KANNUR UNIVERSITY

Faculty of Engineering

Curriculum, Scheme of Examinations and Syllabi for M-Tech Degree Programme with effect from Academic Year 2011-2012

ELECTRICAL & ELECTRONICS ENGINEERING

M-Tech in

POWER ELECTRONICS AND DRIVES

FIRST SEMESTER

Code	Subject	Hours/Week			Sessional Marks	University Examination		Credit
		L	T	P		Hrs	Marks	
PED101	Computational Techniques	3	-	-	50	3	100	3
PED102	Design & Analysis of Power Electronic Systems	3	-	-	50	3	100	3
PED103	Advanced Machine Drives	3	-	-	50	3	100	3
PED104	Power Converters I	3	-	-	50	3	100	3
PED105	Elective I	3	-	-	50	3	100	3
PED106	Elective II	3	-	-	50	3	100	3
PED107(P)	Power Electronics Lab	-	-	2	50	3	100	2
PED108(P)	Seminar	-	-	2	50	-	-	2
TOTAL		**18**		**4**	**400**		**700**	**22**

ELECTIVE I

PED 105 (A) Dynamics of Systems
PED 105 (B) Special Machines
PED 105 (C) Advanced digital signal processing
PED 105 (D) Custom Power Devices
PED 105 (E) Power Semiconductor Devices

ELECTIVE II

PED 106 (A) Digital System Design
PED 106 (B) Project Engineering & Management
PED 106 (C) Power Quality Issues and Remedial Measures
PED 106 (D) HVDC Transmission Systems
PED 106 (E) Digital Signal Processors and Applications

Sessional marks for all the Theory based Subjects

The marks allotted for internal continuous assessment and end-semester university examinations shall be 50 marks and 100 marks respectively with a maximum of 150 marks for each theory subject.

The weightage to award internal assessment marks should be as follows:

Test papers (two tests) : 25 marks

Assignments and/or class performance : 25 marks

SECOND SEMESTER

Code	Subject	Hours/Week			Sessional Marks	University Examination		Credit
		L	T	P		Hrs	Marks	
PED201	Control Techniques in Power Electronics	3	-	-	50	3	100	3
PED202	Power Converters II	3	-	-	50	3	100	3
PED203	Machine analysis & control	3	-	-	50	3	100	3
PED204	Elective III	3	-	-	50	3	100	3
PED205	Elective IV	3	-	-	50	3	100	3
PED206	Elective V	3	-	-	50	3	100	3
PED207(P)	Advanced Drives Lab	-	-	2	50	3	100	2
PED208(P)	Term Paper	-	-	2	50	3	100	2
TOTAL		**18**		**4**	**400**		**800**	**22**

ELECTIVE III

PED 204 (A) Design and Analysis of Experiments
PED 204 (B) Quality and Reliability Engineering
PED 204 (C) Embedded System Design
PED 204 (D) Distributed Generation
PED 204 (E) FACTS Controllers
PED 204 (F) Digital Control of Electric Drives

ELECTIVE IV

PED 205 (A) Induction Generators
PED 205 (B) Finite Element Methods
PED 205 (C) Power Electronic Applications in Renewable Energy Systems
PED 205 (D) Energy Conservation
PED 205 (E) Computer Controlled Systems
PED 205 (F) Microcontroller Applications in Power Electronics

ELECTIVE V

PED 206 (A) Artificial Neural Networks and Fuzzy Systems
PED 206 (B) Advanced Control of PWM inverter-fed induction motors
PED 206 (C) Energy Management
PED 206 (D) Mechatronics
PED 206 (E) Electric Vehicles
PED 206 (F) Analysis, Modelling and Control of Electric Drives

THIRD SEMESTER

Code	Subject	Hrs / Week			Marks					Credits
		L	T	P	Internal		University		Total	
					Guide	Evaluation Committee	Thesis	Viva		
PED 301 (P)	Thesis Preliminary			22	200	200	--	--	400	8
	Total			**22**	**200**	**200**			**400**	**8**

THESIS PRELIMINARY

This shall comprise of two seminars and submission of an interim thesis report. This report shall be evaluated by the evaluation committee. The fourth semester Thesis- Final shall be an extension of this work in the same area. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is presentation of the interim thesis report of the work completed and scope of the work which is to be accomplished in the fourth semester.

FOURTH SEMESTER

Code	Subject	Hrs / Week			Marks					Credits
		L	T	P	Internal		University		Total	
					Guide	Evaluation Committee	Thesis	Viva		
PED 401 (P)	Thesis			22	200	200	100	100	600	12
	Total			**22**	**200**	**200**	**100**	**100**	**600**	**12**

Towards the middle of the semester there shall be a pre submission seminar to assess the quality and quantum of the work by the evaluation committee. This shall consist of a brief presentation of Third semester interim thesis report and the work done during the fourth semester. The comments of the examiners should be incorporated in the work and at least one technical paper is to be prepared for possible publication in journals / conferences. The final evaluation of the thesis shall be an external evaluation.

PED 101 COMPUTATIONAL TECHNIQUES

3 hours lecture per week

Objective: *To impart the necessary mathematical skills to aid the analytical capabilities of the students*

Concepts of optimization: Engineering applications-Statement of optimization problem-Classification - type and size of the problem. Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity - formulation of LP problems - simplex method and algorithm -Matrix form- two phase method. Duality- dual simplex method- LU Decomposition. Sensitivity analysis .Artificial variables and complementary solutions- QP.

Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear programming - gradient and Hessian. Unconstrained optimization: First & Second order necessary conditions-Minimisation & Maximisation Local & Global convergence-Speed of convergence. Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method-Lagrange multiplier method - Kuhn-tucker conditions. Quasi-Newton method- separable convex programming - Frank and Wolfe method.

Dynamic programming: Multistage decision process- Concept of sub optimization and principle of optimality- Computational procedure- Engineering applications.

Fundamentals of Genetic algorithms and Simulated Annealing Methods.

References

1. David G Luenberger, Linear and Non Linear Programming., 2nd Ed, Addison-Wesley Pub.Co.,Massachusetts, 2003
2. W.L.Winston, Operation Research-Applications & Algorithms.,2nd Ed., PWS-KENT Pub.Co.,Boston, 2007
3. S.S.Rao, Engineering Optimization., 3rd Ed.New Age Int. (P) Ltd, New Delhi, 2007
4. W.F.Stocker, Design of Thermal Systems, 3rd Ed., McGraw Hill, New York. 1990
5. G.B.Dantzig, Linear Programming and Extensions. Princeton Univ. Press, N.J., 1963.
6. L.C.W.Dixton. Non Linear Optimisation: theory and algorithms. Birkhauser, Boston, 1980
7. Bazarra M.S., Sherali H.D. & Shetty C.M., .Nonlinear Programming Theory and Algorithms., John Wiley,New York,1979.
8 A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering Optimization: Methods And Applications, Wiley, 2008 9 Godfrey C. Onwubolu, B. V. Babu, New optimization techniques in engineering, Springer, 2004
9. Kalyanmoy Deb, Optimisation for Engineering Design- Algorithms and Examples., Prentice Hall India- 1998

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 102 DESIGN & ANALYSIS OF POWER ELECTRONIC SYSTEMS

3 hours lecture per week

Objective: *To develop design and analysis skills of Power Electronic Systems*

Switched DC source with RL, RC and RLC load – recovery of trapped energy – RLC load with an ac source – rectifier circuit analysis and design – design curves – models of power switches – interpreting specification parameters – single phase and three phase controlled rectifiers **-** Choppers – analysis of choppers in various configurations

Analysis of half bridge inverter – load commutation – voltage commutation – single phase bridge inverter – voltage control of single phase inverters – single pulse, multi-pulse and sinusoidal pulse modulation – reduction of harmonics – three phase inverters – series inverters

Cycloconverters – single phase to single phase and three phase to single phase – line commutated frequency multipliers – line commutated cycloconverters

Magnetics design – transformer modeling – loss mechanism in magnetic devices – eddy currents in winding conductors – types of magnetic devices – BH loops, core and copper losses – inductor design constraints – design procedure – multiple winding magnetics design – transformer design constraints – design procedure – AC inductor design

Thermal design – control of semiconductor device temperatures - various heat transfer modes, heat sink design

References

1. Power Semiconductor circuits – S B Dewan, A Straughen John Wiley & Sons
2. Fundamentals of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
3. Power electronics Essentials and Applications – L Umanand
4. Design of Magnetic Components for Switched Mode Power supplies – L Umanand and S P Bhat – New Age International
5. Power electronics Principles and Applications – Joseph Vithayathil – Tata McGraw Hill
6. Power Electronics – Cyril W Lander – Tata McGraw Hill

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 103 ADVANCED MACHINE DRIVES

3 hours lecture per week

Objective: *To develop skills of analysis of machine drives*

Characteristics of DC motor, induction and synchronous motors, elements of electric drives, dynamic conditions of a drive system – stability of electric drives

Control of electric motors: induction motor drives – synchronous motor drives – DC drives – permanent magnet synchronous motors – cycloconverter fed synchronous motor

Rating and heating of motors: Requirements of a drive motor – power losses and heating – cooling and heating of electric motor – selection of electric motor – control techniques

Control techniques of electric drives: block diagram representation of drive systems – transfer function of dc drive systems – basic concepts of transient and stability analysis-compensation and use of controllers to improve performance

Drives for textile mills, steel rolling mills, cranes and hoists, cement mills, sugar mills, machine tools, paper mills, coal mines – centrifugal pumps – turbocompressors

Microprocessors based control: advantages of microprocessor control – application areas and block diagram schemes for control of ac, dc drives and stepper motors – aspects of control system design.

References:

1. Electric Drives – Vedam Subrahmanyam – Tata McGraw Hill – 2nd Edition
2. Advanced Electric Drives – Rik De Doncker, Duco W J Pulle, Andre Veltman – Springer
3. AC Machine Systems – Jingde Gao, Linzheng Zhang, Xiangheng Wang, Springer
4. Fundamentals of Electric Drives – G. K. Dubey, Narosa Publications

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 104 – POWER CONVERTERS I

3 hours lecture per week

Objective: *To develop solid foundation in analyzing DC-DC and AC-DC converters*

Switching DC Power Supplies – Forward, flyback, pushpull, half bridge and full bridge converter circuit, operation, waveforms and design, small signal analysis of DC-DC converters and closed loop control – transfer function of dc-dc converters – stability analysis

Resonant DC-DC converters – 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 converters

Current harmonics in rectifiers – harmonic standards – improved single phase and three phase rectifiers – Multi pulse and multi level rectifiers, Dual thyristor bridge and PWM rectifier;

Residential and industrial applications of power electronics – induction heating, welding, electronic ballast – utility applications - back to back HVDC transmission, UPS, static var compensators and active filters.

References

1. Power Electronics Converters, Application And Design – Ned Mohan, T M Undeland, William P Robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata Mcgraw Hill
3. Fundamentals Of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power Electronics Principles And Applications – Joseph Vithayathil – Tata Mcgraw Hill
5. Power Electronics – Cyril W Lander – Tata Mcgraw Hill

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 105 (A) DYNAMICS OF SYSTEMS

3 hours lecture per week

Objective: *To develop understanding of dynamics of linear and non linear systems*

Dynamical systems- Modeling of dynamical systems- Differential equations and maps- State space formulation- Eigenvalues and eigenvectors- Dynamics in the state space-State variable feedback and Stabilisation.

Dynamics of discrete systems- Methods of discretization- Difference equation- ZT- State space formulation.

Multivariable systems- Transfer function matrices- Realization of MIMO transfer matrices.

Nonlinear sytsems- Differences between the behaviours of linear and nonlinear systems- Concept of equilibrium and operating point- Types of equilibrium points- Linearization of Nonlinear Systems- Local linearization at equilibrium points- Examples from practical systems.

The concepts of stability- Equilibrium states- Lyapunov stability theorems- Lyapunov function and its properties- Lyapunov's first method for equilibrium states- Lyapunov second method- Stability analysis.

Chaos theory- Characteristics of chaos- Fractals- Basic theory- Examples from of engineering systems.

System identification- Mathematical models from data- frequency response data- MATLAB tools.

References:

1. Ogata, K., System Dynamics, 2nd ed., Prentice Hall, 1992
2. Ogata, K., Modern Control Engineering, Prentice Hall, 4rd edition, 2002.
3. M. Gopal, Control Systems, Principles and Design, TMH, ND
4. H. K Khalil, Nonlinear Systems , Prentice Hall, New Jersey, 2002
5. I.J. Nagarath and M.Gopal,-Control Systems Engineering, New Age International (P) Ltd.
6. M. Gopal -Digital Control and State Variable Methods , Tata Mc Graw-Hill Companies, 1997.
7. B. C. Kuo,-Digital control systems – Oxford
8. K.T. Chau and Zheng Wang, Chaos In Electric Drive Systems Analysis, Control And Application, John Wiley & Sons.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 105 (B) SPECIAL MACHINES

3 hours lecture per week

Objective: *To develop understanding about special machines*

Stepper motor

Constructional features - Principle of operation-permanent magnet stepper motor - variable reluctance motor - hybrid motor-single and multi stack configurations - Torque equations - modes of excitations - drive circuits-microprocessor control of stepping motors - closed loop control – applications.

Servomotor

DC servomotors- construction - principle of operation-transfer function - armature control and field control - AC servomotor-construction - theory of operation - shaded pole ac servomotors –applications.

Reluctance motors

Synchronous Reluctance motor - Constructional features - Types - Principle of operation - Axial and radial flux motors - operating principles - variable reluctance motor - hybrid motor - voltage and torque equations – characteristics – applications.

Switched reluctance motor - Constructional features - principle of operation - torque production - steady state performance prediction-Analytical method - Power converters and their controllers - Methods of rotor position sensing - Closed loop control of SRM – Characteristics – applications.

Permanent magnet motor

Permanent magnet brushless DC motors - Permanent magnetic materials - Magnetic characteristics - Principle of operation -Types-Magnetic circuit analysis - Torque equations - Power controllers - Motor characteristics and control, Permanent magnet synchronous motors-Principle of operation--Torque equations-characteristics and control.

Linear Induction motor

Linear induction motor- Double sided linear induction motor from rotary type Induction motor – Scheme of LIM drive for electric traction – development of single sided LIM – Equivalent circuit- applications.

References

1. M D Desai, Control system components, PHI
2. K Venkataratnam, Special Electrical Machines, Universities press(India) Pvt. Ltd. Hyderabad
3. R Krishnan, Electric Motor Drives, Modeling, Analysis, and control, PHI
4. Nasar S.A., Boldea I., Linear Motion Electric Machine, John Wiley & Sons
5. R.Krishnan, Switched Reluctance Motor Drives-Modelling, Simulation, Analysis, Design and application, CRC press New York,2001

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 105 (C) ADVANCED DIGITAL SIGNAL PROCESSING

3 hours lecture per week

Objective: *To develop understanding of digital signal processing techniques*

MULTIRATE DIGITAL SIGNAL PROCESSING

Introduction to Multi-rate Digital Signal Processing – Sample rate reduction – decimation by integer factors- sampling rate increase – interpolation by integer factor – Design of practical sampling rate converters Filter Specification- filter requirement for individual stages – Applications.

STATISTICAL SIGNAL PROCESSING:

Random variables- random process- Ensemble averages, Stationary and ergodic processes, Autocorrelation and Autocovariance- properties of correlation matrix, White noise, Power Spectral Density, Spectral Factorization- Periodogram-Bias and variance.

Stochastic models- AR, MA, ARMA processes- Yule Walker Equations-

Linear Filters-Minimum mean square error-Weiner-Hopf equations-Linear Prediction-. Levinson-Durban Algorithms- Lattice Filter- Properties-Basic Concepts of Kalman Filters.

ADAPTIVE SIGNAL PROCESSING

Adaptive Signal Processing – Adaptive filters – Concepts- FIR Adaptive–The basic LMS adaptive algorithm – Practical limitations of the basic LMS algorithm – Recursive Least Square Algorithm – Limitations – Noise cancellation.

ADVANCED TRANSFORM TECHNIQUES

2-D Discrete Fourier transform and properties–2-D random process- properties-Classical spectral estimation- Applications.

Wavelet Transforms: Fourier Transform- Basics of Wavelet Transform-Gabor transform-classification of wavelets- Haar Wavelet –Applications.

References:

1. Proakis and Manolakis, Digital Signal Processing, Perason Education.
2. Simon Haykin, Adaptive Filter Theory, Pearson Education.
3. Hayes M. H, Statistical Digital Signal Processing and Modeling, John Wiley & Sons, NY
4. Steven M Kay, Modern Spectral estimation Theory and Application, PHI
5. Oppenheiem A. V and Schafer R. W, Discrete Time Signal Processing, PH
6. Papoulis a, Probability, random variables and Stochastic Processes, McGraw Hill NY
7. Chui C. K, An Introduction to Wavelets., Academic Press, NY
8. G. Bachman, L. Narici and E Beckenstein: Fourier and wavelet Analysis, Springer-Verlag, New York/Berlin/Heidelberg, 2000

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 105 (D) CUSTOM POWER DEVICES

3 hours lecture per week

Objective: *To develop understanding of custom power devices*

Power quality –Power electronic application in Transmission systems and distribution systems-distributed generation- Power quality terms -transients, over voltage, under voltage, sag, swell, harmonics, flicker- PQ problems-poor power factor, unbalanced loads, disturbances in supply voltage

Custom power devices-Network configuring and compensating devices- SSCL, SSB, SSTS, custom power park- Structure and control of power converters-open loop voltage control and closed loop voltage control

DSTATCOM-compensator for single phase and three phase loads -generating reference current using PQ theory - three phase four wire systems- neutral current compensation-three phase four wire DSTATCOM.

DVR-Rectifier and capacitor supported-DVR structure-UPQC structure and control of left shunt and right shunt UPQC-Active filters-shunt,series, hybrid filters

References

1. L Ghosh and G Ledwich,Power quality enhancement using custom power Devices,Kluwer Publications, London, 2003
2. K R Padiyar, FACTS controllers in Power Transmision and Distribution, New Age publications, New D elhi, 2007
3. R Sastry Vedam, power quality VAR compensation in power systems, CRC press, NewYork,2009
4. H Akagi, New Trends in active filters for power conditioning, IEEE TIA, vol.32,no.6,pp1312-1322,1996.
5. B Singh, P Jayaprakash, R Somayajulu, D P Kothari, ‘’ Reduced Rating VSC With a Zig-Zag Transformer for Current Compensation in a Three-Phase Four-Wire Distribution System”, IEEE Transactions on Power Delivery, VOL. 24, NO. 1, January 2009.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 105 (E) POWER SEMICONDUCTOR DEVICES

3 hours lecture per week

Objective: *To develop understanding of the physics of power semiconductor devices*

Material properties – intrinsic carrier concentration – band gap narrowing – built in potential – zero bias depletion width – impact ionization coefficients – carrier mobility – resistivity – recombination lifetime

Avalanche breakdown – abrupt one-dimensional diode – ideal specific on-resistance – abrupt punch through diode – linearly graded junction diode – edge terminations – open-base transistor breakdown – surface passivation

Schottky rectifier: structure – forward conduction – reverse blocking – device capacitance – tradeoff analysis

P – I – N rectifiers: structure – reverse blocking – switching performance – buffer layer – non punchthrough – tradeoff curves

Power MOSFET: Structure - Blocking voltage – forward conduction characteristics – on-resistance – cell optimization – transfer characteristics – output characteristics – device capacitances – gate charge – high frequency operation – switching characteristics – safe operating area – integral body diode – high temperature characteristics

Bipolar junction transistor: structure – static blocking characteristics – current gain – emitter current crowding – output characteristics – on state characteristics – switching characteristics – safe operating area – Darlington configuration

Thyristors: structure – blocking characteristics – on state characteristics – switching characteristics – light operated thyristors – self protected thyristors – gate turn off thyristor – triac

IGBT: structure – device operating and output characteristics – equivalent circuit – blocking characteristics – on state characteristics – current saturation model – switching characteristics – power loss optimization – safe operating area – blocking voltage scaling – high temperature operation

Reference:

1. P Jayant Baliga, Fundamentals of Power Semiconductor devices, Springer
2. M D Singh and Khanchandani, Power Electronics , 2nd Edition, Tata Mcgraw Hill
3. Joseph Vithayathil, Power Electronics Principles and Applications, Tata Mcgraw Hill

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 106 (A) DIGITAL SYSTEM DESIGN

3 hours lecture per week

Objective: *To develop understanding of digital system design using VHDL*

Review of logic design fundamentals – introduction to VHDL – designing with programmable logic devices – design of networks for arithmetic operations – digital design with SM charts – designing with programmable gate arrays and complex programmable logic devices – floating point arithmetic – transport and inertial delays – operator overloading – multivalued logic and signal resolution – IEEE 1164 standard logic – generate statements – synthesis of VHDL code – VHDL models for memories and buses – hardware testing and design for testability – design examples

Reference:

1. Charles H Roth, Jr, Digital Systems Design using VHDL, Thomson Brooks/Cole
2. John Wakerly, Digital Design: Principles and Practices, 4/e, Pearson Education.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 106 (B) PROJECT ENGINEERING & MANAGEMENT

3 hours lecture per week

Introduction: Foundations of Project Management, Project Life Cycle, The Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.

Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modelling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations.

Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.

Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management

References:

1. Wiest & Levy, Management Guide to PERT/CPM, With GERT/PDM/DCPM And Other Networks, 2nd Ed. PHI
2. David I. Cleland, Lewis R. Ireland, Project management: strategic design and implementation, McGraw-Hill.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 106 (C) POWER QUALITY ISSUES AND REMEDIAL MEASURES

3 hours lecture per week

Objective: *To develop understanding of power quality and measures to reduce its impact*

Introduction-power quality-voltage quality-overview of power quality phenomena classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C message weights-flicker factor-transient phenomena-occurrence of power quality problems power acceptability curves-IEEE guides, standards and recommended practices.

Harmonics- individual and total harmonic distortion- RMS value of a harmonic waveform triplen harmonics- important harmonic introducing devices- SMPS-Three phase power converters – arcing devices- saturable devices- fluorescent lamps- effect of power system harmonics on equipment and loads.

Modeling 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

Power factor improvement- Passive Compensation. Passive Filtering, Harmonic Resonance, Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC Based on Bilateral Single Phase and Three Phase Converter. Static VAR compensators- SVC and STATCOM

Active Harmonic Filtering-Shunt Injection Filter for single phase , three-phase three-wire and three-phase four-wire systems . d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag, swell and flicker problems.

References

1. Heydt, Power Quality, Star in a circle publications
2. Dugan, Electric Power Systems Quality, Tata Mc Graw Hill
3. K R Padiyar, FACTS controllers in Power Transmission and Distribution, New Age publications, New Delhi, 2007
4. R Sastry Vedam, power quality VAR compensation in power systems, CRC press, NewYork,2009
5. H Akagi, New Trends in active filters for power conditioning, IEEE TIA, vol.32,no.6,pp1312-1322,1996.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 106 (D) HVDC TRANSMISSION SYSTEMS

3 hours lecture per week

Objective: *To develop understanding of HVDC Transmission systems*

Analysis of HVDC Converters: analysis of Graetz circuit – converter bridge characteristics – twelve pulse converters

HVDC system control: system control hierarchy – firing angle control – current and extinction angle control – starting and stopping of DC link – power control

Converter faults and protection: converter faults – protection against overcurrents and overvoltages – surge arresters - smoothing reactor - DC line protection

Reactive power requirements at steady state – sources of reactive power – static VAR systems - reactive power control during transients – generation of harmonics – design of AC and DC filters – multiterminal DC systems – types, control and protection

Converter model – modeling of DC network and AC network – modeling of DC links – DC load flow solution – per unit system for DC quantities – solution of AC – DC power flow

Transient stability analysis – dynamic stability and power modulation

References

1. K R Padiyar, HVDC Power Transmission Systems, New Age Intl'
2. Vijay K Sood, HVDC and FACTS Controllers, Kluwer Academic Publishers
3. J Arillaga, Y H Liu, N R Watson, Flexible Power Transmission – The HVDC Options – John Wiley and Sons

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 106 (E) DIGITAL SIGNAL PROCESSORS & APPLICATIONS

3 hours lecture per week

Review of Discrete – Time Signal & System representation in Z – Transform domain – Inverse Z – Transform – Properties – System characterization in Z – domain -- Equivalencebetween Fourier Transform and the Z-Transform of a Discrete signal.

Sampling in Fourier domain - Discrete Fourier Transform and its properties – Linear filtering using DFT – Resolution of DFT - FFT Algorithm – Radix-2 FFT Algorithm - DIT & DIF Structures - Higher Radix schemes.

Classification of filter design - Design of IIR filters – Bilinear transformation technique– Impulse invariance method – Step invariance method.

FIR filter design – Fourier series method - Window function technique - Finite Word Length Effects.

Introduction to Multirate Signal Processing - Decimation - Interpolation - Case Studies onSpeech Coding, Transform Coding – DSP based measurement system.

References:

1. Ludemann L. C., "Fundamentals of Digital Signal Processing", Harper and Row publications, 1986.
2. Antoniou A., "Digital Filters – Analysis and Design", Tata Mc-Graw Hill, 1980.
3. Oppenheim and Schaffer, 'Discrete time Signal processing', PHI, 1989.
4. P.P. Vaidhyanathan, Multirate systems and filter banks, PHI, 1993.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 107(P) POWER ELECTRONICS LAB

2 hours Practical per week

At least 12 experiments should be conducted in the lab

List of Experiments

1. **Study the characteristics** of a diode, SCR, Triac and MOSFET.

   Obtain I-V characteristics of a diode, SCR, Triac and MOSFET on CRO.

2. **Realize DC-dc buck chopper using a MOSFET** and control them in the open loop and record the DC supply voltage, supply current, load voltage and load current, device voltage and current in resistive and inductive loads.

3. **Study characteristics of a 6-pulse uncontrolled three-phase bridge rectifier with filtered output.**

   Record the AC supply voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor in 6-pulse uncontrolled rectifiers with (i) resistive load (ii) dc series inductor filter, (iii) dc shunt capacitor filter, and (iv) dc series inductor and shunt capacitor (LC) .

   Simulate using a software the AC supply voltage and current waveform, Harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor in 6-pulse uncontrolled rectifiers with (i) resistive load (ii) dc series inductor filter, (iii) dc shunt capacitor filter, and (iv) dc series inductor and shunt capacitor (LC) filter.

4. **Study the characteristics of 12-pulse and 24-pulse uncontrolled three-phase bridge rectifiers**. AC supply voltage its current waveform, Harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor in 12-pulse and 24-pulse uncontrolled rectifiers with (i) resistive load (ii) dc shunt capacitor filter.

5. **Study the performance of a single-phase AC-DC phase controlled converter**.

   Record AC supply voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor in single-phase AC-DC bridge phase controlled converter at two firing angles with resistive (R) and inductive (R-L) loads. Simulate using a software the AC supply voltage and current waveform, Harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, output DC voltage average value, peak-peak ripple and ripple factor

6. **Study the performance of a DC-AC single-phase inverter** with triangular carrier PWM control. AC voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, input DC current average value and waveform in DC-AC single-phase inverter.

7. **Study the performance of single-phase AC voltage controllers** with (i) resistive (R), (ii) resistive-inductive (R-L) and (iii) single-phase motor loads at two firing angles. AC supply voltage, load voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor, active power, reactive power and apparent power and power factor for R and R-L loads.

8. **Study the performance of a DC-AC three-phase inverter with PWM control**.

   AC supply voltage and current waveform, Harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor and power factor, input DC current average value and waveform.

9. **Study the performance of 3-phase AC voltage controllers with (i) resistive (R), (ii) three-phase motor loads.**

   AC supply voltage, load voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor, active power, reactive power and apparent power and power factor for R and motor loads.

10. **Study the performance of a DC-DC boost chopper.**

    DC supply and output voltage and current waveforms, peak-to-peak ripple and ripple factor with R and R-L and R-L-E loads.

11. **Study the power quality of lighting devices**

    Performance of commercially available T-5 fluorescent tubes with (i) magnetic ballast (ii) electronic ballast and (iii) 18W CFL, and (v) 100W incandescent bulb.

    Record lumens, AC supply voltage and current waveform, harmonic spectrum, THD, crest factor, rms value, distortion factor, displacement factor, active power, reactive power and apparent power and power factor at **three** voltage levels.

12. **Study the performance of a DC-DC flyback power supply.**
13. **Study the performance of a DC-DC buck power supply.**
14. **Study the performance of a DC-DC boost power supply.**
15. **Study the performance of a DC-DC buckboost power supply.**
16. **Study the performance of a DC-DC half bridge power supply.**

Sessional work assessment
Regularity – 5 marks
Class work, Lab Record, Mini project Report (if any), viva – 30 marks
Test– 15 marks
Total: Internal continuous assessment: 50 marks

University evaluation

Examination will be for 100 marks of which 70 marks are allotted for writing the procedure/formulae/sample calculation details, preparing the circuit diagram/algorithm/flow chart, conduct of experiment, tabulation, plotting of required graphs, results, inference etc., as per the requirement of the lab experiments, 20 marks for the viva-voce and 10 marks for the lab record.

Note: Duly certified lab record must be submitted at the time of examination

PED 108 (P) SEMINAR

2 hours per week

The student is expected to present a seminar in one of the current topics in the field of specialization and related areas. The student shall prepare a Paper and present a Seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit typed copy of the paper to the Department. Grades will be awarded on the basis of contents of the paper and the presentation. A common format in (.pdf format) shall be given for reports of Seminar and Project. All reports of Seminar and Project submitted by students shall be in this given format.

Sessional work assessment
Presentation: 25
Report: 25
Total marks: 50

PED 201 CONTROL TECHNIQUES IN POWER ELECTRONICS

3 hours lecture per week

Objective: *To develop understanding of techniques of control in Power Electronics*

Principles of steady state converter analysis, steady state equivalent circuit modeling, losses and efficiency, basic AC modeling approach, state space averaging, circuit averaging and averaged switch modeling, canonical circuit model, PWM model converter transfer functions: review of bode plots, analysis of converter transfer functions, graphical construction of impedances and transfer function, graphical construction of converter transfer function, measurement of AC transfer functions and impedances.

Controller design: effect of negative feedback on the network transfer functions, closed loop transfer functions, stability, regulator design, measurement of loop gains.

AC and DC equivalent circuit modeling of the discontinuous conduction mode: DCM averages switch model, small signal AC modeling of DCM switch network, high frequency dynamics of converters in DCM

Current Programmed control: oscillations for D>0.5, first order model, more accurate model, discontinuous conduction mode

Reference:

1. Fundamentals of Power Electronics – Robert W Erickson, Dragan Maksimovic – Kluwer Academic Publishers
2. Modern Power Electronics and AC Drives, B K Bose, Prentice Hall

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 202 – POWER CONVERTERS II

3 hours lecture per week

Objective: *To impart knowledge about AC – AC and DC – AC converters*

Single phase and three phase inverters: PWM switching scheme – unipolar and bipolar single phase inverter – three phase inverters – switch utilization – ripple in the inverter output – dc side current – conduction of switches – effect of blanking time – programmed harmonic elimination switching – current mode control

Three level inverter: basic topology and waveform, improvement in harmonics and high voltage application; resonant converters – load resonant converters – series loaded resonant converter - parallel loaded resonant converter – class E converters – resonant switch converter – ZCS and ZVS – resonant dc link inverter with zero voltage switching – high frequency link integral half cycle converter

Cycloconverters: Circuit, operating principle, control, harmonics, power factor and applications;

Industrial PWM driver chips for power supplies - UC 3843, 3825; Industrial gate driver chips for PWM voltage source inverters with isolation and protection circuits.

References

1. Power electronics Converters, Application and design – Ned Mohan, T M Undeland, William P robbins, John Wiley & Sons 2003
2. Power Electronics – M D Singh, Khanchandani, 2nd Edition, Tata McGraw Hill
3. Fundamentals of Power Electronics, Second Edition, Robert W Erickson, Dragan Maksimovic, Kluwer Academic Publishers
4. Power electronics Principles and Applications – Joseph Vithayathil – Tata McGraw Hill
5. Power Electronics – Cyril W Lander – Tata McGraw Hill

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 203 MACHINE ANALYSIS & CONTROL

3 hours lecture per week

Objective: *To develop understanding of machine analysis and techniques of control*

Principle of unified machine theory, generalized torque equation.

Performance evaluation of DC machine and speed control.

Three phase induction motor- transformation methods, (stationary, rotor and synchronous frames) and corresponding equivalent circuits.

Three Phase synchronous motor: representation, Park transformation.

Drives, various Control techniques. Concept of Space vector, field oriented control and direct torque control of IM.

Permanent magnet synchronous motors- machine model (d-q) and control methods

Switched reluctance motor drive and various power circuit configurations and control.

References

1. Kraus PC, Analysis of Electrical Machines, Mc Graw Hill Book Company
2. Paul C Krause, Oleg Wasynczuk, scott D. Sudhoff, Analysis of Electric Machinery and Drive System, Wiley Interscience
3. Sengupta D.P. & Lynn J.B., Electrical Machine Dynamics, The Macmillan Press Ltd.
4. Jones C.V., The Unified Theory of Electrical Machines, Butterworth
5. Woodson & Melcher, Electromechanical Dynamics, John Wiley & Sons
6. Boldia I. & Nasar S.A., Electrical Machine Dynamics, The Macmillan Press Ltd

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 204 (A) – DESIGN AND ANALYSIS OF EXPERIMENTS

3 hours lecture per week

History of design of experiment; strategy, principle and application of DOE; basic statistical concepts, sampling techniques and distributions; inferences about means and standard deviations and considerations of different hypothesis; Experiments with single factorial design and application of ANOVA; randomized blocking and Latin squares.

Factorial design, 2k and 3k factorial design; blocking and confounding techniques in 2k factorial design; Concept of fractioning of factorial design; Response surface method; Introduction to robust design, robust parameter design for single response system; Experiments with non-normal data.

.

References:

1. Douglas C. Montgomery, Design and analysis of experiments, John Wiley and Sons
2. Lawson, J. & Erjavec, J., “Modern Statistics for Engineering and Quality Improvement “, Thomson Duxbury, Indian EPZ edition.
3. Nibtginertm Diygkas C : Design and Analysis of Experiments”. Fifth ed, -John Wiley & Sons Inc.
4. Box, George E P, Hunter William G, Hunter Sturat J : “Statistics for Experimenters” - John Wiley & Sons inc.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 204 (B) QUALITY AND RELIABILITY ENGINEERING

3 hours lecture per week

Basic Concepts and Definition; Traditional Quality Control; Quality Policy and Objectives,

Quality planning, analysis and control. On-line and off-line quality control. Quality parameter design - Taguchi method - Orthogonal arrays. Robust design - noise factors, testing conditions, quality characteristics, DFMA, identification of control factors, System optimization. Quality audit, ISO 9000.

Fundamental aspects of reliability, Reliability testing and evaluation. Failure patterns and

mathematical models. Role of manufacturing processes in controlling reliability. Role of design in achieving reliability goals. Systems approach to reliability integration.

References:

1. Dale, Managing Quality, Blackwell
2. Caplen, Practical Approach to Quality Control, Random House
3. O'Connor, Practical Reliability Engineering, John Wiley
4. Ryan, Statistical Methods for Quality Improvement, John Wiley
5. Ross, Taguchi Techniques for Quality Engineering, McGraw Hill

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 204 (C) EMBEDDED SYSTEM DESIGN

3 hours lecture per week

Specifications: requirements – models of computation – state charts – general language characteristics – SDL – Petri nets – Message sequence charts – UML – Process networks – Java – VHDL – System C

Embedded System Hardware: Input – communication – processing units – memories – Output

Embedded operating systems, middleware and scheduling: prediction of execution times – scheduling in real-time systems – embedded operating systems – middleware

Implementing embedded systems: task level concurrency management – high level optimizations – hardware/software partitioning – compilers for embedded systems – voltage scaling and power management – actual design flows and tools

Validation: simulation – rapid prototyping and emulation – test – fault simulation – fault injection – risk and dependability analysis – formal verification

References

1. Peter Marwedel – Embedded system design – Springer – Kluwer Academic Publishers
2. Frank Vahid and Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction ,John Wiley & Sons

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 204 (D) DISTRIBUTED GENERATION

3 hours lecture per week

Objective: *To develop understanding of distributed generation systems*

Introduction to energy conversion. Principle of renewable energy systems-technical and social implications; Solar energy- overview of solar energy conversion methods. Solar radiation components collector-measurements-estimation; Solar water heating-Calculation-Types-analysis-economics Applications; Solar thermal power generation

Direct energy conversion (DEC)- DEC devices -Photo voltaic system-Solar cells- Cell efficiency- Limitations-PV modules-Battery back up-System design-Lighting and water pumping applications; Fuel cells. types- losses in fuel cell. applications; MHD generators-application of MHD generation.

Wind energy. Characteristics - power extraction - types of wind machines .dynamics matching- performance of wind generators .wind mills -applications- economics of wind power

Biofuels- classification-biomass conversion process-applications; ocean thermal energy conversion systems; Tidal and wave power-applications; Micro and mini hydel power; Hybrid Energy Systems implementation- case study

References

1. J.N.Twidell & A.D.Weir-Renewable Energy Sources, University press,Cambridge, 2001
2. Sukhatme, S.P., Solar Energy -Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi 1997
3. Kreith, F., and Kreider, J.F., Principles of Solar Engineering, Mc-Graw-Hill Book Co. 2000
4. S.L. Soo ,Direct Energy Conversion , Prentice Hall Publication, 1963
5. James Larminie , Andrew Dicks , Fuel Cell Systems, John Weily & Sons Ltd, 2000
6. J. F. Manwell , J. G. McGowan, A. L. Rogers , Wind Energy Explained, John Weily & Sons Ltd 2009
7. E.J. Womack , MHD power generation engineering aspects , Chapman and Hall Publication, 2002
8. G.D. Rai, Non Conventional energy Sources, Khanna Publications ,New Delhi.1994
9. Loi Lei Lai, Tze Fun Chan, “Distributed Generation- Induction and Permanent Magnet Generators”, IEEE Press, John Wiley & Sons, Ltd., England. 2007.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 204 (E) FACTS CONTROLLERS

3 hours lecture per week

Objective: *To develop understanding of FACTS Controllers*

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. 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

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.

References

1. Hingorani, Understanding FACTS Controllers.
2. K R Padiyar, FACTS controllers in Power Transmision and Distribution, New Age publications, New Delhi, 2007

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 204 (F) DIGITAL CONTROL OF ELECTRIC DRIVES

3 hours lecture per week

Objective: *To develop understanding of control of electric drives using digital techniques*

Basic structure of speed controller – proportional control action – speed controller with proportional and integral action – suppression of load disturbances and tracking errors – feedforward compensation

Parameter setting of analog speed controllers: delays in torque actuation – impact of secondary dynamics on speed control of DC drives – double ratios and absolute value optimum – double ratios with proportional speed controllers – tuning of PI controller – symmetrical optimum

Discrete time implementation of speed controllers – analysis of the system with PI discrete time speed controller – high frequency disturbances and sampling process – closed loop system pulse transfer function – relocation of proportional gain – parameter setting – response to large disturbances and wind up phenomenon – anti wind up mechanism

Digital position control –single-axis positioners –pulse transfer function of the control object –structure of position controllers – discrete time PD position controller – Optimized parameter setting - Operation with large disturbances - nonlinear position controller

Position controller with integral action: operation in linear mode - pulse transfer functions - Parameter setting of PID position controllers - step response and bandwidth of the PD and PID controller - Computer simulation of the input step and load step response - Large step response with a linear PID position controller - nonlinear PID position controller

Trajectory Generation and Tracking: Tracking of ramp profiles with the PID position controller - Computer simulation of the ramp-tracking PID controller - Generation of reference profiles - Spline interpolation of coarse reference profiles

Torsional Oscillations and the anti resonant controller: Control object with mechanical resonance - Closed-loop response of the system with torsional resonance - ratio between the motor and load inertia - Active resonance compensation methods - Passive resonance compensation methods - Series antiresonant compensator with a notch filter - Series antiresonant compensator with the FIR filter

Reference:

1. Slobodan N Vukosavik – Digital Control of Electric Drives – Springer

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 205 (A) INDUCTION GENERATORS

3 hours lecture per week

Objective: *To develop understanding of techniques to analyze induction generators*

Steady state model of Induction Generator: Classical steady state representation of the asynchronous machine – generated power – induced torque – representation of induction generator losses – measurement of parameters – high efficiency induction generator – doubly fed induction generator

Transient models of induction generator: Induction machine in transient state – state space based modeling of induction generator – partition of state matrix with RLC load – transient simulation of induction generators

Self excited induction generator: performance – magnetization curves and self excitation – mathematical description of self excitation process – series capacitors and composed excitation – characteristics and construction features of induction generator

Scalar control – background and schemes, vector control – axis transformation – space vector notation – field oriented control, optimized control for induction generators – optimization principles – hill climbing control based maximum power search – fuzzy logic control based maximum power search

Doubly fed induction generators: features – sub synchronous and super synchronous modes – operation – interconnected and stand alone operation – field oriented control – active and reactive power control – stand alone DFIG

Applications of induction generators in alternative sources of energy

References:

1. M Godoy Simoes, Felix A Farret, Alternative Energy Systems – Design and Analysis with Induction Generators, CRC Press
2. Vladislav Akhmatov, Induction Generators for wind power – Multiscience publishing Co

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

AMD 205 (B) FINITE ELEMENT METHODS

3 hours lecture per week

Basic concepts - Different methods in Finite Element Methods - Steps involved in

FEM.Interpolation Polynomials - Linear elements Shape function - Element and Global matrices Two dimensional elements, triangular and rectangular elements - Local and Global Coordinate systems.

Field problems, Steady state problems - Torsional problem - Fluid flow and Heat transfer

problems - Acoustic vibrations – Application in manufacturing problems – metal cutting and metal forming.

Finite element Solution of structural problems - Two dimensional elasticity problems –

Axisymmetric problem. Higher Order Elements and Numerical Methods - Evaluation of shape functions – Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations – Cholesky decomposition, Skyline storage - Computer implementation-Use of FEM software.

References:

1. Larry J Segerlind,, “Applied Finite Element Analysis”, John Wiley.
2. Bathe K J, “Finite Element Procedures”, Prentice Hall.
3. J. N. Reddy, “An Introduction to the Finite Element Method”, Second Edition, McGraw Hill, New York.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 205 (C) POWER ELECTRONICS APPLICATIONS IN RENEWABLE ENERGY SYSTEMS

3 hours lecture per week

Objective: *To develop understanding of power electronic applications in renewable energy*

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

Wind Energy: Grid connected-Fixed speed and variable speed wind turbines, Type A, type B, type C, type D-induction generators-SCIG, WRIG, DFIG,WRSG and PMSG- soft starter-frequency converters-wind farms.

Stand alone wind energy conversion systems-voltage and frequency controllers--Induction generator-PMSG.

Photovoltaic: Residential PV systems- battery-inverter -grid connected systems.

Small/micro hydro: grid and standalone systems

Fuel cells: Low power and high power fuel cells.

Energy Storage systems for advanced power application: superconducting magnetic energy storage (SMES), battery energy storage systems (BESS), Ultra capacitors, Flywheel energy storage (FES) and their applications.

Hybrid Generation systems: hybrid systems-micro grid-control

Future of power electronics technology: device-packaging-circuit and control.

References:

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..
3. M G Simoes and F A Farret, “Alternate energy systems,”CRC Press, ,Chapter 7, London,2008.
4. 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.
5. 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.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 205 (D) ENERGY CONSERVATION

3 hours lecture per week

Objective: *To understand electric the need of energy conservation and the road to achieve it*

Potential for Industrial energy conservation- Economic analysis of investments- simple payback period- NPV- IRR.

Motors: Operational-retrofit-energy efficient motors-pf correction and variable speed drives

Lighting, Electric load management, power quality

Energy management information systems

Boilers, Compressors, Steam distribution, Refrigeration:

Pumps, Fans and blowers, Cooling tower, Industrial furnaces, Diesel generator

Water audit and conservation

Solar energy options for industries

Energy, climate change and clean development mechanism

Future cleaner energy options

Reference:
Handbook on energy audit and environment management, Y P Abbi, Shashank jain, TERI press, New delhi-2006.

Further reading:
1. Energy management policy: guidelines for energy intensive industry, ministry of power, GOI, 2003.(available at www.bee-india.nic.in)
2. Compressed air systems, TERI, 1999.
3. Renewable energy resources, TERI, 2004
4. Power generation and diesel gen-sets, PCRA, New Delhi
5. Energy conservation using electric drives, B K Bose

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 205 (E) COMPUTER CONTROLLED SYSTEMS

3 hours lecture per week

Objective: *To develop understanding of the principles of computer control in physical systems*

Sampling of continuous time signals, discrete time systems model, process oriented models, analysis of discrete time systems, disturbance models

Design approaches, translation of analog design, state space design methods, pole placement design based on input-output models

Optimal design methods: state space approach, input-output approach, identification, adaptive control, implementation of digital controllers.

Reference:

Karl J Astrom, Bjorn Wittenmark, Computer Controlled Systems, 2nd Edition – Prentice Hall International

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 205 (F) MICROCONTROLLER APPLICATIONS IN POWER ELECTRONICS

3 hours lecture per week

Objective: *To develop understanding of applications of microcontrollers in power electronics*

Evolution of micro-controllers – comparison between micro processor and micro controllers- Micro-controller development systems – simulators- Architecture of 8096 and PIC series microcontrollers

8051 family – architecture of 8051 – 8051 programming model – 8051 pin diagram – internal RAM organization – ports – program status word – register – 8051 assembly language programming – register banks and stack – addressing modes – external data modes Instruction set of 8051 – arithmetic operations – logical operations – data transfer operations – control transfer operations

8051 programming in C – timer programming in assembly language and C – serial port programming in assembly language and C – interfacing to external memory

Typical applications in the control of power electronic converters for power supplies and electric motor drives.

References:

1. Douglas V.Hall , ‘ Microprocessors and Interfacing - Programming and Hardware ‘, Tata McGraw- Hill , Eleventh edition , 2003.
2. Kenheth J. Hintz and Daniel Tabak, 'Microcontrollers - Architecture, Implementation and programming' McGraw Hill, USA, 1992.
3. John.B Peatman , ’Design with microcontrollers', McGraw Hill International Ltd, 1997.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 206 (A) ARTIFICIAL NEURAL NETWORKS AND FUZZY SYSTEMS

3 hours lecture per week

Objective: *To develop understanding of applications of artificial neural networks and fuzzy systems*

Biological foundations, ANN models, Types of activation function, Introduction to Network architectures: Multi Layer Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), Recurring Neural Network (RNN)

Learning process. Supervised and unsupervised learning. Error-correction learning, Hebbian learning, Boltzmen learning, Single layer and multilayer percepturs, Least mean square algorithm, Back propagation algorithm, Applications in forecasting and pattern recognition and other engineering problems.

Fuzzy sets. Fuzzy set operations. Properties, Membership functions, Fuzzy to crisp conversion. fuzzification and defuzzification methods, applications in engineering problems.

Fuzzy control systems . Introduction, simple fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems. inverter pendulum, image processing . home heating system. Adaptive fuzzy systems, hybrid systems.

References

1. J.M. Zurada, .Introduction to artificial neural systems, Jaico Publishers, 1992.
2. Simon Haykins, .Neural Networks . A comprehensive foundation, Macmillan College, Proc, Con, Inc, New York, 1994.
3. D. Driankov, H. Hellendorn, M. Reinfrank, .Fuzzy Control . An Introduction. , Narora Publishing House, New Delhi, 1993.
4. H.J. Zimmermann, .Fuzzy set theory and its applications, III Edition, Kluwer Academic Publishers, London. 2001
5. G.J. Klir, Boyuan, .Fuzzy sets and fuzzy logic, Prentice Hall of India (P) Ltd., 1997.
6. Stamatios V Kartalopoulos, .Understanding neural networks and fuzzy logic .basic concepts and applications., Prentice Hall of India (P) Ltd., New Delhi, 2000.
7. Timothy J. Ross, .Fuzzy logic with engineering applications, McGraw Hill, New York.
8. Suran Goonatilake, Sukhdev Khebbal (Eds), .Intelligent hybrid systems., John Wiley & Sons, New York, 1995.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 206 (B) ADVANCED CONTROL OF PWM INVERTER FED INDUCTION MOTORS

3 hours lecture per week

Objective: *To develop understanding of techniques of control of PWM Inverter fed Induction Motors*

Principles for vector and field-oriented control-Complex-valued dq-model of induction machines. Turns ratio and modified dq-models. Principles for field-oriented vector control of ac machines. Current controllers in stationary and synchronous coordinates. Rotor-flux oriented control of current-regulated induction machine - Dynamic model of IM in rotor-flux coordinates. Indirect rotor-flux oriented control of IM - Direct rotor-flux oriented control of IM.- Methods to estimation of rotor-flux

Generalized flux-vector control using current- and voltage decoupling networks-Generalized flux-vector oriented control. Current and voltage decoupling networks. Airgap-oriented control. Voltage-fed vector control. Stator-flux oriented vector control.

Parameter sensitivity, selection of flux level, and field weakening - Parameter detuning in steady-state operation. Parameter detuning during dynamics. Selection of flux level. Control strategies for used in the over-speed region.

Principles for speed sensor-less control - Principles for speed sensor-less control. Sensor-less methods for scalar control. Sensor-less methods for vector control .Introduction to observer-based techniques

References

1. Extract of D. W. Novotny and T. A. Lipo, Vector Control and Dynamics of AC Drives, Oxford University Press,1996.
2. P. L. Jansen and R. D. Lorenz, A Physically Insightful Approach to the Design and Accuracy Assessment of Flux Observers for Field Oriented Induction Machine Drives, IEEE Trans. on Industry Applications, Vol. 30, No. 1, Jan./Feb. 1994, pp. 101110.
3. Extract of I. Boldea and S. A. Nasar Electric Drives, CRC Press, 1998.
4. J. Holtz, Methods for Speed Sensorless Control of AC Drives, in K. Rajashekara Sensorless Control of AC motors. IEEE Press Book, 1996. Supplementary literature
5. R. W. De Doncker and D. W. Novotny, The Universal Field Oriented Controller, IEEE Trans. on Industry Applications, Vol. 30, No. 1, Jan./Feb. 1994, pp. 92100.
6. J. Holtz, The Representation of AC Machine Dynamics by Complex Signal Flow Graphs, IEEE Transactions on Industrial Electronics, Vol. 42, No. 3, 1995, pp. 263271.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 206 (C) ENERGY MANAGEMENT

3 hours lecture per week

Objective: *To develop understanding of management techniques to efficiently utilize energy*

Importance of energy management. Energy auditing: methodology System approach and End use approach to efficient use of Electricity; Electricity tariff types; Types and objectives-audit instruments- ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models-Case study. Demand side management.

Electric motors- Energy efficient controls and starting -Motor Efficiency and Load Analysis- Energy efficient motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Case study

Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance, case study. Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study.

Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study.

Energy conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration & air conditioning systems.

Boiler -efficiency testing, excess air control, Steam distribution & use- steam traps, condensate recovery, flash steam utilization

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study; electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage. Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures;

References

1. Handbook on Energy Audit and Environment Management , Y P Abbi and Shashank Jain, TERI, 2006
2. Utilization, Generation & Conservation of Electrical Energy, Sunil S.Rao, Khanna publishers, 2007.
3. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998)
4. Partab H., 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Sons, New Delhi. 1975
5. Tripathy S.C.,'Electric Energy Utilization And Conservation', Tata McGraw Hill, 1991
6. L.C.Witte, P.S.Schmidt, D.R.Brown , Industrial Energy Management and Utilisation, Hemisphere Publ, Washington,1988.
7. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
8. Guide Book for National Certification Examination for Energy Managers & Energy Auditors – Bureau of Energy Efficiency, Ministry of Power, Govt of India.

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 206 (D) MECHATRONICS

3 hours lecture per week

Introduction to Mechatronics-sensors and transducers- signal conditioning-pneumatic and hydraulic systems- mechanical and electrical systems.

System modeling- mathematical models-mechanical, electrical, fluid and thermal system building blocks-system models- dynamic response of systems- first and second order systems-modeling dynamic systems-systems transfer functions-frequency response-stability.

Controllers Closed loop controllers-continuous and discrete processes-proportional, derivative and integral controls-PID controller-digital controllers-controller tuning-adaptive control.

Digital circuits -Micro controllers and micro processors-digital logic circuits-micro controller architecture and programming-programmable logic controllers

References

1. Dorf R.C. & Bishop R.H., *Modern Control Systems*, Addison Wesley
2. Krishna Kant, *Computer Based Industrial Control*, Prentice Hall of Indian Private Limited
3. HMT Limited, *Mechatronics*, Tata McGraw Hill Publishing Company Limited
4. Herbert Taub & Donald Schilling, *Digital Integrated Electronics*, McGraw Hill InternationalEditions

Text Book

1. Bolton W., *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, Addison Wesley Longman Limited

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 206 (E) ELECTRIC VEHICLES

3 hours lecture per week

Objective: *To understand electric vehicles and to develop design skills for electric vehicles*

Fundamentals of Vehicle Propulsion and Brake: - Vehicle Resistance - Dynamic Equation - Tire–Ground Adhesion and Maximum Tractive Effort - Power Train Tractive Effort and Vehicle Speed - Vehicle Power Plant and Transmission Characteristics - Vehicle Performance

Internal Combustion Engines – 4 stroke spark ignited and compression ignited engines – 2 stroke engines – Wankel rotary engines – strirling engines – gas turbine engines – quasi isothermal brayton cycle engines

Electric vehicles: configuration – performance – tractive effort in normal driving – energy consumption

Hybrid electric vehicles: series and parallel electric drive trains

Electric propulsion systems: DC motor drives – Induction motor drives – permanent magnet BLDC motor drives – SRM drives – SRM design

Parallel (Mechanically Coupled) Hybrid Electric Drive Train Design - Design and Control Methodology of Series–Parallel (Torque and Speed Coupling) Hybrid Drive Train - Statistics of Daily Driving Distance - Energy Management Strategy - Energy Consumed in Braking and Transmission - Regenerative Breaking - Control Strategy for Optimal Energy Recovery

Fuel Cells - Fuel Cell Hybrid Electric Drive Train Design - Power and Energy Design of Energy Storage

References:

1. Modern Electric Vehicles, Hybrid Electric and Fuel Cell Vehicles – 2nd Edition – Meherdad Ehsani, Yimin Gao, Ali Emadi – CRC Press
2. Electric Vehicle Technology Explained – James Larminie, John Lowry – John Wiley & Sons

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 206 (F) ANALYSIS, MODELLING AND CONTROL OF ELECTRIC DRIVES

3 hours lecture per week

Objective: *To develop understanding of methods of analysis, modeling and control of Electric Drives*

Modulation Techniques for Power Electronic Converters: Single phase half bridge converter, Single phase full bridge converter, Three phase converter, Space vector modulation, Dead time effects

Current control of single phase load: Hysteresis based current control, Model based current control, Augmented model based current control

Current Control of a three phase load: Hysteresis control, model based and augmented model based control, frequency spectrum of model based and hysteresis current control

Modeling and Control of DC Machines: Separately excited current control of DC Machines

References:

1. Doncker, W J Pulle, Andre Veltman – Advanced electric Drives Modelling Analysis and Control – Springer
2. Kraus PC, Analysis of Electrical Machines, Mc Graw Hill Book Company
3. Paul C Krause, Oleg Wasynczuk, sCott D. Sudhoff, Analysis of Electric Machinery and Drive System, Wiley Interscience

Question Pattern:

There would be 7 questions out of which 5 should be answered. Each question would carry 20 marks each. Each question shall carry a maximum of four sub sections which can have uneven distribution of marks. The questions would touch upon all the sections of the syllabus as far as possible and would preferably be analytic in nature.

PED 207 (P) - ADVANCED DRIVES LABORATORY

2 hours Practical per week

Part (a): Experiments

1. Closed loop control of high frequency of DC – DC converters
2. Closed loop control of BLDC motors.
3. Closed loop control of Switched reluctance motors.
4. Vector control of three phase induction motors.
5. Vector control of three phase synchronous motors.
6. Closed loop control of Permanent magnet synchronous motor.
7. Sensor less control of motors.
8. Use of Microcontrollers, DSP and FPGA for the control motors.

(At least 5 experiments in the list are to be conducted in the laboratory. Additional Experiments and simulation assignments can also be given by the department)

Part (b): Mini Project

It should be an implemented prototype from Power Electronics and allied areas backed by analysis and simulation.

Sessional work assessment
Regularity – 5 marks
Class work, Lab Record, Mini project Report, viva – 30 marks
Test– 15 marks
Total: Internal continuous assessment: 50 marks

University evaluation

Examination will be for 100 marks of which 70 marks are allotted for writing the procedure/formulae/sample calculation details, preparing the circuit diagram/algorithm/flow chart, conduct of experiment, tabulation, plotting of required graphs, results, inference etc., as per the requirement of the lab experiments, 20 marks for the viva-voce and 10 marks for the lab record.

Note: Duly certified lab record must be submitted at the time of examination

PED 208 (P) TERM PAPER

The student is expected to present a report on the literature survey conducted as a prior requirement for the project to be taken up in the third and fourth semesters. Head of department can combine TP hours of many weeks and allot a maximum of 4 weeks exclusively for it. Students should execute the project work using the facilities of the institute. However, external projects can be taken up, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work. Project evaluation committee should study the feasibility of each project work before giving consent. An overview on the project work should be introduced before the closure of first semester. A paper should be prepared based on the project results and is to published in refereed Conferences/Journals.

Sessional work assessment
Presentation: 25
Report: 25
Total marks: 50

PED 301 (P) THESIS – PRELIMINARY

This shall comprise of two seminars and submission of an interim thesis report. This report shall be evaluated by the evaluation committee. The fourth semester Thesis-Final shall be an extension of this work in the same area. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is presentation of the interim thesis report of the work completed and scope of the work which is to be accomplished in the fourth semester.

Weightages for the 8 credits allotted for the Thesis-Preliminary
Evaluation of the Thesis-Preliminary work: by the guide - 50% (200 Marks)
Evaluation of the Thesis–Preliminary work: by the Evaluation Committee-50%(200 Marks)

PED 401 (P) THESIS

Towards the end of the semester there shall be a pre submission seminar to assess the quality and quantum of the work by the evaluation committee. This shall consists of a brief presentation of Third semester interim thesis report and the work done during the fourth semester. At least one technical paper is to be prepared for possible publication in journals / conferences. The final evaluation of the thesis shall be an external evaluation. The 12 credits allotted for the Thesis-Final may be proportionally distributed between external and internal evaluation as follows.

Weightages for the 12 credits allotted for the Thesis
Internal Evaluation of the Thesis work: by the guide - (200 Marks)
Internal Evaluation of the Thesis work: by the Evaluation Committee - (200 Marks)

Final Evaluation of the Thesis work by the Internal and External Examiners:-
(Evaluation of Thesis + Viva Voce) - (100+100 Marks)