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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	Core-I	Subject Code:		MTPS 101	Subject Name	ADVANCED POWER SYSTEM ANALYSIS			
Maximum Marks Allotted						Contact Hours			Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
70	20	10	-	-	100	3	0	0	3

UNIT-I Incidence and Network Matrices: Introduction – graphs – incidence matrices formation - Y_{Bus}, Y_{BR} and Z_{loop} by singular transformation, single phase modeling of transmission lines, off-nominal transformer tap representation and phase shift representation - formation of Y_{bus} with direct inspection method.

UNIT-II Power Flow Analysis: Formulation of power flow problem – solution through Gauss-Seidel method, Newton Raphson method - decoupled and fast decoupled power flow solutions - DC power flow solution – comparison of GS – NR – FDC method. Study of Power flow solution with FACTS devices - Renewable Energy Sources –Solar and Wind Energy Sources.

UNIT-III Fault Studies: Algorithms for formation of Z_{bus} matrix; Short Circuit (SC) studies – introduction – Short circuit calculations using Z_{bus} – Z^f_{abc} – Y^f_{abc} – Z^f_{012} – Y^f_{012} matrices for various faults, short circuit analysis using Z_{bus} for L–L–L, L-G, L-L and L-L–G faults. Analysis of open circuit faults- one line conductor open and two-line conductor open.

UNIT-IV Contingency Analysis: Adding and removing multiple lines, piece wise solution of interconnected systems, analysis of single and multiple contingencies, Contingency analysis by DC Model.

UNIT-V State Estimation: Method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation.

References:

[1] Stagg G.Ward, El–Abiad, Computer methods in power system analysis, McGraw Hill ISE.

[2] J.Arrilaga & C.P. Arnold: Computer Modeling of Electric Power Systems, John Wiley & Sons, N.Y.

 [3] Nagarath & Kothari Modern power system analysis 3rd Edition, TMH.

[4] Nagsarkar & Sukhija, Power system analysis, Oxford press, New Delhi.

[5] Grainger, J.J. and Stevenson, W.D. 'Power System Analysis' TMH, New Delhi.

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Semester/Year		I/I		Program		M.Tech: Power System				
Subject Category	Core-II	Subject Code:		MTPS 102	Subject Name	POWER SYSTEM DYNAMICS-I				
Maximum Marks Allotted							Contact Hours			Total Credits
Theory			Practical			Total Marks				
ES	MS	Assignment/Quiz	ES		LW		L	T	P	
70	20	10	-		-	100	3	0	0	3

POWER SYSTEM DYNAMICS-I

UNIT 1 INTRODUCTION TO POWER SYSTEM STABILITY PROBLEM: Basic concepts and definitions: Rotor angle stability, voltage stability and voltage collapse, Midterm and long-term stability, Classification of stability, states of operation and system security system dynamic problems.

UNIT 2 REVIEW OF CLASSICAL METHOD: System model, some mathematical analysis of steady state stability, analysis of transient stability, simplified representation of excitation control.

UNIT 3 MODELING OF SYNCHRONOUS MACHINE: Introduction, synchronous machine, parks transformation, analysis of steady state performance per unit equivalent circuits of synchronous machine, determination of parameters of equivalent circuits, measurements for obtaining data, saturation models, transient analysis of a synchronous machine.

UNIT 4 EXCITATION AND PRIME MOVER CONTROLLERS: Excitation system Modeling, system representation by state evasions, prime move control systems.

UNIT 5 TRNMISSION LINE, SVC AND LOADS: D-Q transformation using L-B variables, static var compensators, loads Dynamics of a synchronous generator connected to estimate bus: system model, synchronous machine model, calculation of initial conditions, inclusion of SVC Model, Analysis of single machine system, small signal analysis with block diagram representation, synchronizing and damping torque analysis, small signal model, nonlinear oscillators.

References:

[1] Prabha Kundur, "Power system stability and control", Tata McGraw Hill

[2] Kimbark EW. "Power system stability-III, synchronous machines", John Wiley & Sons

[3] Taylor C.W. "Power systems voltage stability", TMH

[4] K.R. Padiyar, "Power systems Dynamics stability and control", Interline publishing pvt., ltd., Bangalore.

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	PE-I	Subject Code:	MTPS 103(A)	Subject Name		WIND AND SOLAR SYSTEMS			
Maximum Marks Allotted						Contact Hours			Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
70	20	10	-	-	100	3	0	0	3

UNIT-I Historical development and current status: Introduction, Historical Background, Status of Wind Turbine Technology- Design approaches. Characteristics of Wind Power Generation, Basic Integration Issues Related to Wind Power. Generators and Power Electronics for Wind Turbines: Introduction, State-of-the-art Technologies, Generator Concepts- Asynchronous (induction) generator, the synchronous generator, other types of generators. Isolated systems with wind power: Use of wind energy in isolated power systems, categorization of systems and experience; wind power impact on power quality, interconnected system.

UNIT-II Power Quality Standards for Wind Turbines: Introduction, Power Quality Characteristics of Wind Turbines, Impact on Voltage Quality. Technical Regulations for the Interconnection of Wind Farms to the Power System: Introduction, Overview of Technical Regulations, Comparison of Technical Interconnection Regulations, Technical Solutions for New Interconnection Rules- Absolute power constraint, Balance control, Power rate limitation control approach, Delta control; Interconnection Practice.

UNIT-III Introduction to solar energy and its prospects: Physical principles of the conversion of solar radiation into heat, flat-plate collectors, energy balance equation and collector efficiency, thermal analysis of flat-plate collector and useful heat gained by the fluid, concentrating collector, advantages and disadvantages of concentrating collector over flatplate type collectors, solar energy storage systems, solar pond, applications of solar energy.

UNIT-IV Photovoltaic Energy Conversion: Solar cells and their characteristics -PV arrays - Electrical storage with batteries - Switching devices for solar energy conversion Grid connection

Issues - Principle of operation; line commutated converters (inversion-mode) - Boost and buck boost converters- selection of inverter, battery sizing, array sizing.

PV Applications: Stand-alone inverters - Charge controllers - Water pumping, audio visual equipment, street lighting - analysis of PV systems

References:

[1] Thomas Ackermann, Editor, "Wind power in Power Systems", JHS.

[2] G.D. Rai, "Non-conventional Energy Resources", Khanna Publishers.

[3] Siegfried Heier, "Grid integration of wind energy conversion systems", JWS.

[4] K. Sukhatme and S.P. Sukhatme, "Solar Energy". TMH, Second Edition.

[5] B.H. Khan, "Non-conventional Energy Resources", TMH, 2nd edition.

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	PE-I	Subject Code:	MTPS 103(B)	Subject Name		HIGH POWER CONVERTERS			
Maximum Marks Allotted						Contact Hours			Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
70	20	10	-	-	100	3	0	0	3

UNIT-I Non-Isolated DC-DC converters: Buck converter, boost converter, buck - boost converter, averaged circuit modeling, input-output equations, ripple calculations, filter design.

UNIT-II Isolated DC-DC converters: Forward – fly – back - push-pull- and full-bridge converters. Relationship between I/P and O/P voltages- expression for filter inductor and capacitors.

UNIT-III Inverters: Single phase, three phase, Multi level inverters-diode clamped, flying capacitor, cascaded H-bridge. Pulse Width Modulation Techniques: Single pulse, multi- pulse, sinusoidal PWM, space vector modulation.

UNIT-IV Front End (AC-DC) converters: PWM rectifiers-configuration types, three-phase full and semi converters- reactive power- power factor improvements – extinction angle control symmetrical angle control- PWM control

References:

[1] Mohammed H. Rashid, "Power electronics", Pearson education, 3rd edition.

[2] Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronic Converters applications and Design", John Wiley & sons, 3rdedition.

[3] Umanand L, "Power electronics essentials & applications", Wiley India Pvt. Ltd.

 [4] Robert. W. Erickson, "Fundamentals of Power electronics", springer, 2nd edition.

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Semester/Year		I/I		Program		M.Tech: Power System				
Subject Category	PE-I	Subject Code:	MTPS 103(C)	Subject Name		SMARTGRIDS				
Maximum Marks Allotted							Contact Hours			Total Credits
Theory			Practical		Total Marks					
ES	MS	Assignment/Quiz	ES	LW		L	T	P		
70	20	10	-	-	100	3	0	0		3

UNIT-1 Introduction: Conventional power systems and Smart grid, definition of smart grid, need for smart grid, Smart grid architecture, smart grid domains, enablers of smart grid, Communication architecture and protocols for smart grid, smart grid priority standards and regulation, smart-grid activities in India.

UNIT-2 Systems of nonlinear equations: Fixed point iteration, Newton Raphson Iteration, Continuation methods, Power system application: power flow, regulating transformer, Fast decoupled load flow, PV curves and continuation power flow, three phase power flow

UNIT-3 Smart Grid Security analysis: Concept of security, Security analysis and monitoring, factors affecting power system security, detection of network problems, an overview of security analysis. Contingency analysis for generator and line outages by Interactive Linear Power Flow (ILPF) method, Fast decoupled inverse Lemma based approach, network sensitivity factors, Contingency selection, concentric relaxation and bounding.

UNIT-4 Smart Grid Operation and Planning: Economic Dispatch, Optimal Power Flow, Load forecasting, Operation of smart grid system, Load Dispatch Centre functions, preventive, Emergency and Restorative, control objectives of a smart distribution system, Operational bottlenecks in smart grid. Planning Aspects of smart grid, Planning and operation Standards.

UNIT-5 Distributed Generation in Smart Grid: Renewable-based Distributed generations, Energy Storage Technologies, Modeling, Control of energy storage system, Short- mid -long term application of energy storage system in smart grids.

References:

1. Muhammad Kamran, Fundamentals of Smart Grid Systems, Academic Press, 2022

 2. Mariesa L Crow, Computational methods for Electric Power Systems, CRC Press, NW, 2016, 3 rd Edition.

3. Francisco D´ıaz-Gonz´alez, Andreas Sumper and Oriol Gomis-Bellmunt, Energy Storage in Power Systems, John Wiley & Sons Ltd, 2016

4. Prabha Kundur, Power System Stability and Control, McGraw Hill Education, 2006, 1 st Edition.

5. A. Mahaboob Subahani, G. R. Kanagachidambaresan, M. Kathiresh, Integration of Renewable Energy Sources with Smart Grid, Willey, 2021

6. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, John Wiley & Sons, 2015, 1st Edition.

7. Ali Keyhani, Design of smart power grid renewable energy systems, Wiley, 2019, 3rd Edition.

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	PE-II	Subject Code	MTPS 104(A)	Subject Name		POWER SYSTEM PLANNING & RELIABILITY			
Maximum Marks Allotted						Contact Hours			Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
70	20	10	-	-	100	3	0	0	3

UNIT-1 Load forecasting: Classification and characteristics of loads. Approaches to load forecasting. Forecasting methodology. Energy forecasting.

UNIT-2 Basic Reliability Concepts: General reliability function, Markov Chains and processes and their applications, simple series and parallel system models.

UNIT-3 Static Generating Capacity Reliability Evaluation: Outage definitions, loss of load probability methods, loss of energy probability method. Frequency and duration methods, load forecasting uncertainty. Spinning Generating Capacity Reliability Evaluation: Spinning capacity evaluation, load forecast uncertainty.

UNIT-4 Transmission System Reliability Evaluation: Average interruption rate method. The frequency and duration method. Stormy and normal weather effects.

UNIT-5 Inter-connected Systems Generating Capacity Reliability Evaluation: Introduction, The loss of toad approach. Reliability evaluation in two and more than two interconnected systems. Interconnection benefits.

Reference:

1. Roy Billinton, "Power System Reliability Evaluation", Gordan & Breach Scain Publishers, 1990.

2. J. Endrenyi, "Reliability modelling in Electric Power System", John Wiley, 1980.

3. David Elmakias, "New Computational Methods in Power System Reliability", Springer-Verlag, 2008.

4. Ali Chowdhury, Don Koval, "Power Distribution System Reliability: Practical Methods and Applications", Wiley-IEEE Press, 2009.

5. Richard E. Brown, "Electric Power Distribution Reliability", CRC Press, 2002.

6. R. L. Sullivan, "Power System Planning", Heber Hill, 1987

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Semester/Year		I/I		Program		M.Tech: Power System				
Subject Category	PE-II	Subject Code:	MTPS 104(B)	Subject Name		MATHEMATICAL METHODS FOR POWER ENGINEERING				
Maximum Marks Allotted							Contact Hours			Total Credits
Theory			Practical		Total Marks					
ES	MS	Assignment/Quiz	ES	LW		L	T	P		
70	20	10	-	-	100	3	0	0	3	

UNIT-I Vector spaces, sub-spaces, Linear transformations, Null spaces and range, Isomorphisms, Matrix representation of linear transformation

UNIT-II Matrix algebra, Systems of linear equations, Matrix representation of linear transformation, Eigen values and Eigen vectors of the linear operator

UNIT-III Linear Programming, Formation of problem, Graphical methods, Linear programming Problems, Simplex method, Duality, Non-linear programming problems, Sensitivity analysis.

UNIT-IV Optimization Methods: Mathematical model, Unconstrained problems, Discrete optimization, Search methods, Constrained problems, Robust optimization, Lagrange method, Kuhn-Tucker conditions.

UNIT-V Random Variables, Distributions Independent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes.

REFERENCES:

1. Kenneth Hoffman and Ray Kunze, "LinearAlgebra",2nd Edition, PHI,1992

2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons,2004

3. Irwin Millerand Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn,PHI. 2002

4. J. Medhi, "Stochastic Processes", New Age International, NewDelhi.,1994

5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002

6. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley,2000

7. Hillier F S and Liebermann GJ, "IntroductiontoOperationsResearch",7th Edition, McGraw Hill, 2001

8. Simmons D M, "Non-Linear Programming for Operations Research", PHI, 1975

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	PE-II	Subject Code:	MTPS 104(C)	Subject Name		ELECTRIC AND HYBRID VEHICLES			
Maximum Marks Allotted						Contact Hours			Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
70	20	10	-	-	100	3	0	0	3

Unit 1: Introduction to Electric Vehicles: Evolution of Electric Vehicles, EV configurations - Fixed and variable gearing, Single and multiple motor drives, In-wheel drives, Parameters of EV systems - Weight and size parameters, Force parameters, Energy parameters, Performance parameters

Unit 2: Hybrid EV systems and HEV configurations: Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Power flow control in Series hybrid system, Parallel hybrid system, Series parallel hybrid system, Complex hybrid system, Case Study

Unit 3: Electric Propulsion Systems: DC motor drives, Induction motor drives, Permanent-magnet motor drives, Switched reluctance motor drives and their role in EV and HEV systems. Performance study of electrical propulsion system with respect to application.

Unit 4: Energy Sources in EV and HEV systems: Electrochemical Batteries – Terminology, Specific Energy, Specific Power, Energy Efficiency in Lead Acid Batteries, Nicked based batteries, Lithium based batteries, Requirement of Ultra capacitors – Features, Principle of operation and Performance of UC, High Speed Flywheels – Operating Principles, Power capacity, Flywheel technologies, Hybrid Energy Storage Systems, Fuel Cell – Principle of Operation and Performance

Unit 5: EV Auxiliary Systems: Battery characteristics and chargers, Battery indication, Temperature control unit, Power Steering Unit, Auxiliary Power Supply, Navigation system. Case Study: Public and Domestic Charging Infrastructure for Electric Vehicles.

References:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001

2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2 nd edition, 2009.

4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category		Subject Code:	MTPS 105	Subject Name		RESEARCH MEHODOLOGY AND IPR			
Maximum Marks Allotted						Contact Hours			Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
70	20	10	-	-	100	2	0	0	2

UNIT 1: INTRODUCTION TO RESEARCH METHODS

Definition and Objective of Research, Various steps in Scientific Research, Types of Research, Criteria for Good Research, Defining Research Problem, Research Design, Case Study Collection of Primary and Secondary Data, Collection Methods: Observation, Interview, Questionnaires, Schedules,

UNIT 2: SAMPLING DESIGN AND HYPOTHESIS TESTING

steps in Sampling Design, Types of Sample Designs, Measurements and Scaling Techniques - Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), concerning variance – one tailed Chi-square test.

UNIT 3: INTERPRETATION AND REPORT WRITING

Techniques of Interpretation, Precaution in Interpretation, Layout of Research Report, Types of Reports, Oral Presentation, Mechanics of Writing Research Report.

UNIT 4: INTRODUCTION TO INTELLECTUAL PROPERTY

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights, Innovations and Inventions trade related intellectual property rights.

UNIT 5

TRADE MARKS, COPY RIGHTS AND PATENTS

Purpose and function of trade marks, acquisition of trade mark rights, trade mark registration processes, trademark claims –trademark Litigations- International trademark law

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

Text/References Books:

1. C.R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques, New Age International Publishers.

2. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets", Delmar Cengage Learning.

3. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", Tata McGraw Hill Education.

4. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi.

5. Ranjith Kumar, Research Methodology – A step by step Guide for Beginners', Sage publisher.

6. D Llewelyn & T Aplin W Cornish, "Intellectual Property: Patents, Copyright, Trade Marks and Allied Rights", Sweet and Maxwell.

7. Ananth Padmanabhan, "Intellectual Property Rights-Infringement and Remedies", Lexis Nexis,

8. Ramakrishna B and Anil Kumar H.S, "Fundamentals of Intellectual Property Rights: For Students,Industrialist and Patent Lawyers", Notion Press.

9. M.Ashok Kumar and Mohd.Iqbal Ali :"Intellectual Property Rights" Serials Pub.

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	Lab-I	Subject Code:		MTPS 106	Subject Name	Lab-I Power System Lab			
Maximum Marks Allotted						Total Marks	Contact Hours			Total Credits
Theory			Practical						
ES	MS	Assignment/Quiz	ES	LW			L	T	P	
-	-	-	90	60		150	0	0	4	2

POWER SYSTEM LABORATORY

List of experiments:

1. Study of Bucholz relay.

2. To determine the characteristics of inverse time current relay.

3. To determine the dielectric strength of transformer oil.

4. Separation of eddy current & iron losses of single-phase transformer.

5. To perform slip test on synchronous machine and to determine d-axis & q-axis reactance.

6. To measure the direct axis subtransient reactance of synchronous machine.

7. To measure the quadrature axis subtransient reactance of synchronous

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Semester/Year		I/I		Program		M.Tech: Power System				
Subject Category	Lab-II	Subject Code:		MTPS 107	Subject Name	Lab-II Renewable Energy Lab				
Maximum Marks Allotted							Contact Hours			Total Credits
Theory			Practical			Total Marks				
ES	MS	Assignment/Quiz		ES	LW		L	T	P	
-	-	-		90	60	150	0	0	4	2

RENEWABLE ENERGY LABORATORY

List of experiments:

• Solar water heating

• Solar cooking

• Solar concentrator

• PV module characterization

• Inverter performance analysis

• Wind energy convertor

• Biomass for energy

• Solar passive concepts and thermal comfort

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Semester/Year		I/I		Program		M.Tech: Power System			
Subject Category	Audit-1	Subject Code:	MTPS 108	Subject Name		ENGLISH FOR RESEARCH PAPER WRITING			
Maximum Marks Allotted							Contact Hours		Total Credits
Theory			Practical		Total Marks				
ES	MS	Assignment/Quiz	ES	LW		L	T	P	
-	-	-	-	-	-	2	0	0	0

UNIT-I: Planning and preparation, word order & breaking up long sentences, structuring sentences and paragraphs.

Unit II: Being concise, avoiding redundancy, ambiguity and vagueness, literature survey - highlighting your findings, hedging, paraphrasing and plagiarism.

Unit III: Sections of a paper – abstract, introduction, etc. review of the literature, writing - methods, results, discussion, conclusions and final check.

Unit IV: Writing – Title, Abstract and Introduction, Review of Literature and Methods.

Unit V: Useful phrases and punctuation, in-text citation and bibliography – MLA/APA styles.

References:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg, London, 2011.

2. Day R. How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.

3. Goldbort R. Writing for Science, Yale University Press, 2006.

4. Highman N. Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book, 1998.