UNIVERSITY OF CALICUT
(Abstract)

Faculty of Engineering – Scheme & Syllabi of M.Tech Courses in Applied Electronics and Communication system and Power Electronics and Drives – Sanctioned – implemented with effect from 2010 admission - Orders Issued.

GENERAL AND ACADEMIC BRANCH – IV 'E' Section

No.GAIV/E1/7377/2010. Dated: Calicut University. P.O., 20.04.2011

Read: 1. U.O. No. GA IV/E1/7377/2010 (iii) dated 10.11.2010.
2. Minutes of the meeting of the Board of Studies in Engineering (PG) held on 25.03.2011 (item no. 1).
3. Orders of the Vice-Chancellor in the file of even no. dated 08.04.2011.

<u>O R D E R</u>

As per paper read 1st above, Expert Committees were constituted for the preparation of the scheme & syllabi for the M.Tech courses in (1) Applied Electronics and Communication System and (2) Power Electronics and Drives with the following members.

<u>M.Tech in Applied Electronics and Communication System.</u>

a. Prof. Muneera. C.R., Assistant Professor in Electronics and Communication Engineering, Government Engineering College, Thrissur (Co-ordinator).
b. Mr. Mohammed Salih. K.K., Lecturer in Electronics and Communication Engineering, Government Engineering College, Thrissur.
c. Mr. Nelson. K.J., Lecturer in Electronics and Communication Engineering, Government Engineering College, Thrissur.

<u>M.Tech in Power Electronics and Drives</u>

a. Dr. M.Nandakumar, Assistant Professor in Electrical and Electronics Engineering, Government Engineering College, Thrissur (Co-ordinator).
b. Dr. Jayanand. M., Assistant Professor in Electrical and Electronics Engineering, Government Engineering College, Thrissur.
c. Sri. T.G. Sanish Kumar, Senior Lecturer in Electrical and Electronics Engineering, Government Engineering College, Thrissur.

Vide paper read 2nd above, the meeting of the Board of Studies in Engineering (PG) held on 25.03.2011, vide item no. 1, unanimously resolved to recommend the approval of the scheme & syllabi of the M.Tech courses in Applied Electronics and Communication System and Power Electronics and Drives, submitted by the expert committees concerned.

Considering the urgency of the matter, the Vice-Chancellor has accorded sanction to implement the scheme & syllabi of the above mentioned M.Tech courses, subject to ratification by the Academic Council, vide paper read 3rd above.

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Sanction is therefore accorded for implementing the scheme & syllabi of the M.Tech course in

(1) Applied Electronics and Communication System & (2) Power Electronics and Drives with effect from 2010 admission.

Orders are issued accordingly. The scheme & syllabi are available in the University website. (www.university of calicut.info.)

Sd/-
DEPUTY REGISTRAR(G &A-IV)

For REGISTRAR

To
The Principals of Engineering Colleges offering the course.

Copy to : The System Administrator (with request to upload in the University website urgently)/PS to VC/PA to Registrar/ M.Tech Sn./Ex. Sn./Eg/Chairman, Board of Studies in English (PG)/(UG)/Dean, Faculty of Engineering/SF/FC.

Forwarded/By Order

Sd/-
SECTION OFFICER

UNIVERSITY OF CALICUT

SCHEME AND SYLLABUS FOR
M.Tech.
in
POWER ELECTRONICS & DRIVES
(2010 Admission onwards)

Scheme of M. Tech Programme in Power Electronics & Drives

SEMESTER 1

Sl. No.	Course code	Subject	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
1	EPD10 101	Applied Mathematics	3	1	0	100	100	200	4
2	EPD10 102	System Dynamics	3	1	0	100	100	200	4
3	EPD10 103	Analysis of Power Electronic Circuits I	3	1	0	100	100	200	4
4	EPD10 104	Electric Drives	3	1	0	100	100	200	4
5	EPD10 105	Elective	3	1	0	100	100	200	4
6	EPD10 106 (P)	Power Electronics Lab	0	0	2	100		100	2
7	EPD10 107 (P)	Seminar	0	0	2	100		100	2
TOTAL			15	5	4	700	500	1200	24

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

ELECTIVES

EPD10 105 (A) Power Semiconductor Devices & Modeling
EPD10 105 (B) Dynamics of Electrical Machines
EPD10 105 (C) Optimization Techniques
EPD10 105 (D) High Voltage AC and DC Transmission

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

SEMESTER 2

Sl. No.	Course code	Subject	Hours/week			ICA	ESE	Total	Credits
			L	T	P				
1	EPD10 201	Analysis of Power Electronic Circuits II	3	1	0	100	100	200	4
2	EPD10 202	Digital Control Systems	3	1	0	100	100	200	4
3	EPD10 203	Advanced Electric Drives	3	1	0	100	100	200	4
4	EPD10 204	Elective I	3	1	0	100	100	200	4
5	EPD10 205	Elective II	3	1	0	100	100	200	4
6	EPD10 206 (P)	Electric Drives Lab	0	0	2	100		100	2
7	EPD10 207 (P)	Seminar	0	0	2	100		100	2
TOTAL			15	5	4	700	500	1200	24

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

ELECTIVE I

EPD10 204 (A) FACTS and Custom Power Devices
EPD10 204 (B) Power Quality
EPD10 204 (C) Digital Simulation of Power Electronic Systems

ELECTIVE II

EPD10 205 (A) Embedded Controllers & Real Time Systems
EPD10 205 (B) DSP & Applications
EPD10 205 (C) Switched Mode Power Converters

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

SEMESTER 3

Sl. No.	Course code	Subject	Hours/week			ICA		ESE	Total	Credits
			L	T	P					
1	EPD10 301	Elective I	3	1	0	100		100	200	4
2	EPD10 302	Elective II	3	1	0	100		100	200	4
3	EPD10 303(P)	*Industrial Training						50	50	1
4	EPD10 304(P)	Master Research Project Phase I	0	0	22	Guide 150	EC 150		300	6
TOTAL			6	2	22	500		250	750	15

*Industrial Training is for a minimum period of two weeks
L-Lecture T-Tutorial P-Practical ICA-Internal Continuous Assessment
ESE-End Semester Examination

ELECTIVE I
EPD10 301 (A) Research Methodologies
EPD10 301 (B) Special Electrical Machines & Drives
EPD10 301 (C) Industrial Instrumentation
ELECTIVE II
EPD10 302 (A) VLSI Architecture & Design Methodologies
EPD10 302 (B) Soft Computing Techniques
EPD10 302 (C) Computer Networking

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

SEMESTER 4

Sl. No.	Course code	Subject	Hours/week			ICA		ESE		Total	Credits
			L	T	P	Guide	Evaluation Committee	External Examiner	Viva Voce		
1	EPD10 401	Master Research Project Phase II	0	0	30	150	150	150	150	600	12

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

Note: The student has to undertake the departmental work assigned by HOD
Total credits for all semesters: 75

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SEMESTER 1

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EPD10 101	**APPLIED MATHEMATICS** **(Common for EPS10 101, EPE10 101, EPD10 101)** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective: To enable the students apply probability and reliability theory in various electrical engineering problems

MODULE 1 (13 Hours)

Probability: Probability distributions, Binomial, Poisson, Normal, Uniform, Exponential, Weibull, Log normal, Beta, Gama, Joint distributions

Sampling distributions: Sampling distributions of mean and variance, Estimation, Point animation, Interval Estimation, Test of hypothesis

MODULE 2 (14 Hours)

Curve fitting: Method of least squares, Normal Equations, Fitting of straight line, Fitting of second degree curve, Correlations and regressions, Curvilinear regression, Multiple regression & Multiple correlation

Design of experiments: Analysis of variance-statistical principle of experimentation, Basic designs - Completely randomized design- Randomized block design.

MODULE 3 (14 Hours)

Stochastic Process: Examples, Specifications of Stochastic Process, stationary process

Markov chains: Definition and examples, Transition matrix, order of Markov chain, higher transition probabilities, Generalization of independent Bernoulli trails, Markov – Bernoulli chain, Correlated Random walk - Classification of states and chains. Determination of higher transition probabilities- Stability of Markov system.

MODULE 4 (13 Hours)

Reliability: series configuration- Parallel configuration-An r-out of n configuration - Failure time distributions-Exponential model in reliability-exponential model in life testing –Weibull model in life testing

REFERENCES

1. Miller & Freud's, *Probability and statistics in Engineering*, Pearson edition
2. Schupta and V.K.Kapoor *Fundamentals of statistics*, S Chand
3. J. Medhi, *Stochastic Process*, New age international publication-Chapter 2.1,2.2,2.3,3.1,3.2.3.3,3.4,3.5,3.6
4. Martin Shoo man, *Probabilistic Reliability An Engineering Approach*, McGrawHill

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks

Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 102	**SYSTEM DYNAMICS** **(Common for EPS10 102, EPE10 102& EPD10 102)** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objectives:

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

MODULE 1 (13 Hours)
State variable representation of system - concept of state - Equilibrium points – Stability - Solution of state equation - eigen values - eigen vectors – modes - modal decomposition - eigen value and stability - mode shape – sensitivity - participation factor - State space representation of discrete time systems - Discretization of continuous time state equation

MODULE 2 (12 Hours)
Lyapunov stability - definition of stability, asymptotic stability and instability - Lyapunov’s second method - Lyapunov’s stability analysis of LTI continuous time and discrete time systems - stability analysis of non linear system - Krasovski’s theorem - variable gradient method

MODULE 3 (14 Hours)
Concepts of controllability and observability - controllability and observability tests for continuous time and discrete time systems - controllability and observability studies based on canonical forms of state model - effect of state feedback on controllability and observability - pole placement by state feedback for continuous and discrete time systems - Design of full order and reduced order observer for continuous time and discrete time systems

MODULE 4 (15 Hours)
Optimal control - formulation of optimal control problem - Minimum time control problem -minimum energy problem - minimum fuel problem - state regulator problem - output regulator problem – tracking problem - choice of performance measure - optimal control based on quadratic performance measure – optimal control system design using second method Lyapunov - solution of reduced Riccatti equation.
Robust control systems – introduction - sensitivity analysis of robustness - system with uncertain parameters - design of robust PID controlled systems.

REFERENCES

1. Thomas Kailath, *Linear systems*, Prentice Hall Inc
2. K.Ogata, *Modern control Engg* (Second Edition), Prentice Hall Inc, 1990
3. K.Ogata, *Discrete time control systems*, P.H.I
4. M.Gopal, *Digital Control and State Variable methods*, TMH, 1997
5. M.Gopal, *Modern Control System Theory*
6. P.Kundur, *Power System Stability and Control*, McGraw-Hill Publishing Company, 1994
6. C.T.Chen, *Linear system theory and design*, New York,Holt Rinechart and Winston , 1984
7. Richard.C.Dorf and R.T Bishop, *Modern Control System*, P.H.I

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 103	ANALYSIS OF POWER ELECTRONIC CIRCUITS – I (Common for EPE10 103 & EPD10 103) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objective:

Detailed analysis of different power electronic circuits

MODULE 1(14 Hours)

Review of Power Devices – characteristics of Ideal and practical switches – Power diodes – reverse recovery characteristics – power diode types – Diodes with RC,RL, LC and RLC loads –power transistors – power MOSFET – IGBT – Thyristor – GTO – IGCT – steady state characteristics & switching characteristics – two-transistor model of thyristor - di/dt and dv/dt protection- gate trigger circuits – R, RC & UJT triggering – commutation circuits – natural & forced commutation – class A,B,C,D,E,F commutation - comparison of power devices.

Uncontrolled rectifiers – single-phase half-wave and full-wave bridge – performance parameters – FF, RF, TUF, DF, HF, input PF - single-phase full-wave bridge with RL load – 3-phase bridge rectifiers – FF,RF,TUF – R and RL load – analysis with C filter – effect of source and load inductances.

MODULE 2 (14 Hours)

Controlled rectifiers – single-phase half converter and full converters – analysis with R & RL loads – DF, HF, input PF - 3-phase half-wave – full converters & semiconverters – analysis with R & RL loads – continuous conduction & discontinuous conduction – inversion mode - effect of source inductance on 1-phase & 3-phase full converters – overlap angle - single-phase dual converters – circulating & non circulating current operation.

DC-DC converters – Step-down chopper – step- up chopper - analysis with R & RL load –PWM, frequency modulation control – current limit control – fourier analysis of output voltage - two-quadrant & four-quadrant chopper – voltage commutated chopper – current commutated chopper - switching-mode regulators – buck, boost, buck-boost and cuk regulators – condition for continuous inductor current and capacitor voltage - design of LC filter – comparison of regulators

MODULE 3 (11 Hours)

AC voltage controllers – ON-OFF control – phase control – 1-phase full wave – analysis with R & RL load – input PF – two stage sequence control with R & RL load – 3-phase full-wave controller with R load – 3-phase bidirectional delta connected controllers

Cycloconverter – single-phase to single-phase cycloconverter with R & RL load - 3-phase to 1-phase cycloconverter – 3-phase to 3-phase cycloconverter - thyristor-controlled reactor (TCR) - thyristor-switched capacitor (TSC)

MODULE 4 (13 Hours)

Inverters – 1-phase half bridge and full bridge – HF, THD, DF – 3-phase inverter - 180^o and 120^o conduction – Analysis with R & RL load – PWM techniques – single pulse, multiple pulse & sinusoidal pulse width modulation – modulation index – voltage control of 3-phase inverters – sine PWM – harmonic reduction – bipolar & unipolar modulation – current source inverter – 1-phase & 3-phase – Variable DC link inverter – boost inverter.

REFERENCES

1 Ned Mohan, Undeland, Robbins, *Power Electronics Converters, Applications and Design*, John Wiley

2 M.H. Rashid, *Power Electronics Circuits, Design and Applications*, Pearson Education

3 Cyril W Lander, *Power Electronics*, McGraw Hill

4 M.D. Singh, K.B. Khanchandani, *Power Electronics*, Tata McGraw-Hill

5 V.R. Moorthi, *Power Electronics Devices, Circuits & Industrial Applications*, Oxford University Press

6 Philip T Krein, *Elements of Power Electronics*, Oxford

7 Issa Batarseh, *Power Electronics Circuits*, John Wiley

8 Daniel W Hart, *Introduction to Power Electronics*, Prentice-Hall

9 Joseph Vithayathil , *Principles of Power Electronics*, Mc-Graw Hill

10 William Shepherd, Li Zhang, *Power Converter Circuits*, Marcell Dekker

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPE10 104	ELECTRIC DRIVES (Common for EPE10 104 & EPD10 104) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objective:

T*o provide a strong background on various methods of speed control of different electrical machines.*

MODULE 1 (12Hours)

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

MODULE 2 (14Hours)

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 drives – converter ratings and closed loop control - transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feeds back elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive.

MODULE 3 (14Hours)

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 – 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.

MODULE 4 (14Hours)

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.

REFERENCES

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

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPE10 105: ELECTIVE

EPD10 105(A)	**POWER SEMICONDUTOR DEVICES & MODELING** **(Common for EPE10 105(A) & EPD10 105(A))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:
The purpose is to make students aware of the device physics and operation of common power semiconductor devices and also those which are in the development stage

MODULE 1(13Hours)

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

MODULE 2(14Hours)

Current Controlled Devices - BJT's – Construction, Device Physics, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington - Thyristors – Physical and electrical principle underlying operation - Gate and switching characteristics - converter grade and inverter grade and other types - series and parallel operation - comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor.

MODULE 3(13Hours)

Voltage Controlled Devices - 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.

MODULE 4(14Hours)

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

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.

REFERENCES

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

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 105(B)	**DYNAMICS OF ELECTRICAL MACHINES** **(Common for EPE10 105(B) & EPD10 105(B))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:

This course deals with generalized modeling and analysis of different electrical machines used for industrial drive applications.

MODULE 1 (13 Hours)

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.

MODULE 2 (13 Hours)

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.

MODULE 3 (14 Hours)

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.

MODULE 4 (14 Hours)

Induction machines – 3-phase induction machine- generalized model – voltage equation – steady state analysis – equivalent circuit – torque-slip characteristics – effect of voltage and frequency variations – electric transients in induction machines – speed control of induction motor – introduction to vector control – applications in speed control of induction machine – single phase induction motor – generalized model – voltage and torque equations – steady state analysis.

TEXT BOOK:

1. PS. Bhimbra, *Generalized Theory of Electrical Machines*, Khanna Publishers
2. Krauss, Wasyncsuk and Sudholf, *Analysis of Electrical Machines and Drive Systems*, John Wiley
3. A E Fitzgerald, Kingsley, Umans, *Electric Machinery*, McGraw Hill
4. Adkins and Harey, *General Theory of AC Machines*
5. Bimal K Bose, *Modern Power Electronics & AC Drives*, Pearson Education

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 105(C)	OPTIMIZATION TECHNIQUES (Common for EPS10 105 (C), EPE10 105 (C), EPD10 105 (C),CEH10 105(C)) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objective:

To apply the different optimization techniques to both linear and non-linear systems.

MODULE 1 (13Hours)

Linear programming: Statement and classification of optimization problems overview of optimization techniques standard form of linear programming problems-Definitions and theorems-Simplex method-Revised simplex method-Duality and Dual simplex method-Sensitivity analysis.

MODULE 2 (14Hours)

Unconstrained dimensional optimization techniques: Necessary and sufficient conditions-search methods(unrestricted Fibonacci and golden)-Interpolation methods(Quadratic, Cubic and direct root method).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.

MODULE 3 (14Hours)
Constrained optimization techniques & dynamic programming:
Necessary and sufficient conditions-Equality and inequality constraints-Kuhn-Tacker conditions-Gradient projection method-cutting plane method-Penalty function method(Interior and exterior).Principle of optimality-recurrence relation-Computation procedure-continuous dynamic programming.

MODULE 4 (13Hours)
Recent developments in optimization techniques:
Rosenbrocks Rotating Coordinate Method-Tabu search-Simulated Annealing-Genetic Algorithm-Particle Swarm Optimization –Ant colony Optimization-Bees Algorithm.

REFERENCES:

1. Rao S.S, *Optimisation:Theory and Application*, Wiley Eastern Press
2. Pierre, D.A., *Optimisation*, *Theory with Applications*, John Wiley & Sons
3. Fox, R.L., *Optimisation method for Engineering Design*, Addition Wesley
4. Hadely,G., *Linear Programming*, Addition Wesley
5. Bazaara & Shetty, '*Non-linear Programming*'
6. D.E. Goldberg, *Genetic Algorithm in Search, Optimization, and Machine Learning*, Addison-Wesly, 1989.
7. 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.
8. 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
9. Recent literature should also be referred

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 105(D)	**HIGH VOLTAGE DC AND AC TRANSMISSION**	**Credits: 4**

	(Common for EPS10 105 (D), EPE10 105 (D)& EPD10 105 (D)) Hours/week: Lecture-3 and Tutorial-1	

Objective**:**

To give the students an in depth knowledge of the configuration and working of HVDC & AC systems.

MODULE 1 (12Hours)

General Aspects, Converter circuits and analysis: HVDC links - comparison –Economic, Technical performance – Reliability – Limitations - Properties of thyristor converter circuits-assumptions-Choice of best circuit for HVDC converters-Transformer connections - Analysis with gate control but no overlap less than 60 degrees- operation of inverters

MODULE 2 (14Hours)

Bridge converters-Analysis, Control, Protection and Harmonics Filters: Converter Inverter circuits for HVDC Transmission-basic means of control –Power reversal-desired features of control – actual control characteristics. Converter disturbance –bypass action in bridges- commutation failure-basics of protection-DC Reactors-Voltage and current oscillations-Circuit breakers - Over voltage protection-Characteristics and uncharacteristic harmonics-troubles due to harmonics-harmonic filters-Converter charts of direct current and voltage- active and reactive power.

MODULE 3 (14Hours)

Lightning, Travelling waves and switching Transients: Mathematical model to represent lightning- Travelling wave in transmission lines-Circuits with distributed constants- Wave equations- Reflection and Refraction of travelling waves-Travelling waves at different line terminations-effect of short length of cables- Shape and attenuation and distortion of travelling waves- Selection of typical wave to represent over voltages-Switching transients- the circuit closing transient-the recovery transient initiated by the removal of the short circuit – Double frequency transients- Abnormal switching transients- Current suppression- capacitance switching-Arcing ground-Transformer inrush current –Ferro resonance- neutral connections- Transients in switching a three phase reactor –Three phase capacitor

MODULE 4 (13Hours)

Protective device in HVAC transmission, Interaction between AC & dc System: Basic ideas about protection – surge diverters- surge absorbers- ground fault neutralizers- Protection of lines and stations by shielding- Ground wires – counter poises-Driven rods- Modern lightning arrestors-Insulation co ordination- Protection of alternators- Industrial drive system. Interaction between AC & DC systems- Voltage interaction-Harmonic instabilities- Smoothing Reactors – Overhead lines – Cable Transmission-Earth Electrodes-Design of back to back thyristor convertor system.

REFERENCES:

1. Kimbark,E.W., *Direct current transmission-Vol.1*, Wiley Interscience, New York, 1971
2. Arrilaga,J., *High Voltage Direct current transmission*, Peter Pereginver Ltd., London,UK.
3. Allen Greenwood, *Electrical Transients in power system*, Wiley Interscience
4. Diesendorf,W., *Overvoltage on High voltage system*, Rensselaer Book store ,Troy, New York,1971
5. Klaus Ragallea, *Surges and high voltage networks*, Plenum Press
6. Padiyar,K.R., *HVDC Transmission system*, Wiley Eastern Limited, NewDelhi
7. R.D.Begamudre, *High Voltage Engineering*, New Age International Publishers

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 106(P)	POWER ELECTRONICS LAB Hours/week: 2	Credits: 2

Objective:

To provide practical knowledge through hardware implementation & simulation of power electronic circuits

LIST OF EXPERIMENTS

A) HARDWARE

1. Single Phase Semi-converter with R-L load for continuous & discontinuous conduction modes
2. Single Phase Full-converter with R-L load for continuous & discontinuous conduction modes
3. Digital firing circuit
4. Three Phase Full-converter with R-L-E load
5. Controlled and Uncontrolled rectifier with different types of filters - continuous & discontinuous modes of operation
6. Transformer and Inductor design
7. Current & voltage commutated thyristorized chopper
8. MOSFET/ IGBT/Transistor based DC Choppers (Buck & Boost)
9. Half bridge square wave inverter
10. Single-phase Sine triangle PWM inverter
11. Single Phase AC Voltage Controller
12. Transfer function of armature controlled DC Motor
13. Microcontroller and DSP based control of dc-dc converters
14. Study of harmonic pollution by power electronics loads using power quality analyser

B) SIMULATION

1. 3-phase full converter and semi-converter with R, RL and RLE loads
2. 3-phase ac voltage controller
3. Closed loop control of DC-DC converter
4. 3-phase sine PWM inverter
5. Measurement of THD of current & voltage waveforms of controlled & uncontrolled 3-phase rectifiers.

Out of the above, a minimum of SIX hardware experiments and FOUR simulation experiments are to be conducted. Simulation can be done using any of the software packages like MATLAB/SIMULINK, PSPICE, PSCAD etc.

Internal continuous assessment: 100 marks

- **Regularity – 30%**

- **Record – 20%**
- **Test and Viva – 50%**

EPD10 107(P)	SEMINAR Hours/week: 2	Credits: 2

Objective:

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

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

Internal continuous assessment: 100 marks

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SEMESTER 2

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EPD10 201	ANALYSIS OF POWER ELECTRONIC CIRCUITS – II (Common for EPE10 201 & EPD10 201) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objectives:
To provide a strong foundation on advanced converter techniques and their control in modern Power Electronic Systems

MODULE 1 (14 Hours)
PWM Strategies for Inverters **-** Review of Sinusoidal PWM – Trapezoidal modulation, staircase modulation, stepped modulation, harmonic injected modulation, delta modulation – Third harmonic PWM - Space Vector Modulation – concept of space vector - space vector switching - over modulation – Multilevel inverters – Diode-clamped multilevel inverter – improved diode-clamped inverter - Flying-capacitors multilevel inverter – cascaded multilevel inverter – applications of multilevel converters – reactive power compensation, back-to-back intertie, adjustable speed drives.

MODULE 2 (14 Hours)
Power factor improvement of rectifier circuits **–** Extinction angle control, symmetric angle control, PWM control - 1-phase sinusoidal PWM, 3-phase PWM rectifier - 1-phase series converters – semi converters & full converters – Twelve-pulse converter
AC voltage controllers with PWM control.
Matrix converter – principle – 3-phase matrix converter – Venturini control method – principle – switching duty cycles – modulation functions – modulation matrix

MODULE 3 (12 Hours)
Current Regulated PWM Voltage Source Inverters **-** Methods of Current Control, hysteresis Control- hysteresis current controller used in specific application- Variable Band Hysteresis Control, Fixed Switching Frequency Current Control Methods
Static switches – 1-phase ac switches – 3-phase ac switches – 3-phase reversing switches –AC switches for bus transfer- DC switches- Solid-state relays – microelectronic relays.

MODULE 4 (14 Hours)
Applications of power electronics in power systems – principle of power transmission – principle of shunt compensation – Thyristor controlled reactor (TCR) – Thyristor-switched capacitor (TSC) – principle of series compensation – Thyristor-switched series capacitor (TSSC) – Thyristor-controlled series capacitor (TCSC) – Forced-commutation-controlled series capacitor (FCSC) – Series static VAR compensator (SSVC) – principle of phase angle compensation – phase-angle compensator – unified power flow controller (UPFC)

REFERENCES
1. M.H. Rashid, *Power Electronics Circuits, Design and Applications*, Pearson Education
2. Mohan, Undeland, Robbins, *Power Electronics*, John Wiley and Sons
3. William Shepherd, Li Zhang, *Power Converter Circuits*, Marcel Decker
4. Prof. Ramnarayanan, *Course Material on Switch Mode Power Conversion*, Electrical Department, IISc, Bangalore
5. Philip T Krein, *Elements of Power Electronics*, Oxford

6. B K Bose, *Modern Power Electronics and AC Drives*, PHI
7. B W Williams, *Principles and Elements of Power Electronics,* University of Strathclyde Glasgow
8. Kazmierkowski, Krishnan, Blaabjerg, *Control in Power Electronics*, Academic Press
9. Issa Batarseh, *Power Electronic Circuits*, John Wiley
10. Bin WU, *High Power Converters and AC drives*, John Wiley
11. D Grahame Holmes, Thomas A Lipo, *Pulse Width Modulation for Power Converters: Principles and Practice*, IEEE Press
12. M H Rashid (Ed), *Power Electronics Handbook*, Academic Press

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks Question 2 : 20 marks	Question 3 : 20 marks Question 4 : 20 marks	Question 5 : 20 marks Question 6 : 20 marks	Question 7 : 20 marks Question 8 : 20 marks

EPD10 202	DIGITAL CONTROL SYSTEMS (Common for EPE10 202 & EPD10 202) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objectives

- *To familiarise digital controllers.*
- *To understand the analysis and design of digital control system.*

MODULE 1 (12 Hours)

Introduction to discrete time control system- Block diagram of a digital control system-Typical examples- Sampling process- Data reconstruction and hold circuits-Zero and first order hold-Review of z- transforms and inverse z- transforms- solution of difference equations- pulse transfer function- pulse transfer function with dead time- system time response- Realization of pulse transfer functions (Digital Controllers)- Direct Programming- Standard Programming- Series programming- parallel programming- ladder programming.

MODULE 2 (16 Hours)

Review of stability analysis in z- plane- Jury's stability test and extension of Routh's stability criterion to discrete systems- Transient and Steady state response analysis- transient response specifications- steady state error analysis- Construction of root loci- effect of sampling period on transient response specifications- frequency response specifications- Nyquist stability criterion in the z- plane- Digital Controllers- PI, PD & PID Controllers- Lag, lead, and lag-lead compensators- Design of lag compensator and lead compensator based on root locus and Bode plot approaches

MODULE 3 (14 Hours)

State Space analysis of digital control systems- state space representation of discrete time systems- Transfer function from state model- Diagonal/ Jordan Canonical forms from transfer function- Solution of linear time invariant discrete time state equations- discretization of continuous time space equation- representing state models in CCF, OCF, DCF/ JCF using transformation matrix

MODULE 4 (12 Hours)

Concept of controllability and observability for a linear time invariant discrete time control system- condition for controllability and observability- state feedback- condition for arbitrary pole placement- design via pole placement- state observers- design of full order state observer

REFERENCES

- K. Ogata, *Discrete- time control systems*, PHI
- M. Gopal, *Digital Control and State Variable Methods*, Tata McGraw Hill
- B. C. Kuo, *Digital Control Systems*, Prentice Hall
- Charles L. Philip and Troy Nagle, *Digital control Systems*, Prentice Hall

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 203	**ADVANCED ELECTRIC DRIVES** **(Common for EPE10 203 & EPD10 203)** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objectives:

To provide the fundamental concepts in modeling and control schemes used in advanced AC drives systems

MODULE 1 (12 Hours)

Modeling - Dynamic modeling of induction machines – 3-phase to 2-phase transformation –power equivalence – generalized model in arbitrary reference frame – electromagnetic torque – derivation of stator reference frame model, rotor reference frame model, synchronously rotating reference frame model – equations in flux linkages - dynamic d-q model of synchronous machines.

MODULE 2 (13 Hours)

Vector Control - Vector controlled induction motor drive – Principle of vector or field oriented control – direct rotor flux oriented vector control – estimation of rotor flux and torque– implementation with current source and voltage source inverters - Stator flux oriented vector control - Indirect rotor flux oriented vector control scheme - implementation – tuning - Dynamic simulation - Parameter sensitivity and compensation of vector controlled induction motors - Selection of Flux level - Flux weakening operation - Speed controller design – simulation of vector control of induction motor using MATLAB/SIMULINK.

MODULE 3 (13 Hours)

Doubly-fed machine speed control by rotor rheostat – static kramer drive – phasor diagram, equivalent – speed control – power factor improvement – Static Scherbius drive – Modes of operation - Direct torque control of induction motor – principle – control strategy – space vector modulation – reduction of torque and flux ripple – comparison of DTC and FOC – simulation of DTC of induction motor using MATLAB/SIMULINK

MODULE 4 (15 Hours)

Permanent magnet synchronous and brushless DC motor drives – types of permanent magnet synchronous machines – Vector control of PM synchronous machine – model of PMSM – Vector control – control strategies – constant torque-angle control, unity power factor control, constant mutual flux-linkages control, optimum torque per ampere control, flux weakening operation, direct flux weakening algorithm, speed-controlled PMSM drive – sensorless PMSM drive – PM brushless DC motor – modeling – drive scheme – Switched reluctance motor drives.

REFERENCES

1. R Krishnan, *Electric Motor Drives*, PHI
2. D W Novotny and T A Lipo, *Vector Control and Dynamics of AC Drives*, Oxford University Press
3. B K Bose, *Modern Power Electronics and AC Drives*, PHI
4. Leonhard, *Control of Electric Drives*, Springer
5. Kazmierkowski, Krishnan, Blaabjerg, *Control in Power Electronics-Selected Problems*, Academic Press
6. John Chiasson, *Modeling and High Performance Control of Electric Machines*, Wiley-IEEE Press
7. I Boldea, S A Nasar, *Electric Drives*, CRC Press
8. K Rajashekara, *Sensorless Control of AC motors*, IEEE Press
9. I Boldea, S A Nasar, *Vector Control of AC Drives*, CRC Press
10. J Holtz, *Sensorless Control of Induction Motor Drives*, Proceedings of the IEEE, August 2002, PP 1359-1394.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 204: ELECTIVE 1

EPD10 204(A)	FACTS AND CUSTOM POWER DEVICES (Common for EPE10 204(A), EPD10 204(A)& EPS10 204(A)) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objectives:
Operation, control and application of different FACTS devices and custom power devices.

MODULE 1 (14 Hours)
FACTS and preliminaries: FACTS concept and general system considerations - power flow in AC system - definitions on FACTS - basic types of FACTS controllers.
Converters for Static Compensation - Three phase converters and standard modulation strategies (Programmed Harmonic Elimination and SPWM) - GTO Inverters - Multi-Pulse Converters and Interface Magnetics - Transformer Connections for 12, 24 and 48 pulse operation - Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) - Multi-level inverters of Cascade Type and their modulation - Current Control of Inverters.

MODULE 2 (14 Hours)
Static Shunt and Series Compensators: Static Shunt Compensators - SVC and STATCOM - operation and control of TSC, TCR, STATCOM - Compensator Control - Comparison between SVC and STATCOM - STATCOM for transient and dynamic stability enhancement.
Static Series Compensation - GCSC, TSSC, TCSC and SSSC - operation and control - external system control for series compensators - SSR and its damping - static voltage and phase angle regulators - TCVR and TCPAR - operation and control.

MODULE 3 (13 Hours)
UPFC and IPFC: The Unified Power Flow Controller - operation, comparison with other FACTS devices - control of P and Q - dynamic performance - Special Purpose FACTS Controllers - Interline Power Flow Controller - operation and control.

MODULE 4 (13 Hours)
Power Quality and introduction to custom power devices: Power Quality issues related to distribution systems – custom power devices – Distribution STATCOM – Dynamic Voltage restorer – Unified Power Quality Conditioner – Application of D-STATCOM, DVR and UPQC for improving power quality in distribution systems.

REFERENCES:

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

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 204(B)	**POWER QUALITY** **Hours/week: Lecture-3 and Tutorial-1** **(Common for EPE10 204(B), EPD10 204(B) & EPS10 204(B))**	**Credits: 4**

Objectives:

To familiarize with power quality problems and measurements.

To study the impact of and on the device and different mitigation techniques.

MODULE 1 (14 Hours)

Overview of power quality phenomena-classification of power quality issues-power quality measures and standards-flicker-transient phenomena-Harmonics-sources of harmonics-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and recommended practices.

MODULE 2 (14 Hours)

Modelling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and its impact on drives.

MODULE 3 (13 Hours)

Power quality application of state estimation-flicker-impulses-high frequency issues-common mode and transverse mode noise-geometric interference-susceptibility of loads-loss of life of power system components

MODULE 4 (13 Hours)
Power quality improvement: harmonic filters-active filters-phase multiplication-power conditioners-uninterruptible power sources-constant voltage transformers-static compensators and static watt compensators.

TEXT BOOK

1. Heydt, G.T., *Electric Power Quality*‟, Stars in a Circle Publications, Indiana
2. Ewald F Fuchs, Mohammad A.S., *Power Quality in Power Systems and Electrical Machines*, Elsevier, Academic Press

REFERENCES

6. Bollen, M.H.J., *Understanding Power Quality Problems: Voltage sags and interruptions*, IEEE Press, New York
7. Arrillaga. J, Watson, N.R., Chen, S., *Power System Quality Assessment*, Wiley, New York, 2000.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 204(C)	**DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS** **(Common for EPE10 204(C) & EPD10 204(C))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective: *To focus on different approaches to modeling of power electronics systems and the use of software tools for analysis*

MODULE 1 (13 Hours)
Principles of Modeling Power Semiconductor Devices - Macro models versus Micro models - Thyristor model - Semiconductor Device modeled as Resistance, Resistance-Inductance and Inductance-Resistance-Capacitance combination - Modeling of Electrical Machines.

MODULE 2 (14 Hours)

Modeling of Control Circuits for Power Electronic Switches. Computer Formulation of Equations for Power Electronic Systems –Review of graph theory as applied to Electric networks- Systematic method of Formulating State Equations - Computer Solution of State Equations - Explicit Integration method - Implicit Integration method.

AC equivalent circuit modeling: Basic AC modeling approach-State space averaging-circuit averaging and averaged switch modeling-Modeling the PWM.

MODULE 3 (14 Hours)

Analysis Using Software Tools

Circuit Analysis Software ORCAD- PSpice - Simulation Overview - Creating and Preparing a Circuit for Simulation - Simulating a Circuit with PSpice - Simple Multi-run Analyses - Statistical Analyses - Simulation Examples of Power Electronic systems- Creating Symbols - Creating - Models - Analog Behavioral Modeling - Setting Up and Running analyses – Viewing Results - Examples of Power Electronic Systems.

MODULE 4 (13 Hours)

Dynamic modeling and simulation of DC-DC converters using MATLAB - Simulation of State Space Models - Modeling and simulation of inverters using MATLAB

REFERENCES

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

Internal continuous assessment: 100 marks

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

End semester Examination:100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 205 ELECTIVE 2

EPD10 205(A)	**EMBEDDED CONTROLLERS IN REAL TIME SYSTEMS** **(Common for EPE10 205(A) & EPD10 205(A))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective: *This course introduces embedded controllers, its architecture, applications and real time systems.*

MODULE 1 (14 Hours)

8051 Microcontroller - Assembly Language programming and C Programming- Instruction set – Interrupts - Timers – Memory- I/O ports – Serial Communication - Interfacing –Key board, LED display, External memory, ADC, DAC, LCD, RTC – Typical applications- DC motor speed control, speed measurement, Temperature control, Stepper motor control, PID control.

MODULE 2 (13 Hours)

Real-time Systems - Introduction to real time systems-interrupt driven systems-context switching-scheduling-round robin-preemptive-rate monotonic-Foreground and Background systems-Intertask communication- Buffering data-Mailboxes-Critical regions-Semaphores-Deadlock-Process stack management- Dynamic allocation-Response time calculation-Interrupt latency.

MODULE 3 (14 Hours)

PIC Processors - RISC concepts - PIC processors- overview-16F877 - Architecture – Elementary Assembly Language Programming- Interrupts – Timers – Memory – I/O ports – SPI – I2C bus - A/D converter - USART- PWM – Interfacing - Introduction to FPGA Devices.

MODULE 4 (13 Hours)

DSP Architecture - Introduction to DSP architecture- computational building blocks - Address generation unit- Program control and sequencing- Speed issues- Harvard Architecture, Parallelism, Pipelining. TMS 320F2407- Architecture- Addressing modes- I/O functionality, Interrupts, ADC, PWM, Event managers- Elementary Assembly Language Programming- Typical applications-buck boost converter, stepper motor control- Software and Hardware Development Tools.

REFERENCES

1. Mazidi & Mazidi, *Embedded System Design using 8051 Microcontroller*, Pearson
2. Ajay V DeshMukh, *Microcontrollers -Theory and Applications*, TMH
3. Phillip A Laplante, *Real Time Systems Design and Analysis*, PHI
4. Daniel W Lewis, *Fundamentals of Embedded Software*, Pearson
5. Sen M Kuo, Woon Seng Gan, *Digital Signal Processors-Architecture, Implementation and Applications*, Pearson
6. H A Toliyat, S Campbell, *DSP Based Electro Mechanical Motion Control*, CRC Press,
7. Avtar Singh, S Srinivasan, *Digital Signal Processing*, Thomson Brooks
8. Phil Lapsley, Bler, Sholam, E A Lee, *DSP Processor Fundamentals*, IEEE Press
9. Wayne Wolf, *FPGA Based System Design*, Pearson
10. Scott Hauck, *The Roles of FPGAs in Reprogrammable Systems*, Proceedings of the IEEE, Vol. 86, No. 4, pp. 615-639, April, 1998.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 205(B)	DSP AND ITS APPLICATIONS (Common for EPE10 205(B) & EPD10 205(B)) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objective:

- *To study the various methods for the analysis of digital systems*
- *Design a digital filter for the given specifications*
- *To study the architecture and applications of digital signal processors*

MODULE 1 (13 Hours)

Review of signals and systems – Review of discrete-time Fourier transform (DTFT) – Discrete Fourier Transform – properties – inverse DFT – relationship between DFT and Z-transform – circular convolution – linear convolution using DFT – overlap add/save method – Fast Fourier Transform (FFT) - Decimation-in-time (DIT) & Decimation-in-Frequency (DIF) FFT algorithms.

MODULE 2 (15 Hours)

Realization of IIR filters – direct form I & II – cascade – parallel – lattice-ladder – state space realizations – type I & II – realization of FIR filters – direct form – cascade – linear phase realizations – lattice – conversion from lattice to direct form - Digital filter design – analog to digital transformation – backward-difference technique – impulse invariant – bilinear transformation – design of IIR filter from analog filter – Butterworth & Chebyshev filter – FIR filter design – Fourier series method – design using windows – Rectangular, Bartlett, Hanning, Hamming, Blackman, Kaiser windows - comparison of FIR & IIR filters.

MODULE 3 (15 Hours)

Multirate digital signal processing – sampling rate conversion – decimation, interpolation – sampling rate alternation or conversion – filter design and implementation for sampling rate alternation – direct form FIR digital filter structure, polyphase filter structure, time-varying digital filter structure – sampling rate conversion by an arbitrary factor .

Finite word length effects – fixed point and floating point formats – quantization errors – limit cycle oscillations - Digital signal processors – selection of digital signal processors – Von Neumann & Harvard architecture – Multiply Accumulate Unit (MAC) - architecture of DSP processor - fixed point & floating point (block diagram approach) - applications of digital signal processors

MODULE 4 (11 Hours)
Applications of DSP – speech processing – speech analysis, synthesis and compression – radar signal processing – image processing – image formation, recording, compression, restoration, enhancement – echo cancellation
Execution of simple programs using digital signal processor – solution of specific problems in digital signal processing using MATLAB programs

REFERENCES

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

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 205(C)	**SWITCHED MODE POWER CONVERTERS** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:
To acquaint the students with working, analysis and modelling of different types of converters.

MODULE 1 (14 Hours)
Review of Buck, Boost, Buck-Boost topologies - basic operation – Waveforms - modes of operation - voltage mode control principles.
Push-pull and Forward converter - basic operation – waveforms - modes of operation - Transformer design - voltage mode control principles.

Half and Full Bridge Converters - basic operation – waveforms - modes of operation -voltage mode control principles.
Fly back Converter - basic operation – waveforms - modes of operation - voltage mode control principles.

MODULE 2 (14 Hours)

Voltage Mode Control of SMPS - Loop gain and Stability Considerations - Shaping the Error Amplifier gain versus frequency characteristics - Error amplifier Transfer function – Tran conductance Error amplifiers.
Current Mode Control of SMPS – Current Mode Control Advantages - Current Mode versus Voltage Mode Control of SMPS – Current Mode Deficiencies - Slope Compensation.

MODULE 3 (13 Hours)

Modelling of SMPS - Basic AC modelling Approach – Modelling of non ideal fly back converter - State Space Averaging – basic state space averaged model – State space averaging of non ideal buck boost converter - Circuit averaging and averaged switch modelling – Modeling of pulse width modulator

MODULE 4 (13 Hours)

Introduction to Resonant Converters – Classification of Resonant Converters – Basic Resonant circuit concepts – load resonant converters – resonant switch converters – Zero voltage switching, clamped voltage topologies – resonant DC Link inverters with zero voltage switching – High frequency link integral half cycle converter

REFERENCES

11 Ned Mohan, *Power Electronics:Converters,Applications And Design* , John Wiley & Sons
12 Abraham I Pressman , *Switching Power Supply Design* , McGraw-Hill Publishing Company
13 R. W. Erickson , *Fundamental of Power Electronics* , Chapman & Hall Publishers
14 William Shepherd, Li Zhang, *Power Converter Circuits*, CRC Taylor Francis

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 206(P)	ELECTRIC DRIVES LAB Hours/week: 2	Credits: 2

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

(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)

Internal continuous assessment: 100 marks

a. **Regularity – 30%**
b. **Record – 20%**
c. **Test and Viva – 50%**

EPD10 207(P)	SEMINAR Hours/week: 2	Credits: 2

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

Individual students are required to choose a topic of their interest from power electronic related topics preferably from outside the M.Tech syllabus. And give a seminar on that topic about 45 minutes. A committee consisting of at least three faculty members (preferably specialized in power electronics) shall assess the presentation of the seminar and award marks to the students based on merits of topic of presentation. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

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SEMESTER 3

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EPD10 301: ELECTIVE 1

EPD10 301(A)	**RESEARCH METHODOLOGY** **(Common for EPS10 301(B), EPE10 301(A), EPD10 301(A), CEE10 301(A), CEH10 301(A), MIT10 301(A), PMS10 301(A))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:
To impart knowledge about various methodologies followed in engineering research, formulation of research problems and to apply the same in project work. To make students aware of the problems faced by Indian researchers.

MODULE 1 (13Hours)
Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research. Research process – Criteria for good research – Problems encountered by Indian researchers.

MODULE 2 (13Hours)
Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions – Field Study – Critical Analysis of Generated Facts – Hypothetical proposals for future development and testing, selection of Research task

MODULE 3 (14Hours)
Mathematical modeling and simulation – Concepts of modeling – Classification of mathematical models – Modeling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

MODULE 4 (14Hours)
Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

REFERENCES
1. J.W Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, N.York
2. Schank Fr., *Theories of Engineering Experiments*, Tata Mc Graw Hill Publication.
3. C. R. Kothari, *Research Methodology*, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication
5. Krishnaswami, "*Management research methodology – Integration of methods & Techniques*", Pearson

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 301(B)	**SPECIAL ELECTRICAL MACHINES AND DRIVES** **(Common for EPE10 301(B) & EPD10 301(B))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:
To introduce special types of electric machines and their controls for special applications.

MODULE 1 (13Hours)
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

MODULE 2 (14Hours)
Switched Reluctance Motors
Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control. Microprocessor based controller. Sensor less control.
Synchronous Reluctance Motors
Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque – Phasor diagram, motor characteristics.

MODULE 3 (13Hours)
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.

MODULE 4 (13Hours)
Permanent Magnet Synchronous Motors
Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes - Sensor less control.

REFERENCES
1. Kenjo T, Sugawara A, *Stepping Motors and Their Microprocessor Control*, Clarendon Press, Oxford
2. Miller T J E, *Switched Reluctance Motor and Their Control*, Clarendon Press, Oxford
3. Miller T J E, *Brushless Permanent Magnet and Reluctance Motor Drives*, Clarendon Press, Oxford
4. B K Bose, *Modern Power Electronics & AC drives*, Pearson Education
5. Kenjo T, *Power Electronics for the Microprocessor Age*, Oxford University Press
6. Ali Emadi (Ed), *Handbook of Automotive Power Electronics and Motor Drives*, CRC Press
7. R Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, PHI
8. H A Toliyat, S Campbell, *DSP Based Electro Mechanical Motion Control*, CRC Press

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 301(C)	**INDUSTRIAL INSTRUMENTATION** **(Common for EPE10 301(C) & EPD10 301(C))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objectives

- *To create an awareness of the different transducers used in industry and signal conditioning*
- *To familiarize the process control elements and their control characteristics*

MODULE 1 (13Hours)
Signal Conditioning – Analog – Digital - Signal conversions - Process Control Principles - Identification of elements, block diagram, the loop, control system evaluation stability, regulation, evaluation criteria, and cyclic response.

MODULE 2 (14Hours)
Final Control Element: Final control operation, signal conversions, analog electrical signal, digital electrical signals, Direct action – pneumatic signals, Actuators – electrical actuators, pneumatic actuators, control elements – fluid valves. Signal Conditioning of Transducers- Temperature Transducers - flow transducers

MODULE 3 (14Hours)
Controller Principles - Process characteristics, control system parameters, controller modes, discontinuous controller modes, continuous controller modes, composite controller modes.
Analog Controllers - Electronic controller – Direct action, reverse action, proportional mode, integral mode, derivative mode, composite controller modes - Pneumatic controllers – implementation of PI, PID, PD - Design consideration.

MODULE 4 (13Hours)
Control Loop Characteristics: Control system configurations, cascade control, multivariable control, feed forward control, Split range control, inferential control, Adaptive control, control system quality – loop disturbance, optimum control, measure of quality, Stability, process loop tuning

REFERENCES

1. Curtis D. Johnson, *Process Control Instrumentation Technology*, Pearson Education
2. Curtis D. Johnson, *Microprocessors in Process Control*, PHI
3. George Stephanopoulis, *Chemical Process Control*
4. Caughner, *Process Analysis and Control*
5. Deshpande and Ash, *Elements of computer process control of Industrial processes*, ISA
6. Jayantha K. Paul, *Real- Time microcomputer control of Industrial processes*, Kluwer Publications, Netherlands
7. S. K. Singh, *Computer Aided Process Control*, PHI
8. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mekkichamp, *Process Dynamics and Control*, Wiley India

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 302: ELECTIVE 2

EPD10 302(A)	VLSI ARCHITECTURE AND DESIGN METHODOLOGIES (Common for EPE10 302(A) & EPD10 302(A)) Hours/week: Lecture-3 and Tutorial-1	Credits: 4

Objective

- *Overview of VLSI System Design and fabrication*

MODULE 1 (14Hours)

Overview Of VLSI Design Methodology: VLSI design process -. Architectural design -Logical design -Physical design -Layout styles -Full custom -Semi custom approaches. .

VLSI Fabrication Techniques : .An overview of wafer fabrication –Wafer Processing -Oxidation -Patterning -Diffusion - Ion Implantation -Deposition –Silicon gate nMOS process - CMOS processes -nWell - pWell -Twin tub -Silicon on insulator- CMOS process (enhancements -Interconnect -Circuit elements.

MODULE 2 (13Hours)

Basic Electrical Properties Of MOS And CMOS Circuits: nMOS enhancement transistor -PMOS enhancement transistor -Threshold voltage - Threshold voltage equations -MOS device equations -Basic DC equations - Second order effects - MOS Modules - Small signal AC characteristics - nMOS inverter -Steered input to an nMOS inverter - Depletion mode and enhancement mode pull ups – CMOS inverter -DC characteristics -Inverter delay -Pass transistor -Transmission gate.

MODULE 3 (13Hours)

Layout Design Rules: Need for design rules - Mead conway design rules for the.silicon gate nMOS process - CMOS nwell-Pwel1 design rules - Simple layout examples - Sheet resistance - Area capacitance -Wiring capacitance - Drive large capacitive loads.

MODULE 4 (14Hours)

Logic Design : Switch logic - Pass transistor and transmission gate -Gate logic - Inverter -Two input NAND gate -NOR gate - Other forms of CMOS logic –Dynamic CMOS logic -Clocked CMOS logic - Precharged domino CMOS logic - Structured design -Simple combinational logic design examples –Parity generator -Multiplexers – Clocked sequential circuits - Two phase clocking - Charge storage –Dynamic register element - nMOS and CMOS - Dynamic shift register - Semi static register - JK flip flop circuit.

REFERENCES

1. Doglas A. PuckJ1ell and Kamran Eshranghian, *Basic VLSI design*, Prentice Hall of India, New Delhi

2. Neil H. E. West and Kamran Eshranghian, *Principles of CMOS VLSI Design: A System Perspective*, Addison- Wesley.
3. Amar Mukherjee, *Introduction to nMos and CMOS VLSI System Design*, Prentice Hall, USA.,
4. Caver Mead and LyTUI Conway, *Introduction to VLSI Systems*, Addison- Wesley, USA.
5. Eugene D. Fabricus, *Introduction to VLSI Design*, McGraw Hill International Edn

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 302(B)	**SOFT COMPUTING TECHNIQUES** **(Common for EPE10 302(B), EPD10 302(B), CEH10 302(B), MIT10 302(B), PMS10 302(B))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:
To acquaint the students with soft computing methodologies such as neural networks, fuzzy logic, genetic algorithms and hybrid algorithms and enable the students to implement real time intelligent and adaptive systems.

MODULE 1 (13Hours)
Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Deffuzzification methods- Fuzzy logic controller(Block Diagram)

MODULE 2 (14Hours)
Artificial Neural Networks: Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self organizing maps-ART

MODULE 3 (13Hours)

Fundamentals of genetic algorithms: Basic concepts- working principle – encoding – different methods – fitness function – reproduction-different methods. Genetic modelling-inheritance-Crossover mutation-convergence of genetic algorithm.

MODULE 4 (14Hours)

Hybrid systems: Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids-Genetic algorithm based back propogation network- Fuzzy back propagation networks -fuzzy logic controlled genetic algorithms.

REFERENCES

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

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 302(C)	**COMPUTER NETWORKING** **(Common for EPS10 302(A), EPE10 302(C), EPD10 302(C), PMS 10 302(C))** **Hours/week: Lecture-3 and Tutorial-1**	**Credits: 4**

Objective:

To impart knowledge about techniques and terminologies regarding computer networking so that power engineering students can apply them in applications like distributed computing, parallel computing, SCADA, WAPS, WAM etc

MODULE 1 (13Hours)

General: Structure of networks and the internet, circuit, packet and message switching, routing, physical media, types of delay, internet protocol stack, internet backbone, NAPs (Network Access Points) and ISPs

Application Layer: Structure of networking applications, Web and Web caching, FTP (File Transfer Protocol), Electronic mail, DNS (Domain Name Service), socket programming

MODULE 2 (13Hours)

Transport layer: Transport layer principles, multiplexing and demultiplexing, UDP (User Datagram Protocol), principles of reliable data transport, TCP (Transmission Control Protocol), flow control, principles of congestion control, TCP congestion control

MODULE 3 (14Hours)

Network Layer: Network layer services, datagram and virtual circuits, routing principles, link state routing algorithms, distance vector routing algorithms, hierarchical routing, Internet Protocol (IP), IP addressing, IP transport, fragmentation and assembly, ICMP (Internet Control Message Protocol), routing on the internet, RIP (Routing Information Protocol), OSPF (Open Shortest Path First), router internals, IPv6

MODULE 4 (14Hours)

Link Layer: Link layer services, error detection and correction, multiple access protocols, LAN addressing and ARP (Address Resolution Protocol), Ethernet, CSMA/CD multiple access protocol, Hubs, Bridges, and Switches, Wireless LANs, PPP (Point to Point Protocol), Wide area protocols

Selected topics from multimedia networking, network security and real-life networks.

REFERENCES

James F. Kurose and Keith W. Ross, *Computer Networking, A top down approach*, Addison Wesley, 2003.

Internal continuous assessment: 100 marks

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

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

EPD10 303(P)	**INDUSTRIAL TRAINING** Hours/week: 30 (during the period of training)	Credits: 1

Objective: To enable the student to correlate theory and industrial practice.

The students have to arrange and undergo an industrial training of minimum two weeks in an industry preferably dealing with power electronic equipments during the semester break between semester 2 and semester 3 and complete within 15 calendar days from the start of semester 3.The students are requested to submit a report of the training undergone and present the contents of the report before the evaluation committee. Evaluation committee will award the marks of end semester based on training quality, contents of the report and presentation.

End semester Examination: Marks 50

EPD10 304(P)	**MASTER RESEARCH PROJECT PHASE 1** Hours/week: 22	Credits: 6

Objective:

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

The project work can be a design project/experimental project and/or computer simulation project on any of the topics in power electronics/drives related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute, subject to the conditions in clause 10 of MTech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

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

Internal Continuous assessment:

	Guide	Evaluation Committee
First Review	50	50
Second Review	100	100
Total	150	150

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SEMESTER 4

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EPD10 401	MASTERS RESEARCH PROJECT PHASE 2 Hours/week: 30	Credits: 12

Objective:

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

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

Internal Continuous assessment:

	Guide	Evaluation Committee
First Review	50	50
Second Review	100	100
Total	150	150

End Semester Examination:

Project Evaluation by external examiner: 150 marks
Viva Voce by external / internal examiner: 150 marks