UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY
MAHARSHI DAYANAND UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATIONS
Doctor of Philosophy (Ph.D.) – Electrical Engineering
Scheme w.e.f. 2012-13

Pre-Ph-D Course

i) The duration of the Pre-Ph.D. course will be of one semester.

ii) The Department concerned shall design the Pre-Ph.D. course as per latest guide lines of UGC which are: "The Pre-Ph.D. course must include a course on research methodology which may include quantitative methods and computer applications. It may also involve review of published research in relevant area".

iii) The scheme for Pre-Ph.D. course work is as under:

a) Common course:

PhD-FET-101: Research Methodology (Quantitative Techniques and Computer Applications in Research)

b) Departmental course:

PhD-FET-102: Review of Literature and Seminar (in Relevant Research Area)

PhD-FET-103: Departmental – Elective Course (in Relevant Research Area)

iv) The qualifying marks in each paper of the course work shall be 50%.

vi) It is only on satisfactory completion of Pre-Ph.D Programme, which shall be an essential part and parcel of the Ph.D. programme that a candidate shall be eligible to apply for registration in Ph.D. Programme.

Sr. No.	Course No.	Course Title	Marks of Internal Assessment	Examination Marks		Total Marks	Duration of Exam
				Theory	Practical		
1	PhD-FET-101	Research Methodology (Quantitative Techniques and Computer Applications in Research)	20	80	-	100	3
2	PhD-FET-102	Review of Literature and Seminar (in Relevant Research Area)	20	-	80	100	3
3	PhD-FET-103	Departmental – Elective Course (in Relevant Research Area)	20	80	-	100	3
	Total		60	160	80	300	

* Marks of internal assessment of theory courses are based two assignments of 10 marks each.

PhD-FET- 101: RESEARCH METHODOLOGY
(Quantitative Techniques and Computer Applications in Research)

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

UNIT I: Element of Research

Scientific process meaning and definition, a brief history of scientific process. Introduction to research methodology- Meaning of research, objective of research, types of research, significance of research, problem encountered by researchers in india, Research problem- Definition, necessity and techniques of defining research problem, formulation of research problem, objective of research problem, research design- Meaning, need and features of good research design, types of research designs, basic principles of Experimental design. Sampling design, census and sample surveys, different types of sample designs, characteristics of good sample design, Techniques of selecting a random sample. Data collection-primary and secondary data, methods of selecting primary and secondary data,

UNIT II: Hypothesis & Statistical Analysis

Hypothesis- definition, testing of hypothesis, procedures of hypothesis testing, flow diagram for hypothesis testing, parametric and non-parametric tests for testing of hypothesis, limitations of tests of hypothesis. Hypothesis tests- One sample test-two sample tests/ chi square tests, association of attributes. T-tests, statistical analysis, correlation and regression analysis- analysis of variance, completely randomized design, randomized complete block design, Latin square design-partial and multiple correlations – discriminent analysis - cluster analysis – principle component and factor analysis, repeated measure analysis. Probability and probability distributions; Binomial, Poisson, distribution, Basic ideas of testing of hypotheses; Tests of significance based on normal distributions.

UNIT III: Paper Writing and Report Generation

Basic concepts of paper writing and report generation, review of literature, concepts of bibliography and references, significance of report writing, steps of report writing, types of research reports, methods of presentation of report.

UNIT IV: Computer Applications in Research

Computer Applications: Fundamentals of computers-Definition, types of computers, RAM, ROM, CPU, I/O devices, Number systems-Binary, octal and hexadecimal, base conversion, logic gates- AND, OR, NOT, Operating system-definition, types of operating system, Database system – definition & applications, Networks – definition & applications, Internet & its applications, Web Searching, Email, Uses of software's MS-Office-Power Point, Word, Excel and Access.

Text Books:

1. C. R. Kothari – Research Methodology Methods and Techniques – Wishwa Prakashan Publishers – Second Edition.

PhD- FET-102: Review of Literature and Seminar (in Relevant Research Area)

1. The research student is required to prepare a concept paper/working, paper/review paper by reviewing at least 50 research papers / references books / unpublished doctoral dissertations / other reports etc.

2. To qualify the paper the research student is required either to present the prepared paper in a International Conference/ Seminar/ Workshop or published the same in a research journal. Acceptance for publication or presentation will be considered as published/ presented.

3. A duly constituted committee of three teachers of the department by the Director/Head shall evaluate the completion of the paper.

PhD- FET-103 **SYLLABUS (Pre PhD in Electrical Engineering)**

List of Electives:

1	PhD-EE-101	POWER DISTRIBUTION SYSTEM
2	PhD-EE-102	POWER SYSTEM MODELING & ANALYSIS
3	PhD-EE-103	POWER SYSTEMS OPERATION AND CONTROL
4	PhD-EE-104	COMPUTER AIDED POWER SYSTEM ANALYSIS
5	PhD-EE-105	POWER SYSTEM OPTIMIZATION
6	PhD-EE-106	POWER SYSTEM RELIABLITY
7	PhD-EE-107	POWER SYSTEM PROTECTION
8	PhD-EE-108	FLEXIBLE AC TRANSMISSION SYSTEMS
9	PhD-EE-109	EHVAC AND HVDC TRANSMISSION
10	PhD-EE-110	POWER QUALITY MANAGEMENT
11	PhD-EE-111	SYSTEM THEORY
12	PhD-EE-112	ESTIMATION AND IDENTIFICATION
13	PhD-EE-113	OPTIMAL CONTROL SYSTEMS
14	PhD-EE-114	NONLINEAR DYNAMICAL SYSTEMS
15	PhD-EE-115	INTELLIGENT CONTROLLERS
16	PhD-EE-116	DIGITAL SIGNAL PROCESSING
17	PhD-EE-117	EMBEDDED SYSTEMS DESIGN
18	PhD-EE-118	FUZZY LOGIC AND EXPERT SYSTEMS IN POWER SYSTEMS
19	PhD-EE-119	IMAGE PROCESSING
20	PhD-EE-120	MODELING OF ELECTRICAL MACHINES
21	PhD-EE-121	ADVANCED ELECTRICAL DRIVES
22	PhD-EE-122	SPECIAL MACHINES AND THEIR CONTROLLERS
23	PhD-EE-123	POWER ELECTRONICS IN WIND AND SOLAR ENERGY CONVERSION

Note: The departmental elective subjects will be offered as per availability of expertise and the required infrastructure in the department.

PhD-EE-101

POWER DISTRIBUTION SYSTEM

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	**Marks of Internal:**	**20**
			Examination:	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

Unit -1

Review: Steady-state circuit analysis, Phasor, Load and load factor, Three phase circuits, Powers

Utility Distribution System: Utility industry, Utility distribution system, Useful definitions.

Unit-2

Transformers and Regulators: Equivalent circuit, Types, System analysis with per unit system, Regulators.

Unit-3

Application of Capacitors for Distribution Systems: Voltage drop, Voltage regulation, Power factor correction, Voltage improvement.

Unit-4

Faults and Protection in Power System: Types, Fault calculations, Protection.

Cogeneration: Definition, Types, Examples.

TEXT BOOK

Power Distribution Engineering By James Burke 1994, Deksen

REFERENCE BOOK

Electrical Power Distribution and Transmission by L M Faulken Berry and W. Coffer 1996, PHI

PhD-EE-102

POWER SYSTEM MODELING & ANALYSIS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:			3 Hrs	Total Marks:	100

Unit -1

Overview of power system modeling for various studies –Distinction between steady state, Quasi steady state and transient modeling of power systems –Generation system planning – transmission system planning – steady state and transient analysis – load forecasting Overview - mathematics for basic power system analysis – algebraic equation –differential algebraic equation – differential quation, numerical solution of algebraic equations – Gauss elimination method and bifactorization method –sparsity techniques for large system – sparsity oriented network solution.

Unit-2

Bus classification, Power flow model using Y bus computational aspects of power flow problem – Gauss Seidel iterative technique – Newton Raphson method – Fast decoupled power flow method – Multi area power flow analysis with tie line control –contingency & sensitivity analysis.

Special purpose power flow studies – Harmonic Power flow, three Phase load flow, distribution power flow. Optimal power flow using Newton's method & interior point method.

Unit-3

Symmetrical short circuit analysis, Symmetrical components and sequence impedances. Algorithm for symmetrical fault analysis using Z bus –Unsymmetrical fault analysis using symmetrical components – Algorithm for unsymmetrical fault analysis using Z bus – limitations.

Unit-4

Physical description of synchronous machine – Mathematical description of a synchronous machine – dq transformation – Per unit representation – Equivalent circuit – Steady state analysis – transient performance characteristics – Magnetic saturation – simplified model with damper neglected – classical 4model – constant flux linkage model including the effect of sub transient circuits.

Study using simulation softwares for the above problems- power flow, short circuit, transient stability studies of power systems.

REFERENCE BOOKS

1. Stagg.G.W. &Abiad. A.H., "Computer methods in Power Systems Analysis", McGraw ill International Editions, 1968.
2. Elgerd.Olle L., "Electric Energy systems theory An Introduction", Tata McGraw Hill Edition,1982
3. George L.Kusic, "Computer Aided Power Systems Analysis", Prentice Hall of India Ltd.,1986.
4. John J. Grainger & Stevenson .D, "Power System Analysis", McGraw Hill International Editions,1994
5. Singh L.P., "Advanced power system analysis", Wiley Eastern Limited,1986.
6. Kundur. P "Power system stability and control", McGraw Hill, 1994.

PhD-EE-103

POWER SYSTEMS OPERATION AND CONTROL

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

General - Problems associated with modern interconnected power Systems, deregulation, power systems restructuring, distributed generation, congestion, available transfer capacities, pricing of energy and transmission services.

Power flow studies - Formulation of static power flow equations and solutions using Gauss- Seidel, Newton Raphson and FDLF methods, comparison of these methods, Economic operation of power system - Economic dispatch, Emission dispatch, line loss, ITL, economic dispatch usinglagrangian multiplier method.

Unit-2

MW Frequency control- Coherency, control area, modeling of speed control mechanism, load damping, block diagrammatic representation of single and two area interconnected system, static and dynamic response, .optimum parameter adjustment.

Unit-3

MVAR Voltage control Problem- Difference in control strategy over MW – f control, characteristics of an excitation system, DC AC and static excitation system, General block diagram representation of voltage regulators.

Unit-4

Power System Stability - Steady state, dynamic and transients stability, Swing equation , equal area criterion, solution of swing equation using step by step method modified Eulers method and Rnge-Kutta method, methods of improving transient stability.

REFERENCE BOOKS

1. Modern Power System Analysis-by I.J. Nagrath& D.P. Kothari Tata McGraw – Hill Publication Company Ltd 2nd edition.
2. Electrical Power Systems-by C.L. Wadhwa New Age International (P) Limited Publishers, 2nd edition 1998.
3. Reactive power Control in Electric Systems-by T.J.E. Miller, John Wiley & Sons.
4. T.K. Nagsarkar, M.S. Sukhiza, -"Power System Analysis", Oxford University Press.
5. Elgerd O.I., "Electric Energy Systems Theory", TMH, New Delhi, Second Edition 1983.
6. PrabhaKundur, "Power system stability and control", Mc-Graw Hill Inc, New York, 1993.
7. Taylor C.W., "Power System Voltage Stability", Mc-Graw Hill Inc, New York, 1993.
8. Nagrath IJ, Kothari D.P., "Power System Engineering", Tata Mc-Graw Hills, New Delhi 1994.
9. Weedy B.M. "Electric Power System" John Wiley and Sons, 3rd edition.
10. P.S.R. Murthy, "Power System Operation and Control", Tata Mc-Graw Hill, New Delhi 1984.
11. Power Generation, Operation and Control by A.J. wood and B.F. Wollenberg John Wiley & Sons Inc. 1984.
12. Power Systems Analysis- by A.R. Bergen Prentice Hali Inc.

PhD-EE-104

COMPUTER AIDED POWER SYSTEM ANALYSIS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Digital computers in power system simulations, System view point, Hierarchy of transmission and distribution system, nature and scope of power system studies, Electric supply industry structure under Deregulation, Regulatory and policy developments. Power system components, representation of transmission lines.

Transformers - Two winding and auto-transformers, tap changing transformer and loads.

Unit-2

Oriented graph, reference direction, system graph for transmission network, concept of graph theory, loop matrix, cutset matrix, incidence matrix, Topological relations, multiport representation, Bus impedance and Bus admittance matrix formulation, bus impedance algorithm.

Unit-3

Analytical formulation, methods of load flow solutions, Bus mismatch and convergence criteria, Gauss-Siedel method, Newton Rephson method, concept of decoupled methods.

Thermal system, transmission losses, optimum scheduling of thermal plants taking losses into account, economic load scheduling of hydro-thermal plants.

Unit-4

Electric utility Restructuring, Power System Restructuring Models, Market-power, Transmission pricing in a Restructured Electricity Market, Congestion Management in Deregulated Market, Role of FACTS devices in competitive Power Market.

REFERENCE BOOKS

1. Electrical Energy Systems Theory by O.I.Elgerd
2. Computer Methods in Power system Analysis by A.H.El.Abiad
3. Understanding FACTS concept and Technology by Hingorani N.L.
4. Power System Restructuring and Deregulation Trading Performance andIT by L.L. Lai, John Wiley & Sons Ltd. England
5. Electricity Market Investment Performance and Analysis by B. Murrey, Mc-Hill,1998
6. Understanding Electric Utilities and Deregulation by LorrinPhillipson&H.Lee Willis, Mareely Dekker Inc. New York, 1999
7. Power System Restructure Engineering & Economics by M.Illic, F.Faliana and L.Fink, Kluwer Academic Publisher, 1998
8. Restructured Electrical Power System Operation Trading and Volatility by Mohammad Shahidhpour and MuwaffaqAlmoush, Marcel Dekker, 2001

PhD-EE-105

POWER SYSTEM OPTIMIZATION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Optimization Techniques: Introduction, Statement of an optimization problem, design vector, design constraints,constraint surface, objective function, classification of optimization problem. Classical optimization Techniques, single variable optimization, multivariable optimization with equality constraints, Direct substitution method, constrained variation method, Lagrange Multiplier method, formulation of multivariable optimization, Kunh-Tucker conditions.

Unit-2

Optimization Techniques: Nonlinear Programming, Unconstrained optimization Techniques, Direct searchmethods, Indirect search methods, Descent methods, One dimensional minimization methods, unimodal function, elimination methods.

Load flow studies: Revision of Load flow studies by using Newton Raphson method (polar and rectangular) .Contingency evaluation, concept of security monitoring, Techniques of contingency evaluation, Decoupled load flow and fast decoupled load flow.

Unit-3

Optimal Power Flow Analysis: Optimal power flow analysis considering equality and inequality constraints. Economic dispatch with and without limits(Classical method) Gradient method, Newton's method, Newton Raphson method, calculation of loss coefficients, loss coefficients using sensitivity factors, power loss in a line, Generation shift distribution factors, Transmission loss coefficients, transmission loss formula as a function of generation and loads, economic dispatch using loss formula which is function of real and reactive power, linear programming method.

Unit-4

Three phase Load flow: Three phase load flow problem notation, specified variables, derivation of equations.

AC-DC load flow: Introduction, formulation of problem, D.C. System model, converter variables, Derivation of equations, Inverter operation, generalized flow chart for equation solution.

Fault Analysis: Revision of symmetrical and unsymmetrical faults, formulating the sequence impedance matrix, fault configurations and equations, General computer simulation of faults.

REFERENCE BOOKS

1. Aided Power System operation and Analysis-R.N.Dhar, Tata Mc-Graw Computer Hill New Delhi.
2. Computer Techniques in Power System Analysis- M.A. Pai, Tata Mc-Graw Hill New Delhi.
3. Computer Methods in Power System Analysis- Stagg and El.Abiad, Mc-Graw Hill (International Student Edition.)
4. Computer Analysis of Power Systems-J.Arrilinga, C.P.Arnold. Wiely Eastern Ltd.
5. Optimisation Techniques-S.S.Rao, Wiely Eastern Ltd, New Delhi
6. Modern Power System Engineering, Nagrath and Kothari (TataMcGraw Hill)
7. Electrical Energy System Theory–an introduction- OlleElgerd. TMH Publishing Company, New Delhi
8. Power System Optimisation- D. P. Kothari, J. S. Dhillon, PHI
9. Power Generation Operation and Control – Allen Wood, Wiley Publications.

PhD-EE-106

POWER SYSTEM RELIABLITY

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

Unit -1

Review of Probability Theory

Element of probability theory Probability Distribution, Random variable, Density and distribution functions.Mathematical expectation.Binominal distribution, Poisson distributions, Normal distribution, Exponential distribution, Weibull distribution.

Reliability of Engineering Systems

Component reliability, Hazard models, Reliability of systems wit non-repairable components, series, Parallel, Series-Parallel, Parallel-series configurations. Non-series-parallel configurations, minimal tie-set, minimal cut-set and decomposition methods. Repairable systems, MARKOV process, Long term reliability, Power System reliability.

Unit-2

Reliability of Engineering Systems

Reliability model of a generating unit, State space methods, Combing states, sequential addition method, Load modeling, Cumulative load model, merging of generation and load models, Loss of load probability, Percentage energy loss, Probability and frequency of failure, Operating reserve calculations.

Unit-3

Power Network Reliability

Weather effect on transmission lines, Common mode failures, Switching after fauls, three, state components, Normally open paths, Distribution system reliability.

Composite System Reliability

Bulk Power supply systems, Effect of varying load, Inter connected systems, correlated and uncorrelated load models, Cost and worth of reliability.

Unit-4

Reliability Improvement & Testing

Proper Design simplicity, Component improvement Testing Plans, time censored & sequential reliability tests, accelerated life test, Environ mental test, Reliability estimations

REFERENCE BOOKS

1. J. Endreny, Reliability Modeling in Electric Power Systems, John Wiley & Sons.
2. Roy Billinton& Ronald, N allan, Reliability Evaluation of Power Systems, Plenum Press, New York.

PhD-EE-107

POWER SYSTEM PROTECTION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Review of basic protection – Static relays – advantages – Basic construction –characteristics of protective relays – Phase & amplitude comparators – Over current relays – different types of time – Over current relays – differentialprotection scheme.

Unit-2

Transmission line protection – fault clearing times – Types of distance relays –Evaluation of distance relay performance during swings – prevention of tripping during transient conditions – automatic re-closing – Three-zone protection.

Unit-3

Protection of generators – Stator protection – rotor protection – generator outof-step protection – protection of transformers – Magnetizing in-rush current, Buchholz relay – over fluxing protection.

Unit-4

Nature of system response to serve upsets – frequency actuated schemes for load shedding and islanding.

Microprocessor based protective relays – Development of Computer relaying –Benefits of computer relaying – Computer relay architecture – Substation computer hierarchy.Modeling, analysis and simulation of protection systems using advanced software such as CAPE.

REFERENCE BOOKS

1. MadhavaRao.T.S, “Power System protection :Static relay with Microprocessor applications”, Tata McGraw Hill, 1989.10
2. Ram.B, Viswakarma.D.N, “Power System Protection and Switch Gear”, Tata McGraw Hill, 1995.
3. Ram.B, “Fundamentals of Microprocessors and Microcomputers” DhanpatRai& Sons, 1985.
4. Kundur.P, “Power System Stability and Control”, Tata McGraw Hill, 1994.

PhD-EE-108

FLEXIBLE AC TRANSMISSION SYSTEMS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Electrical Transmission Network - Necessity - Power Flow in AC System - Power Flow and Dynamic stability considerations of a transmission interconnection - relative importance of controllable parameter - opportunities for FACTS - possible benefits for FACTS Technology - FACTS Controllers - Types, brief description and definitions

Unit-2

Need for compensation - introduction to shunt and series compensation - objectives of shunt and series compensation - configuration and operating characteristics - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitor (TSC) - Fixed Capacitor - Thyristor Controlled Reactor (FC - TCR) - Comparison of TCR, TSC and FC – TCR

Unit-3

Variable Impedance Type Series Compensators - Switching Converter Type Series Compensators Objectives of voltage and phase angle regulators - approaches to Thyristor - Controlled Voltage and Phase Angle Regulator

Unit-4

STATCOM - Introduction to Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC) - basic operating principles and control structure of UPFC - introduction to subsynchronous resonance - NGH - SSR damping scheme.

REFERENCE BOOKS

- Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS - Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers, New Delhi, 2001
- R. Mohan Mathur and Rajiv K. Varma, "Thyristor Based FACTS Controller for Electrical Transmission Systems", Wiley Interscience Publications, 2002
- Narain G. Hingorani, "Flexible AC Transmission", IEEE Spectrum, April 1993, pp 40 - 45
- Narain G. Hingorani, "High Power Electronics in Flexible AC Transmission", IEEE Power Engineering Review, 1998
- Elinar V. Larsen, Juan J Sanchez - Gasca Joe H. Chow, "Concepts for design of FACTS controllers to damp power swings", IEEE Transactions on Power Systems, Vol. 10, No. 2, May 1995

PhD-EE-109

EHVAC AND HVDC TRANSMISSION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Introduction to EHV AC and HVDC transmission-Comparison between HVAC and HVDC overhead and underground transmission schemes-Break even.
Distance-problems involved in EHVAC transmission.

Unit-2

Bundled conductors-Surface voltage gradient on single, double and more than three conductor bundles-Effects of corona-power loss-charge voltage diagramwith corona-attenuation of traveling waves due to corona loss-noise generation and their characteristics-corona pulses, their generation and properties
(qualitative study only) Problems of EHV AC transmission at power frequency.

Unit-3

HVDC Transmission- Rectification and inversion process a brief introduction -constant current and constant extinction angle modes of operation- DC transmission system – harmonics on AC and DC sides - filters for their suppression – multi terminal DC transmission systems-parallel operation of AC and DC transmission – voltage stability in AC/DC systems – recent trends in HVDC transmission.

Unit-4

Design of EHV lines-Design factors under steady state-steady state limits-line insulation coordination based upon transient over voltages-design examples.
EHV Cable transmission - Characteristics of EHV cables – desired properties of cable insulation materials -design basis of cable insulation. EHV testing –standard specifications and standard wave shapes for testing-general lay out of EHV laboratory**.**

REFERENCE BOOKS

1. BegamudreR.D , “Extra High Voltage AC Transmission Engineering”, Wiley Eastern Ltd., second edition,1991.
2. Padiyar K.R, “HVDC Power Transmission system technology and System Interaction” , New Age International (P) Ltd., Publishers,1990.

PhD-EE-110

POWER QUALITY MANAGEMENT

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:		3 Hrs		Total Marks:	100

Unit -1

Power Quality phenomena - Basic terminologies & Definitions - Various events in Power Quality - Causes for reduction in Power Quality -- Power Quality Standards. Interpretation and analysis of Power Quality Measurements - Active Filters as Power Quality Conditioners - Basic concept of Unified Power Quality Conditioners.

Unit-2

Causes of voltage sags - magnitude and duration of voltage sags - effect on adjustable AC Drives, DC drives, computers and consumer electronics - monitoring and mitigation of voltage sags.

Unit-3

Origin of Long and Short interruptions - influence on various equipments - reliability of power supply - basic reliability evaluation techniques - monitoring and mitigation of interruptions.

Unit-4

Origin of harmonics - Harmonic Distorsion in electric supply system - effect of harmonics on adjustable speed ac drives, - harmonic reduction using PWM and harmonic injection - THD - Measurements & Analysis.

REFERENCE BOOKS

1. Math. H. J. Bollen, "Understanding Power Quality Problems - Voltage Sags and Interruptions", IEEE Press, 2000
2. David D. Shipp and William S. Vilcheck, "Power Quality and Line Considerations for Variable Speed AC Drives", IEEE Transactions on Industry Applications, Vol. 32, March / April - 1996
3. Po - Tai Cheng, Subhashish Bhattacharya and Deepak. D. Divan, " Line Harmonics Reduction in High - Power Systems Using Square - Wave Inverters - Based Dominant Harmonic Active Filter", IEEE Transactions on Power Electronics, Vol. 14, No. 2, March 1999
4. Hideaki Fujita and HifofumiAkagi, "The Unified Power Quality Conditioner: The Integration of Series and Shunt Active Filters", IEEE Transactions on Power Electronics, Vol. 13, No. 2, March 1998
5. Christopher J. Melhorn and Mark. F. McGranaghan, "Interpretation and Analysis of Power Quality Measurements", Electrotek Concepts, Inc.1998
6. "Harmonic Distortion in the electric supply system", - Technical Note No. 3 from Integral Energy Power Quality Centre, University of Wollongong, March 2000

PhD-EE-111

SYSTEM THEORY

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

Unit -1

Normalisation of differential equations. Introduction to state variable representation models of linear continuous time system solution of state equation, by various methods.

Diagonalization of matrices. Calculation of generalized eigen vectors. Reduction to canonical and Jordan's canonical form.Gilberts and Kalman's test for controllability and observability.

Unit-2

Impulse response and transfer function matrices. Properties of transfer functions, reducibility, Realization of transfer functions.Controllability and observability canonical forms.

Unit-3

State space design. Controllable and observable companion forms. Design by state feedback and pole placements.

Unit-4

Non linear systems. Phase plane analysis method of isoclines equilibrium points stability concepts and definitions. Lyaponouv's stability criteria- RouthHourwitz stability criteria.

REFERENCE BOOKS

1. Gopal .M,"Modern control theory", Wiley Eastern Ltd., 1993
2. Doebelin,E.O, "Control systems Principles and Design", John Wiley,1990
3. Gopal .M,"Digital control and state variable methods", Wiley Eastern Ltd., 1993
4. Ogata .K,"Modern Control Engineering" 4th Edition Prentice Hall 1997
5. Nagarath.I.J. and Gopal.M, "Control system Engineering", Wiley Eastern 1993

PhD-EE-112

ESTIMATION AND IDENTIFICATION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

Unit -1

Introduction to linear least square estimation : a geometric approach.Wiener filter, Levinson filter, updating QR filter and the Kalmanfilter.

Unit-2

Filter implementation structures : lattice, ladder and the systolic QR.Stochastic realization theory (modelling given the covariance).

Unit-3

Modelling given the raw data. Spectral estimation.

Unit-4

Recursive least squares identification algorithms: Levinson-type, Kalman-type and the QR-type.

REFERENCE BOOKS

1. U.B. Desai, Lecture notes on estimation realization and identification, Unpublished, 1986.
2. B.D.O Anderson and J.B. Moore, Optimal Filtering, Prentice-Hall, 1979.
3. T. Kailath, Lecture notes on Wiener and Kalman Filtering, Springer Verlag, 1980.
4. L. Ljung, System Identificaiton Theory for the user, Prentice-Hall, 1987.
5. P.S. Maybeck, Stochastic Models, Estimation and Control, Vols. 1-3, Academic Press, 1980-1982.

PhD-EE-113

OPTIMAL CONTROL SYSTEMS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Introduction: static and dynamic optimization. Parameter optimization.

Caculus of Variations : problems of Lagrange,. Mayer and Bolza.Euler-Language equation and transversality conditions, Lagrange multipiliers.

Unit-2

Pontryagins maximum principle; theory; application to minimum time, energy and control effort problems, and terminal control problem.

Unit-3

Dynamic programming :Belamans principle of optimality, multistage decision processes. application to optimal control.

Linear regulator problem : matrix Riccati equation and its solution, tracking problem.

Unit-4

Computational methods in optimal control.application of mathematical programming. singular perturbations, practical examples.

REFERENCE BOOKS

1. D.E.Kirk, Optimal Control Theory, Prentice-Hall. 1970.
2. A.P.Sage and C.C.White II, Optimum Systems Control, 2nd ED., Prentice-Hall, 1977.
3. D.Tabak and B.C.Kuo, Optimal Control by Mathematical Programming, Prentice-Hall, 1971.
4. B.D.O. Anderson and J.B.Moore, Linear Optimal Control, Prentice-Hall, 1971.

PhD-EE-114

NONLINEAR DYNAMICAL SYSTEMS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Introduction to nonlinear systems; analysis by phase plane and describing function methods.Lyapunov stability theory.

Unit-2

The Lure problem: Popov's method, circle criterion. Hyperstability.

Unit-3

Hamiltonian, Lagrangian and gradient systems: physical examples and analysis. Stability of Hamiltonian systems.

Unit-4

Periodic systems: Floquet-Lyapunov theory, Krein's stability theorem.

REFERENCE BOOKS

V. M. Popov :Hyperstability of control systems. Springer Grundleheren series, 1970.
M. Vidyasagar, Nonlinear systems analysis. 2nd Edition.Prentice Hall, 1993.
Y. A. Yakubovitch and V. M. Starzhinskii, Linear differential equations with periodic coefficients.Wiley, 1975.

PhD-EE-115

INTELLIGENT CONTROLLERS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

Unit -1

Neural Networks – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised learning –perceptron networks back propagation networks – learning factors – linear separability – Hopfield networks.

Recurrent auto association memory – bi-directional associative memory –temporal – self – organising feature maps – adaptive resonance theory. Network –radial basis function networks.

Unit-2

Genetic Algorithms: Working principles – terminology – Importance of mutation – comparison with traditional methods – constraints and penalty function – GA operators – Real coded GAS.

Unit-3

Fuzzy set - Crisp set – vagueness – uncertainty and imprecision – fuzzy set – fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relation – cardinality operations, properties – fuzzy Cartesian product and composition – composition of fuzzy relations

Unit-4

Fuzzy to crisp conversion – Lambda cuts for fuzzy sets and relations –definition methods – structure of fuzzy logic controller – database – rule base – Inference engine

Applications of Neural network and Fuzzy system for power system application. Designing using Simulation Software Fuzzy Logic Toolbox – Use of fuzzy logic, and Neural Network tool box for power system application.

REFERENCE BOOKS

1. Lawrence Fausatt, “Fundamentals of neural networks”, Prentice Hall of India, New Delhi, 1994.24
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill International Edition, USA, 1997.
3. Bart kosko, “ Neural Networks and Fuzzy Systems”, Prentice Hall of India, New Delhi, 1994.
4. Jack M.Zurada, “Introduction to Artificial Neural Systems”, Jaico publishing house 2006.
5. Zimmerman H.J. “Fuzzy set theory – and its applications”, Kluwer Academic Publishers 1994.
6. Simon Haykin, “Neural Networks – A comprehensive foundation”, Pearson Education Asia, 2002.
7. Kalyanmoy Deb, a optimization for engineering design, prentice hall of India 1988.
8. A.Goldberg, “Genetic Algorithms”

PhD-EE-116

DIGITAL SIGNAL PROCESSING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:	**3 Hrs**		**Total Marks:**	**100**

Unit -1

Characteristics and classification of signals – examples of signals –multichannel – multi-dimensional – continuous versus discrete – analog versus digital – concepts of signal processing – advantages of digital signal processing over analog processing.

Unit -2

Discrete time signals – Linearity, shift invariance – sequences – Stability and causality – Frequency domain response – Z-transform – Theorems & properties – Structure for discrete time system – direct, cascade and parallel, ladder.

Discrete fourier series – Properties – Sampling Z-transformer – discrete fouriertransform – properties – Linear & circular convolution – Decimation-in-time and decimation–in–frequency - FFT algorithms.

Unit -3

Introduction – Properties of IIR filter – Design of IIR filters – Impulse invariance & Bilinear transformation techniques – Properties FIR filters –Design of FIR -filters using windows – Comparison of IIR & FIR digital filters.

Unit-4

Introduction – A/D quantisation noise – Co-efficient quantisation –Quantization in sampling analog signals – overflow errors – product round off errors – limit cycles due to product round off – finite word length effects in IIR and FIR filters, discrete fourier transform.

REFERENCE BOOKS

1. Alan V. Oppenheim, Ronald W.Schafer, “Digital signal processing”, Prentice Hall of India pvt Ltd.,2002.
2. John G.Proakis, DimitrisG.Manolakis, “Digital signal processing”, Prentice Hall of India pvtLtd.,third edition.1996.
3. SanjitK.Mitra, “Digital signal processing”, Tata McGraw Hill,.1998.
4. Alan V. Oppenheim, Ronald W.Schafer, “Discrete-time signal processing”, Prentice Hall of India pvt Ltd.,1998.

PhD-EE-117

EMBEDDED SYSTEMS DESIGN

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:		3 Hrs		Total Marks:	100

Unit -1

The concept of embedded systems design. Embedded microcontroller cores, embedded memories.Examples of embedded systems.

Unit -2

Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing.

Unit -3

sub-system interfacing, interfacing with external systems, user interfacing.

Design trade offs due to process compatibility, thermal considerations, etc.

Unit -4

Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

REFERENCE BOOKS

1. J.W. Valvano, "Embedded Microcomputor System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

PhD-EE-118

FUZZY LOGIC AND EXPERT SYSTEMS IN POWER SYSTEMS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

Unit -1

Expert systems and their tools, with methodology for building an Expert system.Fuzzy logic basics and operations.Fuzzy arithmetic and representation, classical logic.

AI – definition – the AI problems – defining a problem as a state space search –heuristic search techniques – breath first search – depth first search – hill climbing and best first search technique – symbolic reasoning under uncertainty – non monotonic reasoning – statistical reasoning – probability and Baye's theorem – certainty factor and rule base system.

Unit -2

Introduction to expert systems – components of an expert systems – features of an ES – ES categories – developing and using an ES – model based ES –knowledge acquisition and typical building process. Basics of fuzzy logic-vagueness-uncertainty and imprecision – Concepts of crisp set - fuzzy sets – crisp to fuzzy - complements – union – intersection –combination of operation – General aggregation operation – fuzzy relational equation - fuzzy measure – fuzzy function – approximate reasoning – fuzzy proposition – fuzzy quantifiers.

Unit -3

Structure of fuzzy logic controller – input, output, if then rules – fuzzification and its types, knowledge base, defuzzification and its types – fuzzy logic tools –fuzzy logic controller examples.

Unit -4

Application of AI to Power Systems-Application of expert systems, fuzzy logic systems and neuro fuzzy controllers to load forecasting, contingency analysis –

VAR control – load restoration and other power system operation and control problems.

REFERENCE BOOKS

1. Rich and Knight, "Artificial Intelligence", Tata McGraw Hill,1991.
2. Dan W.Patterson, "Introduction to AI and expert systems", Prentice Hall India (P) Ltd,1990.
3. Bark Kosko, "Neural networks and fuzzy systems", Prentice Hall, 1994.31
4. Klin.G.J. and Folger.T.A., "Fuzzy sets, uncertainty and information," Prentice Hall,1998.
5. Timothy.J.Ross, "Fuzzy logic with Engineering applications", McGraw Hill, USA, 1997.

PhD-EE-119

IMAGE PROCESSING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	**Examination:**	**80**
Duration of Exam:	**3 Hrs**		**Total Marks:**	**100**

Unit -1

Image representation - Gray scale and colour Images, image sampling and quantization.

Two dimensional orthogonal transforms - DFT, FFT, WHT, Haar transform, KLT, DCT.

Image enhancement - filters in spatial and frequency domains, histogram-based processing, homomorphic filtering.

Unit -2

Edge detection - non parametric and model based approaches, LOG filters, localisation problem.

Image Restoration - PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.

Unit -3

Mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition.

Computer tomography - parallel beam projection, Radon transform, and its inverse, Back-projection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection.

Unit -4

Image communication - JPEG, MPEGs and H.26x standards, packet video, error concealment.

Image texture analysis - co-occurence matrix, measures of textures, statistical models for textures.

Misc. topics such as - Hough Transform, boundary detection, chain coding, and segmentation, thresholding methods.

REFERENCE BOOKS

1. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
2. R.M. Haralick, and L.G. Shapiro, Computer and Robot Vision, Vol-1, Addison Wesley, Reading, MA, 1992.
3. R. Jain, R. Kasturi and B.G. Schunck, Machine Vision, McGraw-Hill International Edition, 1995.
4. W. K. Pratt, Digital image processing, Prentice Hall, 1989.
5. Rosenfold and A. C. Kak, Digital image processing, Vols. 1 and 2, Prentice Hall, 1986.
6. H. C. Andrew and B. R. Hunt, Digital image restoration, Prentice Hall, 1977

PhD-EE-120

MODELING OF ELECTRICAL MACHINES

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Essentials of rotating electrical machines - Linear Transformations - transformation from a displaced brush axis, three phases (a,b,c) to two phases (o), rotating axis (o) to stationary axis (d, q, o).

Unit -2

Park's transformation - application of generalized theory - Electrical Torque - Restrictions of generalized theory of machines.

Unit -3

Steady state analysis of separately excited DC Generators - Steady state analysis of separately excited DC Generators - modeling of DC Series Motor - Modeling of DC Shunt Motor and DC Generator under no load and loaded conditions.

Transformation applied to three - phase Induction Machine - Electrical performance equations - steady state analysis.

Unit -4

Basic synchronous machine parameters - General synchronous machine equation - vector diagram for motoring and generating operations - three phase synchronous machine with no Amortisseurs - balanced steady - state analysis - steady state power angle characteristics.

REFERENCE BOOKS

1. Bimbhra. P. S., "Generalised Theory of Electrical Machines", Khanna Publishers, New Delhi, 2000
2. VedamSubrahmanyam, "Thyristor control of Electric Drives", Tata McGraw Hill Company Limited, New Delhi, 2003

PhD-EE-121

ADVANCED ELECTRICAL DRIVES

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Switching converters and their applications to variable frequency drives - Power electronic converters for control of amplitude and AC variable frequency drives - Mathematical representation of switching functions- reduction of switching losses in practical switches.

Field orientation principles for Induction motors - current controllers - Flux and Torque regulation methods.Vector control concept, PWM current control- Mat lab Simulation.

Motion control performance requirements of variable frequency PMAC machines - closed loop speed control of VVVF PMAC motor drive.

Unit -2

Sensor less control of AC drives - parameter identification in Brush less motors and induction motor - Estimation of disturbance torque, instantaneous speed and machine back emf, Ideal back emf and current waveforms, Sensor requirements.

Unit -3

SRM configuration and design - converter topologies - control strategies- Sensor less control Principles of Fuzzy logic control and Neural network - Design methodology and block diagram implementation of DC drive and Vector - controlled induction motor. Recent trends in fuzzy control of electrical drives.

Unit -4

CONCURRENCY MANAGEMENT - DATABASE SECURITY: Integrity and control - security and integrity threats - DATABASE DESIGN - The organization and its information system - definition of the problem - analysis of existing system and procedures - preliminary design - computing system division - final design - implementation and testing - operation - operation and tuning.

REFERENCE BOOKS

1. Bimal.K. Bose, "Power Electronics and Variable frequency drives" Standard Publishers Distributors, New Delhi, 2000
2. Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989
3. Murphy J.M.D, Turnbull, F.G, "Thyristor control of AC motor, Pergamon press, Oxford, 1988
4. Sheperal, Wand Hully, L.N. "Power Electronic and Motor control" Cambridge University Press Cambridge 1987
5. Dewan, S. Slemon B., Straughen, A. G.R., "Power Semiconductor drives", John Wiley and Sons, NewYork 1984

PhD-EE-122

SPECIAL MACHINES AND THEIR CONTROLLERS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Operation, Types of stepper motors - Torque production, modes of excitation, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor.

Operation, Torque equation, Power controllers, speed torque characteristics - Switched Reluctance Motors.

Unit -2

Difference between mechanical and electronic Commutators, Hall sensors, Optical sensors, Square - Wave permanent magnet brushless motor drives, torque and EMF equation, torque - speed characteristics of Permanent Magnet Brush less DC Motors - controllers PM DC Motor.

Unit -3

Principle of operation, EMF, power input and torque expressions, phasor diagram, power converters, Torque - Speed characteristics, self control, controllers for Permanent Magnet Synchronous Motors.

Unit -4

Construction and principle of operation of Linear Induction Motor - Universal Motor - Linear Synchronous motor - Applications.

REFERENCE BOOKS

1. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989
2. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989
3. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford, 1989
4. Krishnan R, "Switched Reluctance Motor Drives", Modelling, Simulation, Analysis, Design and applications, CRC press

PhD-EE-123

POWER ELECTRONICS IN WIND AND SOLAR ENERGY CONVERSION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly the question paper, question no 1 will be set up from all the four sections/units and of short answer type. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:		**3 Hrs**		**Total Marks:**	**100**

Unit -1

Recent trends in energy consumption - World energy scenario - Energy sources and their availability - Solar radiation and measurement - Solar cells and their characteristics - Influence of insulation and temperature - PV arrays - Electrical storage with batteries - Solar availability in India - Switching devices for solar energy conversion - Stand alone inverters - Charge controllers - Water pumping - Audio visual equipments, Street lighting, Analysis of PV systems.

Unit -2

DC Power conditioning converters - Maximum Power point tracking algorithms - AC power conditioners - Line commutated inverters - synchronized operation with grid supply - Harmonic problem.

Unit -3

Basic principle of wind energy conversion - nature of wind - Wind survey in India - Power in the wind - components of a wind energy conversion system - Performance of Induction Generators for WECS - Classification of WECS.

Unit -4

Self excited Induction Generator for isolated Power Generators - Theory of self excitation - Capacitance requirements - Power conditioning schemes - Controllable DC Power from SEIGs Wind / Solar PV integrated systems - selection of power conversion ratio - Optimisation of system components – Storage.

REFERENCE BOOKS

1. Rai G.D., "Non - Conventional Energy Sources", Khanna Publishers, 1993
2. Rai G.D., "Solar Energy Utilisation", Khanna Publishers, 1993
3. Daniel, Hunt. V, "Wind Power - A Handbook of WECS", Van Nostrend Co., New York, 1981
4. Gary L. Johnson, "Wind Energy Systems", Prentice Hall Inc., 1985
5. Freris L. L., "Wind Energy Conversion", Prentice Hall (UK) Ltd., 1990