KERALA TECHNOLOGICAL UNIVERSITY

(THRISSUR CLUSTER - 07)

SCHEME AND SYLLABI

of

M.TECH.

in

POWER ELECTRONICS AND DRIVES

(As on 29/09/2015)

OFFERING DEPARTMENT

ELECTRICAL & ELECTRONICS ENGINEERING

CLUSTER LEVEL GRADUATE PROGRAM COMMITTEE

1.	Dr. Devdas Menon, Professor, IIT Madras, Chennai	Chairman
2	Principal, Government Engineering College Trichur, Thrissur	Convener
3	Principal, AXIS College of Engineering & Technology, East Kodaly, Murikkingal, Thrissur	Member
4	Principal, IES College of Engineering, Chittilappilly, Thrissur	Member
5	Principal, MET'S School of Engineering, Mala, Thrissur	Member
6	Principal, Royal College of Engineering & Technology, Akkikkavu, Thrissur	Member
7	Principal, Vidya Academy of Science & Technology, Thalakkottukara, Thrissur	Member
8	Principal, Thejus Engineering College, Vellarakkad, Erumappetty, Thrissur	Member
9	Principal, Universal Engineering College, Vallivattom, Konathakunnu, Thrissur	Member
10	Principal, Sahrdaya College of Engineering & Technology, Kodakara, Thrissur	Member

CERTIFICATE

This is to certify that

1. The scheme and syllabi are prepared in accordance with the regulation and guidelines issued by the KTU from time to time and also as per the decisions made in the CGPC meetings.
2. The suggestions/modifications suggested while presenting the scheme and syllabi before CGPC on 25.6.2015 have been incorporated.
3. There is no discrepancy among the soft copy in MS word format, PDF and hard copy of the syllabi submitted to the CGPC.
4. The document has been verified by all the constituent colleges.

Coordinator in charge of syllabus revision of the programme

Dr. Gopakumar P,
Asst. Professor,
Sahrdaya College of Engineering and Technology
Kodakara, Thrissur

Principal of the lead college

Dr. Sudha George Valavi
Sahrdaya College of Engineering and Technology
Kodakara, Thrissur

Principals of the colleges in which the programme is offered

No	Name of the college	Principal's Name	Signature
1	Sahrdaya College of Engineering and Technology, Kodakara	Dr. Sudha George Valavi	
2			
3			
4			
5			

Date: Chairman
Place:

VISION and MISSION of the Programme

VISION

Vision of this programme is to train the professionals for meeting the global challenges through research and innovation.

MISSION

Mission of this programme is to promote research, discovery and entrepreneurship through collaborative actions for providing effective solutions in engineering industries.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

A. Design and implement innovative engineering industrial products and services in the regime of power electronics and drives
B. Effectively engage with latest advancements in power converters and solid state electrical drives for both industrial and domestic applications
C. Proficient in communication to impart knowledge and endorse teamwork
D. Accomplish intellectual leadership with professional ethics to cope with changing technological needs of industry and society.

PROGRAM OUTCOMES (POs)

A. Design and implement power electronic converters, electrical drives with real time controllers by applying theoretical and practical considerations.
B. Analyze and synthesis power flow control and motion control requirements in industrial and domestic systems.
C. Investigate critical engineering problems and develop optimal technological solutions for power electronic systems and electrical drives adopted in domestic and industrial applications
D. Apply research techniques for ascertaining and deciphering potential problems in the regime of power electronics and electrical drives with the aid of simulations and practical experiments.
E. Simulate and experiment the design of power electronic converters and electrical drives using mathematical modelling and modern soft computing techniques.
F. Participate in the regime of collaborative-multidisciplinary engineering / research tasks by integrating innovations from allied departments giving due consideration to ecological and economical intricacies
G. Develop consultative and entrepreneurial solutions pertaining to practical power electronic and drives projects in both domestic and industrial domains.
H. Communicate effectively and compose technical reports concerning with engineering projects and researches.
I. Endure research attitude for engaging life-long learning to enhance knowledge and competency.
J. Practice professional ethics and uphold intellectual integrity for the sustainable development of society
K. Develop a positive attitude towards problems and pursue learning with self-motivation

KERALA TECHNOLOGICAL UNIVERSITY

Proposed Scheme and Syllabus For

M.Tech.

in

POWER ELECTRONICS & DRIVES

(2015 Admission onwards)

Scheme of M.Tech Programme in Power Electronics & Drives

SEMESTER1

Exam Slot	Course code	Course Title	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
A	07MA 6019	Applied Mathematics	3	1	0	40	60	100	4
B	07EE 6201	System Dynamics	3	1	0	40	60	100	4
C	07EE 6303	Power Converters	4	0	0	40	60	100	4
D	07EE 6305	Electric Drives	4	0	0	40	60	100	4
E	07EE 63XX	Elective I	3	0	0	40	60	100	3
	07GN 6001	Research Methodology	0	2	0	100	0	100	2
	07EE 6309	Power Electronics Lab	0	0	2	100	0	100	1
	07EE 6311	Introduction to Seminar	0	0	1	0	0	0	0
TOTAL			17	4	3	400	300	700	22

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment
ESE-End Semester Examination

ELECTIVE I

07EE 6307 Power Semiconductor Devices & Modeling

07EE 6317 Digital Simulation of Power Electronic Systems

07EE 6327 DSP & Its Applications

07EE 6337 Dynamics of Electric Machines

Note: 6 hours/week is meant for departmental assistance by students.

SEMESTER 2

Exam Slot	Course code	Course Title	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
A	07EE 6302	Electric and Hybrid Vehicles	3	0	0	40	60	100	3
B	07EE 6304	Switched Mode Power Converters	3	0	0	40	60	100	3
C	07EE 6306	Advanced Electric Drives	3	0	0	40	60	100	3
D	07EE 6XXX	Elective II	3	0	0	40	60	100	3
E	07EE 63XX	Elective III	3	0	0	40	60	100	3
	07EE 6314	Seminar I	0	0	2	100	0	100	2
	07EE 6316	Mini Project	0	0	2	100	0	100	2
	07EE 6320	Electric Drives Lab	0	0	2	100	0	100	1
TOTAL			15	0	6	500	300	800	20

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment
ESE-End Semester Examination

ELECTIVE II

07EE 6208 Flexible AC Transmission Systems

07EE 6318 Design of Power Electronic Systems

07EE 6328 Modeling and Analysis of AC Drives

ELECTIVE III

07EE 6312 Industrial Control Electronics

07EE 6322 Renewable Energy Technologies

07EE 6332 Embedded Control of Electrical Drives

Note: 6hours/week is meant for departmental assistance by students.

SEMESTER3

Exam Slot	Course code	Course Title	Hours/week			ICA		ESE	Total	Credits
			L	T	P					
A	07EE 7XXX	Elective IV	3	0	0	40		50	100	3
B	07EE 7XXX	Elective V	3	0	0	40		50	100	3
	07EE 7305	Seminar II	0	0	2	100		0	100	2
	07EE7307	Project (Phase1)	0	0	12	Guide 20	EC 30	0	50	6
TOTAL			6	0	14	250		100	350	14

L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment

ESE-End Semester Examination

Industrial training if required, should be in between semester break (After completion of Second Semester)

ELECTIVE IV

07EE 7301 Smart Grid Technologies

07EE 7211 Power Quality

07EE 7321 PWM Converters and Applications

ELECTIVE V

07EE 7303 Special Electrical Machines & Drives

07EE 7213 Soft Computing Techniques

07EE 7323 Energy Auditing and Management

Note: The student has to undertake the departmental work assigned by HOD

SEMESTER4

Course code	Course Title	Hours/week			ICA			ESE	Total	Credits
		L	T	P	Guide	Evaluation Committee	External Examiner			
07EE 7302	Project (Phase2)	0	0	21	30	40	30	0	100	12

L- Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment
ESE-End Semester Examination.

Note: The student has to undertake the departmental work assigned by HOD
Total credits for all semesters: 68

SYLLABUS

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SEMESTER1

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07MA 6019	APPLIED MATHEMATICS	L-T-P: 3-1-0 Credits: 4 Year: 2015

Prerequisite:
UG level Mathematics

Course Objective:
The main objective of this course is to familiarize the students with the ideas and notions of eigen value problems, principle of least squares, geometry of Fourier series, wavelets, development of probability distributions and probability theory, aspects of inferential statistics, reliability modelling, stationary stochastic processes, discrete time Markov chains and its stationary distributions etc.

Syllabus:
Solution of system of linear equations, Eigen value problems in engineering, method of least squares, geometry of Fourier series, discrete wavelet transform, probability distributions, conditional probability, CLT, linear regression and correlation, statistical inference, reliability, stationary processes and Markov chains.

Course Outcome:
These concepts will help the students to appreciate (i) matrix methods in engineering, structure of vector spaces applied to wavelets which is a tool in signal and image processing and (ii) probabilistic and statistical methods to understand and analyze uncertainty.

References:

1. B N Datta, Numerical Linear Algebra and Applications, 2nd Edition, PHI Learning Pvt. Ltd., Delhi, 2010 (-for Module 1).
2. J A Gubner, Probability and Random Processes for Electrical and Computer Engineers, Cambridge University Press, Cambridge, New York, 2006. (for Module 2).
3. R A Johnson, Miller & Freud's Probability and statistics in Engineering, 7th Edition, Pearson, Delhi, 2008 (for Modules 2 & 3).
4. J Medhi, Stochastic Processes, 3rd Edn., New Age International (P) Ltd., New Delhi, 2009 (for Module 4).
5. K P Soman, K I Ramachandran, and N G Resmi, Insight into Wavelets, from Theory to Practice,

3rd Edn., PHI Learning, Delhi, 2013 (for Module 1).
6. E Kreyszig, Advanced Engineering Mathematics, 8th Edn, Wiley India Pvt. Ltd., Delhi, 1999/2007 (for Module 1).

Course Plan:

COURSE NO: 07MA 6019 COURSE TITLE: APPLIED MATHEMATICS (L-T-P : 3-1-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Matrices and Least squares: Solution of system of linear equations using LU factorization - Gauss-Siedel methods - Eigen value problems in engineering - Method of least squares - Fitting a straight line and a second degree curve	08	15
MODULE : 2 Discrete wavelet transform: Fourier series and geometry - Discrete wavelet transform - Haar scaling function and wavelet function and their orthogonality - Haar bases	08	15
FIRST INTERNAL TEST		
MODULE : 3 Probability distributions: Binomial and Poisson - Uniform, exponential, gamma and Weibull - Normal distributions	08	15
MODULE : 4 Probability: Conditional probability, Bayes' theorem, independence - Lindeberg-Levy central limit theorem - Sampling distributions (t, $\chi 2$ and F) - Linear regression and correlation	08	15
SECOND INTERNAL TEST		
MODULE : 5 Statistics and Reliability: Unbiased estimators of mean and variance - Tests for mean and variance - Interval estimation of mean and variance - Reliability of series and parallel systems, failure time distributions, - Exponential and Weibull models in reliability and life testing.	10	20
MODULE : 6 Stochastic processes: Specification/ classification of processes - Strict and wide sense stationary processes - Discrete time Markov chains, higher transition probabilities - Communication classes, irreducible chains - Classification of states, regular chains - Stationary (invariant) distributions	10	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The

assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks
End Semester Examination: 60 marks

07EE6201	**SYSTEM DYNAMICS**	**L-T-P: 3-1-0** **Credits: 4** **Year: 2015**

Prerequisite:

Basic control, Linear algebra

Course Objective:

To study the analysis of systems using state space model
To understand the concept of stability
To familiarize the optimal control problem
To familiarize robust control systems

Syllabus:

State variable representation of systems - Equilibrium points – Stability - Solution of state equation - eigen values and eigen vectors – modes - modal decomposition - mode shap- State space representation of discrete time systems - Discretization of continuous time state equation. Case studies. Lyapunov stability - Lyapunov's stability analysis of LTI continuous time and discrete time systems - Stability analysis of non-linear systems-Krasovski's theorem -variable gradient method. Concepts of controllability and observability - controllability and observability tests for continuous time and discrete time systems - effect of state feedback on controllability and observability - pole placement by state feedback for continuous and discrete time systems- design of full order and reduced order observer for continuous time and discrete time systems. Optimal control - formulation of optimal control problem - optimal control based on quadratic performance measure – optimal control system design using second method Lyapunov - solution of reduced Riccatti equation. Robust control systems – introduction - sensitivity analysis of robustness - system with uncertain parameters - design of robust PID controlled systems.

Course Outcome:

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

- Analyze the dynamics of a linear continuous/discrete system by developing state models.
- Investigate the stability of linear/nonlinear systems.
- Design state feedback controllers and state observers for continuous and discrete systems.

- Design an optimal control system.
- Design a robust control system.

References:

1. Thomas Kailath, “Linear systems”, Prentice Hall Inc
2. K.Ogata, “Modern Control Engineering” (Second Edition), Prentice Hall Inc, 1990
3. K.Ogata, “Discrete-time Control Systems”, PHI
4. M.Gopal, “Digital Control and State Variable Methods”, TMH, 1997
5. M.Gopal, “Modern Control System Theory”, New Age International, 1993
6. P.Kundur, “Power System Stability and Control”, McGraw-Hill Publishing Company, 1994
7. C.T.Chen, “Linear System Theory and Design”, Holt Rinechart and Winston, 1984
8. Richard.C.Dorf and R.T Bishop, “Modern Control System”, PHI

Course Plan:

COURSE NO: 07EE 6201 COURSE TITLE: SYSTEM DYNAMICS (L-T-P : 3-1-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 State variable representation of system - concept of state – Equilibrium points – Stability - Solution of state equation - eigen values – eigen vectors – modes - modal decomposition - eigen value and stability - mode shape.	08	15
MODULE : 2 State space representation of discrete time systems - Discretization of continuous time state equation. Case study- Development of discrete state model for a simple power electronics and power system application.	08	15
FIRST INTERNAL TEST		
MODULE : 3 Lyapunov stability - definition of stability, asymptotic stability and instability - Lyapunov’s second method - Lyapunov’s stabilityanalysis of LTI continuous time and discrete time systems – stability analysis of non-linear system - Krasovski’s theorem – variable gradient method.	08	15
MODULE : 4 Concepts of controllability and observability - controllability and observability tests for continuous time and discrete time systems - controllability and observability studies based on canonical forms of state model - effect of state feedback on controllability and observability - pole placement by state	10	15

feedback for continuous and discrete time systems - Design of full order and reduced order observer for continuous time and discrete time systems. Combined state feedback controller and observer.		
SECOND INTERNAL TEST		
MODULE : 5 Optimal control - formulation of optimal control problem – Minimum time control problem -minimum energy problem - minimum fuel problem - state regulator problem - output regulator problem – tracking problem - choice of performance measure - optimal control based on quadratic performance measure- optimal control system design using second method Lyapunov - solution of reduced Riccatti equation.	10	20
MODULE : 6 Robust control systems – introduction - sensitivity analysis of robustness - system with uncertain parameters - design of robust PID controlled systems- MATLAB Exercises	10	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6303	**POWER CONVERTERS**	**L-T-P: 4-0-0** **Credits: 4** **Year: 2015**

Prerequisite:

Basic concepts of Power Electronics studied in under graduate course

Course Objective:

The main objective of this course is to give a systematic approach for transient and steady state analysis of all major power electronic converters with passive and active loads.

Syllabus:

Controlled rectifiers–circulating & non circulating current operation. Overview of commercially available controlled rectifiers; DC-DCconverters–Fourieranalysisofoutputvoltage-two-quadrant&four-quadrantchopper; Voltage commutated chopper-design of LC filter–DC-AC converters- Inverters–PWMtechniques–bipolar&unipolarmodulation–currentsourceinverter; AC to AC power conversion using voltage regulators, choppers and cyclo-converters; Multilevel voltage source converter- PWM-inverter topologies.

Course Outcome:

Upon completing the course, students are expected to have the ability to comprehensively understand and carry out transient and steady state analysis of different power converters with different types of loads and switching sequences.

References:

1. Ned Mohan, Undeland, Robbins, *Power Electronics Converters, Applications and Design*, John Wiley
2. M.H. Rashid, *Power Electronics Circuits, Design and Applications*, Pearson Education
3. Bin Wu, *High-Power converters and AC Drives*, IEEE Press, Wiley-Interscience.
4. Cyril W Lander, *Power Electronics*, McGraw Hill
5. M.D. Singh, K.B. Khanchandani, *Power Electronics*, Tata McGraw-Hill
6. V.R. Moorthi, *Power Electronics Devices, Circuits & Industrial Applications*, Oxford University Press
7. P.C Sen., 'Modern Power Electronics', Wheeler publishing Company, 1st Edition, New Delhi, 2005.
8. Issa Batarseh, *Power Electronics Circuits*, John Wiley
9. Daniel W Hart, *Introduction to Power Electronics*, Prentice-Hall
10. Joseph Vithayathil , *Principles of Power Electronics*, Mc-Graw Hill
11. William Shepherd, Li Zhang, *Power Converter Circuits*, Marcell Dekker
12. Application notes and specification charts of commercial power electronic converters

Course Plan:

COURSE NO: 07EE 6303 COURSE TITLE: POWER CONVERTERS (L-T-P : 4-0-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Controlled rectifiers– single-phase half converter and full converters – analysis with R & RL loads – DF, HF, input PF - 3-phase half-wave – full converters & semi converters – analysis with R & RL loads – continuous conduction & discontinuous conduction – inversion mode - effect of source inductance on 1-phase & 3-phase full converters – overlap angle - single-phase	09	15

dual converters – circulating & non circulating current operation. Overview of commercially available controlled rectifiers.		
MODULE : 2 DC-DC converters– Step-down chopper – step- up chopper - analysis with R & RL load –PWM, frequency modulation control – current limit control – Fourier analysis of output voltage - two- quadrant & four-quadrant chopper	07	15
FIRST INTERNAL TEST		
MODULE : 3 Voltage commutated chopper – current commutated chopper - switching-mode regulators – buck, boost, buck-boost and Cuk regulators – condition for continuous inductor current and capacitor voltage - design of LC filter – comparison of regulators. Overview of commercially available DC_DC converters	09	15
MODULE : 4 DC-AC converters- Inverters **–** 1-phase half bridge and full bridge – HF, THD, DF – 3-phase inverter - 180º and 120º conduction – Analysis with R & RL load – PWM techniques – single pulse, multiple pulse & sinusoidal pulse width modulation – modulation index – voltage control of 3-phase inverters – sine PWM – harmonic reduction – bipolar & unipolar modulation – current source inverter – 1-phase & 3-phase – Variable DC link inverter – boost inverter. Overview of commercially available DC-AC converters.	10	15
SECOND INTERNAL TEST		
MODULE : 5 AC to AC power conversion using voltage regulators, choppers and cyclo-converters, consideration of harmonics, introduction to Matrix converters- Overview of commercially available matrix converters- applications.	07	20
MODULE : 6 Multilevel voltage source converter- cascaded H-bridge multilevel inverter-bipolar-unipolar PWM-inverter topologies-carrier based PWM schemes-staircase modulation-Diode clamped multilevel inverter-three level-space vector modulation-neutral point voltage control-high level diode clamped inverters-fylying capacitor inverters-configuration-modulation schemes. Overview of commercially available multi-level inverters-applications.	10	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks
End Semester Examination: 60 marks

07EE 6305	**ELECTRIC DRIVES**	**L-T-P: 4-0-0** **Credits: 4** **Year: 2015**

Prerequisite:
A course in Power Electronics and electrical machines

Course Objective:
The main objective of this course is to provide a strong background on power electronics based methods for speed control of different electrical machines**.**

Syllabus:
Electric Drives - load equalization – classes of motor duty- determination of motor rating; DC motor drives – single phase fully controlled & half controlled rectifier control of separately excited DC motor – Three-phase fully controlled & half controlled rectifier control separately excited DC motor - dual converter for multi-quadrant operation of separately excited DC motor– closed loop speed control below and above base speed; Induction motor drives – 3-phase induction motor– regenerative braking, pugging, dynamic braking – speed control; VSI and CSI induction motor drives – cycloconverter control; Synchronous motor drives.

Course Outcome:
Upon completing the course, students are expected to have the ability to analyze, simulate and evaluate performance of variable speed drives for electric machines.

References:

1. R. Krishnan, *Electical Motor Drives*, PHI
2. G K Dubey, *Fundamentals of Electrical Drives*, Narosa
3. K Dubey, *Power Semi-conductor Controlled Drives*, Prentice Hall
4. Bimal K Bose, *Modern Power Electronics & AC Drives*, PHI
5. S A Nasar, Boldea, *Electrical Drives*, CRC press
6. M A Elsharkawi, *Fundamentals of Electrical Drives*, Thomson Learning
7. W Leohnard, *Control of Electric Drives*, Springer
8. Murphy and Turnbill, *Power Electronic Control of AC motors*, Pergamon Press

9. Vedam Subarhmanian, *Electric Drives*, TMH
10. Application notes and specification charts of power electronics based commercial electrical drives

Course Plan:

COURSE NO: 07EE 6305 COURSE TITLE: ELECTRIC DRIVES (L-T-P : 4-0-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Electric Drives – advantages – parts of electric drives - dynamics of electric drive - torque equation – four quadrant operation - equivalent values of drive parameters- classification of load torques - steady state stability - load equalization.	09	15
MODULE : 2 Classes of motor duty- determination of motor rating. DC motor drives – starting – regenerative braking, dynamic braking, plugging – Transient analysis of separately excited motor – speed control – controlled rectifier fed DC drives – single phase fully controlled & half controlled rectifier control of separately excited DC motor – discontinuous and continuous conduction - three-phase fully controlled & half controlled rectifier control separately excited DC motor	09	15
FIRST INTERNAL TEST		
MODULE : 3 Dual converter for multi-quadrant operation of separately excited DC motor – rectifier control of series motor – supply harmonics, power factor and ripple in motor current –chopper control of separately excited DC motor and series motor –closed loop speed control below and above base speed.	10	15
MODULE : 4 Induction motor drives – 3-phase induction motor - torque equation – analysis with unbalanced source voltages and single-phasing – analysis of induction motor fed from non-sinusoidal voltage supply – regenerative braking, plugging, dynamic braking – speed control – pole changing – stator voltage control – static rotor resistance control - stator frequency control below and above base speed	10	15
SECOND INTERNAL TEST		
MODULE : 5 VSI and CSI induction motor drives – cycloconverter control – closed cloop slip controlled VSI and CSI drive – slip power	09	20

recovery – static Kramer drive – static Scherbius drives – subsynchronous and super synchronous motoring and regeneration - single phase induction motor – equivalent circuit – speed control.		
MODULE : 6 Synchronous motor drives – cylindrical rotor and salient pole types – torque equation – power factor control – operation with non-sinusoidal supply - speed control of synchronous motors – true synchronous mode and self controlled mode – rotor position encoder – load commutated synchronous motor drive – closed loop speed control – line commutated cycloconverter fed synchronous motor drive.	09	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE63XX: ELECTIVE I

07EE 6307	**POWER SEMICONDUCTOR DEVICES & MODELING**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

A course in Power Electronics

Course Objective:

The main objective of this course is to make the student aware of the device physics and operation of common power semiconductor devices and also those which are in the development stage

Syllabus:

Power switching devices overview; Current Controlled Devices-switching characteristics; Power

Darlington - Thyristors– steady state and dynamic models of BJT & Thyristor; Voltage Controlled Devices-Basics of GTO, MCT, FCT, RCT and IGCT; Firing and Protection Circuits - Design of snubbers**;** Thermal Protection.

Course Outcome:

Upon completing the course, students are expected to have the ability to design and analyze various power semiconductor devices. Also this course enable the student to design gate driving circuits and protection systems for power semiconductor devices.

References:

1. Kassakian J G et al, *Principles of Power Electronics*, Addison Wesley
2. B W Williams, *Principles and Elements of Power Electronics*, University of Strathclyde, Glasgow
3. Mohan, Undeland, Robins, *Power Electronics – Concepts, Applications and Design*, John Wiley and Sons, Singapore
4. M D Singh, K B Khanchandani, *Power Electronics*, Tata McGraw Hill

Course Plan:

COURSE NO: 07EE 6307 COURSE TITLE: POWER SEMICONDUCTOR DEVICES & MODELING (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols - Power handling capability – SOA - Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes – Types - forward and reverse characteristics - switching characteristics – rating - Schottky Diode.	07	15
MODULE : 2 Current Controlled Devices - BJT's – Construction, Device Physics, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington	07	15
FIRST INTERNAL TEST		
MODULE : 3 Thyristors – Physical and electrical principle underlying operation - Gate and switching characteristics - converter grade and inverter grade and other types - series and parallel operation - comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor.	07	15
MODULE : 4 Voltage Controlled Devices - Power MOSFETs and IGBTs –	07	15

Principle of voltage controlled devices, construction, types, Device physics, Static and Switching Characteristics- Steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.		
SECOND INTERNAL TEST		
MODULE : 5 Firing and Protection Circuits - Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT - Over voltage, over current and gate protections - Design of snubbers	07	20
MODULE : 6 Thermal Protection - 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.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6317	**DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

A course in Power Electronics, Electrical machines and Simulation softwares.

Course Objective:

The main objective of this course is to make the student aware of modeling of power electronics systems and the use of software tools for analysis

Syllabus:

Principles of Modeling Power Semiconductor Devices; Modeling of Control Circuits for Power

Electronic Switches; Computer Formulation of Equations for Power Electronic Systems; AC equivalent circuit modeling; Analysis Using Software Tools; Simulation Examples of Power Electronic systems; Dynamic modeling and simulation of DC-DC converters using MATLAB.

Course Outcome:

Upon completing the course, students are expected to have the ability to design and analyze various electrical components, power semiconductor devices and electrical machines.

References:

1. V Rajagopalan, *Computer Aided Analysis of Power Electronic Systems,* Marcel Dekker, Inc.
2. Erickson, Maksimovic, *Fundamentals of Power Electronics - 2nd edition*, Springer
3. Randall Shaffer, *Fundamentals of Power Electronics with MATLAB*, Firewall Media, India
4. Mohan, Undeland, Robbins, *Power Electronics, 3rd edition,* John Wiley
5. Jai P Agrawal, *Power Electronic Systems-Theory and Design*, Pearson
6. ORCAD PSpice Basics: Circuit Analysis Software, User's Guide, ORCAD Corporation.

Course Plan:

COURSE NO: 07EE 6317 COURSE TITLE: DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Principles of Modeling Power Semiconductor Devices - Macro models versus Micro models - Thyristor model - Semiconductor Device modeled as Resistance, Resistance-Inductance and Inductance-Resistance-Capacitance combination - Modeling of Electrical Machines.	07	15
MODULE : 2 Modeling of Control Circuits for Power Electronic Switches. Computer Formulation of Equations for Power Electronic Systems –Review of graph theory as applied to Electric networks- Systematic method of Formulating State Equations - Computer Solution of State Equations - Explicit Integration method - Implicit Integration method.	07	15
FIRST INTERNAL TEST		
MODULE : 3 AC equivalent circuit modeling: Basic AC modeling approach-State space averaging-circuit averaging and averaged switch modeling-Modeling the PWM.	05	15
MODULE : 4 Analysis Using Software Tools-Circuit Analysis Software ORCAD- PSpice - Simulation Overview - Creating and Preparing a Circuit for Simulation - Simulating a Circuit with PSpice -	08	15

Simple Multi-run Analyses - Statistical Analyses		
SECOND INTERNAL TEST		
MODULE : 5 Simulation Examples of Power Electronic systems- Creating Symbols - Creating - Models - Analog Behavioral Modeling - Setting Up and Running analyses – Viewing Results - Examples of Power Electronic Systems.	08	20
MODULE : 6 Dynamic modeling and simulation of DC-DC converters using MATLAB - Simulation of State Space Models - Modeling and simulation of inverters using MATLAB	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6327	**DSP AND ITS APPLICATIONS**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

Linear Systems Fundamentals, Signals and Systems, Circuit Theory, Mathematics

Course Objective:

The main objectives of this course are to understand various methods for the analysis of digital systems, Design a digital filter for the given specifications and to study the architecture and applications of digital signal processors.

Syllabus:

Review of signals and systems –Discrete Fourier Transform –Fast Fourier Transform (FFT) - Decimation-in-time (DIT) & Decimation-in-Frequency (DIF) FFT algorithms; Realization of IIR filters –Digital filter design; Multirate digital signal processing –Finite word length effects – Von Neumann & Harvard architecture – Applications of DSP; Execution of simple programs using digital signal processor.

Course Outcome:

Upon finishing the course, students are expected to accomplish the knowledge about basic operations of sampling and quantization processes, frequency domain transformations and to design different kinds of digital filters for engineering applications.

References:

1. Oppenheim A. V. & Schafer R. W., *Discrete- time Signal Processing*, Pearson Education
2. Proakis J. G. & Manolakis D. G., *Digital Signal Processing, Principles, algorithms & applications*, Pearson Education.
3. Li Tan, *Digital Signal Processors- Architectures, Implementations and applications,* Academic Press (Elsevier)
4. Sen M. Kuo & Woon-Seng S. Gan, *Digital Signal Processors- Architectures, Implementations and Applications*, Pearson Education.
5. V. Oppenheim & R. W. Schafer, *Digital Signal Processing*, Prentice- Hall of India
6. Sanjit K. Mitra, *Digital Signal Processing- A computer based approach*, Tata Mc Graw Hill
7. Emmanuel C. Ifeachor, Barrie W. Jervis, *Digital Signal Processing- A practical approach,* Pearson education.
8. Ludeman, *Fundamentals of Digital Signal Processing*, Wiley India Pvt. Ltd.

Course Plan:

COURSE NO: 07EE 6327 COURSE TITLE: DSP AND ITS APPLICATIONS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Review of signals and systems – Review of discrete-time Fourier transform (DTFT) – Discrete Fourier Transform – properties – inverse DFT – relationship between DFT and Z-transform – circular convolution – linear convolution using DFT – overlap add/save method – Fast Fourier Transform (FFT) - Decimation-in-time (DIT) & Decimation-in-Frequency (DIF) FFT algorithms.	06	15
MODULE : 2 Realization of IIR filters – direct form I & II – cascade – parallel – lattice-ladder – state space realizations – type I & II – realization of FIR filters – direct form – cascade – linear phase realizations – lattice – conversion from lattice to direct form.	06	15
FIRST INTERNAL TEST		
MODULE : 3 Digital filter design – analog to digital transformation – backward-difference technique – impulse invariant – bilinear transformation – design of IIR filter from analog filter –	06	15

Butterworth &Chebyshev filter – FIR filter design – Fourier series method – design using windows – Rectangular, Bartlett, Hanning, Hamming, Blackman, Kaiser windows - comparison of FIR & IIR filters.		
MODULE : 4 Multirate digital signal processing – sampling rate conversion – decimation, interpolation – sampling rate alternation or conversion – filter design and implementation for sampling rate alternation – direct form FIR digital filter structure, polyphase filter structure, time-varying digital filter structure – sampling rate conversion by an arbitrary factor.	08	15
SECOND INTERNAL TEST		
MODULE : 5 Finite word length effects – fixed point and floating point formats – quantization errors – limit cycle oscillations - Digital signal processors – selection of digital signal processors – Von Neumann & Harvard architecture – Multiply Accumulate Unit (MAC) - architecture of DSP processor - fixed point & floating point (block diagram approach) - applications of digital signal processors.	08	20
MODULE : 6 Applications of DSP – speech processing – speech analysis, synthesis and compression – radar signal processing – image processing– image formation, recording, compression, restoration and enhancement – echo cancellation Execution of simple programs using digital signal processor – solution of specific problems in digital signal processing using MATLAB programs	08	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6337	DYNAMICS OF ELECTRIC MACHINES	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:
Electromagnetic field theory, Vector algebra and fundamentals of all electrical rotating machines

Course Objective:

The main objective of this course is to provide a systematic approach for modeling and analysis of various electrical machines under both transient and steady state conditions.

Syllabus

Introduction – Unified approach to the analysis of electrical machine – voltage, power and torque equation –linear transformation – power invariance – park's transformation. DC machines – application of generalized theory to separately excited, shunt, series and compound machines – Polyphase synchronous machines – generalized machine equations – steady state analysis – transient analysis – Induction machines – generalized model – steady state analysis – equivalent circuit – effect of voltage and frequency variations – electric transients in induction machines – speed control of induction motor – introduction to vector control – single phase induction motor – generalized model – steady state analysis..

Course Outcome:

After successful completion of this course the students will know the working principles of electric machine (DC machine, synchronous Machine and induction machine, Control techniques of electric motors, also the steady state and transient analysis.

References:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, "Analysis of Electrical Machines and Drive Systems", John Wiley
2. PS. Bhimbra, "Generalized Theory of Electrical Machines", Khanna Publishers
3. A E Fitzgerald, Kingsley, Umans, "Electric Machinery", McGraw Hill
4. Adkins and Harey, "General Theory of AC Machines"
5. Bimal K Bose, "Modern Power Electronics & AC Drives", Pearson Education

Course Plan:

COURSE NO: 07EE 6337 COURSE TITLE: DYNAMICS OF ELECTRIC MACHINES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**

MODULE : 1 Introduction – Unified approach to the analysis of electrical machine – basic two-pole machine – Kron's primitive machine – voltage, power and torque equation –linear transformation from 3-phase to 2-phase - transformation from rotating axes to stationary axes – power invariance.	06	15
MODULE : 2 Park's transformation for 3-phase synchronous and induction machines. DC machines – application of generalized theory to separately excited, shunt, series and compound machines	06	15
FIRST INTERNAL TEST		
MODULE : 3 Sudden short circuit of separately excited generator - separately excited dc motor - steady state and transient analysis – transfer functions of separately excited dc generator & motor.	06	15
MODULE : 4 Polyphase synchronous machines – generalized machine equations – steady state analysis of salient pole and non-salient pole machines – phasor diagrams – power angle characteristics – reactive power – short circuit ratio – transient analysis – sudden 3-phase short circuit at generator terminals – reactance – time constants – transient power angle characteristics.	08	15
SECOND INTERNAL TEST		
MODULE : 5 Induction machines – 3-phase induction machine- generalized model – voltage equation – steady state analysis – equivalent circuit – torque-slip characteristics – effect of voltage and frequency variations – electric transients in induction machines	08	20
MODULE : 6 Speed control of induction motor – introduction to vector control – applications in speed control of induction machine – single phase induction motor – generalized model – voltage and torque equations – steady state analysis.	08	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07GN 6001	RESEARCH METHODOLOGY	L-T-P: 0-2-0 Credits: 2 Year: 2015

Prerequisite:
Basic knowledge of engineering technology.

Course Objective:
The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:

- The scientific research process and the various steps involved
- Formulation of research problem and research design
- Thesis preparation and presentation.
- Research proposals, publications and ethics
- Important research methods in engineering

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role.

Syllabus:
Overview of research methodology - Research process, scientific method, research design process.
Research Problem and Design - Formulation of research task, literature review, web as a source, problem solving approaches, experimental research, and ex post facto research.
Thesis writing, reporting and presentation -Interpretation and report writing, principles of thesis writing- format of reporting, oral presentation.
Research proposals, publications and ethics - Research proposals, research paper writing, considerations in publishing, citation, plagiarism and intellectual property rights.
Research methods – Modelling and Simulation, mathematical modeling, graphs, heuristic optimization, simulation modeling, measurement design, validity, reliability, scaling, sample design, data collection methods and data analysis

Course Outcome:

At the end of course, the student will be able to:

- Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.
- Analyze and evaluate research works and to formulate a research problem to pursue research
- Prepare a thesis or a technical paper, and present or publish them
- Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.

References:

1. C. R. Kothari, Research Methodology, Methods and Techniques, New Age International Publishers
2. K. N. Krishnaswamy, Appalyer Sivakumar, M. Mathirajan, Management Research Methodology, Integration of principles, Methods and Techniques, Pearson Education
3. R. Panneerselvam, Research Methodology, PHI Learning
4. Deepak Chawla, Meena Sondhi, Research Methodology–concepts & cases, Vikas Publg House
5. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
6. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.
8. Fred M Kerlinger , Research Methodology
9. Ranjit Kumar, Research Methodology – A step by step guide for beginners, Pearson Education
10. John W Best, James V Kahan – Research in Education , PHI Learning
11. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co Ltd
12. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes
13. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
14. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
15. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
16. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
17. Donald H. McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047- 0,2006
18. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers..
19. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing
20. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.

21. Additional suitable web resources
22. Guidelines related to conference and journal publications

Course Plan:

COURSE NO:07GN 6001 COURSE TITLE: RESEARCH METHODOLOGY (L-T-P : 0-2-0) CREDITS: 2		
MODULES	**Contact hours**	**Int. Exam Marks (%)**
MODULE : 1 Overview of Research Methodology Research concepts – meaning – objectives – motivation - types of research –research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process – decisional research	05	10
MODULE : 2 Research Problem and Design Formulation of research task – literature review – methods – primary and secondary sources – web as a source – browsing tools -formulation of research problems – exploration - hypothesis generation - problem solving approaches- introduction to TRIZ(TIPS)- experimental research – principles - Laboratory experiment - experimental designs - ex post facto research - qualitative research	05	10
FIRST INTERNAL TEST		
MODULE : 3 Thesis writing, reporting and presentation Interpretation and report writing – techniques of interpretation – precautions in interpretation – significance of report writing – principles of thesis writing- format of reporting - different steps in report writing – layout and mechanics of research report - references – tables – figures – conclusions. oral presentation – preparation - making presentation – use of visual aids - effective communication	04	10
MODULE : 4 Research proposals, publications, ethics and IPR Research proposals - development and evaluation – research paper writing – layout of a research paper - journals in engineering – considerations in publishing – scientometry- impact factor- other indexing like h-index – citations - open access publication -ethical issues - plagiarism –software for plagiarism checking- intellectual property right- patenting case	05	10

studies.		
SECOND INTERNAL TEST		
MODULE : 5 Research methods – Modelling and Simulation Modelling and Simulation – concepts of modelling – mathematical modelling - composite modelling – modelling with – ordinary differential equations – partial differential equations – graphs heuristics and heuristic optimization - simulation modelling	05	10
MODULE : 6 Research Methods – Measurement, sampling and Data acquisition Measurement design – errors -validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data - data collection methods - data preparation and data analysis	04	10
THIRD INTERNAL TEST		

Internal Continuous Assessment: 100 marks

Internal continuous assessment is in the form of periodical tests and assignments. There are three tests for the course (3 x 20 = 60 marks) and assignments (40 marks). The assignments can be in the form of seminar, group tasks, case studies, research work or in a suitable format as decided by the teacher. The assessment details are to be announced to students at the beginning of the semester by the teacher.

07EE 6309	**POWER ELECTRONICS LAB** **Hours/week:2**	**L-T-P: 0-0-2** **Credits: 1** **Year: 2015**

Prerequisite:

Fundamentals of Power electronics

Course Objective:

Toprovidepracticalknowledgethroughhardwareimplementation&simulationofpowerelectroniccircuits

Syllabus:

Semi-converter; Full Converter; Chopper; PWM inverter; DC-DC Converter; Voltage Controller; Study of Power Quality; Transformer and Inductor design;

Course Outcome:
Upon completing the course, the students are expected to accomplish hand on experience in various power electronic converters and acquire proficiency in handling simulation software.

Course Plan:

COURSE NO: 07EE 6309 COURSE TITLE: POWER ELECTRONICS LAB (L-T-P : 0-0-2) CREDITS: 1	
Hardware Experiments (Minimum Six experiments to be conducted)	**Contact hours**
1. Single Phase Semi-converter with R-L load for continuous & discontinuous conduction modes 2. Single Phase Full-converter with R-L load for continuous & discontinuous conduction modes 3. Digital firing circuit 4. Three Phase Full-converter with R-L-E load 5. Controlled and Uncontrolled rectifier with different types of filters - continuous & discontinuous modes of operation 6. Transformer and Inductor design 7. Current & voltage commutated thyristorized chopper 8. MOSFET/ IGBT/Transistor based DC Choppers (Buck & Boost) 9. Half bridge square wave inverter 10. Single-phase Sine triangle PWM inverter 11. Single Phase AC Voltage Controller 12. Transfer function of armature controlled DC Motor 13. Microcontroller and DSP based control of dc-dc converters 14. Study of harmonic pollution by power electronics loads using power quality analyser	02 per Experiment
Simulation Experiments	

(Minimum Four experiments to be conducted)	
1. 3-phasefullconverterandsemi-converterwithR,RLandRLEloads 2. 3-phaseacvoltagecontroller 3. Closed loop control of DC-DC converter 4. 3-phasesinePWMinverter 5. Measurement of THD of current& voltage waveforms of controlled & uncontrolled3-phase rectifiers.	02 per Experiment

(Simulation can be done using any of the software packages like MATLAB/SIMULINK, PSPICE, PSCAD, PSIM etc.)

Internal Continuous Assessment: 100 marks

i) Practical Records /outputs 40%

ii) Regular Class Viva-Voce 20%

iii) Final Test (Objective) 40%

07EE 6311	**INTRODUCTION TO SEMINAR**	**L-T-P: 0-0-1** **Credits: 0** **Year: 2015**

Course Objective:

The basic objective of this course is to improve the oral communication skill of the students.

Syllabus:

Individual students are required to choose a topic (need not be engineering) of their interest in consultation with faculty and present for about 30 minutes. They will be guided about sound modulation, sequence of presentation, eye contact and writing on the black board.

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SEMESTER2

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07EE 6302	**ELECTRIC AND HYBRID VEHICLES**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:
Power Converters, Electrical Machines.

Course Objective:
The basic objective of this course is to familiarize the students the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.

Syllabus:
History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive; Basic concept of hybrid traction; Basic concepts of electric traction; Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives; Matching the electric machine and the internal combustion engine (ICE); Introduction to energy management strategies used in hybrid and electric vehicle.

Course Outcome:
Upon completing this course, students are expected to gain deeper understanding of various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used, energy storage devices, etc

References:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, (2nd Edition), CRC press, 2009
2. Chris MI, M. Abul and David Wenzhong Gao, *Hybrid Electrical Vehicle Principles and Application with Practical Perspectives*, Standards media, 2009.
3. John M. Miller, *Propulsion System for Hybrid Vehicle* 2nd Edition,
4. Mehrdad Ehsani, YiminGao and AliEmadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design*"
5. Bimal Bose, 'Power electronics and motor drives', Elsevier, 2006
6. Ion Boldea and S.A Nasar, 'Electric drives', CRC Press, 2005
7. Sira -Ramirez, R. Silva Ortigoza, 'Control Design Techniques in Power Electronics
8. Devices', Springer, 2006
9. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, 'Sliding mode control of switching Power Converters', CRC Press, 2011
10. Ali Emadi, Mehrdad Ehsani, John M.Miller Vehicular Electric Power Systems, Special Indian Edition, Marcel dekker, Inc 2010

Course Plan:

COURSE NO: 07EE 6302 COURSE TITLE: ELECTRIC AND HYBRID VEHICLES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem Exam Marks (%)**

MODULE : 1 History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	08	15
MODULE : 2 Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	06	15
FIRST INTERNAL TEST		
MODULE : 3 Basic concepts of electric traction, introduction to various electric drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	06	15
MODULE : 4 Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	08	15
SECOND INTERNAL TEST		
MODULE : 5 Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.	07	20
MODULE : 6 Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks

Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6304	SWITCHED MODE POWER CONVERTERS	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:

Power Converters

Course Objective:

The main objective of this course is to understand the concepts, basic operation, steady-state operation of efficient switched mode power conversion techniques, including basic circuit operation and magnetics design.

Syllabus

Converters in steady state - Converters with electrical isolation; Converter Dynamics and control -

Direct duty ratio control; Resonant converters; Utility interface issues and magnetic circuits design; Magnetic materials and cores-copper windings-thermal considerations;

Course Outcome:

Upon finishing the course, students are expected to accomplish the knowledge for Steady-State Analysis, modelling and design of switched-mode dc-dc power converters and corresponding control techniques.

References:

1. Ned Mohan, Power Electronics: Converters, Applications And Design , John Wiley & Sons
2. R. W. Erickson , Fundamental of Power Electronics , Chapman & Hall Publishers
3. L. Umanand, "Power Electronics : Essentials & Applications" , Wiley India Pvt Ltd
4. S. S. Ang, A. Oliva, "Power Switching Converters", Marcel Dekker, 2nd ed.,
5. Keith H Billings "Handbook of Switched Mode Power Supplies", McGraw Hill Publishing Company
6. Marian K. Kazimierczuk, "Pulse-width Modulated DC-DC Power Converters", John Wiley & Sons Ltd., 1st Edition.
7. Abraham I Pressman ,"Switching Power Supply Design". McGraw Hill Publishing Company.
8. Otmar Kilgenstein,"Switched Mode Power Supplies in Practice", John Wiley and Sons.
9. H. W. Whittington, B. W. Flynn, D. E. Macpherson, "Switched Mode Power Supplies", John Wiley & Sons Inc., 2nd Edition.

Course Plan:

COURSE NO: 07EE 6304 COURSE TITLE: SWITCHED MODE POWER CONVERTERS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Converters in steady state - Converters without electrical isolation- buck, boost and buck-boost converters-different modes of operation- converters with non idealities - a brief survey of power semiconducting devices-linear and switched mode power supplies.	07	15
MODULE : 2 Converters with electrical isolation-forward converter-fly back converter-half bridge converter-full bridge converter-push pull converter-flux imbalance problems and solutions-switch stress and utilization	06	15
FIRST INTERNAL TEST		
MODULE : 3 Converter Dynamics and control - Basic ac modeling approach-state space averaged modeling-circuit averaging and averaged switch modeling-converter transfer functions. Direct duty ratio control-error amplifiers-current mode control-slope compensation-comparison between direct duty ratio control and current mode control.	08	15
MODULE : 4 Resonant converters - Classification of resonant converters-basic resonant circuit concepts-load resonant converters-resonant switch converters-ZVS clamped voltage dc-dc	08	15

converters.		
SECOND INTERNAL TEST		
MODULE : 5 resonant dc link inverters with zero voltage switching-high frequency link integral half cycle converter	05	20
MODULE : 6 Utility interface issues and magnetic circuits design - Generation of current harmonics-current harmonics and power factor-harmonic standards and recommended practices-need for improved utility interface-improved single phase utility interface-active shaping of input line current-improved 3-phase utility interface-electromagnetic interference.	08	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6306	**ADVANCED ELECTRIC DRIVES**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

Fundamental knowledge in Power converters, Electrical drives and Electrical machinery.

Course Objectives:

To introduce advanced concepts of AC machine modeling and speed control concepts using advanced electrical drives for various electric machines.

Syllabus:

Basic principles for Electric Machine Analysis- Dynamic modeling of induction machines;Vector controlled induction motor drive –Stator flux oriented vector control; Flux weakening operation of vector controlled induction motor; Permanent magnet synchronous machine drives Vector control of PM synchronous machine – control strategies.

Course Outcome:

Upon finishing this course, students are expected to accomplish the ability to analyze, simulate and evaluate performance of variable speed drives for AC machines. Become proficient with computer skills (e.g., MATLAB) for the analysis and design of electrical drives

References:

1. R Krishnan, *Electric Motor Drives*, PHI, 2007
2. B K Bose, *Modern Power Electronics and AC Drives*, PHI, 2006
3. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, "Analysis of Electrical Machines and Drive Systems", John Wiley
4. R Krishnan, "*Permanent Magnet Synchronous and Brushless dc drives*", CRC Press, 2010
5. DWNovotnyandTALipo,*VectorControlandDynamicsofACDrives*,OxfordUniversityPress, 1997
6. Ned Mohan, "Advanced Electric Drives", John Wiley, 2014
7. Joseph Vithayathil, "Power Electronics- Principles and Applications", TMH, 2010
8. W Leonhard, "Control of Electric Drives", Springer, 2001
9. C.M. Ong, "Dynamic simulation of Electric Machinery", Prentice Hall, 1998
10. A.M. Trzynadlowski, "Field orientation Principle in the control of Induction Motors, Kluwer

Course Plan:

COURSE NO: 07EE 6306 COURSE TITLE: ADVANCED ELECTRIC DRIVES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Basic principles for Electric Machine Analysis- Magnetically coupled circuits- Electro mechanical Energy conversion- energy, co-energy and electromagnetic torque- Air gap MMF due to sinusoidal winding distribution- Dynamic modeling of induction machines – 3-phase to 2-phase transformation –power equivalence	05	15
MODULE : 2 Generalized model in arbitrary reference frame – electromagnetic torque – derivation of stator reference frame model, rotor reference frame model, synchronously rotating reference frame model – dynamic model of synchronous machines-Vector controlled induction motor drive – Principle of vector or field oriented control – Comparison with separately excited dc motor- direct rotor flux oriented vector control – estimation of rotor flux and torque–Indirect rotor flux oriented vector control scheme	06	15
FIRST INTERNAL TEST		

MODULE : 3 Parameter sensitivity - Stator flux oriented vector control- decoupling requirements- implementation of vector control schemes with current source and current regulated inverters- implementation with voltage source inverters- decoupling- Typical applications of vector controlled drives- Speed controller design	08	15
MODULE : 4 Flux weakening operation of vector controlled induction motor - flux weakening for stator and rotor flux orientation- comparison with dc motor torque capability curves- Sensor less vector control schemes- Speed estimation using slip calculation- Direct torque control of induction motor – control strategy - comparison of DTC and FOC	08	15
SECOND INTERNAL TEST		
MODULE : 5 Permanent magnet synchronous machine drives – types of permanent magnet and magnet characteristics– operating point and air gap line- radial and parallel magnetization- Halbach arrays- SPM and IPM machines- Modelling of PMSM	08	20
MODULE : 6 Vector control of PM synchronous machine – control strategies – constant torque-angle control, unity power factor control, constant mutual flux-linkages control, optimum torque per ampere control, flux weakening operation, speed controller design	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6XXX: ELECTIVE II

07EE 6208	FLEXIBLE AC TRANSMISSION SYSTEMS	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:
Power System Analysis, Power Converters.

Course Objective:
The main objective of this course is to introduce the application of a variety of high power-electronic controllers for active and reactive power in transmission lines. Students are exposed to the basics, modeling aspects, control and scope for different types of FACTS controllers.

Syllabus:
FACTS and preliminaries; Three Phase Converters and Standard Modulation Strategies Programmed Harmonic Elimination and SPWM; GTO Inverters; Static Shunt Compensators; Static Series Compensators; UPFC and IPFC-Special Purpose FACTS Controllers - Interline Power Flow Controller - operation and control;

Course Outcome:
Upon completing the course, students are expected to be able to model different FACTS controllers, a given engineering application and analyze and compare the performance of various FACTS controllers

References:

1. N.G.Hingorani&L.Gyugyi,*UnderstandingFACTS:ConceptsandTechnologyofFlexible AC Transmission Systems*, IEEE Press
2. K. R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International
3. T. J. E Miller, *Reactive Power Control in Electric Systems*, John Wiley & Sons.
4. Ned Mohan et.al, *Power Electronics*, John Wiley and Sons.
5. Dr Ashok S & K S SureshKumar "*FACTS Controllers and applications*" course book for STTP, 2003.
6. Published Literatures

Course Plan:

COURSE NO: 07EE 6208 COURSE TITLE: FLEXIBLE AC TRANSMISSION SYSTEMS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**

MODULE : 1 FACTS and preliminaries: FACTS concept and general system considerations - power flow in AC system - definitions on FACTS - basic types of FACTS controllers – dynamic brake	06	15
MODULE : 2 Static Shunt Compensators - SVC and STATCOM - operation and control of TSC, TCR, STATCOM - Compensator Control - Comparison between SVC and STATCOM	08	15
FIRST INTERNAL TEST		
MODULE : 3 STATCOM for transient and dynamic stability enhancement, case studies. Static Series Compensators: Static Series Compensation - GCSC, TSSC, TCSC and SSSC - operation and control - external system control for series compensators	08	15
MODULE : 4 SSR and its damping - static voltage and phase angle regulators - TCVR and TCPAR - operation and control, case studies	05	15
SECOND INTERNAL TEST		
MODULE : 5 UPFC and IPFC: The Unified Power Flow Controller - operation, comparison with other FACTS devices - control of P and Q - dynamic performance	08	20
MODULE : 6 Special Purpose FACTS Controllers - Interline Power Flow Controller - operation and control – case studies	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6318	DESIGN OF POWER ELECTRONIC SYSTEMS	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:
Systems Dynamics, Power Converters and Electrical drives

Course Objective:
The main objective of this course is to understand the design aspects of practical power electronic converters and electrical drives

Syllabus
Design of Gate and Base Drive Circuits; Snubber circuits-turn off and turn-on snubber; Cooling and Design of heat sinks; Design of Magnetic components; Demonstration design of converter circuits.

Course Outcome:
Upon completing this course, the students are expected to accomplish the ability to design gate drivers, snubbers and magnetic components for various power electronic converters and electrical drives.

References:

1. Ned Mohan, Tore M. Undeland and William P.Riobbins, "Power Electronics—Converters, Applications and Design" Third Edition, John Wiley and Sons. Inc2014
2. Muhammad H. Rashid, " Power Electronics, Circuits, Devices and Application"' Third Edition, Prentice Hall of India Private Limited, 2004
3. Joseph Vithayathil, "Power Electronics-Principle and Applications'', Tata McGraw Hill Education Pvt Ltd, 2010.
4. Barry W. Williams, "Principles of Elements of Power Electronics Devices, Drivers, Applications and Passive Components", Barry W. Williams, 2006.
5. Daniel W. Hart, "Power Electronics", Tata McGraw Hill, 2011.

Course Plan:

COURSE NO: 07EE 6318 COURSE TITLE: DESIGN OF POWER ELECTRONIC SYSTEMS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Design of Gate and Base Drive Circuits: Design consideration, dc – coupled drive circuits isolated drive circuits, cascade-connected drive circuits Thyristor drive circuits power device protection in drive circuits layout considerations.	06	15

MODULE : 2 Snubber circuits: Function and type of Snubber circuits, diode snubbers thyristor snubber circuits, Transistor snubber circuits.	04	15
FIRST INTERNAL TEST		
MODULE : 3 Turn off and turn-on snubber, overvoltage snubber, snubber for bridge circuit configurations, GTO snubber considerations.	08	15
MODULE : 4 Cooling and Design of heat sinks-Control of device temperature, heat transfer by conduction, heat sinks, heat transfer by radiation and convection.	08	15
SECOND INTERNAL TEST		
MODULE : 5 Design of Magnetic components: Magnetic materials and core, copper windings, thermal considerations, inductor design analysis and procedure, transformer design, eddy currents, leakage inductance, transformer design, comparison of sizes of transformer and inductor.	08	20
MODULE : 6 Demonstration design of converter circuits, 3 phase rectifier. Buck converter, boost converter.	08	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6328	**MODELING AND ANALYSIS OF AC DRIVES**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

Fundamental knowledge in Power Converters, Electrical Drives, Electrical Machinery, Proficiency in simulation softwares like MTALB/SIMULINK.

Course Objective:

The main objective of this course is to understand the key concepts of dynamic modeling of induction machines and synchronous machines in various reference frames. With the help of these mathematical model, various operational aspects of AC drives are analyzed.

Syllabus

Reference Frame Theory; Modeling of induction machines- Dynamic performance under unbalanced/fault conditions - Computer simulation; Modeling of synchronous machines– Dynamic performances under unbalanced/fault conditions - Computer simulation; Induction motor drives– Dynamic and regenerative braking of VSI fed drives – Power factor considerations – Field oriented control; Synchronous motor drives– Power factor control – Brush less excitation systems – Starting methods;

Course Outcome:

Upon completing this course, the students are expected to accomplish the ability to model and simulate electrical drives of induction and synchronous machines.

References:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, "Analysis of Electrical Machines and Drive Systems", John Wiley.
2. R. Krishnan," Electric Motor Drives, Modeling, Analysis and Control" Prentice Hall of India, 2002.
3. Bose. B. K., Power Electronics and Motor Drives - Advances and Trends, IEEE Press, 2006.
4. Murphy J.M.D., Turnbull F.G., "Thyristor control of AC Motors", Peragamon Press, Oxford, 1988.
5. Ned Mohan, Advanced Electric Drives, Analysis, Control and Modelling using Simulink MNPERE, 2001.
6. Bin Wu, "High Power Converters and AC Drives", IEEE Press, A John Wiley and Sons, Inc., 2006.

Course Plan:

COURSE NO: 07EE 6328 COURSE TITLE: MODELING AND ANALYSIS OF AC DRIVES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Reference Frame Theory- Theory of transformation – Phase transformation and commutator transformation – Invariance of Power - Static and rotating reference frames – balanced steady-state voltage and torque equations using transformation theory.	07	15

MODULE : 2 Modeling of induction machines – Equivalent circuit – Complete speed-torque characteristics -Voltage and torque equations in static and rotating reference frames – Analysis of steady state and dynamic operations - Dynamic performance under unbalanced/fault conditions - Computer simulation.	07	15
FIRST INTERNAL TEST		
MODULE : 3 Modeling of synchronous machines – Equivalent circuit – Machine reactances and time constants - Voltage and torque equations in static and rotating reference frames – Analysis of steady state and dynamic operations - Dynamic performances under unbalanced/fault conditions - Computer simulation.	08	15
MODULE : 4 Induction motor drives-Variable voltage operation – Variable frequency operation – Constant flux operation – Torque-Slip characteristics – Constant Torque and Constant power operation – Dynamic and regenerative braking of VSI fed drives – Power factor considerations – Field oriented control – Design of closed loop operation of Induction motor drive systems-Computer simulation.	08	15
SECOND INTERNAL TEST		
MODULE : 5 Synchronous motor drives- Need for leading PF operation – Open loop VSI fed drive and its characteristics – Self-control – Torque control – Torque angle control – Power factor control.	06	20
MODULE : 6 Brush less excitation systems – Starting methods – Field oriented control – Design of closed loop operation of Synchronous motor drive systems-Computer simulation.	06	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 63XX ELECTIVE III

07EE 6312	INDUSTRIAL CONTROL ELECTRONICS	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:

Fundamental knowledge about analog, digital and Power electronic circuits.

Course Objective:

This course gives a comprehensive coverage of various control electronics used in engineering industries. This combines the analog and digital concepts together with Power Electronics for the design of the controllers. Further an overview of stepper motor and servomotor with associated control circuits is given.

Syllabus

Analog Controllers; Digital control schemes- control algorithms; Signal conditioners- Instrumentation amplifiers; Isolation circuits – cabling; magnetic and electro static shielding and grounding; Opto-Electronic devices and control- Applications of opto-isolation, interrupter modules and photo sensors; Fiber-optics; Bar code equipment; Introduction to microprocessors, microcontrollers, Digital Signal Processors.

Course Outcome:

Upon completing the course, students are expected to have the ability to design and analyze analog controllers for UPS, Switching regulators and inverters. Students will acquire a comprehensive knowledge about signal conditioning circuits and engineering industrial applications of stepper motors and servomotors.

References:

1. Michael Jacob, *Industrial Control Electronics – Applications and Design*, Prentice Hall, 1995.
2. Thomas E. Kissell, *Industrial Electronics*, Prentice Hall India, 2003
3. James Maas, *Industrial Electronics*, Prentice Hall, 1995.
4. Toliyat, Hamid A. and SlevenCampell, “DSP Based Electomechanical Motion Control”, CRCPress 2003.
5. M.D. Singh and K. B. Khanchandani, *Power Electronics*, Tata McGraw-Hill, 2nd Edition, New Delhi, 2008.
6. TMS 320 F 240 Technical Reference Manual.
7. Application notes on DSP based Motor Control.

Course Plan:

COURSE NO: 07EE 6312 COURSE TITLE: INDUSTRIAL CONTROL ELECTRONICS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID Controllers, derivative overrun, integral windup, cascaded control, Feed forward control.	07	15
MODULE : 2 Digital control schemes, control algorithms, programmable logic controllers.	05	15
FIRST INTERNAL TEST		
MODULE : 3 Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters; Isolation circuits – cabling; magnetic and electro static shielding and grounding.	08	15
MODULE : 4 Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors.	08	15
SECOND INTERNAL TEST		
MODULE : 5 Fiber-optics; Bar code equipment, application of barcode in industry.	05	20
MODULE : 6 Introduction to microprocessors, microcontrollers, Digital Signal Processors. Basic building blocks, architecture ofTMS320LF 28xx DSP, instruction set, programming, application development, PI controller, Clarks and Park transformation, PWM generation, PLL and unit sine wave generation.	09	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6322	**RENEWABLE ENERGY TECHNOLOGIES**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:
Power electronics, Electric machines

Course Objective:
The main objective of this course is to understand various forms of renewable energy sources and various energy conversion systems using power electronic converters.

Syllabus
Renewable energy Sources– stand alone, hybrid and grid –connected; Recent developments in renewable energy sector- global and national energy policies; Wind energy- WEG technologies for grid connection; Solar energy –PV cell- Maximum power tracking; SPV systems – stand alone and grid-connected; Biomass – gasifiers; small hydro-resource assessment; Wave, Tidal, Ocean thermal and Geothermal energy systems; Energy storage systems.

Course Outcome:
Upon completing this course, students are expected to accomplish the knowledge for proper selection and designing of renewable energy systems for various engineering applications

References:

1. Thomas B Johansson , "Renewable Energy: Sources for Fuels and Electricity", Island Press, Washington, 1993
2. John W Twidell and A D Weir , "Renewable Energy Sources",ELBS,1986
3. N K Bansal, M Kleeman and M Mellis , "Renewable Energy Resources and Conversion Technology", Tata McGraw Hill , 1990
4. S N Bhadra, D Kasthaand SBanarji , "Wind Electrical Systems", Oxford University Press , 2005.

Course Plan:

COURSE NO: 07EE 6322 COURSE TITLE: RENEWABLE ENERGY TECHNOLOGIES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Renewable energy Sources: Renewable energy utilization in ancient times, classification of RE technologies – stand alone, hybrid and grid –connected	07	15
MODULE : 2 Recent developments in renewable energy sector- global and national energy policies.	07	15
FIRST INTERNAL TEST		
MODULE : 3 Wind energy- Global and local winds, resource assessment, wind regime modeling –Weibull parameters; WEG technologies for grid connection.	07	15
MODULE : 4 Solar energy – Solar radiation and measurements; PV cell-principle, types and construction; modeling of PV cell, Maximum power tracking; SPV systems – stand alone and grid-connected.	07	15
SECOND INTERNAL TEST		
MODULE : 5 Other renewable energy technologies; Biomass – gasifiers; small hydro-resource assessment, selection of turbines, Electronic load controller.	07	20
MODULE : 6 Wave, Tidal, Ocean thermal and Geothermal energy systems – principles and technologies; Energy storage systems.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6332	EMBEDDED CONTROL OF ELECTRICAL DRIVES	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:
Power Converters, Electrical drives, Basic course on microcontrollers (UG level)

Course Objective:

The main objective of this course is to have comprehensive knowledge in PIC18F microcontrollers and DSP TMS320LF240x for Electrical Drives applications.

Syllabus:
Introduction to Microcontrollers- PIC18F microcontroller; Design of electrical drives using PIC18F microcontrollers- DC motor Interfacing and PWM- Bidirectional control-LCD Interfacing-Keyboard interfacing; Introduction to DSP controllers -peripherals-type of memory-PWM signal generation; DSP based implementation of DC-DC buck-boost converter-code description-DSP-based control of stepper motor-implementation using LF2407 DSP-subroutine of speed control module-DSP-based control of PM BLDC motor-implementation using LF2407- Introduction to TMS320F2812- TMS320F28332- TMS320FLF28335

Course Outcome:
Upon finishing the course, students are expected to accomplish the knowledge to design and develop electrical drives for various engineering applications using PIC 18F microcontrollers and DSP TMS320LF240x

References:

1. Barry B. Brey, "Applying PIC18 Microcontrollers: Architecture, Programming, and Interfacing using C and Assembly", Prentice Hall, 2007
2. Mazidi, RolinMcKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC 18", Prentice Hall, 2009
3. Hamid A. Toliyat and Steven G. Campbell, DSP Based Electromechanical Motion Control, CRC Pres, 2004
4. Bimal K. Bose, "Power Electronics and Variable Frequency Drives - Technology and Application", IEEE Press, 1997.
5. Ramesh Gaonkar, "Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC", Delmar Cengage Learning, 2007
6. Texas Application Notes on DSP

Course Plan:

COURSE NO: 07EE 6332 COURSE TITLE: EMBEDDED CONTROL OF ELECTRICAL DRIVES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Introduction to Microcontrollers- PIC18F microcontroller - Architecture - memory organization - addressing modes - instruction set - Timers - Capture / Compare / PWM (CCP) Modules – Interrupts - I/O ports - I2C bus for peripheral chip access - A/D converter – USART-programming techniques using C and Assembly.	09	15
MODULE : 2 Design of electrical drives using PIC18F microcontrollers- Relays and Optoisolators - Stepper motor Interfacing- Controlling stepper motor using optiisolators.	05	15
FIRST INTERNAL TEST		
MODULE : 3 DC motor Interfacing and PWM- Bidirectional control- PWM motor control using CCP- DC motor Control with ECCP- Programming in Assembly and C- -LCD Interfacing-Keyboard interfacing.	08	15
MODULE : 4 Introduction to DSP controllers -peripherals-type of memory- C2xx DSP CPU instruction set- System configuration registers- GPIO functionality- Interrupts on TMS320LF2407-interrupt control registers- ADC-operation usage exercise-Event managers-PWM signal generation.	08	15
SECOND INTERNAL TEST		
MODULE : 5 DSP based implementation of DC-DC buck-boost converter-code description-DSP-based control of stepper motor-implementation using LF2407 DSP-subroutine of speed control module.	06	20
MODULE : 6 DSP-based control of PM BLDC motor-implementation using LF2407 DSP-Implementation of Clarke's and Park's transformation using LF240x DSP- Introduction to TMS320F2812- TMS320F28332- TMS320FLF28335	06	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a

combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 6314	**SEMINAR I** **Hours/week:2**	**L-T-P: 0-0-2** **Credits: 2** **Year: 2015**

Prerequisite:

Power Electronics, Electrical drives

Course Objective:

To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that are essential for an engineer.

Seminar:

Individual students are required to choose a topic of their interest from power electronics and drives related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in power electronics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Course Outcome:

Upon completing this course, students are expected to accomplish capability to properly present a technical topic.

Internal Continuous Assessment: 100 marks
i) Marks for the report: 30%
ii) Presentation: 40%
iii) Ability to answer questions on the topic: 30%

07EE 6316	**MINI PROJECT**	**L-T-P: 0-0-2** **Credits: 2** **Year: 2015**

Prerequisite:

Power converters, Electrical drives

Course Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Mini Project Work:

Mini project work can be a design project/experimental project and/or computer simulation project on any of the topics in power electronics/drives related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their mini project work in the parent institute itself. Department will constitute an Evaluation Committee to review the mini project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

Course Outcome:

On successful completion of this course, the students are expected to accomplish

- Practical knowledge in the regime of power electronics and/or electrical drives by carrying out investigations
- Improved problem solving skills, communication skills and enhanced intellectual independence
- Relevant computing skills, including use of appropriate document preparation and word-processing packages

Internal continuous assessment: 100 marks

07EE 6320	ELECTRIC DRIVES LAB Hours/week:2	L-T-P: 0-0-2 Credits: 1 Year: 2015

Prerequisite:

Power converters, Electrical drives

Course Objective:

Toprovidepracticalknowledgethroughhardwareimplementation&simulationofelectrical drives.

Syllabus:

Closed loop control of converter fed motor drives; Use of Microcontrollers, DSP and FPGA for the control of motors; Simulation of sine PWM & space vector PWM- converter fed motor drives- STATCOM & DSTATCOM- Active Power Filter, DVR- UPQC, UPFC, TCSC

Course Outcome:

Upon completing the course, the students are expected to accomplish hand on experience in various electrical dive topologies and acquire proficiency in handling simulation software.

Course Plan:

COURSE NO: 07EE 6320 COURSE TITLE: ELECTRIC DRIVES LAB (L-T-P : 0-0-2) CREDITS: 1	
Experiments **(Minimum Ten experiments to be conducted)**	**Contact hours**

1. Closed loop control of converter fed DC motor drives 2. Closed loop control of chopper fed DC motor drives 3. VSI fed three phase induction motor drive using V/f control 4. Three phase synchronous motor drive 5. Closed loop control of Brushless DC motors 6. Closed loop control of Switched reluctance motors. 7. Closed loop control of permanent magnet synchronous motors. 8. Use of Microcontrollers, DSP and FPGA for the control of motors. 9. Simulation of sine PWM & space vector PWM 10. Simulation of 3-phase induction motor drive using V/f control 11. Simulation of Vector control of 3-phase induction motor 12. Simulation of Direct Torque Control of 3-phase induction motor 13. Simulation of Brushless DC Motor drive 14. Simulation of STATCOM & DSTATCOM 15. Simulation of Active Power Filter, DVR 16. Simulation of UPQC, UPFC, TCSC 17. Simulation of matrix converter based control of induction motor	02 per Experiment

(Additionalexperimentsandsimulationassignmentscanalsobegivenbythedepartment)

Internal Continuous Assessment: 100 marks

i) Practical Records /outputs 40%

ii) Regular Class Viva-Voce 20%

iii) Final Test (Objective) 40%

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SEMESTER 3

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07EE 7XXX: ELECTIVE IV

07EE 7301	SMART GRID TECHNOLOGIES	L-T-P: 3-0-0 Credits: 3 Year: 2015

Prerequisite:
Distribution systems and Measuring instruments.

Course Objective:
To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure. To get familiarized with the power quality management issues in Smart Grid. To get familiarized with the high performance computing for Smart Grid applications

Syllabus
Evolution of Electric Grid, Difference between conventional & Smart Grid, Concept of Resilient &Self Healing Grid; Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation,Transmission systems; Plug in Hybrid Electric Vehicles (PHEV); Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits,Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection; Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), Cyber Security for Smart Grid- Web based Power Quality monitoring, Power Quality Audit.

Course Outcome:
After undergoing the course, the students would get acquainted with the smart technologies, smart meters and power quality issues in smart grids.

References:

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and
4. Gerhard P. Hancke, 'Smart Grid Technologies: Communication Technologies and Standards' IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011.
5. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang 'Smart Grid – The New and Improved Power Grid: A Survey', IEEE Transaction on Smart Grids.

Course Plan:

COURSE NO: 07EE 7301 COURSE TITLE: SMART GRID TECHNOLOGIES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact**	**Sem. Exam**

	hours	Marks (%)
MODULE : 1 Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid.	07	15
MODULE : 2 Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.	07	15
FIRST INTERNAL TEST		
MODULE : 3 Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control,	07	15
MODULE : 4 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).	07	15
SECOND INTERNAL TEST		
MODULE : 5 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.	07	20
MODULE : 6 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-Web based Power Quality monitoring, Power Quality Audit.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks

Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 7211	**POWER QUALITY**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:
Power converters, Power systems, DSP.

Course Objective:
The main objective of this course is togain knowledge regarding various power quality issues in electrical systems and their solution approaches

Syllabus:
Overview of power quality phenomena- THD-TIF-DIN-C message weights-flicker factor. Harmonics -sources of harmonics -IEEE guides, standards and recommended practices; Power factor reduction due to harmonics-power quality problems created by drives and its impact on drives; Power Quality Measurement and Analysis - Measurement Error – Analysis; Laplace's, Fourier and Wavelet Transform; Utility-Customer interface –Harmonic filters: Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC–control strategies: P-Q theory, Synchronous detection method.

Course Outcome:
Upon completing this course, students are expected to gain knowledge regarding various power quality issues and design power electronic systems to solve these issues

References:

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer, Academic Publishers
2. Heydt, G.T., "Electric Power Quality", Stars in a Circle Publications, Indiana
3. R SastryVedam, "Power Quality VAR compensation in Power Systems", CRC press,
4. NewYork,2009
5. R.C. Duggan, "Power Quality"
6. A.J. Arrillga, "Power System Harmonics"
7. Derek A. Paice, "Power electronic converter harmonics"
8. Ewald F Fuchs, Mohammad A.S., "Power Quality in Power Systems and Electrical Machines", Elsevier, Academic Press
9. Bollen, M.H.J., "Understanding Power Quality Problems: Voltage sags and interruptions", IEEE Press, New York
10. Arrillaga. J, Watson, N.R., Chen, S., "Power System Quality Assessment", Wiley, New York,

2000.

Course Plan:

COURSE NO: 07EE 7211 COURSE TITLE: POWER QUALITY (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Overview of power quality phenomena-classification of power quality issues-power quality measures and standards-flicker-transient phenomena- THD-TIF-DIN-C message weights-flicker factor. Harmonics -sources of harmonics-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and recommended practices.	07	15
MODULE : 2 Power factor reduction due to harmonics-Distortion power-distortion power factor and displacement power factor. Loads that cause power quality problems-power quality problems created by drives and its impact on drives - case studies	07	15
FIRST INTERNAL TEST		
MODULE : 3 Single phase AC/DC converters, SMPS, three phase AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.	09	15
MODULE : 4 Power Quality Measurement and Analysis -Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods	05	15
SECOND INTERNAL TEST		
MODULE : 5 Frequency domain methods: Laplace's, Fourier and Wavelet Transform. Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters	07	20
MODULE : 6 Custom Power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC – control strategies: P-Q theory, Synchronous detection method - series active power filtering techniques for harmonic cancellation and isolation - case studies.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test	– 15 Marks
Second Internal Test	– 15 Marks
Assignments/Term Paper/Seminar	– 10 Marks

End Semester Examination: 60 marks

07EE 7321	**PWM CONVERTERS AND APPLICATIONS**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

Power Converters

Course Objective:

The main objective of this course is to understand steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

Syllabus:

AC/DC and DC/AC power conversion-advanced PWM techniques- practical devices in converter-calculation of switching and conduction losses; Compensation for dead time and DC voltage regulation- Estimation of current ripple and torque ripple in inverter fed drives; harmonic current compensation; PWM Current Source Inverters-Parallel Current Source Inverters-Inverter Topology-PWM Current Source Rectifiers-Introduction-Single-Bridge Current Source Rectifier-Dual-Bridge Current Source Rectifier-Power Factor Control-Active Damping Control; Power supply applications-linear power supplies-line frequency variable voltage drives soft starting of induction motors-speed control by static slip recovery

Course Outcome:

Upon completing the course, students are expected to design PWM power converters with for industrial electrical drives and for mitigating power quality issues.

References:

1. Mohan, Undeland and Robbins,' Power Electronics; Converters, Applications and

Design',John Wiley and Sons, 1989.
2. Bin Wu, High-Power converters and AC Drives, IEEE Press, Wiley-Interscience.
3. Erickson R W,' Fundamentals of Power Electronics', Chapman and Hall, 1997.
4. VithyathilJ,'Power Electronics: Principles and Applications ', McGraw Hill, 1995

Course Plan:

COURSE NO: 07EE 7321 COURSE TITLE: PWM CONVERTERS AND APPLICATIONS (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 AC/DC and DC/AC power conversion- overview of applications of voltage source converters-Pulse modulation techniques for bridge converters.	06	15
MODULE : 2 Bus clamping PWM- space vector based PWM- advanced PWM techniques- practical devices in converter- calculation of switching and conduction losses.	06	15
FIRST INTERNAL TEST		
MODULE : 3 Compensation for dead time and DC voltage regulation-dynamic model of a PWM converter-multilevel converters-constant V/F induction motor drives. Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation-Active power filtering, reactive power compensation; harmonic current compensation.	09	15
MODULE : 4 PWM Current Source Inverters-Introduction-Trapezoidal Modulation-Selective Harmonic Elimination-Space Vector Modulation-Switching States-Space Vectors-Dwell Time Calculation-Switching Sequence-Harmonic Content.	07	15
SECOND INTERNAL TEST		
MODULE : 5 Parallel Current Source Inverters-Inverter Topology-Space Vector Modulation for Parallel Inverters-Effect of Medium Vectors on dc Currents-dc Current Balance Control-PWM Current Source Rectifiers-Introduction-Single-Bridge Current Source Rectifier-Dual-Bridge Current Source Rectifier-Power Factor Control-Active Damping Control.	07	20
MODULE : 6 Power supply applications-linear power supplies-overview of	07	20

switching power supplies-dc-dc converters with electrical isolation-power supply protection electrical isolation in feedback loop-line frequency variable voltage drives, soft starting of induction motors-speed control by static slip recovery.		

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 7XXX: ELECTIVE V

07EE 7303	**SPECIAL ELECTRICAL MACHINES AND DRIVES**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite: Power converters, Electric machinery, Electrical drives.

Course Objective: The main objective of this course is to gain knowledge regarding special types of electric machines and their controls for engineering applications

Syllabus:

Stepping Motors- Dynamic characteristics, resonance, pull-in and pull-out characteristics- Stepping motor drivers- selection of stepping motor rating; Switched Reluctance Motors- Constructional features, principle of operation, inductance profile- Split dc supply converter-R dump- C dump converters- initial rotor position estimation; Permanent Magnet Brushless DC Motors- Permanent magnet materials and characteristics- BLDC motor- operating principle- Sensorless control- third harmonic voltage detection method - back emf detection method; Permanent Magnet Synchronous Motors- radial and parallel magnetization-angle control, Current control schemes.

Course Outcome:

Upon completing this course, students are expected to accomplish knowledge to design and analyze electrical drives for special machines utilized in engineering industries

References:

1. Kenjo T, Sugawara A, "Stepping Motors and Their Microprocessor Control", Clarendon Press, Oxford
2. Paul Acarnley, "Stepping motors - a guide to theory and practice", 4th Edn. IET UK, 2002
3. Miller T J E, "Switched Reluctance Motor and their Control", Clarendon Press, Oxford
4. Miller T J E, "Brushless Permanent Magnet and Reluctance Motor Drives", ClarendonPress, Oxford
5. B K Bose, "Modern Power Electronics & AC drives", Pearson Education
6. R Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", PHI
7. R Krishnan, "Permanent Magnet Synchronous and brushless dc drives", CRC Press, 2010

Course Plan:

COURSE NO: 07EE 7303 COURSE TITLE: SPECIAL ELECTRICAL MACHINES AND DRIVES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Stepping Motors-Types of stepping motors- variable reluctance, permanent magnet and hybrid motors- Constructional features, principle of operation, modes of excitation- torque production in variable Reluctance (VR) stepping motor- Static torque characteristics- position error due to load torque- performance parameters- resolution, single step response and accuracy- Dynamic characteristics, resonance, pull-in and pull-out characteristics	07	15
MODULE : 2 Stepping motor drivers- Unipolar drive schemes- Dual voltage drive- voltage multiplying drive- Bipolar drive schemes- Bifilar drive scheme- open loop position control- Starting/stopping rate- Velocity profiling- single phase stepping motors- Micro stepping- Closed-loop control of stepping motors- Torque computation- gears, belts and lead screw- selection of stepping motor rating	07	15
FIRST INTERNAL TEST		
MODULE : 3 Switched Reluctance Motors-Constructional features, principle of operation, inductance profile- Torque equation- motoring and generating mode- low speed and high speed operation- magnetization characteristics- flux linkage vs current- partition of input energy- Derivation of Torque equation- Energy conversion loop- Energy effectiveness- Power controllers, Characteristics and control- Six switch converter- Split dc	08	15

supply converter-R dump- C dump converters- initial rotor position estimation.		
MODULE : 4 Permanent Magnet Brushless DC Motors- Permanent magnet materials and characteristics- typical demagnetization curves- air gap line and operating point- BLDC motor- operating principle- Torque and emf equation, Torque-speed characteristics, Hall sensors, Optical sensors.	06	15
SECOND INTERNAL TEST		
MODULE : 5 Radial and axial flux BLDC motors- Drive schemes, soft current chopping and hard chopping- low cost drive schemes- extended speed of operation with phase angle control- State space modelling and simulation of BLDC motor- Torque ripple- Sensorless control- third harmonic voltage detection method - back emf detection method - starting process- comparison of BLDC motor with dc motors and induction motors.	07	20
MODULE : 6 Permanent Magnet Synchronous Motors- radial and parallel magnetization- Halbach arrays- Principle of operation, SPM and IPM machines- EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self-control, Field oriented control- constant torque-angle control, Current control schemes.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 7213	**SOFT COMPUTING TECHNIQUES**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:

Basic Mathematics, Computer applications

Course Objective:

The main objective of this course is to acquaint the students with soft computing methodologies such as neural networks,fuzzy logic,genetic algorithms and hybrid algorithms.

Syllabus:

Introduction to Fuzzy logic-Fuzzification-Defuzzification- Fuzzy logic controller; Artificial Neural Networks- Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks- Kohonen Self organizing maps-ART; Fundamentals of genetic algorithms- Hybrid systems- Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids.

Course Outcome:

Upon completing this course, students are expected to accomplish knowledge to implement realtime intelligent and adaptivesystems for engineering applications

References:

1. S.Rajasekharan, G.A.Vijayalakshmi Pai, *Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications*, Prentice Hall India.
2. S.N.Sivanandam, S.N.Deepa, *Principles of Soft Computing*, Wiley India.
3. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill ,New York.
4. S.Haykins, *Neural Networks a Comprehensive foundation*, Pearson Education.
5. D.E.Goldberg, *Genetic Algorithms in Search Optimisation and Machine Learning*, Pearson Education.
6. Recent Literature

Course Plan:

COURSE NO: 07EE 7213 COURSE TITLE: SOFT COMPUTING TECHNIQUES (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations-Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base	07	15

MODULE : 2 Defuzzification- Deffuzzification methods- Fuzzy logic controller (Block Diagram). Artificial Neural Networks: Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks	07	15
FIRST INTERNAL TEST		
MODULE : 3 Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self organizing maps-ART	07	15
MODULE : 4 Fundamentals of genetic algorithms: Basic concepts- working principle – encoding – different methods – fitness function – reproduction-different methods. Genetic modelling-inheritance-Crossover mutation-convergence of genetic algorithm.	07	15
SECOND INTERNAL TEST		
MODULE : 5 Hybrid systems: Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids	07	20
MODULE : 6 Genetic algorithm based back propogation network- Fuzzy back propagation networks -fuzzy logic controlled genetic algorithms.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 7323	**ENERGY AUDITING AND MANAGEMENT**	**L-T-P: 3-0-0** **Credits: 3** **Year: 2015**

Prerequisite:
Fundamental knowledge in Electrical Machines, Power systems, Utilization of electrical energy

Course Objective:
The main objective of this course is to understand the key concepts behind the energy management on various electrical equipment, economic analysis and load management and energy metering

Syllabus:
Basics of Energy –Transformer and reactors-capacitors and synchronous machines, energy management by cogeneration; Energy management in lighting systems; Metering for energy management-paralleling of current transformers – instrument transformer burdens – multitasking solid state meters, metering location vs requirements, metering techniques and practical examples; Economic analysis –HVAC and energy management – economic justification.

Course Outcome:
Upon completing this course, students are able to apply energy management schemes in electrical systems and perform economic analysis and load management in various engineering industrial applications

References:

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, 'Guide to Energy Management', 5th Edition, The Fairmont Press, Inc., 2006
2. Amit K. Tyagi, 'Handbook on Energy Audits and Management', The Energy and Resources Institute, 2003
3. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
4. IEEE Transactions

Course Plan:

COURSE NO: 07EE 7323 COURSE TITLE: ENERGY AUDITING AND MANAGEMENT (L-T-P : 3-0-0) CREDITS: 3		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
MODULE : 1 Basics of Energy – Need for energy management – energy accounting-energy monitoring, targeting and reporting-energy audit process-	07	15
MODULE : 2 Energy management for electric motors – Transformer and reactors-capacitors and synchronous machines, energy management by cogeneration –forms of cogeneration – feasibility of cogeneration – electrical interconnection	07	15
FIRST INTERNAL TEST		

MODULE : 3 Energy management in lighting systems – task and the working space - light sources – ballasts – lighting controls – optimizing lighting energy – power factor and effect of harmonics, lighting and energy standards	07	15
MODULE : 4 Metering for energy management – units of measure - utility meters – demand meters –paralleling of current transformers – instrument transformer burdens.	07	15
SECOND INTERNAL TEST		
MODULE : 5 Multitasking solid state meters, metering location vs requirements, metering techniques and practical examples.	07	20
MODULE : 6 Economic analysis – economic models- time value of money - utility rate structures – cost of electricity – loss evaluation, load management – demand control techniques – utility monitoring and control system – HVAC and energy management – economic justification.	07	20

Internal Continuous Assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

First Internal Test – 15 Marks
Second Internal Test – 15 Marks
Assignments/Term Paper/Seminar – 10 Marks

End Semester Examination: 60 marks

07EE 7305	**SEMINAR II** **Hours/week:2**	**L-T-P: 0-0-2** **Credits: 2** **Year: 2015**

Prerequisite:

Power Electronics, Electrical drives

Course Objective:

To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that are essential for an engineer.

Seminar:
Individual students are required to choose a topic of their interest from power electronics and drives related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in power electronics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Course Outcome:
Upon completing this course, students are expected to accomplish capability to properly present a technical topic.

Internal Continuous Assessment: 100 marks
i) Marks for the report: 30%
ii) Presentation: 40%
iii) Ability to answer questions on the topic: 30%

07EE 7307	**PROJECT (PHASE1)**	**L-T-P: 0-0-12** **Credits: 6** **Year: 2015**

Prerequisite:
Power Electronics, Electrical drives

Course Objective:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Project (Phase 1):
The project work can be a design project/experimental project and/or computer simulation project on any of the topics in power electronics/drives related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute, subject to the conditions in clause 10 of M. Tech

regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

The student is required to undertake the project phase 1 during the third semester and the same is continued in the 4thsemester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

Course Outcome:

Upon completing this course, students are expected to accomplish

- The ability to identify and articulate a research project in power electronics/drives related topics appropriate for industrial/domestic applications or social requirements
- In-depth understanding of research methods appropriate in power electronics/drives related topics and put into practice
- Ability to apply theoretical and practical tools/techniques to solve real life problems related to industrial/domestic applications or social requirements.
- Ability to contribute as an individual in development of technical projects
- Effective communication skills for presentation of project related activities

Project Evaluation:

Progress evaluation by the Project Supervisor: 20 Marks
Presentation and evaluation by the committee: 30 Marks
Total marks for the Project Phase 1: 50 Marks

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SEMESTER4

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07EE 7302	**PROJECT (PHASE 2)**	**L-T-P: 0-0-21** **Credits: 12** **Year: 2015**

Prerequisite:

Power Electronics, Electrical drives

Course Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Project (Phase 2):

Project phase 2 is a continuation of project phase 1 started in the third semester. There would be two reviews in the fourth semester, First in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a prequalifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation (Viva Voce by external). The external expert must be from outside the cluster.

Project Evaluation:

Project evaluation by the supervisor/s: 30 Marks
Presentation & evaluation by the Committee: 40 Marks
Evaluation by the External expert: 30 Marks
Total marks for the Project Phase 2: 100 Marks