Kerala Technological University

Cluster 4: Kottayam

M. Tech Program in Electrical Engineering

(Power Electronics & Power Systems)

Scheme of Instruction and Syllabus : 2015 Admissions

Compiled By

Rajiv Gandhi Institute of Technology, Kottayam

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Kerala Technological University

(Kottayam Cluster)

M. Tech Program in Power Electronics and Power Systems

Scheme of Instruction

Credit requirements **:** 67 credits (22+19+14+12)
Normal Duration : Regular: 4 semesters; External Registration: 6 semesters;
Maximum duration : Regular: 6 semesters; External Registration: 7 semesters.
Courses: Core Courses: Either 4 or 3 credit courses; Elective courses: All of 3 credits
Allotment of credits and examination scheme:-

Semester 1 (Credits: 22)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits (22)
					Marks	Duration (hrs)	
A	04 EE 6001	Optimization Techniques for Engineering Applications	3-0-0	40	60	3	3
B	04 EE 6301	Power Electronic Devices & Circuits	4-0-0	40	60	3	4
C	04 EE 6403	Computer Applications in Power Systems	3-1-0	40	60	3	4
D	04 EE 6405	Power System Operation and Control	3-0-0	40	60	3	3
E	04 EE 6XXX*	Elective - I	3-0-0	40	60	3	3
	04 GN 6001	Research Methodology	0-2-0	100	0	0	2
	04 EE 6491	Seminar - I	0-0-2	100	0	0	2
	04 EE 6493	Power Systems Simulation Lab	0-0-2	100	0	0	1
		Total	23				22

**See List of Electives-I for slot E*

List of Elective - I Courses

Exam Slot	Course No.	Course Name
E	04 EE 6103	System Theory
E	04 EE 6200	Electric Drive Systems
E	04 EE 6205	Modelling and Analysis of Electrical Machines
E	04 EE 6300	Advanced Power Semiconductor Devices

M. Tech (Power Electronics and Power Systems)

Semester 2 (Credits: 19)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	04 EE 6302	Switched Mode Power Converters	3-1-0	40	60	3	4
B	04 EE 6602	Embedded Controllers for Power Convertors	3-0-0	40	60	3	3
C	04 EE 6418	Power System Dynamics and Stability	3-0-0	40	60	3	3
D	04 EE 6XXX*	Elective - II	3-0-0	40	60	3	3
E	04 EE 6XXX^	Elective - III	3-0-0	40	60	3	3
	04 EE 6492	Mini Project	0-0-4	100	0	0	2
	04 EE 6390	Power Electronics Lab	0-0-2	100	0	0	1
		Total	22				19

**See List of Electives -II for slot D* *^See List of Electives -III for slot E*

List of Elective - II Courses

Exam Slot	Course Code	Course Name
D	04 EE 6002	Computational Intelligent Techniques
D	04 EE 6106	Stochastic Modelling and Applications
D	04 EE 6432	High Voltage DC Transmission
D	04 EE 6506	Energy Conservation and Management

List of Elective - III Courses

Exam Slot	Course Code	Course Name
E	04 EE 6118	Advanced Digital Signal Processing
E	04 EE 6212	Applications of Special Electrical Machines
E	04 EE 6308	Analysis, Design and Grid Integration of Photovoltaic Systems
E	04 EE 6444	FACTS and Power Quality

M. Tech (Power Electronics and Power Systems)

Summer Break

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
NA	04 EE 7490	Industrial Training	0-0-4	NA	NA	NA	Pass /Fail
		Total	4				0

Semester 3 (Credits: 14)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	04 EE 7XXX*	Elective - IV	3-0-0	40	60	3	3
B	04 EE 7XXX^	Elective - V	3-0-0	40	60	3	3
	04 EE 7491	Seminar - II	0-0-2	100	0	0	2
	04 EE 7493	Project (Phase - I)	0-0-12	50	0	0	6
		Total	20				14

**See List of Electives-IV for slot A* *^See List of Electives-V for slot B*

List of Elective - IV Courses

Exam Slot	Course Code	Course Name
A	04 EE 7105	Robotics and Automation
A	04 EE 7303	Power Electronic Applications in Renewable Energy
A	04 EE 7409	Digital Protection of Power Systems
A	04 EE 7503	Renewable Energy Systems

List of Elective - V Courses

Exam Slot	Course Code	Course Name
B	04 EE 7113	Industrial Control Electronics
B	04 EE 7307	Numerical Simulation of Power Electronic Systems
B	04 EE 7421	Electricity Deregulation
B	04 EE 7603	Advanced Controllers for Embedded Systems

M. Tech (Power Electronics and Power Systems)

Semester 4 (Credits: 12)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	External Evaluation Marks		Credits
NA	04 EE 7494	Project (Phase -II)	0-0-21	70	30	NA	12
		Total	21				12

Total: 67

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6001	OPTIMIZATION TECHNIQUES FOR ENGINEERING APPLICATIONS	3-0-0:3	2015

Pre-requisites: NIL

Course Objectives:

To give the Student:-

- A foundation in the theory of optimization methods
- An awareness of the usefulness and limitation of optimization and the framework through which further studies/application in the area can be conducted.
- Practice in some of the well-known optimization techniques and their applicability in a real setting.

Syllabus

Fundamental concepts and overview of Optimization Theory; Linear Programming; Unconstrained Optimization Techniques; Constrained Optimization; Recent Developments in Optimization

Course Outcome:

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

- Understand the basic principles in Optimization Theory
- Formulate Optimization Problems
- Use appropriate Optimization algorithms for solving Engineering Problems
- Be familiar with Recent Developments in Optimization

Text Books:

1. Rao S. S., Engineering Optimization: Theory and Practice, Wiley, New York, 1996.
2. Pierre, D. A., Optimization Theory with Applications, Dover Publications, INC., New York,1969.

References:

1. Fox, R. L., Optimization method for Engineering Design, Addison –Wesley Pub. Co., 1971
2. Hadley, G., Linear Programming, Addison- Wesley Pub. Co., 1963
3. Bazaara M. S., Sherali H.D., Shetty C.M., Non-linear Programming, John Wiley and Sons, 2006.
4. D.E. Goldberg, Genetic Algorithm in Search, Optimization, and Machine Learning, Addison-Wesly, 1989.
5. Glover F., Laguna M., Tabu Search, Kluwer Academic Publishers, 1997.
6. Marco Dorigo, Vittorio Miniezza and Alberto Colorni, “Ant System:Optimization by a colony of Cooperation Agent”, IEEE transaction on system man and Cybernetics-Part B:cybernetics, Volume 26, No 1, pp. 29-41,1996.
7. Shi, Y. Eberhart, R. C., “A Modified Particle Swarm Optimizer”, Proceedings of the IEEE International conference on Evolutionary Computation, Anchorage, AK, pp. 69-73, May 1998.

COURSE PLAN

Course No:	Course Title:	CREDITS
04 EE 6001	OPTIMIZATION TECHNIQUES FOR ENGINEERING APPLICATIONS	3-0-0:3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 Statement and Classification of Optimization Problems, Overview of Optimization Techniques, Standard Form of Linear Programming Problems-Definitions and Theorems.	5	15
MODULE : 2 Simplex Method-Revised Simplex Method-Duality and Dual Simplex Method-Sensitivity Analysis.	8	15
FIRST INTERNAL TEST		
MODULE 3 Necessary and Sufficient Conditions-Search Methods(Unrestricted Fibonacci and Golden)-Interpolation Methods(Quadratic, Cubic and Direct Root Method).	6	15
MODULE 4 Direct Search Methods-Random Search-Pattern Search and Rosen Brock's Hill Climbing Method. Descent Methods-Steepest Descent, Conjugate Gradient, Quasi Newton and DFE Method.	7	15
SECOND INTERNAL TEST		
MODULE 5 Necessary and Sufficient Conditions-Equality and Inequality Constraints-Kuhn-Tucker Conditions. Gradient Projection Method-Cutting Plane Method-Penalty Function Method (Interior and Exterior). Principle of Optimality-Recurrence Relation-Computation Procedure-Continuous Dynamic Programming.	9	20
MODULE 6	7	20

Rosenbrocks Rotating Coordinate Method-Tabu Search-Simulated Annealing. Genetic Algorithm-Particle Swarm Optimization –Ant Colony Optimization-Bees Algorithm.		
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6301	POWER ELECTRONIC DEVICES AND CIRCUITS	4-0-0:4	2015

Pre-requisites:

Course Objectives:

To give the Student:-

- A foundation in the fundamentals of power electronic devices and circuits;
- Ability to design and analytical formulation of various power electronic circuits.

Syllabus

Fundamental concepts and overview of power semiconductor devices; Driver circuits; Study and Analysis phase controlled rectifiers; DC Choppers; Inverters; AC voltage controller and Cyclo converters; Introduction to matrix converters and PWM rectifiers.

Course Outcome:

Students who successfully complete this course will have an ability to understand the fundamental principles and applications of power electronics circuits; Compare and analyze the various types of power converters

Text Books:

1. Mohan, Undeland, Robbins, Power Electronics; Converters, Applications and Design. -3rd edition, John Wiley and Sons, 2003

References:

1. Daniel W. Hart, Power Electronics, Tata McGraw-Hill, 2011
2. L Umanand, Power Electronics Essentials and Applications, Wiley Publications, 2013
3. William Shepherd, Li Zhang, Power Converter Circuits, Marcel Decker, 2004.
4. V. Ramanarayanan, Course Material on Switch Mode Power Conversion, Electrical Department, IISc, Bangalore, 2006.
5. B K Bose, Modern Power Electronics and AC Drives, Pearson Education, 2002.
6. B W Williams, Power Electronics; Principles and Elements, University of Strathclyde Glasgow, 2006.
7. D Grahame Holmes, Thomas A Lipo, Pulse Width Modulation for Power Converters:
8. Principles and Practice, IEEE Press, 2003.
9. M H Rashid (Ed), Power Electronics Handbook: Devices, Circuits and Applications, Academic Press 2010.

COURSE PLAN

COURSE NO:	COURSE TITLE:	CREDITS
04 EE 6301	Power Electronics Devices and Circuits	4-0-0:4

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 - Overview of solid state devices Ideal and Real switches, Power diodes, Power Transistors, Power MOSFETS, IGBTs, Thyristor, GTO, TRIAC- Static and Dynamic Performance, Driver circuits. Turn on; Turn off and Over voltage Snubbers for switching devices.	8	15
MODULE : 2 – Phase controlled Rectifiers Single phase and Three phase converters, half and full wave, fully controlled and semi controlled, Analysis with RL, RLE loads-Performance, Inversion mode of operation, Effect of source inductance-Dual converters-Circulating and Non circulating type	8	15
FIRST INTERNAL TEST		
MODULE : 3 DC Choppers Analysis of DC choppers; two quadrant and four quadrant choppers, PWM control, Forced commutation, Voltage and Current commutated choppers, filter circuits, multiphase chopper.	10	15
MODULE : 4 Inverters Half Bridge and Full Bridge Inverters- Single phase and Three phase. Analysis with delta and star connected RL loads-Harmonics and Voltage control in inverters; PWM principles. Sine triangle modulation, Unipolar and Bipolar modulation, Blanking time and maximum attainable DC Voltage switch utilization, output filter design, Introduction to Multilevel Inverters.	10	15
SECOND INTERNAL TEST		
MODULE : 5 - AC voltage and Cyclo controllers Single Phase and Three phase AC Voltage Controllers-Principle operation-analysis with R and RL loads, Thyristor Controlled Reactor, Cycloconverters-	10	20

circulating and non-circulating type-Analysis with R and RL loads.		
MODULE : 6 - Introduction to Matrix converters and PWM rectifiers Introduction to Matrix Converters- Matrix converter switches and circuits- Control strategies, Single phase and three phase PWM rectifiers -Basic topologies - Control principles.	10	20
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	Credits	YEAR
04 EE 6403	COMPUTER APPLICATIONS IN POWER SYSTEMS	3-1-0:4	2015

Pre-requisites: Nil

Course Objectives:

1. To develop an idea about graph theory and building algorithm.
2. To identify and represent various power system components.
3. Learn to analyze power systems with different load flow studies and short circuit studies.

Syllabus

Elementary linear graph theory; Building algorithm for Bus impedance matrix; Load Flow Studies; Three phase Load Flow; Representation of power system components; Incorporation of FACTS devices in Load Flow; Types of faults-Short circuit study of a large power system; Unsymmetrical Faults; Short circuit calculations using Z bus.

Course Outcome:

The student will able to apply computational techniques to analyse and solve load flow studies and fault calculations.

Text Books:

1. Singh L P, “Advanced Power Systems Analysis and Dynamics”, New Age Intl. Publishers, 1983.
2. Stagg and EL Abiad , “Computer Methods in Power system Analysis”, McGraw Hill, 1968.
3. Kusic G L, “Computer Aided Power System Analysis”, Prentice Hall, 1986.

References:

1. Hadi Saadat, “Power System Analysis”, McGraw Hill-1999.
2. Arriliga J and Watson N R, “Computer Modeling of Electrical Power Systems”, Wiley, 2001.
3. Nagrath J J and Kothari D P, “Modern Power system Analysis”, Tata McGraw Hill, 1980.

COURSE PLAN

COURSE NO:	COURSE TITLE:	CREDITS	
04 EE 6403	COMPUTER APPLICATIONS IN POWER SYSTEMS	3-1-0:4	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE : 1 **Elementary linear graph theory:** Incidence and Network matrices- Development of network matrices from Graph theoretic approach. Building algorithm for Bus impedance matrix. Modification of ZBus matrix due to changes in primitive network.		10	15
MODULE : 2 **Load Flow Studies:** Overview of Gauss- Seidel and Newton - Raphson Methods- Decoupled Newton Load Flow. Fast Decoupled Load Flow- AC/DC load flow- Three phase Load Flow.		10	15
FIRST INTERNAL TEST			
MODULE : 3 Triangular factorization – Optimal ordering – Optimal load flow in power Systems. Representation of Synchronous machine, transmission system, three phase power network.		8	15
MODULE : 4 Incorporation of FACTS devices in Load Flow: Static Tap Changing, Phase Shifting (PS), Static Var Compensator (SVC), Thyristor Controlled Series Compensator (TCSC) and Unified power Flow Controller.		8	15
SECOND INTERNAL TEST			
MODULE : 5 Types of faults-Short circuit study of a large power system-Algorithm for calculating system conditions after fault-Three phase short circuit fault.		10	20
MODULE : 6 Unsymmetrical Faults: Three phase to ground, double line to ground, line to line and single line to ground fault. Short circuit calculations using Z bus –Short circuit calculations for balanced and unbalanced three phase network using Z-bus.		10	20

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
04 EE 6405	POWER SYSTEM OPERATION AND CONTROL	3-0-0-3	2015

Pre-requisites: - NIL

Course Objectives:

- To analyze the coordination of different generating stations, identify the objective function and its optimization by different methods.
- To analyze different kinds of production cost, sample computation with different cases and security control functions with corrective controls including islanding.
- To analyze least square state estimation, its sequential form of solution and static State estimation of power system by different algorithms.
- To develop basic concepts of energy control center based on SCADA-National, Regional and state level.

Syllabus

Characteristics of Power Generation units, problems solving, Dynamic and Linear programming. Optimization Techniques. Production cost models, Interchange of power and energy, Security constraints and Contingency analysis. State Estimation. Energy Management system and Supervisory control and data acquisition system (SCADA)

Course Outcome:

- Candidate should be able to understand the coordination of different generating stations, identify the objective function and its optimization by different methods.
- Candidate should be able to understand different kinds of production cost, sample computation with different cases and security control functions with corrective controls including islanding.
- Candidate should be able to understand least square estimation, its sequential form of solution and static State estimation of power system by different algorithms.
- Candidate should be able to understand energy control center based on SCADA-National, Regional and state level.

References:

1. Allen J Wood, Bruce F Wollenberg, “Power Generation, Operation and Control”, John Wiley& Sons, New York, II Edition, 1984.
2. Mahalanabis AK, Kothari DP and Ahson SI, “Computer Aided Power System Analysis and Control”, McGraw Hill Publishing Ltd., 1984.
3. Kundur P, “Power System Stability and Control”, McGraw Hill, 2006
4. http://nptel.ac.in/courses/108101040/

COURSE PLAN

COURSE NO:	Course Title:	CREDITS
04 EE 6405	Power System Operation And Control	3-0-0:3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 **Characteristics of power generation units**, Hydro thermal co-ordination-Problem definition and mathematical model of long and short term problems. Dynamic programming – Hydro thermal system with pumped hydro units – Solution of hydro thermal scheduling using Linear programming.	7	15
MODULE : 2 **System optimization** - strategy for two generator system – generalized strategies – effect of Transmission losses - Sensitivity of the objective function- Formulation of optimal power flow solution by Gradient method-Newton's method	7	15
FIRST INTERNAL TEST		
MODULE : 3 **Production cost programs**:-Uses and types of production cost programs, probabilistic production cost programs. Sample computation -No forced outages – Forced outages included – interchange of power and energy and its types.	7	15
MODULE : 4 **Power system security**:- System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls (preventive, emergency, and restorative) – Islanding scheme.	7	15
SECOND INTERNAL TEST		
MODULE : 5 **State estimation**: Least square estimation – Basic solution . Sequential form of solution. Static State estimation of power system by different algorithms – Tracking state estimation of power system.	7	20

Computer consideration – External equivalencing – Treatment of bad data.		
MODULE : 6 Energy control center – Various levels – National – Regional and state level SCADA system	7	20
END SEMESTER EXAM		

COURSE No.	COURSE NAME	L-T-P: C	YEAR
04 EE 6103	SYSTEM THEORY	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To give students

- A foundation in state space representation of systems.
- An ability to design observers.
- The ability to analyse the stability of linear and non linear systems.
- An introduction to the basic concepts of optimal control;

Syllabus

State space analysis and design of linear systems, Design of observers, Stability analysis using lyapnov stability criterion, Introduction to Optimal Control and dynamic programming

Course Outcome:

At the end of the course students will be able to

1. Use state space method to represent and analyse a system
2. Analyse the stability of a nonlinear system.
3. Describe the basic concepts of optimal control.

References:

1. Benjamin C. Kuo, Control Systems, Tata McGraw-Hill, 2002.
2. M. Gopal, Modern Control System Theory, Tata McGraw-Hill.
3. Thomas Kailath, Linear System, Prentice Hall Inc., Eaglewood Clis, NJ, 1998
4. D. E. Kirk, Optimal Control Theory, Prentice-Hall. 1970

COURSE PLAN

COURSE NO.	COURSE TITLE	Credits	
04 EE 6103	SYSTEM THEORY	3-0-0: 3	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE : 1 State Space Analysis and Design -Analysis of stabilization by pole cancellation - reachability and constructability - stabilizability - controllability - observability -grammians. - Linear state variable feedback for SISO systems, Analysis of stabilization by output feedback-modal controllablility-formulae for feedback gain		6	15
MODULE: 2 Significance of controllable Canonical form-Ackermann's formula - feedback gains in terms of Eigen values - Mayne-Murdoch formula state feedback and zeros of the transfer function - non controllable realizations and stabilizability -controllable and uncontrollable modes.		7	15
FIRST INTERNAL TEST			
MODULE: 3 Observers -Asymptotic observers for state measurement-open loop observer-closed loop observer formulae for observer gain - implementation of the observer - full order and reduced order observers - separation principle - combined observer -controller optimality criterion for choosing observer poles.		7	15
MODULE: 4 Observer Design -Direct transfer function design procedures- Design using polynomial equations - Direct analysis of the Diophantine equation.		6	15
SECOND INTERNAL TEST			
MODULE: 5 Lyapunov Stability - definition of stability, asymptotic stability and instability - Lyapunov's second method. Lyapunovs stability analysis of LTI continuous time and discrete time systems , stability analysis of non linear system - Krasovskis theorem - variable gradient method.		8	20
MODULE: 6 Introduction to Optimal Control- Pontryagin's maximum principle- theory-		8	20

application to minimum time, energy and control effort problems, terminal control problem. Dynamic programming- Bellman's principle of optimality, multistage decision processes. Linear regulator problem: matrix Riccati equation and its solution.		
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6200	ELECTRIC DRIVE SYSTEMS	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To understand the characteristics of important types of electrical machines used in industry and the loads they drive, the speed control using solid state drives for energy efficient operation and the power electronic converters and control schemes required for realizing the drive systems.

Syllabus

Electric Drive: Components, its dynamics. Components of load torques ,types of load, four quadrant operation, steady state stability, load equalization, classes of motor duty ,motor rating ;DC motor drives: dc motors and its performance, types of braking, transient analysis of SEDC motor – converter control of DC motors, analysis of converter controlled SEDC and series motor drives ,dual converter, chopper controlled drives-analysis, closed loop control, transfer function model of self and SEDC motor, simulation study; Induction motor drive: stator voltage control , stator frequency control, slip control, harmonics, PWM inverter drives, rotor resistance control, slip power recovery schemes; Synchronous motor drives: speed control, principle, adjustable frequency operation-true synchronous mode and self- controlled modes of operation .

Course Outcome:

The students will be able to

- Gain knowledge about electric drive in detail and to understand the speed control techniques implemented in electric drives using solid state power electronics.
- Understand the closed loop control schemes applied in electric drives.

Text Books:

1. R. Krishnan, '*Electrical Motor Drives*', PHI-2003
2. G.K.Dubey, '*Fundamentals of Electrical Drives*', Narosa- 1995
3. Modern Power Electronics and AC drives by Bimal .K.Bose.

References:

1. S.A. Nasar, Boldea , 'Electrical Drives', Second Edition, CRC Press – 2006
2. M. A. ElSharkawi , 'Fundamentals of Electrical Drives' , Thomson Learning -2000
3. W. Leohnard, 'Control of Electric Drives',-Springer- 2001
4. Murphy and Turnbull, 'Power Electronic Control of AC motors', Pergamon Press
5. Vedam Subrahmaniam, 'Electric Drives', TMH-1994

Course No:	Course Title	CREDITS	
04 EE 6200	Electric Drive systems	3-0-0:3	
MODULES		Contact hours	Sem. Exam Marks;%
MODULE : 1 Components of electrical Drives – electric machines, power converter, controllers - dynamics of electric drive - torque equation - equivalent values of drive parameters- components of load torques types of load, Four quadrant operation of a motor — steady state stability, Load equalization – classes of motor duty- determination of motor rating		8	15
MODULE : 2 DC motor drives – dc motors & their performance (shunt, series, compound, permanent magnet motor, universal motor, dc servomotor) – braking – regenerative, dynamic braking, plugging, Transient analysis of separately excited motor, Converter control of dc motors, analysis of separately excited & series motor with 1-phase and 3-phase converters, dual converter –analysis of chopper controlled dc drive.		10	15
FIRST INTERNAL TEST			
MODULE : 3 Converter ratings and closed loop control – transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feedback elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive		6	15
MODULE : 4 Induction motor drives – stator voltage control of induction motor – torque-slip characteristics – operation with different types of loads – operation with unbalanced source voltages and single phasing – analysis of induction motor fed from non-sinusoidal voltage supply.		5	15
SECOND INTERNAL TEST			

MODULE : 5 Induction motor drives : Stator frequency control – variable frequency operation – V/f control, controlled current and controlled slip operation; Effect of harmonics and control of harmonics – PWM inverter drives – multi-quadrant drives – rotor resistance control – slip torque characteristic – torque equations, constant torque operation; Slip power recovery scheme – torque equation – torque slip characteristics – power factor – methods of improving power factor – limited sub synchronous speed operation – super synchronous speed operation.	8	20
MODULE : 6 Synchronous motor drives – speed control of synchronous motors – adjustable frequency operation of synchronous motors – principles of synchronous motor control – voltage source inverter drive with open loop control. Self-controlled synchronous motor with electronic commutation – self-controlled synchronous motor drive using load commutated thyristor inverter.	5	20
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6205	Modelling and Analysis of Electrical Machines	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

1. An idea about the representation of electrical machines and its transformation using different methods.
2. A concept of the generalized machine theory and its application in dc generators and motors
3. A concept of the generalized machine theory application in synchronous generator and transient analysis under different conditions
4. An analysis of the generalized model of three phase induction motor and its speed control

Syllabus

Unified approach to the analysis of electrical machine-basic two-pole machine- Kron's primitive machine- transformation from 3-phase to 2-phase- Park's transformation, DC machines, Polyphase synchronous machines, Induction machines- steady state and transient analysis,

Course Outcome:

Upon the completion of this course, students will

1. Get an idea of the representation of electrical machines and its transformation using different methods.
2. Get the concept of the generalized machine theory and its application in dc generators and motors.
3. Get the concept of the generalized machine theory and its application in dc generators and motors
4. Be able to analyse the generalized model of three phase induction motor and its speed control

References:

1. P.S. Bhimbra, '*Generalized Theory of Electrical Machines'*, Khanna Publishers
   Adkins and Harley, '*General Theory of AC Machines'*
2. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans, *'Electric Machinery'*, ,Tata McGraw Hill
3. Adkins and Harley, '*General Theory of AC Machines'*
4. Bimal K Bose, '*Modern Power Electronics & AC Drives'*, Pearson Education
5. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff'*Analysis of Electrical Machines and Drive Systems'*, John Wiley
6. NPTEL : http://nptel.ac.in/courses/108106023/

COURSE PLAN

COURSE NO:	Course Title	CREDITS	
04 EE 6205	Modelling and Analysis of Electrical Machines	3-0-0: 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, Park's transformation for 3-phase synchronous and induction machines.		8	15
MODULE : 2 DC machines : application of generalized theory to separately excited, shunt, series and compound machines, Sudden short circuit of separately excited generator, separately excited dc motor, steady state and transient analysis, Transfer functions of separately excited dc generator & motor		8	15
FIRST INTERNAL TEST			
MODULE : 3 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**.**		8	15
MODULE : 4 Induction machines: 3-phase induction machine ,generalized model, Voltage equation , steady state analysis , equivalent circuit , torque-slip characteristics, Effect of voltage and frequency variations.		8	15
SECOND INTERNAL TEST			
MODULE : 5 Electric transients in induction machines, speed control of induction motor, Introduction to vector control, applications in speed control of		5	20

induction machine.		
MODULE : 6 Single phase induction motor, generalized model, Voltage and torque equations, steady state analysis.	5	20
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6300	ADVANCED POWER SEMICONDUCTOR DEVICES	3-0-0: 3	2015

Pre-requisites: NIL

Course Objectives:

To give the Student:-

- The fundamentals of static and dynamic characteristics of current controlled & voltage controlled power semiconductor devices
- Ability to realize appropriate solid state device for various power electronic applications

Syllabus

Power switching devices overview; Attributes of an ideal switch; Power handling capability, Construction, Device Physics, static and dynamic characteristics of Power diodes, BJT, Thyristors, Power MOSFETs and IGBTs; Basics of GTO, MCT, FCT, RCT and IGCT; Isolation, snubber circuits, Gate drives circuitry for power devices; Thermal Protection.

Course Outcome:

Students who successfully complete this course will have an ability to understand various power electronics devices such as SCR, TRIAC, DIAC, IGBT, GTO etc. Also able to realize appropriate Power Electronics devices in Choppers, Inverters, Converters to create an optimum design.

Text Books:

1. Mohan, Undeland, Robbins, Power Electronics; Converters, Applications and Design. -3rd edition, John Wiley and Sons, 2003
2. Power Electronics ,P. C. Sen

References:

1. Kassakian J G et al, “Principles of Power Electronics”, Addison Wesley, 1991.
2. B W Williams, Principles and Elements of Power Electronics, University of Strathclyde,Glasgow, 2006.
3. M D Singh, K B Khanchandani, “Power Electronics”, Tata McGraw Hill, 2001.
4. Daniel W. Hart, Power Electronics, Tata McGraw-Hill, 2011
5. M H Rashid (Ed), Power Electronics Handbook: Devices, Circuits and Applications, Academic Press 2010.

COURSE PLAN

COURSE NO.	COURSE TITLE	CREDITS
04 EE 6300	ADVANCED POWER SEMICONDUCTOR DEVICES	3-0-0:3

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.	7	15
MODULE : 2 Power diodes - Types, forward and reverse characteristics, switching characteristics – rating. Shottky Diode BJT's – Construction, Device Physics, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown, steady state and dynamic models of BJT, Power Darlington	7	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 Thyristor	8	15
MODULE : 4 Power MOSFETs and IGBTs – 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	7	15
SECOND INTERNAL TEST		
MODULE : 5 Necessity of isolation, pulse transformer, opto-coupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. Over voltage,	7	20

over current and gate protections; Design of snubbers.		
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	6	20
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
04 GN 6001	RESEARCH METHODOLOGY	0-2-0:2	2015

Pre-requisites:

Course Objectives:

To enable the students:

- To get introduced to research philosophy and processes in general.
- To formulate the research problem and prepare research plan
- To apply various numerical /quantitative techniques for data analysis
- To communicate the research findings effectively

Syllabus

Introduction to the Concepts of Research Methodology, Research Proposals, Research Design, Data Collection and Analysis, Quantitative Techniques and Mathematical Modeling, Report Writing.

Course Outcome:

Students who successfully complete this course would learn the fundamental concepts of Research Methodology, apply the basic aspects of the Research methodology to formulate a research problem and its plan. They would also be able to deploy numerical/quantitative techniques for data analysis. They would be equipped with good technical writing and presentation skills.

Text Books:

1. Research Methodology: Methods and Techniques', by Dr. C. R. Kothari, New Age International Publisher, 2004
2. Research Methodology: A Step by Step Guide for Beginners' by Ranjit Kumar, SAGE Publications Ltd; Third Edition

References:

1. Research Methodology: An Introduction for Science & Engineering Students', by Stuart Melville and Wayne Goddard, Juta and Company Ltd, 2004
2. Research Methodology: An Introduction' by Wayne Goddard and Stuart Melville, Juta and Company Ltd, 2004
3. Research Methodology, G.C. Ramamurthy, Dream Tech Press, New Delhi
4. Management Research Methodology' by K. N. Krishnaswamy et al, Pearson Education

COURSE CODE:	COURSE TITLE	CREDITS
04 GN 6001	RESEARCH METHODOLOGY	0-2-0: 2

MODULES	Contact Hours	
MODULE : 1 Introduction to Research Methodology: Concepts of Research, Meaning and 2 Objectives of Research, Research Process, Types of Research, Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical	5	
MODULE :2 Criteria of Good Research, Research Problem, Selection of a problem, Techniques involved in definition of a problem, Research Proposals – Types, contents, Ethical aspects, IPR issues like patenting, copyrights.	4	
INTERNAL TEST 1 (MODULE 1 & 2)		
MODULE: 3 **Research Design :** Meaning, Need and Types of research design, Literature Survey and Review, Identifying gap areas from literature review, Research Design Process, Sampling fundamentals, Measurement and scaling techniques, Data Collection – concept, types and methods, Design of Experiments.	5	
MODULE 4: **Quantitative Techniques:** Probability distributions, Fundamentals of Statistical analysis, Data Analysis with Statistical Packages, Multivariate methods, Concepts of correlation and regression - Fundamentals of time series analysis and spectral analysis.	5	
INTERNAL TEST 2 (MODULE 3 & 4)		
MODULE: 5 **Report Writing:** Principles of Thesis Writing, Guidelines for writing reports & papers, Methods of giving references and appendices, Reproduction of published material, Plagiarism, Citation and acknowledgement.	5	
MODULE: 6 Documentation and presentation tools – LaTeX, Office with basic presentations skills, Use of Internet and advanced search techniques.	4	

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
04 EE 6493	POWER SYSTEM SIMULATION LAB	0-0-2-1	2015

Pre-requisites:

Course Objectives:

- To carry out experimental/simulation studies on Power System problems.

Syllabus

1. Formation of Bus Admittance Matrix and Bus Impedance Matrix using MATLAB
2. Formation of Jacobian for a system not exceeding 4 buses (no PV Buses) in polar co-ordinates using MATLAB/PSS/E
3. Sequence Components of Power System Network with Single Line to Ground Fault using MATLAB SIMULINK
4. Modelling of Single Machine Power System using SIMULINK
5. Short circuit studies of power system using ETAP/PSCAD/PSS/E
6. Power System dynamic studies using PSS/E
7. Load flow analysis using Gauss Seidel Method, Newton Raphson Method
8. Fast De-coupled for both PQ and PV Buses using ETAP/PSCAD
9. DC Load flow analysis using MATLAB.
10. Simulation & Analysis of magnetic circuits using SIMULINK.
11. Simulation and measurements of Three Phase circuits using SIMULINK.
12. Modelling of Automatic Generation Control for a two area network using SIMULINK/PSS/E.
13. To determine
    a. Swing curve
    b. Critical clearing time for a single machine connected to infinite bus through a pair of identical transmission lines, three phase fault on one of the lines for variation of inertia constant/line parameters/fault locations/clearing time/pre fault electrical output using MATLAB/C-program/PSS/E
14. Modelling and Simulation of Non Conventional Energy Systems using MATLAB

Optional Experiments

1. Analysis of Static Var Compensators.
2. Analysis of STATCOM.
3. Load forecasting using ANN Tool/ETAP
4. Power Quality studies using PSCAD/PSS/E
5. Substation layout using AutoCAD Electrical
6. Transient Stability Analysis and formation of Swing Curves using MATLAB/SIMULINK
7. Modelling of Surge Arresters using PSCAD
8. Modelling of FACTS devices using SIMULINK
9. Transformer Tests using SIMULINK /ETAP
10. Fault Analysis of a synchronous Generator using PSCAD
11. Execute optimal power flow problem using ETAP/PSCAD.
12. Analysis of voltage stability of a SLIB (Single Load Infinite Bus) system while delivering maximum power using MATLAB/PSS-E.
13. Continuation Power Flow (CPF) analysis using MATLAB

(At least 10 experiments in the list are to be conducted in the laboratory. Additional experiments and simulation assignments can also be given by the department)

Course Outcome:

- The student will be able to analyse Power System Problems.

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6302	SWITCHED MODE POWER CONVERTERS	4-0-0: 4	2015

Pre-requisites: [04 EE 6303] Power Electronics Devices and Circuits

Course Objectives:

To give the Student:-

- A comprehensive study of various topologies of switched mode power converters;
- Ability to design and develop power electronic system control.

Syllabus

DC-DC non-isolated switched mode converters; Buck, Boost, Buck-Boost converters, CUK and SEPIC; State space modelling; Switched Mode Power Converters, Fly back, Forward Converter, Push-Pull, Half and Full Bridge Converters; Voltage and Current control methods for converters; Resonant Converters, ZVS and ZCS; Switched Mode inverters, PWM techniques, Space Vector Modulation; Introduction to Multilevel inverters.

Course Outcome:

Students who successfully complete this course will have an ability to understand various topologies of switched mode power converters; Design and develop power electronic system control.

Text Books:

1. Mohan, Undeland, Robbins, Power Electronics; Converters, Applications and Design. -3rd edition, John Wiley and Sons, 2003
2. Abraham I Pressman, Switching Power Supply Design. McGrawHill

References:

1. Daniel M Mitchell, DC-DC Switching Regulator Analysis. McGraHill
2. Daniel W. Hart, Power Electronics, Tata McGraw-Hill, 2011
3. William Shepherd, Li Zhang, Power Converter Circuits, Marcel Decker, 2004.
4. Prof. V. Ramanarayanan, Course Material on Switch Mode Power Conversion, Electrical Department, IISc, Bangalore, 2006.
5. B K Bose, Modern Power Electronics and AC Drives, Pearson Education, 2002.
6. B W Williams, Power Electronics; Principles and Elements, University of Strathclyde Glasgow, 2006.
7. D Grahame Holmes, Thomas A Lipo, Pulse Width Modulation for Power Converters:
8. M H Rashid (Ed), Power Electronics Handbook: Devices, Circuits and Applications, Academic Press 2010.

COURSE PLAN

COURSE NO:	Course Title:	CREDITS
04 EE 6302	SWITCHED MODE POWER CONVERTERS	3-1-0: 4

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 DC-DC switched mode converters, DC steady state principles, Buck, Boost, Buck-Boost converters, CUK- Basic Operation with Waveforms (Continuous and discontinuous operation)- Voltage and current relationship switching stresses - switching and conduction losses - optimum switching frequency – Output voltage ripple; State space modeling	12	15
MODULE : 2 Push-Pull and Forward Converter Topologies - Basic Operation. Waveforms - Flux Imbalance Problem and Solutions - Transformer Design -Output Filter Design -Switching Stresses and Losses -Forward Converter Magnetics --Voltage Mode Control	8	15
FIRST INTERNAL TEST		
MODULE : 3 Half and Full Bridge Converters; Basic Operation and Waveforms-Magnetics, Output Filter, Flux Imbalance, Switching Stresses and Losses, Power Limits, Voltage Mode Control, Flyback Converter; discontinuous mode operation, waveforms, Control, Magnetics - Switching Stresses and Losses, Disadvantages - Continuous Mode Operation, Waveforms, Control, Design Relations.	8	15
MODULE : 4 Study - Voltage and current Mode Control of SMPS, Current Mode Control Advantages, Current Mode vs. Voltage Mode, Tolerance Band control, Fixed and variable Frequency control	8	15
SECOND INTERNAL TEST		

MODULE : 5 Resonant Converters- Classification, Basic Resonant Circuit Concepts, Load Resonant Converter, Resonant Switch Converter, Zero Voltage Switching - Zero current switching, ZVS Clamped Voltage Topologies, Resonant dc-link inverters.	10	20
MODULE : 6 Switched Mode Inverters; PWM Techniques – Natural Sampled PWM (Sinusoidal PWM) – Regular Sampled PWM, Space Vector Modulation; Multilevel inverters – Concepts, Types; Diode clamped, Flying capacitor, Cascaded – Principle of operation, comparison, PWM techniques.	10	20
END SEMESTER EXAM		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 6602	EMBEDDED CONTROLLERS FOR POWER CONVERTERS	3-0-0-3	2015

Pre-requisites:

Course Objectives:

To give the Student:-

- A foundation in the fundamentals of PIC 18F4580 controller based system design;
- Design and develop various power converter circuits using embedded system;
- Introduction to the advanced TMS320F2407 DSP controller for developing embedded system.

Syllabus

PIC 18F4580 - Architecture, Programming, fundamental of embedded system design; Typical functions of PIC18F4580 microcontrollers in power electronic systems; Use of microcontroller in power converters, control; Introduction to TMS 320LF2407, Architecture details, basic programming

Course Outcome:

The students who successfully complete this course will have an ability develop embedded controllers for power electronic based system.

Text Books:

1. Muhammad Ali Mazidi, Rolind D. Mckinlay, Danny Causey. " PIC microcontroller and Embedded Systems – using assembly and C for PIC18" 13th impression, Pearson, 2013
2. Han Way Huang, "PIC Microcontroller, An introduction to software and hardware interfacing", Delmar – 2007
3. George Terzakis, Introduction to C Programming With the TMS320LF2407A DSP Controller, Create Space Independent Publishing Platform, February 2011

References:

1. Richard H. Barnett, Larry O'Cull, Sarah Alison Cox, Embedded C Programming and the Microchip PIC, Volume 1, Thomson Delmar Leaning
2. Kenjo.T, "Power electronics for microprocessor Age", Clarendon press, Oxford, 1999
3. GourabSen Gupta, Subhas Chandra Mukhopadhyay, "Embedded Microcontroller Interfacing, Designing Integrated Projects", Springer, 2010
4. Harprit Singh Sandhu, Making PIC Microcontroller Instruments and Controllers, McGraw-Hill Professional , 2009
5. Harprit Singh Sandhu, Running Small Motors with PIC Microcontrollers, McGraw-Hill Professional, 2009

6. Sen M. Kuo, Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, And Applications, Pearson Education , 2009
7. Phil Lapsley, Jeff Bier, Amit Shoham, Edward A. Lee, DSP Processor fundamentals: Architectures and Features , IEEE Press -1997 , Wiley India Pvt Ltd
8. H.A. Toliyat, S.Campbell, DSP based Electro Mechanical Motion Control, CRC Press-2004
9. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson/Brooks/Cole, 2004
10. PIC18F4580 Data Sheet – DS39637D, Microchip Technology Inc., 2009
11. TMS320LF2407 Data Sheet , Texas Instrument, September 2003

COURSE PLAN

COURSE NO:	Course Title:	CREDITS	
04 EE 6602	Embedded Controllers for Power Converters	3-0-0:3	
MODULES		Contact hours	Sem. Exam Marks; %
MODULE : 1 - Microchip PIC 18F4580: Architecture of PIC 18F4580 microcontroller, PIC memory organization, Interrupt structure, Timers / Counters, Capture / Compare / PWM modules, Master Synchronous Serial Port (MSSP) module, USART A / D Converter module, Comparator module.		10	15
MODULE : 2 – PIC 18F Programming*:* Different addressing modes. Instruction set, General Programming – .LST and .HEX files generation for applications using MpLab IDE		6	15
FIRST INTERNAL TEST			
MODULE : 3 **Typical functions of PIC18F4580 microcontrollers in power electronic systems:** Measurement of voltage, current, speed, power and power factor, Frequency measurement, PWM implementation; Interfacing LCD Display, Keyboard Interfacing		6	15
MODULE: 4 - Use of PIC18F4580 microcontroller in power converters: Overview of Zero Crossing Detectors, Generation of gating signals for Converters, Inverters and chopper circuit, Control of AC/DC electric drives.		6	15
SECOND INTERNAL TEST			
MODULE: 5 - PIC18F4580 based system control: Implementation of PI, PID controller, Power quality/power factor correction, Solar Power Conditioning (MPPT) - Miscellaneous examples.		6	20
MODULE : 6 - Introduction to TMS 320LF2407: Introduction to DSP architecture- computational building blocks - Address generation unit, Program control and sequencing- Parallelism, Pipelining Architecture of TMS320LF2407 - Addressing modes- I/O functionality, Interrupt. ADC, PWM, Event managers- Elementary Assembly Language Programming.		8	20
END SEMESTER EXAM			

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 6418	POWER SYSTEM DYNAMICS AND STABILITY	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

- To understand and work with the modelling of main power system elements like, synchronous machines, excitation systems, prime mover and its governing mechanism and power system load.
- To understand and work with the linearization of power system elements and its small signal stability analysis.
- To understand and work with power system stabilizer, voltage stability and its analysis
- To understand and work with different power system stability enhancements.

Syllabus

Fundamental concepts and overview; Types of Stability; Mathematical description of a synchronous Machine. Modeling of other power system components-Excitation and Turbine and Load Modeling. Small signal Stability analysis, Power system stabilizer and its Multi Machine system. Voltage stability aspects and its analysis including continuation power flow analysis. Enhancement of stability-Transient and its techniques, small signal using PSS-Supplementary control of Static VAR Compensators.

Course Outcome:

- Candidate should be able to work with the modelling of main power system elements like, synchronous machines, excitation systems, prime mover and its governing mechanism and power system load.
- Candidate should be able to work with the linearization of power system elements and its small signal stability analysis.
- Candidate should be able to work with power system stabilizer, voltage stability and its analysis
- Candidate should be able to work with different power system stability enhancements.

Text Books:

1. Kundur P, “Power System Stability and Control”, TMH
2. Anderson and Fouad, “Power System Control and Stability”, Galgotia Publications, Compensation 1981.

References:

1. Ramanujam R, “Power System Dynamics- Analysis & Simulation”, PHI learning Private Limited.
2. Padiyar K R, “Power System Dynamics”, 2nd Edition, B.S. Publishers, 2003.
3. Sauer P W & Pai M A,” Power System Dynamics and Stability”, Pearson, 2003.
4. Olle I Elgerd, “Electric Energy Systems Theory an Introduction”, 2nd Edition, McGraw-Hill, 1983.
5. Kimbark E W, “Power System Stability”, McGraw-Hill Inc., 1994, Wiley & IEEE Press, 1995.
6. Yao-Nan-Yu, “Electric Power Systems Dynamics”, Academic Press, 1983.

COURSE PLAN

COURSE NO:	Course Title:	CREDITS
04 EE 6418	Power System Dynamics and Stability	3-0-0:3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 Power System Stability: Structure of power System and its controls. Concept of Power system stability-Types of stability.	2	15
MODULE : 2 Modelling Power System Components: Synchronous machine modelling: Synchronous Machine Mathematical Description of a Synchronous Machine - Basic equations of a synchronous machine. dq0 Transformation- per unit representation- equivalent circuits for direct and quadrature axes. Excitation System Modelling -Static Excitation System only- Hydraulic turbine modelling- Load modelling concepts.	10	15
FIRST INTERNAL TEST		
MODULE : 3 Small Signal Analysis Fundamental Concepts of Stability of Dynamic Systems: State-space representation- stability of dynamic system - Linearization, Eigen properties of the state matrix – eigen value and stability. Small Signal Stability of Single Machine Infinite Bus (SMIB) System. Swing Equation, H-constant calculation - Representation in system studies-	7	15
MODULE : 4 Effects of K constants on small signal stability: Generator represented by the classical model. Effect of field flux variation on system stability-Effects of Excitation System - Block diagram representation with exciter and AVR- Effect of AVR on synchronizing and damping torque components.	8	15
SECOND INTERNAL TEST		
MODULE : 5 Voltage Stability: Voltage stability – generation aspects - transmission system aspects – load aspects. PV curve – QV curve – PQ curve – analysis with static loads. Load ability limit - sensitivity analysis-continuation power flow	7	20

analysis.		
MODULE : 6 Enhancement of Stability Methods of improving stability – transient stability enhancement – different techniques. Small Signal Stability Enhancement: Using Power System Stabilizers-Supplementary control of Static VAR Compensators.	8	20
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6002	COMPUTATIONAL INTELLIGENT TECHNIQUES	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To initiate the students into the pervasive field of soft computing.
- To understand the nuances of conventional mathematical approaches and unorthodox soft computing methods in vogue.
- To be able to apply some important soft computing methods to different facets of problems encountered in Electrical Engineering.

Syllabus

Introduction to Soft computing, Fuzzy Sets, Set operations, Member Functions, Fuzzy Rules, reasoning and inference Systems, Mamdani, Sugeno and Tsukamoto Fuzzy Models, Genetic Algorithms, Derivative-based Optimization methods, Derivative-free methods, Neural Networks –Introduction, Supervised Learning Neural Networks, Radial Basis Function Networks, Unsupervised networks, Competitive Learning Networks, Hebbian Learning, Applications

Course Outcome:

The student will be in a position to tackle problems in the field of Electrical Engineering, Power Electronics and Power Systems with a deeper insight of alternate solutions extracted from Soft Computing techniques.

Text Books:

1. S. R. Jang, C. T. Sun and E. Mizutani, 'Neuro-Fuzzy and Soft Computing', PHI, Pearson Education 2004.
2. Davis E. Goldberg, 'Genetic Algorithms: Search, Optimization and Machine Learning' Addison Wesley, N.Y., 1989.

References:

1. S.Rajasekaran and G.A.V.Pai, 'Neural Networks, Fuzzy Logic and Genetic Algorithms',PHI, 2003.
2. R.Eberhart, P.Simpson and R.Dobbins, 'Computational Intelligence PC Tools', AP Professional, Boston 1996.

COURSE PLAN

Course No:	Course Title:	CREDITS
04 EE 6002	Computational Intelligent Techniques	3-0-0:3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 Soft Computing terminology, Introduction to Fuzzy Sets, Set theoretic operations, Member Function Formulation and parameterization, Fuzzy rules and reasoning, Extension principle and fuzzy relations, Fuzzy If-Then rules, Fuzzy reasoning	8	15
MODULE : 2 Fuzzy inference systems, Mamdani fuzzy model, Sugeno fuzzy models, Tsukamoto fuzzy model, Input space partitioning and fuzzy modeling	6	15
FIRST INTERNAL TEST		
MODULE : 3 Derivative-based optimization, Descent methods, method of steepest descent, Classical Newton's Method, step size determination, Derivative-free optimization	6	15
MODULE : 4 Genetic Algorithms, Simulated Annealing, Random Search, Downhill simplex search Neural networks- Introduction, Supervised learning neural networks	7	15
SECOND INTERNAL TEST		
MODULE : 5 Neural networks contd., Perceptrons, Adaline, Back propagation, Multilayer perceptrons, Radial Basis Function Networks, Numerical examples, Unsupervised learning, other neural networks, Competitive learning networks, Numerical examples	7	20
MODULE : 6 Kohonen self-organizing networks, Learning vector quantization, Hebbian	8	20

learning, Numerical examples Applications – Inverse kinematics problem, Printed character recognition, Automobile fuel efficiency prediction, Power system Unit Commitment problem, Electronics applications, Soft computing for colour recipe prediction.		
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6106	STOCHASTIC MODELLING AND APPLICATIONS	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To imbibe the essentials of probability models leading up to stochastic processes;
- Acquire the necessary skills in building stochastic models using Markov chains;
- To develop an understanding of queuing systems under different configurations;
- Acquire problem solving skills in applying ingrained subject skills to real world problems.

Syllabus

Discrete probability distributions, Continuous probability densities, Distribution functions, Expectations, moments, Characteristic functions, Moment generating functions, Random variables, Convergence concepts, Law of large numbers, Central limit theorem – Bernoulli trials, Discrete and continuous independent trials, Stochastic processes-Markov chains, Computation of equilibrium probabilities, Stationary distribution and Transient distribution of Markov chains, Poisson processes – Exponential distribution and applications, Birth-death processes and applications.

Course Outcome:

- Have an appreciation of the power of stochastic processes and its range of applications;
- Master essential stochastic modelling tools including Markov chains and queuing theory; Ability to formulate and solve problems which involve setting up stochastic models.

Text Books:

1. Hole, P.G., Port, S.C., and Stone C.J.,' Introduction to Probability Theory', Indian Edition Universal Book Stall, New Delhi, 1998.
2. Hole P.G., Port, S.C., and Stone C.J.,' Introduction to Stochastic Process', Indian Edition Universal Book Stall, New Delhi, 1981

References:

1. Alberto Leon-Garcia; Probability, Statistics and Random process for Electrical Engineering, Pearson Third Edition,2008.
2. Miller and Freund, "Probability", PHI India, 2005.

COURSE PLAN

Course No:	Course Title	CREDITS	
04 EE 6106	**Stochastic Modelling and Applications**	**3-0-0: 3**	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE : 1 Probability Spaces- Discrete probability distributions, Continuous probability densities, Conditional probability		8	15
MODULE : 2 Probability distributions and densities, Distribution functions, Multiple random variables and joint distributions		7	15
FIRST INTERNAL TEST			
MODULE : 3 Expectations, Moments, Characteristic functions, Moment generating functions, Sequence of random variables, Convergence Concepts		6	15
MODULE : 4 Law of large numbers, Discrete and continuous random variables, Central limit theorem, Bernoulli trials, Discrete and continuous independent trials		7	15
SECOND INTERNAL TEST			
MODULE : 5 Stochastic processes-Markov chains – Transient analysis, Computation of equilibrium probabilities, Stationary distribution and Transient distribution of Markov chains		8	20
MODULE : 6 Poisson processes, Exponential distribution and applications, Birth-death processes and applications		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 6432	HIGH VOLTAGE DC TRANSMISSION	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- The Fundamentals of about HVDC Transmission systems;
- Basic understanding of operation of HVDC system;
- Overview of reactive power requirements and protection issues in HVDC Transmission systems

Syllabus

Historical Development, advantages and disadvantages of HVDC systems; Operation and control of three-phase fully controlled thyristor bridge converters; Reactive power requirements in HVDC system; Protection principles and operational issues in HVDC link operation

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of High voltage DC Transmission control and protection related issues.

Text Books:

1. Padiyar K.R; HVDC Transmission Systems, Wiley Eastern

References:

1. Kimbark E.X., “Direct Current Transmission”, Vol. I, Wiley Interscience, NewYork 1971
2. Allan Greenwood, ‘Electrical Transients in Power Systems’, John Wiley and Sons New York, 1992
3. Adamson and Hingorani N.G., “High Voltage Direct Current PowerTransmission”, Garraway ltd., England, 1960.

Course Plan

COURSE NO:	Course Name	CREDITS	
04 EE 6432	High Voltage DC Transmission	3-0-0: 3	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE : 1 Historical development of HVAC and DC links – kinds of DC links-HVDC projects in India and abroad – advantages and disadvantages of HVDC transmission; Applications of DC transmission – economic factors – development of power devices for HVDC transmission – thyristors – light activated thyristors		6	15
MODULE : 2 Three phase fully controlled thyristor bridge converters – operation as rectifiers and line commutated inverters; Converter equivalent circuits – parameters and characteristics of rectifiers and inverters; Series and parallel arrangement of thyristors – multi-bridge converters.		8	15
FIRST INTERNAL TEST			
MODULE : 3 Gate control – basic means of control and modes of operation – power reversal – desired features of control; Control characteristics – constant current control – constant extinction angle control; Stability of control – tap changer control – power control and current limits.		8	15
MODULE : 4 Reactive Power Requirements, Reactive Power Control during Steady State and Transients		5	15
SECOND INTERNAL TEST			
MODULE : 5 Basics of protection of HVDC systems – DC reactors – voltage and current oscillations – DC line oscillations; clearing line faults and re-energizing the line – circuit breakers – over voltage protection		8	20

MODULE : 6 Characteristics and uncharacteristic harmonics – troubles caused by harmonics – means of reducing harmonics —– harmonic filters; Corona and Radio interference; Ground return and ground Electrodes	7	20
END SEMESTER EXAM		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 6506	ENERGY CONSERVATION AND MANAGEMENT	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

- To introduce to student the global energy consumption, energy management in buildings, energy efficient technologies.
- To develop student the ability to do simple energy audit.

Syllabus

Fundamental concepts of Electrical Energy and safety audit ; Electrical Energy Conversion; Different tariff system; Energy Efficiency in Lighting; Demand Side Management

Course Outcome:

Students who successfully complete this course will have ability

- To identify the demand supply gap of energy in Indian scenario.
- To carry out energy audit of an industry/Organization.
- To select appropriate energy conservation method to reduce the wastage of energy.
- To evaluate the techno economic feasibility of the energy conservation technique adopted.

References:

1. Openshaw Taylor E., “Utilisation of Electric Energy”, Orient Longman Ltd, 2003
2. Donald R. Wulfingoff, “Energy Efficiency Manual”, Energy Institute Press, 1999.
3. Tripathy S.C., “Electrical Energy Utilization and Conservation”, TMH, 1991.
4. Cyril G. Veinott, Joseph E. Martin, “Fractional & Sub Fractional HP Electric Motor”, McGraw Hill, 1987.
5. Abhay Jain, “How to Achieve Energy Conservation”, Electrical India, Feb’04, pp.48-53.
6. Ashok Bajpai, “Key Role of Energy Accounting and Audit in Power System”, Electrical India, Apr’04, pp.38-47.
7. Sasi.K.K. & Isha.T.B., “Energy Conservation in Industrial motors”, Electrical India, Apr’04, pp.48-51.
8. Sreejith.P.G., “Electrical Safety Auditing”, Electrical India, May’04, pp.38-46.
9. Sreejith.P.G., “Electrical Safety Auditing”, Electrical India, Jun’04, pp.38-45.
10. Thokal.S.K., “Electrical Energy Conservation by Improvement of Power factor”, Electrical India, Jul’04,pp.38-41
11. Dr.Omprakash G. Kulkarni, “Load End Energy Management”, Electrical India –December Annual Issue, 2004.pp.58-67

COURSE PLAN

COURSE NO.	COURSE TITLE	CREDITS
04 EE 6506	ENERGY CONSERVATION AND MANAGEMENT	3-0-0: 3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE1:-Electrical Energy and safety audit-Overview of Electricity Act – Energy conservation act - Electrical energy audit - Tools for electrical energy audit - billing elements - tariff system, energy and demand charge.	6	15
MODULE: 2 – Electrical demand and load factor improvement, power factor correction, power demand control, demand shifting – Electrical Safety Auditing- Electric motors-Motors efficiency, idle running-Motor Selection.	6	15
FIRST INTERNAL TEST		
MODULE: 3 Factors affecting motor performance Efficiency at low load – high efficiency motors - reduce speed/variable drives, load reduction - high-starting torque, rewound motors, motor generator sets- energy efficiency in transformers - Case studies.	8	15
MODULE: 4 Electrical energy conservation in driven equipments-Input electrical energy- requirements in pumps – fans and compressors – load factor estimation in the equipments- different types of VFD, energy conservation potential – electrical energy conservation in refrigeration and A/C system.	9	15
SECOND INTERNAL TEST		
MODULE : 5 - Electrical Energy conservation in industrial lighting-Choice of lighting - energy saving - control of lighting - lighting standards – light meter audit - methods to reduce costs – summary of different lighting technologies – Case Studies.	7	20
MODULE : 6 - Energy efficiency and demand management-Basic concepts – Co-generation – importance of demand side management – virtues of DSM – efficiency gains - estimation of energy efficiency potential, cost effectiveness, payback period, barriers for energy efficiency and DSM – Case Studies.	6	20
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6118	ADVANCED DIGITAL SIGNAL PROCESSING	3-0-0: 3	2015

Pre-requisites:

Course Objectives:

- To introduce basic concept behind digital signal processing;
- To study the design and realization of IIR and FIR filters;
- To study the different methods for power spectrum estimation;
- To study multirate signal processing fundamentals

Syllabus

Discrete time signals and systems: Properties of systems, Discrete time Fourier transform, Z transform; Discrete Fourier transform and its properties, linear and circular convolution, radix 2 DIT FFT, Radix2 DIF FFT; IIR filter design: Analog Butterworth functions for various filters, analog to digital transformation, Structures for realizing digital IIR filters; Design of FIR filters: Design of FIR filters using Fourier series method, Design of FIR filters using windows, Design using frequency sampling, realization of FIR filters; Spectral estimation: Nonparametric methods, Parametric methods; Multirate digital signal processing: Interpolation and Decimation, Sampling rate conversion by a rational factor, Polyphase filter structures, Multistage implementation of multirate system.

Course Outcome:

The students will be able to

- Understand the basics of digital signal processing and various frequency domains
- Understand the design and implementation of IIR and FIR filters.
- Understand the various methods for spectral estimation.
- Understand the concept behind multirate signal processing.

Text Books:

1. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing*, PHI, New Delhi,1997.
2. Mitra, *Digital Signal Processing*, 3e, Tata McGraw –Hill Education New Delhi,2007

References:

1. Alan V. Oppenheim, Ronald W. Schafer, Discrete time Signal Processing , PHI, New Delhi,1997.
2. Monson H. Hayes, *Statistical Digital Signal Processing and Modelling*, Wiley, 2002.
3. ES Gopi, *Algorithm collections for Digital Signal Processing Applications using Matlab*, Springer, 2007.
4. Roberto Cristi, *Modern Digital Signal Processing*, Thomson Brooks/Cole (2004)

COURSE PLAN

Course No:	COURSE TITLE	CREDITS	
04 EE 6118	ADVANCED DIGITAL SIGNAL PROCESSING	3-0-0: 3	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE : 1 Discrete time signals and systems: Basic principles of signal processing- Building blocks of digital signal processing. Review of sampling process and sampling theorem. Properties of systems-linearity, causality, time variance, convolution and stability Frequency domain representation – Discrete time Fourier transform and its properties- Z transform and inverse Z transform		8	15
MODULE : 2 Discrete Fourier transform-inverse discrete Fourier transform-properties of DFT-linear and circular convolution-overlap and add method-overlap and save method FFT - radix 2 DIT FFT-Radix2 DIF FFT		6	15
FIRST INTERNAL TEST			
MODULE : 3 Digital filter design: Design of IIR filters from analog filter - analog butter worth functions for various filters - analog to digital transformation- backward difference and forward difference approximations-impulse invariant transformation. Structures for realizing digital IIR filters-Direct form 1-direct form II- parallel and cascade structure, lattice structure.		6	15
MODULE : 4 Design of FIR filters-Design of FIR filters using Fourier series method- Design of FIR filters without using windows- Design of FIR filters using windows-Design using frequency sampling- realization of FIR filters.		6	15
SECOND INTERNAL TEST			

MODULE : 5 Spectral estimation-Estimation of spectra from finite duration signals, Nonparametric methods-Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods. Parametric methods – ARMA model based spectral estimation, Yule-Walker equation and solution, Solution using Levinson-Durbin algorithm.	9	20
MODULE : 6 Multirate digital signal processing- Mathematical description of change of sampling rate – Interpolation and Decimation, Decimation by an integer factor, Interpolation by an integer factor, Sampling rate conversion by a rational factor, Polyphase filter structures, Multistage implementation of multirate system	7	20
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6212	APPLICATIONS OF SPECIAL ELECTRICAL MACHINES	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To provide the student a comprehensive study of construction, principle of operation and performance of special electric machines and drives

Syllabus

Constructional features, principle of operation, characteristics and control of Stepper Motors; Switched Reluctance Motors; Synchronous Reluctance Motors; Permanent Magnet Brushless DC Motors; Permanent Magnet Synchronous Motors; Servo Motors .

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of different special electrical machines; apply the knowledge of control and operating characteristics in different fields of application.

Text Books:

1. E. G. Janardanan, *Special Electric Machines*, Prentice Hall India PVT. LTD. NEW DELHI
2. K. Venkataratnam, *Special Electric Machines*, Orient Blackswan PVT. LTD., NEW DELHI

References:

1. Kenjo T, Sugawara A, *Stepping Motors and Their Microprocessor Control*, Clarendon Press, Oxford
2. Miller T J E, *Brushless Permanent Magnet and Reluctance Motor Drives*, Clarendon Press, Oxford
3. Kenjo T, *Power Electronics for the Microprocessor Age*, Oxford University Press

Course Plan

Course Code:	Course Name:	CREDITS
04 EE 6212	Applications of Special Electrical Machines	3-0-0: 3

MODULES	Contact hours	Sem. Exam Marks; %
MODULE : 1 - Stepping Motors Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor, microprocessor based controller.	8	15
MODULE : 2 - **Switched Reluctance Motors:** Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control. Microprocessor based controller. Sensor less control.	6	15
FIRST INTERNAL TEST		
MODULE : 3 **Synchronous Reluctance Motors:** Constructional features: axial and radial air gap Motors. Operating principle; Reluctance torque, Phasor diagram, motor, characteristics. Control of synchronous reluctance motor	6	15
MODULE : 4 - **Permanent Magnet Brushless DC Motors:** Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor; Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics; Controllers-Microprocessor based controller. Sensorless control.	8	15
SECOND INTERNAL TEST		
MODULE : 5 **Permanent Magnet Synchronous Motors**: Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers,	8	20

Torque speed characteristics, Self-control, Vector control, Current control schemes - Sensor less control		
MODULE : 6 - Servo Motors Construction, principle of operation, control of DC servo motor, Construction, principle of operation, control of AC servo motor	6	20
END SEMESTER EXAM		

COURSE NO.	COURSE TITLE	CREDITS	YEAR
04 EE 6308	ANALYSIS, DESIGN AND GRID INTEGRATION OF PHOTOVOLTAIC SYSTEMS	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To familiarize Solar PV System
- To analyze grid integrated PV System
- To learn about PV system over current protection of solar system
- To understand various faults of solar power system

Syllabus

Fundamental concepts and overview of Solar Cells ; MPPT Algorithm; Study of solar panel; Analysis of Grid Connected solar PV systems; Protection of solar PV system

Course Outcome:

Students who successfully complete this course will able to analyze and design the grid integration of photovoltaic systems

Text Books:

1. A K Mukerjee, Niveditha Thakur : *Photovoltaic Systems Analysis and Design*, PHI
2. Chetan Singh Solanki: *Solar Photovoltaics Fundametals, Technologies and Applications*, PHI
3. Amir Naser Yazdani and Reza Iravani: *Voltage - Sourced Converters in Power Systems modeling, control and Applications*, WILEY, IEEE Press
4. Photovoltaic System Over current Protection by cooper bussmann

References:

1. A. Goetzberger V.U. Hoffmann : *Photovoltaic Solar Energy Generation* Springer Series in optical sciences
2. Antonio Luque and Steven Hegedus : *Handbook of Photovoltaic Science and Engineering*, WILEY

COURSE PLAN

Course No:	Course Title	CREDITS	
04 EE 6308	Analysis, Design and Grid Integration of Photovoltaic Systems	3-0-0: 3	
MODULES		**Contact hours**	**Sem. Exam Marks; %**
MODULE : 1 - Solar Cells: Generation of Photo Voltage – Light Generated Current – I V Equation of Solar Cells- Solar Cell Characteristics. **Design of Solar Cells:** Upper Limit of Cell Parameters- Losses in Solar Cells - Diode Equivalent Model		6	15
MODULE: 2 – Solar Cell Energy Conversion Efficiency Effect of Variation of Solar Insolation and Temperature on Efficiency. Solar PV Modules from Solar Cells - Series and Parallel Connection of Cells – Design and Structure of PV Module – Number of Solar Cells in a Module – Wattage of Modules- PV Module Power Output - I- V Equation of PV Module - Ratings of PV Module – I-V Curve and P-V Curve of Module		7	15
FIRST INTERNAL TEST			
MODULE: 3 Mismatch Losses of PV Modules Effect of Variation of Solar Insolation and Temperature – Partial Shading of a Solar Cell and a Module. **Batteries for PV systems** – Factors affecting battery performance **MPPT Algorithms**: Perturb and Observe- Incremental Conductance, Mechanical Tracking - Single Axis Tracking – Dual Axis Tracking.		7	15
MODULE: 4 Standalone P V System Configurations Design PV powered DC fan and pump without battery- Design of Standalone System with Battery and AC or DC Load. A Grid Interactive PV System - Phase , Frequency Matching and Voltage Consideration – Operation of a Grid Interactive Inverter – Protection Against Islanding and Reverse Power Flow – AC Modules- Design of EMI Filters.		8	15
SECOND INTERNAL TEST			

MODULE : 5 - Grid Imposed Frequency VSC system : Control in αβ Frame - Structure of Grid Imposed Frequency VSC system – Real-/ Reactive Power Controllers - Current Mode Versus Voltage Mode Control - Dynamic Model of Real-/ Reactive Power Controllers - Current Mode Control of Real/ Reactive Power	8	20
MODULE : 6 - **PV power protection systems** Over current protection of solar PV power system, Selective fuse links for PV String protection, PV fuse selection flow chart, Fuse rating for PV Applications.	6	20
END SEMESTER EXAM		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 6444	FACTS AND POWER QUALITY	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- An idea about transmission problems and different types of FACTS controllers to improve the power quality
- An idea about the principles of shunt connected and series connected FACTS controllers to increase the transmission capability of transmission system.
- An introduction to the different power quality problems occurring in our power systems
- An idea about the effect of harmonic in our power system and its elimination using power quality conditioner

Syllabus

Fundamental concepts of FACTS Controllers; Shunt Compensation; Series Compensation; Electric Power Quality; Harmonic Mitigation ; Power Quality Conditioners.

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the basic idea of different FACTS controllers; Describe shunt compensation for power quality improvement; Understand the different types of series connected FACTS controllers; Understand different power quality disturbance and voltage variations in a power system; Will have a full understanding of the presence of harmonics and different power.

References

1. Flexible ac transmission systems (FACTS) Song, Y.H. and Allan T. John , Institution of Electrical Engineers Press, London, 1999.
2. Concepts and Technology of flexible ac transmission system, Hingorani, L.Gyugyi, IEEE Press New York, 2000 ISBN –078033 4588
3. http://nptel.ac.in/courses.php?disciplineId=108
4. IEE Tutorials on 'Flexible ac transmission systems', published in Power Engineering Journal, IEE Press, 1995.
5. R M Mathur and R K Varma, Thyristor based FACTS Controllers for Electrical Transmission, IEEE Press.
6. Heydt, G.T., 'Electric Power Quality', Stars in Circle Publications, Indiana, 1991.
7. Bollen, M.H.J., 'Understanding Power Quality Problems: Voltage sags and interruptions', IEEE Press, New York, 1999.
8. Arrillaga, J, Watson, N.R., Chen, S., 'Power System Quality Assessment', Wiley, New York, 1999.
9. C Sankaran; Power Quality, C R C Press.

COURSE PLAN

COURSE NO:	COURSE TITLE:	CREDITS
04 EE 6444	FACTS And Power Quality	3-0-0: 3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 Fundamentals of ac power transmission, Transmission problems and needs, Emergence of FACTS, FACTS control considerations, FACTS controllers	5	15
MODULE : 2 Principles of shunt compensation, Variable Impedance type & switching converter type, Static Synchronous Compensator, (STATCOM) configuration; Characteristics and control. Principles of static series compensation using GCSC, TCSC and TSSC, applications. Static Synchronous Series Compensator (SSSC)	7	15
FIRST INTERNAL TEST		
MODULE : 3 UPFC -Principles of operation and characteristics, Independent active and reactive power flow control; Comparison of UPFC with the controlled series compensators and phase shifters.	5	15
MODULE : 4 Electric power quality phenomena- IEC and IEEE definitions, Power quality disturbances: voltage fluctuations, voltage variations, transients, unbalance, waveform distortion, power frequency variations. Voltage sags and short interruptions : flicker, longer duration variations and impact on sensitive circuits, standards	6	15
SECOND INTERNAL TEST		
MODULE : 5 Harmonics: sources, definitions & standards, impacts, Calculation and simulation, Harmonic power flow, mitigation and control techniques, Filtering: passive and active.	10	20

MODULE : 6 Power Quality conditioners: shunt and series compensators, D-STATCOM, Dynamic voltage restorer, Unified power quality conditioners: case studies.	9	20
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
04 EE 6390	POWER ELECTRONICS LAB	0-0-2-1	2015

Pre-requisites:

Course Objectives:

To enable the students:

1. To design, develop and troubleshoot Power Electronic Circuits.
2. To develop experimental skills for independent research.

Syllabus/List of experiments:

1. Firing schemes for converters.
2. Single Phase Semi-converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
3. Single phase full- converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
4. Three phase full-converter with R-L-E load.
5. Controlled and Uncontrolled rectifier with different types of filters-continuous and discontinuous modes of operation.
6. Transformer and Inductor design.
7. Voltage and current commutated choppers.
8. MOSFET, IGBT based Choppers.
9. IGBT and MOSFET based inverters.
10. Current source inverter.
11. Single phase AC voltage controller.
12. Transfer function of a DC Motor.
13. Resonant Inverters.
14. Microcontroller/DSP/FPGA based control of dc-dc converters.
15. Study of harmonic pollution by power electronics loads.

Simulation Experiments:

1. Simulation of single-phase Semi-converter and Fully controlled converters with R, RL and RLE Load.
2. Simulation of Three-phase semi converter.
3. Simulation of Three-phase fully controlled converter.
4. Simulation of Single-phase full bridge inverter.

5. Simulation of Three-phase full bridge inverter.
6. Simulation of PWM inverters.
7. Simulation of single phase and three phase AC voltage Controller.
8. Simulation of class A, B, C, D and E choppers.
9. Simulation of buck, boost and buck-boost converters.
10. Simulation of single phase and three phase cycloconverter.
11. Measurement of THD of current & voltage waveforms of controlled & uncontrolled 3-phase rectifiers.

(At least 15 experiments in the list are to be conducted in the laboratory. Additional experiments and simulation assignments may also be developed by the department. Suitable simulation tools may be used for simulation studies. Use of open source tools such as Python, SciLab, Octave, gEDA etc are encouraged).

Course Outcome:

After completing this course the students will be able to develop control algorithms in digital control platforms such as DSP/FPGA/Microcontrollers.

The students will be able to develop electrical drive systems from fundamental principles.

The students will acquire sufficient experimental skills to carry out independent experimental research.

COURSE NO.	COURSE TITLE	L-T-P:C	YEAR
04 EE 7105	ROBOTICS AND AUTOMATION	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To learn the specifications necessary to model Industrial Robots.
- To apply prior knowledge of coordinate systems to specific transformation matrices relevant to robotics.
- To learn the complexities of linear and revolute motions in the course of system planning.
- Ability to use the Lagrange-Euler method as an alternative to determine kinematic solutions.

Syllabus

Geometric configuration of robots, Manipulators, Drive systems, Sensors, End effectors, Control systems, Programming languages, Robotic vision, Direct and inverse kinematics, Rotation matrices, Euler angle-representation, Homogenous transformation, Denavit Hartenberg representation, Lagrange – Euler formulation, Kinetic energy, Potential energy, Equations of motion, Generalized D'Alembert equations of motion, Trajectory planning, Joint interpolation, Cartesian path trajectories, Control of robot manipulators, PID control, Computed torque technique, Near minimum time control, Variable structure control , Non-linear decoupled feedback control, Resolved motion control and adaptive control.

Course Outcome:

- To be familiar with general robot specifications.
- Will be able to conceptualize the different frames of reference used in robots.
- Calculate the composite transformation matrices involved when the manipulator progresses through different dimension modes.
- Assess the detailed forward and reverse kinematics for a 2-link assembly.
- Be able to formulate the kinetic energy and potential energy calculations while applying Lagrange–Euler method to solve the 2-DOF, 2-link kinematics problem.
- Versed in the application of higher order polynomials in trajectory planning.

Text Books:

1. Fu K S, Gonazlez R C and Lee C S G, 'Robotics Control, Sensing, Vision and Intelligence',McGraw-Hill, 1987.
2. Saeed B Niku, 'Introduction to Robotics, Analysis, Systems and Applications', PearsonEducation, 2002.

References:

1. Wesley, E Sryda, 'Industrial Robots: Computer Interfacing and Control', PHI, 1985.
2. Asada and Slotine, 'Robot Analysis and Control', John Wiley and Sons, 1986.
3. Groover M P, Mitchell Weiss, 'Industrial Robotics Technology Programming and Applications', Tata McGraw-Hill, 1986.

COURSE PLAN

Course No:	Course Title:	CREDITS:
04 EE 7105	Robotics and Automation	3-0-0:3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 Introduction to Robotics, Geometric configuration of robots, Manipulators, Robot programming languages and applications, Introduction to robotic vision, Drive systems, Internal and external sensors, End effectors, Control systems.	10	15
MODULE : 2 Robot Arm Kinematics, Direct and inverse kinematics, Rotation matrices, Composite rotation matrices.	6	15
FIRST INTERNAL TEST		
MODULE : 3 Euler angle representation, Homogenous transformation, Denavit-Hartenberg representation, Various arm configurations.	8	15
MODULE : 4 Lagrange–Euler formulation, Joint velocities, Kinetic energy, Potential energy, Motion equations, Generalized D'Alembert equations of motion	6	15
SECOND INTERNAL TEST		
MODULE : 5 Trajectory planning, Joint interpolation, Cartesian path trajectories	6	20
MODULE : 6 Control of Robot Manipulators, PID control, Computed Torque control, Near-minimum time control, Variable structure control, Non-linear decoupled feedback control, Resolved motion control and adaptive control.	6	20
END SEMESTER EXAM		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7303	POWER ELECTRONIC APPLICATIONS IN RENEWABLE ENERGY	3-0-0-3	2015

Pre-requisites: [04 EE 6303] Power Electronics Devices and Circuits

Course Objectives:

- To introduce the use of power electronic converters in photovoltaic applications;
- To develop various power converter circuits for wind and fuel cell based systems;
- To design, analyze standalone and grid connected renewable energy systems using power electronic converters.

Syllabus

General aspects of renewable energy technology; Fundamental concepts and overview of Power Electronic converters; Grid connected and standalone renewable energy systems; Wind energy systems; Photovoltaic systems; Small/micro hydro systems; Fuel cells; Energy Storage systems for advanced power application; Hybrid Generation systems

Course Outcome:

Students will have a broad knowledge in designing of power electronic based renewable energy systems.

Text Books:

1. D P Kothari and Nagrath, “Modern Power System Analysis”, Mcgraw Hill, , Chapter 1, 2011.
2. Thomas Ackerman, “Wind power in power systems”, John Wiley& Sons, Chapter 4, London, 2005.

References:

1. M G Simoes and F A Farret, “Alternate energy systems,”CRC Press, ,Chapter 7, London,2008.
2. J P Lyons and V Vlatkovic, “power electronics and alternative energy generation”, in proc IEEE power electronics specialist conference, vol.1, no 1, pp.16-21, Aachen 2004.
3. P F Rebeiro, B K Jhonson, M L Crow, A Arsoy and Y Liu, “Energy Storage systems for advanced power application”, in proc IEEE conf. vol.89, no 12, Dec. 2001.

COURSE PLAN

COURSE NO:	Course Title	CREDITS	
04 EE 7303	POWER ELECTRONIC APPLICATIONS IN RENEWABLE ENERGY	3-1-0:4	
MODULES		**Contact hours**	**Sem. Exam Marks; %**
MODULE : 1 General aspects of renewable energy technology- wind, solar, small/micro hydro, fuel cell, geothermal, OTEC, wave, nuclear fusion; General Power electronics- DC to DC converters, AC-DC conversion; DC to AC conversion, AC to AC conversion matrix converters		7	15
MODULE : 2 Wind Energy: Grid connected-Fixed speed and variable speed wind turbines, Type A, type B, type C, type D-induction generators-SCIG, Wound Rotor Induction Generator, Doubly Fed Induction Generator, Wound Rotor Synchronous Generator and Permanent Magnet Synchronous Generator.		7	15
FIRST INTERNAL TEST			
MODULE : 3 Standalone wind energy conversion systems-voltage and frequency controllers, Induction generator-PMSG; Soft starter-frequency converters-wind farms.		6	15
MODULE : 4 Photovoltaic: Residential PV systems- battery-inverter - Grid connected systems; Small/micro hydro: grid and standalone systems, typical converter applications; Fuel cells: Low power and high power fuel cell, Power electronic applications		8	15
SECOND INTERNAL TEST			
MODULE : 5 Energy Storage systems for advanced power application: superconducting magnetic energy storage (SMES); Battery energy		7	20

storage systems (BESS), Ultra capacitors, Flywheel energy storage (FES) and their applications		
MODULE : 6 Hybrid Generation systems: hybrid systems-micro grid-control; Future of power electronics technology: device-packaging-circuit and control.	7	20
END SEMESTER EXAM		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7409	DIGITAL PROTECTION OF POWER SYSTEMS	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

- Develop an idea about the working and classification of relays and its application in power systems.
- Develop knowledge about the implementation of relays using microprocessors.
- A foundation in the fundamentals of Numerical relay.

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the fundamental concepts of different types of relays; basic concepts of numerical relays;, digital protection and use of Artificial Intelligence in protection.

Syllabus

General philosophy of protection, A review of conventional protection schemes for Transmission lines and station apparatus, Microprocessor implementation of over current relays, Pilot relay protection, SCADA.

References:

1. Y. G. Paithankar , S. R. Bhide, " Fundamentals of Power System Protection", Prentice – Hall India, 2004
2. L. P. Singh, " Digital protection, Protective Relaying from Electromechanical to Microprocessor", John Wiley & Sons, 1995
3. A. G. Phadke, J. S. Thorpe," Numerical relaying for Power Systems", John-Wiley and Sons, 1988
4. T. S. M. Rao, "Digital / Numerical Relays", Tata McGraw Hill,2005
5. Badri Ram and DN Vishwakarma, "Power system protection and Switchgear", Tata McGraw Hill, New Delhi, 2003.
6. Ravindar P. Singh, "Digital Power System Protection", PHI, NewDelhi, 2007.
7. J. L. Blackburn, "Protective Relaying: Principles and Applications", MarcelDekker, New York, 1987

COURSE PLAN

COURSE NO:	COURSE TITLE	CREDITS	
04 EE 7409	DIGITAL PROTECTION OF POWER SYSTEMS	3-0-0:3	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE : 1 General philosophy of protection – Characteristic functions of protective relays – basic relay elements and relay terminology. Classification of Relays – Construction and operation of Electromagnetic relays.		6	20
MODULE : 2 A review of conventional protection schemes for Transmission lines and station apparatus (Qualitative treatment only). Static relays – Solid state devices used in static protection – Amplitude comparator and phase comparator. Static Over current relays: Non-directional, Directional - Synthesis of Mho relay, Reactance relay		8	15
FIRST INTERNAL TEST			
MODULE : 3 Impedance relay and Quadrilateral Distance relay using Static comparators, Differential relay.(Qualitative treatment only). Hardware and software for the measurement of voltage, current, frequency, phase angle.		7	15
MODULE : 4 Microprocessor implementation of over current relays – Inverse time characteristics. Directional relay – Impedance relay– Mho relay, Differential relay. Numerical relay algorithms.		6	15
SECOND INTERNAL TEST			
MODULE : 5 Pilot relay protection: Wire pilot relaying, Carrier current pilot relaying , Microwave pilot relaying – Fibre-optic based relaying – Apparatus Protection: Digital protection of generators, Digital protection of Transformers – Protection of Long and short lines – Protection based on Artificial Intelligence		8	20
MODULE : 6 SCADA: Architecture, Use of SCADA in interconnected power systems.(Qualitative treatment only)		7	15
END SEMESTER EXAM			

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7503	RENEWABLE ENERGY SYSTEMS	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

- To study the difference between renewable and non-renewable energy resources.
- To demonstrate the different types of renewable energy technologies that are currently available, and how they are used to provide energy.

Syllabus

Solar Energy and its availability; Solar thermal Conversion systems; Wind Energy systems; Chemical energy ; Hydrogen energy; Energy from Oceans ;Geothermal Energy

Course Outcome:

- Students will be able to create a list of renewable energy technologies that can be used in a particular situation, based on the situational factors.
- Ability to evaluate the environmental and social impacts of renewable and nonrenewable energy use

References:

1. S P Sukatme, “Solar Energy – Principles of thermal collection and storage, second edition, Tata McGraw Hill, 1991.
2. G D Rai, “Non Conventional Energy Sources”.
3. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, Second Edition, John Wiley, New York, 1991.
4. D. Y. Goswami, F. Kreith and J.F. Kreider, “Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
5. D. D. Hall and R.P. Grover, “Bio-Mass Regenerable Energy, John Wiley, Newyork, 1987.
6 J. Twidell and T. Weir, “Renewable Energy Resources”, E&FN Spon Ltd., London, 1986.Thokal.S.K., “Electrical Energy Conservation by Improvement of Power factor”, Electrical India, Jul’04,pp.38-41
7. Dr. Omprakash G. Kulkarni, “Load End Energy Management”, Electrical India

COURSE PLAN

Course No:	Course Title:	CREDITS	
04 EE 7503	RENEWABLE ENERGY SYSTEMS	3-0-0:3	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE1: Solar Energy-Introduction to solar energy: solar radiation, availability, measurement and estimation- Solar thermal conversion devices and storage- PV systems – MPPT. Applications of PV Systems – solar energy collectors and storages.		8	15
MODULE: 2 Wind Energy-Introduction – Basic principles of wind energy conversion – wind data and energy estimation – site selection consideration - Types of wind machines – basic components of wind electric conversion systems- Schemes for electric generations – generator control, load control, energy storage- Inter connected systems		8	15
FIRST INTERNAL TEST			
MODULE: 3 Chemical Energy Sources-Introduction – fuel cells – design and principles of operation of a fuel cell- classification of fuel cells. Types of fuel cells – conversion efficiency of fuel cells. Types of electrodes, work output and emf of fuel cell, Applications of fuel cells.		7	15
MODULE: 4 Hydrogen energy: Introduction – hydrogen production – electrolysis, thermochemical methods, Westinghouse Electro-chemical thermal sulphur cycle. Fossil fuel methods. Hydrogen storage, Utilization of hydrogen gas.		6	15
SECOND INTERNAL TEST			
MODULE: 5 Energy from oceans-Introduction, ocean thermal electric conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, closed OTEC cycle. Energy from tides: Basic principles of tidal power, component of tidal power plants, operation methods of utilization		7	20

of tidal energy, site requirements, storage, advantages and limitations of tidal power generation. Ocean waves, energy and power from the waves, wave energy conversion devices..		
MODULE: 6 Geothermal energy-Introduction, estimation of geothermal power, nature of geothermal fields, geothermal sources, inter connection of geothermal fossil systems, prime movers for geo thermal energy conversion. Energy from biomass: Biomass conversion technologies, photosynthesis, classification of biogas plants. Biomass Energy conversion, Energy from waste.	6	20
END SEMESTER EXAMINATION		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7113	INDUSTRIAL CONTROL ELECTRONICS	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- A foundation about isolation circuits, signal conditioner and control of stepper motors.
- Practice in the design and formulation of industrial controllers.
- An introduction to the importance of fibre optics and bar code application in industry.

Syllabus

Fundamental concepts and overview about SMPS, UPS, isolation circuits and various signal conditioners; Design and formulation of proportional, integral and differential controllers; Basics of bar code application in industry;

Course Outcome:

Students who successfully complete this course have demonstrated an ability to understand the fundamental concepts and design industrial controllers. Apply the basic idea about fibre optics and recognize the bar code application in industry. Control the working of stepper motors and use it for typical working conditions.

References:

1. Michael Jacob, 'Industrial Control Electronics – Applications and Design',Prentice Hall, 1988.
2. Thomas, E. Kissel, ' Industrial Electronics'PHI, 2003
3. James Maas, 'Industrial Electronics', Prentice Hall, 1995.
4. http://nptel.ac.in/courses/108105063/
5. http://nptel.ac.in/courses/108105062/

COURSE PLAN

Course No:	Course Title:	CREDITS	
04 EE 7113	Industrial Control Electronics	3-0-0:3	
MODULES		**Contact hours**	**Sem. Exam Marks;%**
MODULE : 1 Review of switching regulators and switch mode power supplies, Uninterrupted power supplies. Solid state circuit breakers, programmable logic controllers.		6	15
MODULE : 2 Analog Controllers , Proportional controllers Proportional – Integral controllers, PID controllers, Feed forward control		6	15
FIRST INTERNAL TEST			
MODULE : 3 Signal conditioners: Instrumentation amplifiers , voltage to current, current to voltage converters Voltage to frequency, frequency to voltage converters		6	15
MODULE : 4 Isolation circuits: cabling; magnetic and electro static shielding and grounding.		6	15
SECOND INTERNAL TEST			
MODULE : 5 Opto-Electronic devices and control; Applications of opto isolation, interrupter modules and photo sensors Fibre optics – Bar code equipment, Application of barcode in industry.		9	20
MODULE : 6 Stepper motors and servo motors, control and applications. Servo motors : servo motor controllers, Servo amplifiers , selection of servo motor, Applications of servo motors.		9	20
END SEMESTER EXAM			

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7307	NUMERICAL SIMULATION OF POWER ELECTRONIC SYSTEMS	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

- To familiarize the modeling and simulation of power electronic devices and circuits
- To introduce the basic simulation studies of electric drives

Syllabus

Modeling and simulation of different systems in power electronic applications; Modeling of Electrical machines and drives; Simulation of Rectifier, Chopper and Inverter circuits.

Course Outcome:

The students who successfully complete this course will able to model and simulate various power electronic circuits.

Text Books:

1. Robert Ericson, '*Fundamentals of Power Electronics*', Chapman & Hall, 1997.

References:

1. Simulink Reference Manual, Math works, USA.
2. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004

COURSE PLAN

Course No:	Course Title:	CREDITS	
04 EE 7307	Numerical Simulation of Power Electronic Systems	3-0-0:3	
MODULES		**Contact hours**	**Sem. Exam Marks; %**
MODULE : 1 Review of numerical methods. Application of numerical methods to solve transients in D.C. Switched R, L, R-L, R-C and R-L-C circuits; Extension to AC circuits, Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation.		6	15
MODULE: 2 Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits; State space modelling and simulation of linear systems.		8	15
FIRST INTERNAL TEST			
MODULE : 3 Introduction to electrical machine modeling: induction, DC, and synchronous machines; Simulation of basic electric drives, stability as MEEPCts.		7	15
MODULE : 4 Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self-commutated devices; Simulation of power factor correction schemes		7	15
SECOND INTERNAL TEST			
MODULE : 5 Simulation of converter fed dc motor drives; Simulation of thyristor choppers with voltage, current and load commutation schemes, Simulation of chopper fed dc motor.		6	20

MODULE : 6 Simulation of single and three phase inverters with thyristors and self-commutated devices, Space vector representation; Pulse-width modulation methods for voltage control, waveform control. Simulation of inverter fed induction motor drives.	8	20
END SEMESTER EXAM		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7421	ELECTRICITY DEREGULATION	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

- To acquaint the students with the deregulated electricity market;
- To equip the students with knowledge of the role of the system operator and the pricing mechanisms of the deregulation process

Syllabus

Introduction, Deregulated electric markets, Current international situation, Benefits and effects, Review of economic load dispatch problem, Optimal power flow, Basic OPF model, Unit commitment, Power pools, Energy brokerage system, Independent system operator, British and Nordic electricity sector deregulation, Pool and bilateral markets, Activities of a Genco, Market participation issues, Unit Commitment in deregulated environment, Competitive bidding, Power wheeling, Transmission open access, Cost components, Pricing of power transactions, Different types of transmission pricing, Security management, Scheduling of spinning reserves, Congestion management

Course Outcome:

1. Gain a good level of knowledge of the structure, participants, relations and principles of the deregulated electric power market..
2. Be knowledgeable of the stock markets, especially those with connected to commodity exchange.

Text Books:

1. Kankar Bhattacharya, Math H J Bollen, Jaap E Daader, “Operation of Restructured Power Systems, Kluwer academic publishers”, USA, first Edition, 2001.
2. Marjia Ilic, Francisco Galiana and Lester Fink, “Power systems restructuring engineering and economics”, Kluwer academic publishers, 1998.

References:

1. Zaccour G, ‘Deregulation of Electric Utilities’, Kluwer Academic Publisher, 1998,
2. Wood A J and Woolenberg B F, ‘Power Generation, Operation and Control’, John Wiley and Sons, 1996

COURSE PLAN

Course No:	Course Title:	CREDITS	
04 EE 7421	Electricity Deregulation	3-0-0:3	
MODULES		**Contact hours**	**Sem. Exam Marks; %**
MODULE : 1 Deregulation-Introduction, Different entities in deregulated electric markets, Background to deregulation, Current world situation , Benefits from a competitive electricity market		7	15
MODULE : 2 After effects of deregulation, Review of economic load dispatch problem, Recent developments in Electric load dispatch		6	15
FIRST INTERNAL TEST			
MODULE : 3 Optimal power flow, Basic OPF models, Examples, Characteristic features of OPF, Unit commitment, Basic model, Additional issues, Formation of power pools, Energy brokerage system		7	15
MODULE : 4 Independent system operator, Role of the ISO, Structure of British and Nordic electricity sector deregulation, Operational planning activities of ISO, Role of ISO in pool and bilateral markets		6	15
SECOND INTERNAL TEST			
MODULE : 5 Operational planning activities of a Genco, Genco in pool and bilateral markets, Market participation issues, Unit commitment in deregulated environment, Competitive bidding		6	20
MODULE : 6 Power wheeling, Transmission open access, Cost components in transmission, Pricing of power transactions -Embedded cost based transmission pricing, Incremental cost based transmission pricing, Security management in deregulated environment, Scheduling of		10	20

spinning reserves, Interruptible load options for security management, Congestion management in deregulation, Economic instruments for handling congestion		
END SEMESTER EXAMINATION		

COURSE CODE	COURSE TITLE	L-T-P-C	YEAR
04 EE 7603	ADVANCED CONTROLLERS FOR EMBEDDED SYSTEMS	3-0-0-3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- A introduction in the advanced dsPIC30F4011 motor control and power conversion controller for developing embedded system;
- An outline to the advanced TMS320F2407 DSP controller.
- An overview of FPGA based system design
- A introduction to ARM processors for developing embedded systems

Syllabus

dsPIC30F4011, Architecture, Programming, Motor Control and Power Conversion; Introduction to DSP Controller; outline to the advanced TMS320F2407 DSP controller; FPGA Based System Design using VHDL; Xilinx 4000 Series FPGAs and Altera Flex 10K series CPLDs; Overview of High Performance RISC Architecture, ARM organization.

Course Outcome:

The students who successfully complete this course will have ability to develop embedded systems using advanced microcontrollers such as dsPIC30F4011, TMS320F2407 ARM processors and FPGAs.

References:

1. Lucio Di Jasio, T Wilmshurst, Dogan Ibrahim, John Morton, Martin P. Bates, Jack Smith, D W Smith, C Hellebuyck, PIC Microcontrollers: Know It All: Know It All, Newnes – 2008
2. dsPIC30F4011 Data Sheet – 70135C, Microchip Technology Inc., 2005
3. Sen M. Kuo, Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, And Applications, Pearson Education, 2009
4. Phil Lapsley, Jeff Bier, Amit Shoham, Edward A. Lee, DSP Processor fundamentals: Architectures and Features , IEEE Press -1997 , Wiley India Pvt Ltd
5. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson/Brooks/Cole, 2004
6. TMS320LF2407 Data Sheet, Texas Instrument, September 2003
7. C. Maxfield, “The Design Warrior's Guide to FPGAs: Devices, Tools and flows”, Newnes, 2004
8. W. Wolf, “FPGA Based System Design”, Prentice-Hall, 2004.
9. Brown, S. D. and Vranesic, Z. G., "Fundamentals of Digital Logic with VHDL Design", Second or Third Edition, McGraw-Hill
10. Roth C. H., Digital System Design Using VHDL, Cengage Learning, 2008.
11. Steave Furber, "ARM system - on - chip architecture", Addison Wesley, 2000
12. Andrew N Sloss, Dominic Symes, Chris Wright, ARM System Developer`s Guide , Elseveir

COURSE PLAN

Course No:	Course Title:	CREDITS
04 EE 7603	Advanced Controllers for Embedded Systems	3-0-0 :3

MODULES	Contact hours	Sem. Exam Marks;%
MODULE : 1 - dsPIC30F4011 dsPIC30F4011 – Architecture - MCU and DSP features - Hardware DMA - Interrupt Controller - Digital I/O, On-chip Flash, Data EE and RAM	7	15
MODULE: 2 - dsPIC30F4011 - Motor Control and Power Conversion Peripherals - Timers, Communication Modules Motor Control Peripherals - Capture/Compare/PWM, Analog-to-Digital Converters	6	15
FIRST INTERNAL TEST		
MODULE : 3 DSP Controller Introduction Introduction to DSP architecture- computational building blocks - Address generation unit, Program control and sequencing- Parallelism, Pipelining	6	15
MODULE : 4 TMS 320LF2407 Architecture of TMS320LF2407 - Addressing modes- I/O functionality, Interrupt. ADC, PWM, Event managers**,** Elementary Assembly Language Programming	7	15
SECOND INTERNAL TEST		
MODULE : 5 - FPGA Based System Design using VHDL Overview of Hardware Description Languages – VHDL Introduction, Behavioral, Data flow, Structural Models - Simulation Cycles - Test bench; Design at different levels with special emphasis on FPGA and PLD, Design of sequential and Combinatorial circuits, Xilinx 4000 Series FPGAs and Altera Flex 10K series CPLDs	10	20

MODULE : 6 - High Performance RISC Architecture Overview of ARM architecture – RISC concepts - ARM organization and implementation, ARM instruction set - The thumb instruction set - Basic ARM Assembly language program - ARM CPU cores.	6	20
END SEMESTER EXAMINATION		

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EE 6491/7491	SEMINAR	0-0-2: 2	2015

Course Objectives:

1. Improve the technical presentation skills of the students.
2. To train the students to do literature review.
3. To impart critical thinking abilities.

Methodology

Individual students are required to choose a topic of their interest from related topics to the stream of specialization, preferably from outside the M. Tech syllabus. The students are required to do a moderate literature review on the topic and give seminar. A committee consisting of at least three faculty members (preferably specialized in the respective stream) shall assess the presentation of the seminar and award marks to the students based on merits of topic of presentation. Each student shall submit two copies of a write up of his seminar topic. The seminar report shall not have any plagiarised content (all sources shall be properly cited or acknowledged). One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other shall 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. It is encouraged to do simulations related to the chosen topic and present the results at the end of the semester.

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EE 7493	PROJECT PHASE - I	0-0-12: 6	2015

Course Objectives:

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.

The project work can be a design project/experimental project and/or computer simulation project on any of the topics related to the stream of specialisation. The project work is chosen/allotted individually on different topics. Work of each student shall be supervised by one or more faculty members of the department. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to carry out their main project outside the parent institute, subject to the conditions specified in the M. Tech regulations of the Kerala Technological University. Students are encouraged to take up industry problems in consultation with the respective supervisors.

The student is required to undertake the main project phase-1 during the third semester and the same is continued in the 4th semester (Phase 2). Phase-1 consist of preliminary work, two reviews of the work and the submission of a 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.

COURSE CODE	COURSE NAME	L-T-P: C	YEAR
04 EE 7494	PROJECT PHASE - II	0-0-21: 12	2015

Main project phase II is a continuation of project phase-I 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. It is encouraged to prepare at least one technical paper for possible publication in journals or conferences. The project report (and the technical paper(s)) shall be prepared without any plagiarised content and with adequate citations, in the standard format specified by the Department /University.