOLTAGE SOURCE CONVERTERS BASED ON FACTS CONTROLLLERS**	**09 hours**
Static Reactive Power Compensators and their control. Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping, Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems.		
Unit - 3	**POWER SYSTEM CONVERTER**	**09 hours**
Converters for Static Compensation. Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM). GTO Inverters . Multi-Pulse Converters and Interface Magnetics. Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM). Multi-level inverters of Cascade Type and their modulation. Current Control of Inverters.		
Unit - 4	**STATIC VAR COMPENSATOR**	**09 hours**
Voltage control by SVC – design of SVC voltage regulator, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling . Three-phase four-wire shunt active filters. Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode prevention of voltage instability.		

Unit – 5	POWER QUALITY AND HARMONICS	09 hours
Power quality issues and its correction Current Harmonics - Sources of Harmonics in Distribution Systems and III Effects, Series Active Filtering in Harmonic Cancellation Mode. Series Active Filtering in Harmonic Isolation Mode. Dynamic Voltage Restorer and its control. Power Quality Conditioner.		
Text Books:		
1.	R. Mohan MathurOntanio Power Generator Toronto, ON, Canada	
2.	Rajvi K. Varma, IIT Kanpur –India	
3.	Mathur R. M. and Varma R. K “Thyristor–based FACTS controllers for Electrical Transmission System”, Wiley-IEEE press, 2002.	
Reference Books:		
1.	Reactive Power Control in Electric Systems by T.J.E Miller	
2.	Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems by N.G. Hingorani& L. GyugiIEEE Press, 2000	
3.	Power Electronics by Ned Mohan et.al .	
4.	Sood V. K., “HVDC and FACTS Controllers: Applications of Static Converters in Power Systems”, Springer, 1 st edition, 2004.	
5.	Acha E., Agelidis V. G., Anaya O., Miller T. J. E., “Power Electronics Control in Electrical Systems”, Newnes Power Engineering Series,2002.	

YPE 205D Static Var Controllers and Harmonic filtering

Course Outcomes (COs)

At the end of the course, the students will be able to

1. Understand the fundamentals of reactive power control and their compensation.
2. Understand the principle of shunt and series compensator..
3. Analysis of transient and dynamic stability in power system..
4. Apply the knowledge in different types of power converter..
5. Understand the concept of svc voltage regulator and filtering methods.
6. Gain the knowledge in power quality issues.

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Department	Electrical & Electronics Engineering	Course Code	255	Sub. Code	YPE 205E	Sub. Name	Wind Energy Conversion Systems
Year	I	**Semester**	II	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					Credit				Hours/ Week			
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	0	3	3	0	0	3
15%	15%	20%	50%	100%	**L = 45; T = 0; P =0 ; Total = 45 hrs**							

Objective (s)	To learn the design and control principles of Wind turbine. To understand the concepts of fixed speed and variable speed, wind energy conversion systems.To analyze the grid integration issues.	
Unit – 1	**INTRODUCTION**	**09 hours**
	Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine.	
Unit – 2	**WIND TURBINES**	**09 hours**
	HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.	
Unit – 3	**FIXED SPEED SYSTEMS**	**09 hours**
	Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.	
Unit – 4	**VARIABLE SPEED SYSTEMS**	**09 hours**
	Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.	
Unit – 5	**GRID CONNECTED SYSTEMS**	**09 hours**
	Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.	

Text Books:	
1.	L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2.	S.N.Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Sytems", Oxford University Press, 2010.
Reference Books:	
1.	Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
2.	E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
3.	N. Jenkins," Wind Energy Technology" John Wiley & Sons,1997
4.	S.Heir "Grid Integration of WECS", Wiley 1998.

YPE 205E - WIND ENERGY CONVERSION SYSTEMS **Course Outcomes (Cos)**
At the end of the course, the students will be able to
1. **Understand** the operation of Solar Thermal, Solar Photovoltaic and wind energy systems. 2. **Know** the operation of a wind form. 3. **Understand** the manufacturing process behind Solar Photovoltaic Systems. 4. **Understand** the manufacturing process behind small Wind Energy Systems.

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<table>
<tr><td>Department</td><td>Electrical & Electronics Engineering</td><td>Course Code</td><td>255</td><td>Sub. Code</td><td colspan="2">YPE 206 A</td><td colspan="2">Sub. Name</td><td colspan="3">Soft Computing Techniques</td></tr>
<tr><td>Year</td><td>I</td><td>Semester</td><td>II</td><td>Regulation</td><td colspan="2">2015</td><td colspan="2">Max Mark</td><td colspan="3">100</td></tr>
<tr><td colspan="5">MODE OF EVALUATION & WEIGHTAGE (%)</td><td colspan="4">Credit</td><td colspan="4">Hours/ Week</td></tr>
<tr><td rowspan="2">CA 1</td><td rowspan="2">CA 2</td><td rowspan="2">CA 3</td><td rowspan="2">CA 4</td><td rowspan="2">Total</td><td>L</td><td>T</td><td>P</td><td>Total</td><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>15%</td><td>15%</td><td>20%</td><td>50%</td><td>100%</td><td colspan="8">L = 45; T = 00; P = 0; Total = 45 hrs</td></tr>
</table>

Objective (s)	To review the fundamentals of ANN and fuzzy set theory. To make the students understand the use of ANN for modeling and control of non- linear system and to get familiarized with the ANN tool box. To impart knowledge of using Fuzzy logic for modeling and control of non-linear systems and get familiarized with the FLC tool box. To familiarize the students on various hybrid control schemes such as ANFIS tool box.	
Unit - 1	**OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) AND FUZZY LOGIC**	**09 hours**
	Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union and intersection, fuzzy relation – Fuzzy membership functions.	
Unit - 2	**NEURAL NETWORKS FOR MODELLING AND CONTROL**	**09 hours**
	Modeling of non linear systems using ANN- NARX,NNSS,NARMAX - Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes - Familiarization of Neural Network Control Tool Box.	
Unit - 3	**FUZZY LOGIC FOR MODELLING AND CONTROL**	**09 hours**
	Modeling of non linear systems using fuzzy models (Mamdani and Sugeno) –TSK model - Fuzzy Logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification- Adaptive fuzzy systems. Familiarization of Fuzzy Logic Tool Box.	
Unit - 4	**GENETIC ALGORITHM**	**09 hours**
	Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm.	
Unit - 5	**HYBRID CONTROL SCHEMES**	**09 hours**
	Fuzzification and rule base using ANN – Neuro fuzzy systems - ANFIS – Optimization of membership function and rule base using Genetic Algorithm. Familiarization of ANFIS Tool Box.	

Text Books:	
1.	Laurene V.Fausett, “Fundamentals of Neural Networks, Architecture, Algorithms, and Applications”, Pearson Education, 2008.
2.	Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, Wiley, Third Edition, 2010.
3.	George J.Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, Prentice HalI, First Edition, 1995.
4.	S. Rajasekaran & G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI, 2003.
Reference Books:	
1.	C.Cortes and V.Vapnik, "Support-Vector Networks, Machine Learning”, 1995.
2.	M. Mitchell, “An Introduction to Genetic Algorithms”, Prentice-Hall, 1998.
3.	W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.
4.	S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley - India, 2007

YPE 206A – Soft Computing Techniques
Course Outcomes (COs)

At the end of the course, the students will be able to

1. Able to **define** and **recall** the **fundamentals** of Artificial Neural Network and Fuzzy Logic.
2. Ability to **express** and control linear and non linear systems using ANN and Fuzzy Logic.
3. **Analyze** and **model** fuzzy system of Mamdani and Sugeno type.
4. **Create** a linear or nonlinear control problem and solve it using genetic algorithm.
5. **Build** and **analyze** the combination of different soft computing techniques.

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Department	Power Electronics and Drives	Course Code	255		Sub. Code	YPE 206B	Sub. Name	Flexible AC Transmission Systems.
Year	I		**Semester**	II	**Regulation**	2015	**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE(%)					**Hours / Week**			**Credit**
CA1	**CA2**	**CA3**	**CA4 (End Sem)**	**Total**	**L**	**T**	**P**	4
					3	0	0	
40%	**10%**	**20%**	**30%**	**100%**	**L = 45; T = 00; P= 0;**			**Total = 45 hrs**
Objective (s)	To emphasis the need for FACTS controllers. To learn the characteristics, applications and modelling of series and shunt FACTS controllers. To analyze the interaction of different FACTS controller and perform control coordination.							
Unit - 1	**INTRODUCTION**							**09 hours**
Review of basics of power transmission networks-control of power flow in AC transmission line-Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.								
Unit - 2	**STATIC VAR COMPENSATOR (SVC)**							**09 hours**
Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis-Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.								
Unit - 3	**THYRISTOR AND GTO THYRISTOR CONTROLLED SERIESCAPACITORS (TCSC and GCSC)**							**09 hours**
Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modelling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.								
Unit - 4	**VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS**							**09 hours**
Static synchronous compensator (STATCOM)- Static synchronous series compensator (SSSC)-Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC-Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers (UPFC and IPFC) - Modeling of UPFC and IPFC for load flow and transient stability studies- Applications.								

Unit- 5	CONTROLLERS AND THEIR COORDINATION	09 hours
FACTS Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.		
Text Books:		
1.	A.T.John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.	
2.	NarainG.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi 2001.	
Reference Books:		
1.	V. K.Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", 2004, Kluwer Academic Publishers.	
2.	Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.	
3.	V. K.Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", 2004, Kluwer Academic Publishers.	
4.	Acha E., Agelidis V. G., Anaya O., Miller T. J. E., "Power Electronics Control in Electrical Systems", Newnes Power Engineering Series,2002.	

YPE 206B Flexible AC Transmission Systems.
At the end of the course, the students will be able to
1. **Understand** the importance of controllable parameters and benefits of FACTS controllers. 2. **Know** the significance of shunt, series compensation and role of FACTS devices on system control . 3. **Analyze** the functional operation and control of GCSC, TSSC and TCSC. 4. **Describe** the principles, operation and control of UPFC and IPFC.. 5. Analyze SVC and SVS controller interaction.

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Department	Power Electronics and Drives	**Course Code**	255	**Sub. Code**	YPE 206C	**Sub. Name**	**Computer Aided Design of Electrical machines**
Year	I	**Semester**	II	**Regulation**	2015	**Max Mark**	100

MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**			**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	3
					3	0	0	
15%	15%	20%	50%	100%	**L = 45; T = 0; P = 0; Total = 45 hrs**			

Objective (s)	This course prepares students to work professionally in the area of power and power related fields. Students should be able to apply knowledge of mathematics and engineering, and identify numerical models to solve electromagnetic problems in electrical engineering.	
Unit - 1	**INTRODUCTION**	**08 hours**
	Conventional design procedures – Limitations – Need for field analysis based design – Review of Basic Principles of Energy Conversion – Development Torque/Force.	
Unit - 2	**MATHEMATICAL FORMULATION OF FIELD PROBLEMS**	**09 hours**
	Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in field problems – Inductance- Capacitance - Laplace and Poisson's Equations – Energy functional.	
Unit - 3	**PHILOSOPHY OF FEM**	10 **hours**
	Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variational method- 2D field problems – Discretisation – Shape functions – Stiffness matrix – Solution techniques.	
Unit - 4	**CAD PACKAGES**	**09 hours**
	Elements of a CAD System –Pre-processing – Modelling – Meshing – Material properties- Boundary Conditions – Setting up solution – Post processing.	
Unit - 5	**DESIGN APPLICATIONS**	**09 hours**
	Design of Solenoid Actuator – Inductance and Force calculation - Induction Motor – Torque calculation in Switched Reluctance Motor.	
Text Books:		
1.	S.J Salon,"Finite Element Analysis of Electrical Machines."Kluwer Academic Publishers, London, 1995.	
2.	S.R.H.Hoole, Computer – Aided, Analysis and Design of Electromagnetic Devices, Elsevier, New York, Amsterdam, London, 1989.	
3.	Nicola Bianchi, "Electrical Machine Analysis Using Finite Elements", CRC Taylor & Francis 2005.	

Reference Books:	
1.	D.A.Lowther and P.P Silvester, Computer Aided Design in Magnetics, Springer verlag, New York, 1956.
2.	C.WThrowbridge, "An introduction to computer aided electromagnetic analysis", Vector field Ltd.
3.	Joao Pedro, A. Bastos and Nelson Sadowski, "Electromagnetic modeling by Finite Element Methods", Marcell Dekker Inc., 2003.
4.	User Manuals of MAGNEI, MAXWELL & ANSYS software.

YPE206C – Computer Aided Design Of Electrical Machines Course Outcomes (COs)
At the end of the course, the students will be able to
1. To **formulate** electromagnetic field equations using magnetic vector potential 2. To **formulate and solution** of Laplace and Poisson's equations 3. Able to **describe and analysis** of various electromagnetic problems using finite difference method. 4. Able to **describe and analysis** of various different electromagnetic problems using 2-D finite element method. 5. To **know** CAD packages for solving time invariant and time variant electromagnetic field problems. 6. To **develop** model for electrical apparatus and its solutions in CAD package.

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Department	Electrical & Electronics Engineering	**Course Code**	255		**Sub. Code**		YPE 206D	**Sub. Name**		**Solar and Energy Storage System**		
Year	I	**Semester**	II		**Regulation**		2015	**Max Mark**		100		
MODE OF EVALUATION & WEIGHTAGE (%)					**Credit**				**Hours/ Week**			
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
					3	0	0	3	3	0	0	3
15%	15%	20%	50%	100%	**L = 45; Total = 45 Hrs**							

Objective (s)	To impart the Basic knowledge of semiconductors, cell properties and their interconnection. To understand the concept of solar modules and design of standalone PV system. To Deal with grid connected PV systems. To Discuss about different energy storage systems. To give exposure to different applications of PV systems and its storage systems.	
Unit - 1	**INTRODUCTION**	**09 Hours**
	Characteristics of sunlight – Semiconductors and PN junctions – Behavior of solar cells – Cell properties – PV cell interconnection.	
Unit - 2	**STANDALONE PV SYSTEM**	**09 Hours**
	Solar modules – Storage systems – Power conditioning and regulation - Protection – Stand alone PV systems design – Sizing.	
Unit - 3	**GRID CONNECTED PV SYSTEMS**	**09 Hours**
	PV Systems in buildings – Design issues for central power stations – Safety – Economic aspect – Efficiency and performance - International PV programs.	
Unit - 4	**ENERGY STORAGE SYSTEMS**	**09 Hours**
	Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries - Impact of intermittent generation – Energy storage in battery – Solar thermal energy storage – Pumped hydroelectric energy storage	
Unit - 5	**APPLICATIONS**	**09 Hours**
	Water pumping – Battery chargers – Solar car – Direct-drive applications – Space – Telecommunications.	
Text Books:		
1.	Eduardo Lorenzo G. Araujo, 1994. Solar Electricity Engineering of Photovoltaic Systems, Progensa.	
2.	Stuart R. Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, 2007. Applied Photovoltaics, Earthscan, UK.	

Reference Books:	
1.	Frank S. Barnes and Jonah G. Levine, 2011. Large Energy Storage Systems Handbook, CRC Press.
2.	McNeils, Frenkel and Desai, 1990. Solar & Wind energy Technologies, Wiley Eastern.
3.	Sukhatme, S.P., 1987. Solar Energy, New Delhi: Tata McGraw-Hill.

YPE 206D – Solar and Energy Storage System
Course Outcomes (COs)

At the end of the course, the students will be able to

1. **Recognize and reproduce** Basic knowledge of semiconductors, cell properties and their interconnection.
2. Gain the knowledge in the solar modules & system and **design** the standalone PV system for specific applications.
3. **Classify** the various PV systems in buildings and manage the issues for central power stations.
4. **Define** the various types of energy storage systems.
5. **Employ** different applications of PV systems and its storage systems.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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Department	Power Electronics and Drives	**Course Code**		255	**Sub. Code**	YPE 206E		**Sub. Name**	**Application of MEMS Technology**
Year	I	**Semester**		II	**Regulation**	2015		**Max Mark**	100
MODE OF EVALUATION & WEIGHTAGE (%)					**Hours/ Week**				**Credit**
CA 1	**CA 2**	**CA 3**	**CA 4**	**Total**	**L**	**T**		**P**	
					3	0		0	3
40%	10%	20%	30%	100%	**L = 45; T = 0; P = 0; Total = 45 hrs**				
Objective (s)	To teach the students properties of materials , microstructure and fabrication methods. To teach the design and modeling of Electrostatic sensors and actuators. To teach the characterizing thermal sensors and actuators through design and modeling. To teach the fundamentals of piezoelectric sensors and actuators. To give exposure to different MEMS and NEMS devices.								
Unit - 1	**MEMS:MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONEPTS.**								**09 hours**
	Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsion deflections-Intrinsic stress- resonant frequency and quality factor.								
Unit - 2	**ELECTROSTATIC SENSORS AND ACTUATION**								**09 hours**
	Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications								
Unit - 3	**THERMAL SENSING AND ACTUATION**								**09 hours**
	Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.								
Unit - 4	**PIEZOELECTRIC SENSING AND ACTUATION**								**09 hours**
	Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.								
Unit - 5	**CASE STUDIES**								**09 hours**
	Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices								

Reference Books:	
1.	Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2.	Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.
3.	Boston , "Micromachined Transducers Sourcebook",WCB McGraw Hill, 1998.
4.	1. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.
5.	P. RaiChoudry" MEMS and MOEMS Technology and Applications", PHI, 2012.
6.	Stephen D. Senturia, " Microsystem Design", Springer International Edition, 2011.

YPE 206E Application of MEMS Technology **Course Outcomes (COs)**
At the end of the course, the students will be able to
1. The **learning** process delivers insight onto design of micro sensors, embedded sensors & actuators in power aware systems like grid. 2. **Improved employability and entrepreneurship capacity** due to **knowledge up gradation** on recent trends in embedded systems design. 3. **Discuss** the properties of materials, microstructure and fabrication methods. 4. **Design and modeling** of Electrostatic sensors and actuators. 5. **Understand** the fundamentals of piezoelectric sensors and actuators.

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

YPE 106A– Power Electronics for Renewable Energy Systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	2	-	2	-	3	-	2
CO2	2	2	-	1	1	2	3	-	-
CO3	1	3	-	3	-	2	2	-	2
CO4	-	3	-	1	2	1	-	2	-
CO5	-	3	-	-	1	-	-	1	1
CO6	1	-	3	3	-	-	2	-	-
CO7	1	2	3	1	-	-	-	1	-

1- Slightly 2 – Supportive 3 – Highly related

YPE106B Microcontroller Based System Design

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	-	-	-	-	-	-	1
CO2	2	1	-	3	1	-	-	-	-
CO3	3	3	-	1	1	-	-	-	-
CO4	3	1	2	3	-	2	1	-	-
CO5	3	2	1	3	-	1	-	-	1

1- Slightly 2 – Supportive 3 – Highly related

YPE 106C System Theory:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**1**	**2**	**3**	**-**	**-**	**1**	**-**	**-**
CO3	**3**	**1**	**-**	**3**	**1**	**-**	**1**	**-**	**-**
CO4	**3**	**3**	**-**	**1**	**1**	**-**	**-**	**-**	**-**
CO5	**3**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**1**

1- Slightly 2 – Supportive 3 – Highly related

YPE 106D – Electro Magnetic Interferences and Harmonic Elimination

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	2	-	2	-	-	-	2
CO2	2	1	1	1	-	-	-	1	2
CO3	2	1	3	1	1	-	-	2	2
CO4	1	-	2	2	1	-	-	1	2
CO5	1	2	-	-	1	-	-	-	3

1- Slightly 2 – Supportive 3 – Highly related

YPE 106E Non Linear Dynamics for Power Electronic Circuits

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	2	1	-	-	-	-	-	1
CO2	2	1	2	-	-	-	-	-	1
CO3	2	1	-	-	1	-	-	-	-
CO4	3	1	-	1	1	-	-	-	1

1- Slightly 2 – Supportive 3 – Highly related

YPE 205A Smart Grid

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	2	-	2	-	3	-	2
CO2	-	-	-	1	-	-	-	-	2
CO3	1	-	-	-	1	-	-	-	-
CO4	-	-	2	2	-	-	-	-	2
CO5	-	-	-	-	-	-	3	-	3

1- Slightly 2 – Supportive 3 – Highly related

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YPE 205B Energy Auditing Conservation and Management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	2	-	2	-	2	-	2
CO2	1	-	-	1	-	-	-	-	2
CO3	1	-	-	-	1	-	1	-	-
CO4	-	3	2	2	-	-	-	-	2
CO5	-	-	-	-	-	-	3	-	3
CO6	1	-	-	1	2	-	2	-	1

1- Slightly 2 – Supportive 3 – Highly related

YPE 205C Special Electrical Machines

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	-	2	-	-	-	-	-	-
CO2	1	2	1	3	1	-	-	-	2
CO3	-	-	-	-	-	1	2	-	1
CO4	1	1	2	2	1	-	-	-	2
CO5	1	-	2	-	-	-	-	-	-
CO6	1	2	1	3	1	-	-	-	2
CO7	-	-	-	-	-	1	2	-	1

1- Slightly 2 – Supportive **3** – Highly related

YPE 205D Static Var Controllers and Harmonic filtering

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1		2	1	2	-	3	-	2
CO2	-	-	-	1	-	-	-	-	2
CO3	1	-	-	-	1	3	-	-	-
CO4	1	-	2	2	-	-	-	-	
CO5	-	1	-	-	-	-	3	-	3
CO6	1	-	-	1	2	-	2	-	1

1- Slightly 2 – Supportive 3 – Highly related

YPE 205E – Wind Energy Conversion Systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	2	2	3	-	-	-	3
CO 2	3	2	1	1	2	-	-	-	2
CO 3	3	3	2	3	2	-	-	1	3
CO 4	-	-	-	1	-	-	-	-	1

1- Slightly 2 – Supportive 3 – Highly related

YPE 206A – Soft Computing Techniques:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	-	2	1	2	1	-	-	-
CO2	2	3	-	1	-	-	2	1	-
CO3	-	-	3	-	2	1	1	1	2
CO4	1	2	2	-	-	3	1	-	-
CO5	-	2	3	2	3	1	-	1	-

1- Slightly 2 – Supportive 3 – Highly related

YPE 206B Flexible AC Transmission Systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	2	-	2	-	-	-	2
CO2	1	2	-	1	-	-	-	-	2
CO3	2	2	-	-	1	-	-	-	-
CO4	2	1	2	2	-	-	-	-	2
CO5	-	-	-	-	-	-	-	-	2

1- Slightly 2 – Supportive 3 – Highly related

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YPE 206C – Computer Aided Design of Electrical Machines :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	1	1	2	-	-	-	-
CO2	1	2	2	2	2	-	-	-	1
CO3	2	1	3	1	2	-	-	-	1
CO4	1	1	2	2	1	-	-	-	-
CO5	2	2	2	1	1	-	-	-	1
CO6	2	2	2	1	2	-	-	-	-

1- Slightly 2 – Supportive 3 – Highly related

YPE 206D –Solar and Energy Storage System

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	1	1	2	1	2	-	-
CO2	1	1	2	3	2	1	1	-	-
CO3	2	1	1	2	1	1	1	-	-
CO4	1	2	2	2	1	-	1	-	-
CO5	1	1	1	1	1	1	-	-	-

1- Slightly 2 – Supportive **3** – Highly related

YPE 206E Application of MEMS Technology

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	-	-	-	1	-	1
CO2	3	1	1	-	-	3	2	1	-
CO3	-	2	-	-	1	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-
CO5	-	1	1	-	-	-	-	-	1

1- Slightly 2 – Supportive 3 – Highly related