



SYLLABUS

For

Master of Engineering Programmes
(M.TECH.-Electrical Engineering)

(For admission in 2022-23 and onwards)



[M.Tech. (Electrical Engineering) Model Curriculum Structure]

Semester-I												
S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	(AHT-301)	Advanced Mathematics	3	1	0	30	20	50	100		150	4
2	(MEET101)	Advanced Power Electronics	3	1	0	30	20	50	100		150	4
3	(MEET102)	Advanced Control System	3	1	0	30	20	50	100		150	4
4	(MEET111)	1. Renewable Energy Systems	3	0	0	30	20	50	100		150	3
	(MEET112)	2. Power System Modeling										
	(MEET113)(MEET114)	3. Applications of Power Electronics to Power Systems										
		4. Hybrid Electric Vehicles										
5	(MEET121)	1. Power Electronics for Renewable Energy Systems	3	0	0	30	20	50	100		150	3
	(MEET122)	2. HVDC Transmission Systems										
	(MEET123)	3. Modern Optimization Techniques										
	(MEET124)	4. Advanced Digital Signal Processing										
6	(MEEP101)	Advanced Power Electronics Lab	0	0	3		25	25		25	50	1
7	(MEEP102)	Advanced Control System Lab	0	0	3		25	25		25	50	1
8	(AHT-302)	Research Methodology and IPR	2	0	0		50	50	50		100	2
9	(AHT-303)	Technical Writing and Presentation Skill	2	0	0			50	0			0
		Total	19	3	6			400	600		950	22
10		*Open Elective-I (Optional)	3	0	0	30	20	50	100		150	3

Abbreviations: L-No. of Lecture hours per week, T-No. of Tutorial hours per week, P-No. of Practical hours per week, CT-Class Test Marks, TA-Marks of teacher's assessment including student's class performance and attendance, PS-Practical Sessional Marks, ESE-End Semester Examination, TE- Theory Examination Marks, PE- Practical External Examination Marks



[M.Tech. (Electrical Engineering) Model Curriculum Structure]

Semester-II												
S. No.	Subject Codes	Subject Name	Periods			Sessional Exam			ESE		Subject Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	(MEET201)	Digital Protection of PowerSystem	3	1	0	30	20	50	100		150	4
2	(MEET202)	Semiconductor Controlled Drives	3	1	0	30	20	50	100		150	4
3	(MEET231) (MEET232) (MEET233) (MEET234)	1. RestructuredPowerSystems 2. Energy Management and Auditing 3. Dynamics of Electrical Machines 4. PowerApparatusDesign	3	1	0	30	20	50	100		150	4
4	(MEET241) (MEET242)(MEET243)(M EET244)	1. Advanced Micro-Controller BasedSystems 2. SCADA System andA pplications 3. PowerQuality 4. Artificial Intelligence Techniques	3	0	0	30	20	50	100		150	3
5		Open Elective-1	3	0	0	30	20	50	100		150	3
6	(MEEP201)	Advanced Power System Protection Lab	0	0	3		25	25	25	25	50	1
7	(MEEP202)	Electric Drives Lab	0	0	3		25	25	25	25	50	1
		Total	15	3	6			300	550		950	20
8		*Open Elective-2(Optional)	3	0	0	30	20	50	100		150	3

Abbreviations: L-No. of Lecture hours per week, T-No. of Tutorial hours per week, P-No. of Practical hours per week, CT-Class Test Marks, TA-Marks of teacher's assessment including student's class performance and attendance, PS-Practical Sessional Marks, ESE-End Semester Examination, TE- Theory Examination Marks,



Syllabus Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0

Credits-4

Course objectives:

From this course, students will be able to:

1. learn distinct methods of solving simultaneous equations.
2. well-versed with partial differential equations and their solutions and applications.
3. acquire the knowledge of transformation to ease the complex problems.
4. acquaintance with basics of random variables and their distribution for dealing with events by chance.
5. study different mathematical domains to deal with real-time engineering problems.

Learning outcomes:

1. Comprehend with engineering problems in different mathematical realm.
2. Learn analytical and numerical methods to deal with mathematical problems.
3. Understand how to model the engineering problems and their solutions.
4. Implement the solutions to real-time complex engineering problems.
5. Apprehend with mathematical methodology.

Course content:

Unit I: Solution of linear simultaneous equations: (8 hours)

Consistency, Iterative method, Convergence, Cholesky's (Crout's) method, Gauss-Jordan method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems, Smallest, largest, and intermediate Eigen values

Computer based algorithm and programme for these methods (non-evaluative)

Unit II: Partial differential equation and its applications: (10 hours)

Introduction and classification of partial differential equation, Four standard forms of non-linear partial differential equations and their solutions, linear equations with constant coefficients. Applications of partial differential equations one and two-dimensional wave equation, one and two-dimensional heat equation, Two-dimensional Laplace's equation.



Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0

Credits-4

Unit III: Transform calculus-I: (8 hours)

Laplace transform, Properties of Laplace transform, Inverse Laplace transform, Applications of Laplace transform, Fourier integral theorem, Fourier transforms, Application of Fourier transform

Unit IV: Transform calculus-II: (8 hours)

Z-transform, Properties of Z-transform, Shifting theorems, Initial and final value theorem, Convolution theorems, Inverse Z-transform, Application of Z-transform

Unit V: Basic probability theory: (8 hours)

Concept and laws of probability, Discrete and continuous random variable and their distributions; Some special distributions such as Binomial, Poisson, Negative Binomial, Geometric, Continuous uniform, Normal, Exponential, Weibull, Moments, Moment generating functions, Expectation and variance

Practical demo with statistical software like R, SPSS, SAS, etc. (non-evaluative)

Text Books / References:

1. B.S. Grewal, Engineering Mathematics, Khanna Publications, 44th edition.
2. F.B. Hilderbrand, Method of Applied Mathematics, PHI Publications, 2nd edition.
3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publication, 20th edition.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Publication, 4th edition.
5. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th edition.
6. S. Ross, A First Course in Probability, Pearson Education, 8th edition.



Syllabus

Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0

Credits-2

Course Objectives: Students will be able to:

1. To understand the fundamentals of research in today's world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Outcomes:

1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student's competence to discover new inventions.

Syllabus Contents:

UNIT I: FUNDAMENTAL OF RESEARCH

Meaning of research; objectives of research; basic steps of research; criteria of good research; Research methods vs. Methodology. Types of research –criteria of good research; Meaning of research problem; selection of research problem; Approaches of investigation of solutions for research problem, Errors in selecting a research problem, Scope and objectives of research problem, Review of related literature- Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION

Research design: Types of research design- exploratory, descriptive, diagnostic and experimental; Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis; Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation, case study, survey etc.

Unit 3: REPORT WRITING AND ITS INTERPRETATION

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.



Syllabus Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0

Credits-2

Unit 4: RESEARCH ETHICS AND SCHOLARY PUBLISHING

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism and its concept and importance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR)

IPR- intellectual property rights and patent law, commercialization, New developments in IPR; copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Process of Patenting and Development; Procedure for grants of patents, Patenting under PCT; Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0

credit:00

Course Objectives:

- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:

After the successful completion of course, the students will be able to:

CO1: Write clearly and fluently to produce effective technical documents.

CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.

CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I (4 hours)

Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II (4 hours)

Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III (6 hours)

Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV (6 hours)

Speaking Skills: Accuracy vs. Fluency, The Audience, Pronunciation Guidelines, Voice Control.

Unit-V (8 hours)

Professional Presentations: Planning, Preparing, Presentation Strategies, Overcoming, Communication Barriers, Using Technology, Effective Presentations.

References:

1. Kumar, Sanjay & Pushp Lata, "Communication Skills", Oxford University Press, 2011.
2. Quirk & Randolph, "A University Grammar of English", Pearson, 2006.
3. Rutherford, Andrea J., "Basic Communication Skills for Technology", Pearson 2007.
4. Rizvi, M Ashraf, "Effective Technical Communication", McGraw Hill, 2009.
5. Leigh, Andrew & Maynard, Michael, "The Perfect Presentation", Random House.
6. Barker, Larry L., "Communication", Prentice-Hall.
7. Lesikar & Flatley, "Basic Business Communication-Skills for Empowering the Internet Generation", Tata McGraw-Hill.



Syllabus

ADVANCED POWER ELECTRONICS (MEET-101)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of the behaviour of power semiconductor devices operated as power switches, Analyse operation of DC-DC power converters. To familiarize with the inverter for different application, advance power conversion techniques, power conversion technology for exploring RES.

Course Outcomes:

At the end of course the student will be able to-

1. Explain the behaviour of power semiconductor devices operated as power switches.
2. Analyse operation of DC-DC power converters
3. Select inverter for different application
4. Adopt advance power conversion techniques
5. Apply power conversion technology for exploring RES

Syllabus:

UNIT-I

(8 hours)

Overview of Switching Power Devices:

Solid State Power Semi-conducting Devices: Review of the thyristors, TRIAC, GTO, transistors, BJT, MOSFET, IGBT, switching circuits for MOSFET and IGBT, SiC based MOSFETs

UNIT-II

(8 hours)

DC-DC Converters:

Non-isolated DC-DC converters: buck, boost, buck-boost converters under continuous and discontinuous conduction operation. Isolated DC-DC converters: forward, fly-back, push-pull, half-bridge- and full-bridge converters. Sepic converter, Zeta converter

UNIT-III

(8 hours)

Inverters:

Three-phase inverters- 120° and 180° modes of operation- PWM techniques, space vector modulation, current source inverter, multi-level inverters, techniques for reduction of harmonics

UNIT-IV

(8 hours)

Advance Techniques

Advanced power conversion techniques, resonant power conversion, multilevel converters, Multi-pulse Converters



Syllabus
ADVANCED POWER ELECTRONICS (MEET-101)

L:T:P:: 3:1:0

Credits-4

UNIT-V

(8 hours)

Convertor for Non-Conventional Energy Sources

Power Electronics Controller for Wind Energy Electric Conversion Systems, Photo Voltaic Arrays, energy saving in AC and DC Drives.

REFERENCES:

1. Power Electronics-circuits, Devices & Applications, M.H. Rashid : 3rd ed., PHI, 2005.
2. Power Electronics: Converters, Applications, Ned Mohan, T.M. Undeland, William P. Robbins: 3rd ed., John Wiley & Sons, 2009



Syllabus

ADVANCED CONTROL SYSTEM (MEET-102)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of the dynamics of a linear system by State Space Representation, stability of a linear system using pole-placement technique. To familiarize with the optimal control problems in terms of performance indices and discrete time system and model its action mathematically.

Course Outcomes:

At the end of course the student will be able to-

1. Analyze dynamics of a linear system by State Space Representation.
2. Determine the stability of a linear system using pole-placement technique and Design state observers.
3. Analyze basics of Non-linear control system.
4. Formulate and solve deterministic optimal control problems in terms of performance indices.
5. Realize the structure of a discrete time system and model its action mathematically

Syllabus:

UNIT-I

(8 hours)

State Space Models, State Diagram, State Space and State Trajectory, State Space, Representation using Phase Variable and Canonical Variables, Solution of State Equation, State Transition Matrix and its Properties, Eigen Values, Eigen Vectors, Model Matrix, Diagonalization, Generalized Eigen vectors, Computation of State Transition Matrix using Laplace Transformation, Power Series Method, Cayley-Hamilton Method, Similarity Transformation Method. Controllability and Observability Tests: Kalman's test, Gilbert's Test, Controllability and Observability Canonical Forms.

UNIT-II

(8 hours)

POLE PLACEMENT TECHNIQUES Controller Design by State Feedback, Necessary and Sufficient Condition for Arbitrary Pole Placement-State Regulator Problem and State Regulator Design, Evaluation of State Feedback Gain Matrix K, Selection of Location of Desired Closed Loop Poles, State Observer Design, Full Order/Reduced Order Observer Design, Observer Based State Feedback Control, Separation Principle **DC-DC**

UNIT-III

(8 hours)

NONLINEAR CONTROL SYSTEM Introduction, Properties of Nonlinear System, Behavior of Non-Linear System, Classification of Nonlinearities, Common Physical Nonlinearities: Saturation, Friction, Backlash, Dead-Zone, Relay, On-Off Nonlinearity, Nonlinear Spring, Limit cycle, Jump resonance. Phase-Plane Method, Singular points, Stability of Nonlinear System, Construction of Phase Trajectories, Describing Functions Method, Stability Analysis by Describing Function Method. Lyapunov's Stability Analysis, Lyapunov's Stability Criterion, Direct Method of Lyapunov and the Linear Systems, Method of Construction of Lyapunov Functions for Nonlinear Systems.



Syllabus

ADVANCED CONTROL SYSTEM (MEET-102)

L:T:P:: 3:1:0

Credits-4

UNIT-IV

(8 hours)

OPTIMAL CONTROL Introduction to Optimal Control, Parameter Optimization: Servomechanism, Optimal Control Problem: Transfer Function and State Variable Approach, State Regulator Problem, Infinite Time Regulator Problem, Output Regulator and the Tracking Problem, Parameter Optimization: Regulators.

UNIT-V

(8 hours)

DIGITAL CONTROL SYSTEMS Introduction to Discrete Time Systems, Necessary for Digital Control System, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equations, Z transforms, and the Inverse Z transform, Pulse Transfer Function, Time Response of Sampled Data Systems, Stability using Jury Criterion, Bilinear Transformation.

REFERENCES:

- 1) Katsuhiko Ogata, Modern Control Engineering Prentice-Hall of India, New Delhi.
- 2) I. J. Nagarath and M. Gopal, Control system Engineering, New Age International (P) Ltd.
- 3) Katsuhiko Ogata, State Space Analysis of Control Systems, Prentice Hall Inc, New Jersey.
- 4) Benjamin C. Kuo and FaridGolnaraghi, Automatic Control Systems, 8th Edition, John Wiley & Sons.
- 5) Brain D., Anderson and J. B. Moore, Optimal Control, Prentice Hall.
- 6) Andrew P., Sage, Optimum Systems Control, Prentice Hall.
- 7) M. Gopal , Digital Control & State Variable Methods, TMH.
- 8) A. NagoorKani, Control System, RBA Publications



Syllabus Renewable Energy System (MEET111)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of distributed generation and renewable energy sources , integrated operation of renewable energy sources.To comprehend the Impact of Distributed Generation on Power System. To familiarize with the Power Electronics Interface with the Grid and to analyze the issues of power quality disturbances.

Course Outcomes:

Students will be able to-

1. Appreciate the need for distributed generation and renewable energy sources.
2. Explain the concept of the integrated operation of renewable energy sources.
3. Describe the Power Electronics Interface with the Grid.
4. Analyze the issues of power quality disturbances.
5. Impact of Distributed Generation on Power System.

Syllabus:

UNIT-I

(8 hours)

Introduction, Distributed vs Central Station, Generation, Sources of Energy such as Micro-turbines, Internal Combustion Engines.

UNIT-II

(8 hours)

Introduction to Solar Energy, Wind Energy, Combined Heat and PowerHydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells.

UNIT-III

(8 hours)

Power Electronic Interface with the Grid

UNIT-IV

(8 hours)

Impact of Distributed Generation on the Power System,
Power Quality Disturbances

UNIT-V

(8 hours)

Transmission System Operation, Economics of Distributed Generation, Case Studies



Syllabus
Renewable Energy System (MEET111)

L:T:P:: 3:0:0

Credits-3

REFERENCES:

1. Ranjan Rakesh, Kothari D. P, Singal K.C, “Renewable Energy Sources and Emerging Technologies”, 2nd Ed. Prentice Hall of India, 2011.
2. Math H. Bollen, Fainan Hassan, “Integration of Distributed Generation in the Power System,” July 2011, Wiley –IEEE Press.
3. Loi Lei Lai, Tze Fun Chan, “Distributed Generation: Induction and Permanent Magnet Generators.” October 2007, Wiley-IEEE Press.
4. Roger A. Messenger, Jerry Ventre, “Photovoltaic System Engineering”, 3rd Ed, 2010.
5. James F. Manwell, Jon G. McGowan, Anthony L Rogers, “Wind energy explained: Theory Design and Application”, John Wiley and Sons 2nd Ed, 2010



Syllabus POWER SYSTEM MODELING (MEET112)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of transmission line, load and reactive power compensator modeling. To comprehend the effect of steady state and dynamic analysis on simulation models. To understand the modeling of synchronous machine and analyze its performance. To develop excitation system components modeling and analyze their performance.

Course Outcomes:

The student will be able to:

1. Develop power system components modeling and analyze their performance
2. Develop modeling of synchronous machine and analyze its performance
3. Perform steady state and dynamic analysis on simulation models
4. Develop excitation system components modeling and analyze their performance.
5. Understand and transmission line, load and reactive power compensator modeling.

Syllabus:

UNIT-I

(8 hours)

Modeling of Power System Components

The need for modeling of power system, different areas of power system analysis. Models of non-electrical components like boiler, steam & hydro-turbine & governor system. Transformer modeling such as auto-transformer, tap-changing & phase shifting transformer.

UNIT-II

(8 hours)

Synchronous machine modeling

Model required for steady-state analysis. The development of model required for dynamic studies. The current & flux linkage models using Park's transformation leading to simulation as linear model.

UNIT-III

(8 hours)

Analysis of synchronous machine modeling

Synchronous machine connected to an infinite bus, its simulation for steady-state condition

UNIT-IV

(8 hours)

Excitation systems

Excitation control systems using dc generator exciter, alternator-rectifier, alternator SCR, and voltage regulators such as electro-mechanical and solid state. Modeling of excitation systems



Syllabus
POWER SYSTEM MODELING (MEET112)

L:T:P:: 3:0:0

Credits-3

UNIT-V

(8 hours)

Transmission line, SVC and load modeling

Transmission line modeling, Modeling of static V AR compensators, load modeling

REFERENCES:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. R. Ramunujam, "Power System Dynamics Analysis and Simulation, PHI Learning Private Limited," New Delhi, 2009.
3. Electric Power Systems: B.M. Weddy and B.J. Cory, John Wiely and Sons, Fourth edition (2002).
4. Power System Analysis and Design :J. Duncan Glover, MulukutlaS. Sarma, Thomson Brooks/cole/ Third Edition (2003).



Syllabus

APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS (MEET113)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of FACTs and identify FACTS devices . To comprehend the effect of different thyristors and self-commutating device based compensator. To understand the Model and analyse the FACT controllers . To understand the active filtering techniques in mitigation of harmonic distortion.

Course Outcomes:

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

1. Explain the concept of FACTs and identify FACTS devices
2. Select proper compensator to solve the problems occurring power transmission
3. Control different thyristors and self-commutating device based compensator
4. Model and analyse the FACT controllers
5. Apply the active filtering techniques in mitigation of harmonic distortion.

Syllabus:

UNIT-I

(8 hours)

Review of semiconductor devices, Steady state and dynamic problems in AC systems, Power flow

UNIT-II

(8 hours)

Flexible AC transmission systems (FACTS): Basic realities & roles, Types of facts controller, Principles of series and shunt compensation.

UNIT-III

(8 hours)

Description of static VAR compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC).

UNIT-IV

(8 hours)

Impact of Distributed Generation on the Power System,
Power Quality Disturbances



Syllabus

APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS (MEET113)

L:T:P:: 3:0:0

Credits-3

UNIT-V

(8 hours)

Harmonics, harmonics creating loads, modelling, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters.

REFERENCES:

1. Understanding of FACTs., Hingorani, N. G.; IEEE Press 1996.
2. Electric Power Quality, Heydt G.T.; Stars in a Circle Publications , Indiana, 1991.
3. Static Reactive Power Compensation.; Miller T.J.E.; John Wiley & Sons, New York, 1982
4. Flexible AC Transmission System. (FACTs).; Yong Hua Song.; IEE 1999.
5. Recent Publications on IEEE Journals



Syllabus
HYBRID ELECTRIC VEHICLES(MEET114)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic need and history behind electric vehicles, configurations of hybrid electric vehicles. To comprehend the electric Traction drive train mechanism and power flow. To understand the energy management strategies in a hybrid electric vehicle. To understand the electric motor required for HEV.

Course Outcomes:

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

1. Appreciate the need and history behind electric vehicles.
2. Present the configurations of hybrid electric vehicles (HEV).
3. Explain the electric Traction drive train mechanism and power flow.
4. Select and employ the electric motor required for HEV.
5. Describe the energy management strategies in a hybrid electric vehicle.

Syllabus:

UNIT-I

(8 hours)

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics vehicle performance, vehicle, power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance

UNIT-II

(8 hours)

The basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

UNIT-III

(8 hours)

Introduction to electric components used in hybrid and electric Vehicles, Configuration, and control of DCMotor drives configuration and control of Introduction Motor drives, control of Permanent Magnet Motor drives configuration, and control of Switch Reluctance Motor drives, drive system efficiency

UNIT-IV

(8 hours)

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, Selecting the energy storage technology, Communications, supporting subsystems, Introduction to energy management and the strategies used in hybrid and electric vehicle



Syllabus
HYBRID ELECTRIC VEHICLES(MEET114)

L:T:P:: 3:0:0

Credits-3

UNIT-V

(8 hours)

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
4. CRC Press Freebook, "Hybrid and Electric Vehicles," CRC Press (Taylor and Francis group).
5. Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control," Wiley Publications.
6. A. K. babu, "Electric and Hybrid Vehicles," Khanna Publishing.
7. K. T. Chau, "Electric Vehicles, Machines and Drives: Design, Analysis and Application," IEEE Press



Syllabus

POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (MEET 121)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of stand alone and grid connected renewable energy systems. To comprehend the power converters for renewable energy applications. To understand the Model and analyse the FACT controllers. To understand the power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems. To understand how to develop MPPT algorithms.

COURSE OUTCOMES:

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

- 1) Describe and analyse the stand alone and grid connected renewable energy systems.
- 2) Design power converters for renewable energy applications.
- 3) Analyze the various operating modes of wind electrical generators and solar energy systems.
- 4) Design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- 5) Develop maximum power point tracking algorithms.

Syllabus:

UNIT-I

(8 hours)

INTRODUCTION Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems: operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT-II

(8 hours)

ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT-III

(8 hours)

POWER CONVERTERS: Block diagram of solar photo voltaic system, line commutated converters, (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT-IV

(8 hours)

ANALYSIS OF WIND AND PV SYSTEMS Standalone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS, Grid Integrated solar system



Syllabus

POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (MEET 121)

L:T:P:: 3:0:0

Credits-3

UNIT-V

(8 hours)

HYBRID RENEWABLE ENERGY SYSTEMS Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

REFERENCES:

- 1) S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009
- 2) Rashid M. H. “Power Electronics Hand book”, Academic press, 2001.
- 3) Rai G.D., “Non Conventional Energy Sources”, Khanna publishes, 1993.
- 4) Rai. G.D.,” Solar Energy Utilization”, Khanna publishes, 1993.



Syllabus HVDC TRANSMISSION SYSTEM (MEET122)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of HVDC converters and the applicability and advantage of HVDC transmission over conventional AC transmission. To Analyze the different harmonics generated by the converters and their variation with the change in firing angles. To understand the existing HVDC systems along with MTDC systems and their controls.

Course Outcomes:

At the end of the course, a student will be able to:

1. Select the HVDC converters and the applicability and advantage of HVDC transmission over conventional AC transmission.
2. Formulate and solve mathematical problems related to rectifier and inverter control methods.
3. Analyze the different harmonics generated by the converters and their variation with the change in firing angles.
4. Develop harmonic models and use the knowledge of circuit theory to develop filters and assess the requirement and type of protection for the filters.
5. Review the existing HVDC systems along with MTDC systems and their controls

Syllabus:

UNIT-I

(8 hours)

Introduction: Introduction of DC power transmission technology, comparison of AC and DC transmission, limitation of HVDC transmission, reliability of HVDC systems, application of DC transmission, description of DC transmission system, planning for HVDC transmission, modern trends in DC transmission

UNIT-II

(8 hours)

Analysis of HDVC converters: Choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, Characteristics of a twelve pulse converter, detailed analysis of converters.

UNIT-III

(8 hours)

Control of HVDC converter and systems: Necessity of control of a DC link, rectifier control, compounding of rectifiers, power reversal of DC link, voltage dependent current order limit(VDCOL), inverter extinction angle control, pulse phase control, starting and stopping of DC link, constant power control, control scheme of HVDC converters.



Syllabus
HVDC TRANSMISSION SYSTEM (MEET122)

L:T:P:: 3:0:0

Credits-3

UNIT-IV

(8 hours)

Harmonics and filters: Generation of harmonics by converters, characteristics of harmonics on DC side, characteristics of current harmonics, characteristic variation of harmonic currents with variation of firing angle and overlap angle, effect of control mode on harmonics, non-characteristic harmonic. Harmonic model and equivalent circuit, use of filter, filter configuration, filters with voltage source converter HDVC schemes

UNIT-V

(8 hours)

Multi-terminal HVDC systems: Types of multi-terminal (MTDC) systems, parallel operation aspect of MTDC. Control of power in MTDC. Multilevel DC systems. Power upgrading and conversion of AC lines into DC lines, Parallel AC/DC systems. HYBRID

REFERENCES:

1. HVDC Transmission, S. Kamakshaiah & V. Kamaraju, Tata McGraw Hill education
2. HVDC Power transmission system, K.R. Padiyar, Wiley Eastern Limited
3. High Voltage Direct Current Transmission, J. Arrillaga, Peter Pregrinu
4. Power System Stability and Control by Prabha Kundur, McGraw hill
5. Power System Analysis: Operation and Control, Abhijit Chakrabarti and Sunita Halder, PHI Learning Pvt.



Syllabus

MODERN OPTIMIZATION TECHNIQUES (MEET123)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of constrained and unconstrained optimization techniques . To Solve complex problem using the Evolutionary algorithms. To understand the multi-objective function approach for optimization . To understand the transportation and assignment problems .

Course Outcomes:

After the completion of the course the student will be able to

- 1) Explain the difference between constrained and unconstrained optimization techniques.
- 2) Solve complex problem using the Evolutionary algorithms.
- 3) Apply PSO technique.
- 4) Solve constrained problems like the transportation and assignment problems.
- 5) Use multi-objective function approach for optimization.

Syllabus:

UNIT-I

(8 hours)

FUNDAMENTALS OF OPTIMIZATION Definition-Classification of optimization problems, Unconstrained and Constrained optimization, Optimality conditions, Classical Optimization techniques (Linear and non linear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, PSO, Application of fuzzy set theory).

UNIT-II

(8 hours)

EVOLUTIONARY COMPUTATION TECHNIQUES Evolution in nature, Fundamentals of Evolutionary algorithms, Working Principles of Genetic Algorithm, Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation, GA based Economic Dispatch solution, Fuzzy Economic Dispatch including losses, Tabu search algorithm for unit commitment problem, GA for unit commitment, GA based Optimal power flow, GA based state estimation.

UNIT-III

(8 hours)

PARTICLE SWARM OPTIMIZATION Fundamental principle, Velocity Updating, Advanced operators, Parameter selection, Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO), Binary, discrete and combinatorial PSO Implementation issues, Convergence issues, PSO based applications to Drive Control



Syllabus

MODERN OPTIMIZATION TECHNIQUES (MEET123)

L:T:P:: 3:0:0

Credits-3

UNIT-IV

(8 hours)

ADVANCED OPTIMIZATION METHODS Simulated annealing algorithm, Tabu search algorithm, SA and TS for unit commitment, Ant colony optimization, Bacteria Foraging optimization.

UNIT-V

(8 hours)

MULTI OBJECTIVE OPTIMIZATION Concept of pareto optimality, Conventional approaches for MOOP, Multi objective GA, Fitness assignment-Sharing function, MOGA-Multi-objective PSO and its application in Drive Control.

REFERENCES:

- 1) D. P. Kothari and J. S. Dhillon, "Power System Optimization", 2ndEdition, PHI learning private limited, 2010.
- 2) Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms", John Wiley and Sons, 2008.
- 3) Kalyanmoy Deb, "Optimization for Engineering Design", Prentice hall of India first edition, 1988.
- 4) Carlos A. Coello Coello, Gary B. Lamont, David A. Van Veldhuizen, "Evolutionary Algorithms for solving Multi Objective Problems", 2ndEdition, Springer, 2007.
- 5) Kwang Y. Lee, Mohammed A. ElSharkawi, "Modern heuristic optimization techniques", John Wiley and Sons, 2008.



Syllabus

ADVANCED DIGITAL SIGNAL PROCESSING (MEET124)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of the time domain and frequency domain representations as well analysis of discrete time signals and systems. To Study the design techniques for IIR and FIR filters and their realization structures. To understand the finite word length effects in implementation of digital filters. To understand the Design of optimum FIR and IIR filters.

Course Outcomes:

Students will be able to-

1. Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems.
2. Study the design techniques for IIR and FIR filters and their realization structures.
3. Acquire knowledge about the finite word length effects in implementation of digital filters.
4. Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals.
5. Design of optimum FIR and IIR filters.

Syllabus:

UNIT-I

(8 hours)

Discrete time signals, Linear shift invariant systems- Stability and causality
Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier Transform, Z transform-Properties of different transforms

UNIT-II

(8 hours)

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters Impulse invariance method, Bilinear transformation method

UNIT-III

(8 hours)

FIR filter design using window functions, Comparison of IIR and FIR digital filters Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantization effects in IIR and FIR filters



Syllabus

ADVANCED DIGITAL SIGNAL PROCESSING (MEET124)

L:T:P:: 3:0:0

Credits-3

UNIT-IV

(8 hours)

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling Overflow of oscillations and zero Input limit cycles in IIR filter, Linear Signal Models

UNIT-V

(8 hours)

Single pole, All zero and Pole-zero models ,Power spectrum estimation- Spectral analysis of deterministic signals. Estimation of power spectrum of stationary random signals, Optimum linear filters, Optimum signal estimation Mean square error estimation, Optimum FIR and IIR Filters

REFERENCES:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMcGrow-Hill Edition1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and AdaptiveSignal Processing", Mc Grow Hill international editions. -2000



Syllabus

DIGITAL PROTECTION OF POWER SYSTEM(MEET201)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of digital protection with the usefulness of mathematics in digital protection. To analyze and implement the Interpolation, Numerical differentiation, Curve fitting, Least-squares, Fourier, and Walsh function-based techniques in digital protection. To understand the Signal conditioning and Conversion subsystems of the digital relay to work as a Units consisting of hardware and software. To analyze and implement the Sinusoidal, Fourier, and Walsh-based algorithms in digital protection.

Course Outcomes:

Students will be able to-

1. Analyze the major advantages of digital protection with the usefulness of mathematics in digital protection.
 2. Analyze and implement the Interpolation, Numerical differentiation, Curve fitting, Least-squares, Fourier, and Walsh function-based techniques in digital protection.
 3. Analyze the Signal conditioning and Conversion subsystems of the digital relay to work as a Units consisting of hardware and software.
 4. Analyze and implement the Sinusoidal, Fourier, and Walsh-based algorithms in digital protection.
- Analyze and implement the Differential equation-based algorithms

Syllabus

UNIT-I

(8 hours)

Evolution of digital relays from electro mechanical relays, Performance and operational characteristics of digital protection .

UNIT-II

(8 hours)

Mathematical back ground to protection algorithms, Finite difference techniques.

UNIT-III

(8 hours)

Interpolation formulae, Forward, backwardandcentraldifferenceinterpolationNumericaldifferentiation
Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform,
Walsh function analysis



Syllabus

DIGITAL PROTECTION OF POWER SYSTEM(MEET201)

L:T:P:: 3:1:0

Credits-4

UNIT-IV

(8 hours)

Basic elements of digital protection , Signal conditioning :transducers, surge protection, analog filtering, analog multiplexers, Conversion sub system: the sampling theorem, signal aliasing, Error,sampleandholdcircuits,multiplexers,analogtodigitalconversion, Digital filtering concepts, The digital relay as a Units consisting of hard ware and software

UNIT-V

(8 hours)

Sinusoidal wave based algorithms, Sample and first derivative (MannandMorrison) algorithm. Fourier and Walsh based algorithms, Least Squares based algorithms. Differential equation based algorithms. Traveling Wave based Techniques. Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.

REFERENCES:

1. A.G.PhadkeandJ.S.Thorp,“ComputerRelayingforPowerSystems”,Wiley/ResearchstudiesPress, 2009.
2. A.T.JohnsandS.K.Salman,“Digital Protection of Power Systems”, IEEEPress,1999
3. GerhardZeigler,“NumericalDistanceProtection”,SiemensPublicisCorporatePublishing,2006
4. S.R. Bhide“DigitalPowerSystemProtection”PHILearningPvt.Ltd.2014.



Syllabus

SEMI CONDUCTOR CONTROLLED DRIVES (MEET202)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of the closed loop controlled DC drives. To Describe the modern trends of DC Drives. To understand the vector control method for controlling the Induction and synchronous motor.

Course Outcomes:

- 1) Develop the closed loop controlled DC drives.
- 2) Describe the modern trends of DC Drives.
- 3) Use vector control method of speed control of Induction motor.
- 4) Apply the various speed control methods for controlling the speed of synchronous motor.
- 5) Use vector control method for controlling the Induction and synchronous motor.

Syllabus

UNIT-I

(8 hours)

D.C. DRIVES Introduction, principle of DC motor speed control, phase controlled converters, steady state analysis of three phase supplied converter controlled DC motor Drive, Introduction, Principle of operation of the chopper, Chopper controlled drives, Duty-ratio control, current-limit control, steady state analysis, four quadrant chopper circuit, chopper for inversion, chopper with other power devices, mode of chopper, input to the chopper, steady state analysis of chopper controlled DC Drives, pulsating torques.

UNIT-II

(8 hours)

CLOSED-LOOP CONTROL OF DRIVES Introduction- Basic features of an Electric Drive- Block diagram representation of Drive systems, signal flow graph representation of the systems, Transfer functions, transient response of closed loop drives systems. Speed control of a separately excited DC drive with inner current loop and outer speed loop

UNIT-III

(8 hours)

SPEED CONTROL OF INDUCTION MOTOR Speed control methods of Induction motor, Variable voltage operation, Variable frequency operation, Constant flux operation, Constant Torque and Constant power operation, V/f control with slip compensation scheme Closed loop control schemes, dynamic and regenerative braking, speed reversal. Torque slip characteristics- speed control through slip, rotor resistance control- chopper controlled resistance equivalent resistance combined stator voltage control and rotor



Syllabus

SEMI CONDUCTOR CONTROLLED DRIVES (MEET202)

L:T:P:: 3:1:0

Credits-4

resistance control- design solutions. Closed loop control scheme. Slip power recovery, torque slip characteristics, power factor considerations.

UNIT-IV

(8 hours)

VECTOR CONTROL OF INDUCTION MOTOR DRIVE Review of dq0 model of 3-Ph IM, Principle of vector control of IM, Direct vector control, Indirect vector control with feedback, Indirect vector control with feed-forward, Indirect vector control in various frames of reference, Decoupling of vector control with feed forward compensation, Direct Torque Control of IM

UNIT-V

(8 hours)

SPEED CONTROL OF SYNCHRONOUS MOTOR DRIVES (09Hours) Three phase synchronous machine and analysis of steady state operation, voltage and torque equations in machine variables and rotor reference frame variables (Park's equations), analysis of dynamic performance for load torque variations. Types of PM Synchronous motors, Torque developed by PMSM, Model of PMSM, vector control for PMSM

REFERENCES:

- 1) G.K.Dubey, Power Semi conductor controlled Drives, New Age Int. Pub.
- 2) S.B.Dewan, G.R.Slemon&A.Stranghan, Power Semi conductor controlled Drives, Johnwiley Pub.
- 3) Shepherd Hully&Liag, Power Electronics & Motor Control: Cambridge Univ. Press
- 4) R.Krishnan, Electric Motor drives – Modelling, Analysis & Control:, PHI India,Ltd.
- 5) VedamSubramanyam, Thyristor Control of Electric Drives
- 6) Vector Control of AC Drives, I. Boldea and S. A. Nasar, CRC Press LLC, 1992.



Syllabus

RESTRUCTURED POWER SYSTEMS(MEET231)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of various types of regulations in power systems. To Identify the need of regulation and deregulation. To describe the Technical and Non-technical issues in Deregulated Power Industry. To understand different market mechanisms and summarize the role of various entities in the market.

Course Out comes:

Students will be able to-

1. Describe various types of regulations in power systems.
2. Identify the need of regulation and deregulation.
3. Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4. Identify and give examples of existing electricity markets.
5. Classify different market mechanisms and summarize the role of various entities in the market.

Syllabus:

UNIT-I

(8 hours)

Fundamentals of restructured system, Market architecture Load elasticity, Social welfare maximization

UNIT-II

(8 hours)

OPF: Role in vertically integrated systems and in restructured markets, congestion management

UNIT-III

(8 hours)

Optimal bidding ,Risk assessment Hedging , Transmission pricing , Tracing of power

UNIT-IV

(8 hours)

Ancillary services, Standard market design ,Distributed generation in restructured markets



Syllabus

RESTRUCTURED POWER SYSTEMS(MEET231)

L:T:P:: 3:1:0

Credits-4

UNIT-V

(8 hours)

Developments in India, IT applications in restructured markets, Working of restructured power systems PJM, Recent trends in Restructuring Transmission System Operation, Economics of Distributed Generation, Case Studies.

REFERENCES:

1. Lorrin Philipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub., 1998.
2. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002.
3. Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Boelen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.



Syllabus

ENERGY MANAGEMENT AND AUDITING (MEET232)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of present state of energy security and its importance. To describe the basic principles and methodologies adopted in energy audit of utility . To describe the Audit energy in domestic and industrial units. To understand the energy performance evaluation of installations having motors.

COURSE OUTCOMES:

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

- 1) Identify and describe present state of energy security and its importance.
- 2) Identify and describe the basic principles and methodologies adopted in energy audit of utility.
- 3) Carryout the energy performance evaluation of installations having motors.
- 4) Analyze the data collected during performance evaluation and recommend energy saving measures
- 5) Audit energy in domestic and industrial units.

Syllabus:

UNIT-I

(8 hours)

BASIC PRINCIPLES OF ENERGY AUDIT Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit Need for energy management, energy basics, designing and starting an energy management program, energy audit process. Need for energy management, energy basics, designing and starting an energy management program, energy accounting, energy monitoring, targeting and reporting.

UNIT-II

(8 hours)

ENERGY COST AND LOAD MANAGEMENT Important concepts in an economic analysis, economic models, time value of money, utility rate structures, cost of electricity, loss evaluation. Load management: demand control techniques, utility monitoring and control system-HVAC and energy management, economic justification.

UNIT-III

(8 hours)

ENERGY EFFICIENT MOTORS Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics, variable speed, variable duty cycle systems, RMS hp voltage variation,



Syllabus

ENERGY MANAGEMENT AND AUDITING (MEET232)

L:T:P:: 3:1:0

Credits-4

voltage unbalance, over motoring, motor energy audit applications to Systems and equipment such as: electric motors, transformers and reactors, capacitors and synchronous machines.

UNIT-IV

(8 hours)

METERING FOR ENERGY MANAGEMENT Relationships between parameters, Units of measure, typical cost factors, utility meters, timing of meter disc for kilowatt measurement, demand meters, paralleling of current transformers, instrument transformer burdens, multitasking solid-state meters, metering location vs. requirements, metering techniques and practical examples.

UNIT-V

(8 hours)

LIGHTING SYSTEMS AND COGENERATION Concept of lighting systems, the task and the working space, light sources, ballasts –luminaries, lighting controls, optimizing lighting energy, power factor and effect of harmonics on power quality, cost analysis techniques, lighting and energy standards. Cogeneration: forms of cogeneration, feasibility of cogeneration, electrical interconnection. Economics Analysis-Depreciation Methods

REFERENCES:

- 1) Eastop T.D and Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, 1990.
- 2) Reay D.A., “Industrial Energy Conservation”, first edition, Pergamon Press, 1977.
- 3) IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
- 4) Amit K. Tyagi, “Handbook on Energy Audits and Management”, TERI, 2003.
- 5) Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, “Guide to Energy Management”, Fifth Edition, The Fairmont Press, Inc., 2006



Syllabus

DYNAMICS OF ELECTRICAL MACHINES (MEET233)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of electrodynamic equations of all electric machines and analyze the performance characteristics. To describe the basic principles of transformations for the dynamic analysis of machines. To describe the stability of the machines under small signal and transient conditions.

Course Outcomes:

Students will be able to-

1. Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics.
2. Knowledge of transformations for the dynamic analysis of machines.
3. Knowledge of determination of stability of the machines under small signal and transient conditions.
4. Study about synchronous machine.
5. Determine the stability of machine.

Syllabus:

UNIT-I

(8 hours)

Stability, Primitive four-Winding Commutator Machine, Complete Voltage Equation of Primitive four-Winding Commutator Machine

UNIT-II

(8 hours)

Torque Equation Analysis of Simple DC Machines using the Primitive Machine Equations, Three Phase Induction Motor. Transformed Equations, Different Reference Frames for Induction Motor Analysis Transfer Function Formulation

UNIT-III

(8 hours)

Three Phase Salient Pole Synchronous Machine, Parks Transformation, Steady State Analysis



Syllabus

DYNAMICS OF ELECTRICAL MACHINES (MEET233)

L:T:P:: 3:1:0

Credits-4

UNIT-IV

(8 hours)

Large Signal Transient, Small Oscillation Equations in State Variable form
Dynamical Analysis of Interconnected Machines

UNIT-V

(8 hours)

Large Signal Transient Analysis using Transformed Equations ,DC Generator /DC Motor System
Alternator /Synchronous Motor System

REFERENCES:

1. D. P. Sengupta & J.B. Lynn, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education.,2001
3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company,1987
4. I. Boldia & S.A. Nasar,, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967



Syllabus

POWER APPARATUS DESIGN (MEET234)

L:T:P:: 3:1:0

Credits-4

Course Objectives:

To explore the basic understanding of rotating machine employed in Power Systems . To describe the basic principles of electromagnetic energy conversion, sizing and rating of machines. To describe the Model rotating machines under transient conditions.

Course Outcomes:

Students will be able to-

1. Analyze of rotating machine employed in Power Systems.
2. Explain electromagnetic energy conversion.
3. Select sizing and rating of machines.
4. Model rotating machines under transient conditions.
5. Design rotating electrical machines.

Syllabus:

UNIT-I

(8 hours)

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Design of Transformers-General considerations, output equation, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling.

UNIT-II

(8 hours)

Specific loadings, choice of magnetic and electric loadings Real apparent flux -densities, temperature rise calculation Separation of main dimension for DC machines Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating.

UNIT-III

(8 hours)

General considerations, output equation, density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, Calculation of losses, efficiency and regulation Forces winding during short circuit.



Syllabus

POWER APPARATUS DESIGN (MEET234)

L:T:P:: 3:1:0

Credits-4

UNIT-IV

(8 hours)

General considerations, output equation, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor Elimination of harmonic torques

UNIT-V

(8 hours)

Design of stator and rotor winding, slot leakage flux ,Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data, Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions, Introduction to Computer Aided Electrical Machine Design Energyefficient machines.

REFERENCES:

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman
3. Sawhney A.K, "A course in Electrical Machine Design", Dhanpat Rai& Sons, 5th Edition.



Syllabus

ADVANCED MICRO-CONTROLLER BASED SYSTEMS (MEET241)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To Describe the architecture of advanced microcontrollers. To employ processor for these controllers
To understand the program a processor in assembly language for application system. To understand the DSP and FPGA for control applications.

Course Outcomes:

Students will be able to-

1. Describe the architecture of advanced microcontrollers
2. Employ processor for these controllers
3. Program a processor in assembly language for application system
4. Configure different peripherals in a digital system

Explain DSP and FPGA for control applications

Syllabus

UNIT-I

(8 hours)

Basic Computer Organization with examples of 8086, 80X86, 8051 etc. Accumulator based Processes- Architecture, Memory Organization-I/O Organization

UNIT-II

(8 hours)

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories/I/O Ports, Serial Communication Timers, Interrupts, Programming

UNIT-III

(8 hours)

Intel 8051 – Assembly language programming Addressing-Operations, Stack & Subroutines Interrupts- DMA

UNIT-IV

(8 hours)

PIC 16F877- Architecture Programming Interfacing Memory/ I/O Devices, Serial I/O and data communication



Syllabus

ADVANCED MICRO-CONTROLLER BASED SYSTEMS (MEET241)

L:T:P:: 3:0:0

Credits-3

UNIT-V

(8 hours)

Digital Signal Processor (DSP)Architecture – Programming Introduction to FPGA
Microcontroller development for motor control applicationsStepper motor control using micro controller

REFERENCES:

1. John. F. Wakerly: “Microcomputer Architecture and Programming”, John Wiley and Sons1981
2. Ramesh S. Gaonker: “Microprocessor Architecture, Programming and Applications with the8085”,Penram International Publishing (India), 1994
3. Raj Kamal: “The Concepts and Features of Microcontrollers”, Wheeler Publishing, 2005
4. Kenneth J. Ayala, “The 8051 microcontroller”, Cengage Learning, 2004
5. John Morton,” The PIC microcontroller: your personal introductory course”, Elsevier, 2005
6. Dogan Ibrahim,” Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18FSeries”, Elsevier, 2008
7. Microchip datasheets for PIC16F877



Syllabus

SCADA SYSTEM AND APPLICATIONS (MEET242)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of Supervisory Control Systems (SCADA) as well as their typical applications. To understand about the SCADA architecture and the various advantages and disadvantages. To learn about SCADA system components: remote terminal Units, PLCs, intelligent electronic devices, HMI systems, and SCADA servers. Learn and understand SCADA applications in the transmission and distribution sector, industries etc.

Course Outcomes:

Students will be able to-

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.
2. Acquire knowledge about SCADA architecture and the various advantages and disadvantages of each system.
3. Knowledge about single unified standard architecture IEC 61850.
4. To learn about SCADA system components: remote terminal Units, PLCs, intelligent electronic devices, HMI systems, and SCADA servers.
5. Learn and understand SCADA applications in the transmission and distribution sector, industries etc.

Syllabus

UNIT-I

(8 hours)

Introduction to SCADA, Data acquisition systems, Evolution of SCADA, Communication technologies

UNIT-II

(8 hours)

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industrial SCADA

UNIT-III

(8 hours)

SCADA System Components, Schemes- Remote Terminal Units (RTU) Intelligent Electronic Devices (IED) Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems



Syllabus

SCADA SYSTEM AND APPLICATIONS (MEET242)

L:T:P:: 3:0:0

Credits-3

UNIT-IV

(8 hours)

SCADA Architecture, Various SCADA architectures, advantages and disadvantages of each System, single unified standard architecture -IEC 61850.

UNIT-V

(8 hours)

SCADA Communication, various industrial communication technologies wired and wireless methods and fiber optics Open standard communication protocols, SCADA Applications: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and Improvement, Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises

REFERENCES:

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004
3. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003
5. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999



Syllabus

POWER QUALITY (MEET243)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of power quality issues to be addressed and recommended practices . To understand about the Model network components . To learn about series and shunt active power filtering techniques .To study the reactive power control and eliminate undesired harmonics.

Course Outcomes:

Students will be able to-

1. Explain the different power quality issues to be addressed and recommended practices
2. Analyze the effect of harmonics
3. Model network components
4. Compensate for reactive power control and eliminate undesired harmonics
5. Apply series and shunt active power filtering techniques

Syllabus

UNIT-I

(8 hours)

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

UNIT-II

(8 hours)

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

UNIT-III

(8 hours)

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 drive



Syllabus

POWER QUALITY (MEET243)

L:T:P:: 3:0:0

Credits-3

UNIT-IV

(8 hours)

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

UNIT-V

(8 hours)

Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection, Filter for single phase, 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. Grounding and wiring introduction. NEC grounding requirements

REFERENCES:

1. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
3. J. Arrillaga, "Power System Quality Assessment", John Wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R. Wood, "Power system Harmonic Analysis", Wiley, 1997
5. H. W. Beaty, Mark F. McGranaghan, Roger C Dugan, "Electrical Power Systems Quality" McGraw-Hill



Syllabus

ARTIFICIAL INTELLIGENCE TECHNIQUES (MEET244)

L:T:P:: 3:0:0

Credits-3

Course Objectives:

To explore the basic understanding of ANN Artificial Neural Networks , its use, control and design application. To Identify the fuzzy and neural network. To learn about series and shunt active power filtering techniques .To study the Genetic algorithm and evolutionary algorithms .

Course Outcomes:

Students will be able to-

1. Explain and apply ANN Artificial Neural Networks
2. Explain and apply fuzzy logic
3. Use Fuzzy logic in control and design application
4. Identify of fuzzy and neural network
5. Explain and apply Genetic algorithm and evolutionary algorithms

Syllabus

UNIT-I

(8 hours)

Biological foundations to intelligent Systems,Artificial Neural Networks, Single layer and Multilayer Feed Forward Neural Networks, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks

UNIT-II

(8 hours)

Fuzzy Logic , Knowledge Representation and Inference Mechanism Defuzzification Methods, Fuzzy logic in control and design application

UNIT-III

(8 hours)

Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA



Syllabus

ARTIFICIAL INTELLIGENCE TECHNIQUES (MEET244)

L:T:P:: 3:0:0

Credits-3

UNIT-IV

(8 hours)

System Identification using Fuzzy and Neural Network

UNIT-V

(8 hours)

Genetic algorithm, Reproduction cross over, mutation,
Introduction to evolutionary program, Applications

REFERENCES:

1. J M Zurada , “An Introduction to ANN”,Jaico Publishing House
2. Simon Haykins, “Neural Networks”, Prentice Hall
3. Timothy Ross, “Fuzzy Logic with Engg. Applications”, McGraw. Hill
4. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication
5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Company



Syllabus

ADVANCED POWER ELECTRONICS LAB (MEEP101)

L:T:P:: 0:0:3

Credits-01

Course Objectives:

To introduce the hands-on descriptions of various power semiconductor devices, converters, inverter etc. with the help of related instruments and devices.

Course Outcomes:

1. Analyse the behaviour of power semiconductor devices operated as power switches.
2. Analyse operation of DC-DC power converters
3. Select inverter for different application
4. Understand the advance power conversion techniques
5. Understand different tools like MATLAB, PSPICE etc..

Syllabus:

1. Experimental study for characteristics of DC-DC Buck converter.
2. Experimental study for characteristics of the DC-DC Boost converter.
3. Experimental study for characteristics of DC-DC Buck-Boost converter.
4. Experimental study for characteristics of single phase fully controlled Full Bridge converter.
5. Experimental study for characteristics of three-phase fully controlled Full Bridge converter.
6. Experimental study for characteristics of three-phase semi-controlled Full Bridge converter
7. PSPICE & MATLAB Simulation of Three phase full converter using RL and E loads.
8. PSPICE & MATLAB Simulation of Single-phase AC Voltage controller using RL load.
9. PSPICE & MATLAB Simulation of Three-phase inverter with PWM controller.
10. PSPICE & MATLAB Simulation of resonant pulse commutation circuit.
11. PSPICE & MATLAB Simulation of impulse commutation circuit.



Syllabus

ADVANCED CONTROL SYSTEM LAB(MEEP102)

L:T:P:: 0:0:3

Credits-01

Course Objectives:

To introduce the hands-on descriptions of various power semiconductor devices, converters, inverter etc. with the help of related instruments and devices.

Course Outcomes:

1. Analyze dynamics of a linear system by State Space Representation.
2. Determine the stability of a linear system using pole-placement technique and Design state observers.
3. Analyze basics of Non-linear control system.
4. Formulate and solve deterministic optimal control problems in terms of performance indices.
5. Realize the structure of a discrete time system and model through MATLAB.

Syllabus:

- 1 Design of lead-lag compensator for the given system.
- 2 Control of Linear and circular inverted Pendulum
- 3 Control of higher degree of freedom of robotic manipulator
- 4 Closed Loop Speed control of PMDC motor
- 5 Study of Water level control using Industrial PLC
- 6 Design of H infinity controller for any nonlinear system using MATLAB
- 7 Analyze the plots of time and frequency responses of MIMO systems using MATLAB.
- 8 Fuzzy Logic Controller design for a Pendulum on a cart using MATLAB.



Syllabus

ADVANCED POWER SYSTEM PROTECTION LAB (MEEP201)

L:T:P:: 0:0:3

Credits-01

Course Objectives:

To introduce the hands-on descriptions of various digital protection device , different protection relays etc. with the help of related instruments and devices.

Course Outcomes:

1. Analyze the major advantages of digital protection with the usefulness of mathematics in digital protection.
2. Analyze and implement the Interpolation, Numerical differentiation, Curve fitting, Least-squares, Fourier, and Walsh function-based techniques in digital protection.
3. Analyze the Signal conditioning and Conversion subsystems of the digital relay to work as a Units consisting of hardware and software.
4. Analyze and implement the Sinusoidal, Fourier, and Walsh-based algorithms in digital protection.
5. Analyze and implement the Differential equation-based algorithms

Syllabus:

1. Introduction to Power System Protection
2. Impact of Induction Motor Starting on Power System
3. Modeling of Differential Relay using MATLAB
4. Radial Feeder Protection
5. Parallel Feeder Protection
6. Principle of Reverse Power Protection
7. Differential Protection of Transformer
8. To the study time vs. voltage characteristics of over-voltage induction relay



Syllabus

ELECTRIC DRIVES LAB(MEEP202)

L:T:P:: 0:0:3

Credits-01

Course Objectives:

To introduce the hands-on descriptions of various type of speed control of different motors i.e. induction, synchronous etc. with the help of related instruments and devices.

Course Outcomes:

1. Develop the closed loop controlled DC drives.
2. Describe the modern trends of DC Drives.
3. Use vector control method of speed control of Induction motor.
4. Apply the various speed control methods for controlling the speed of synchronous motor.
5. Use vector control method for controlling the Induction and synchronous motor.

Syllabus:

1. Semiconductor converter based scalar control of permanent magnet synchronous motor
2. Three-phase voltage source converter based vector Controlled induction motor drive
3. DC-DC converter (Buck/Boost) based DC motor drive control
4. Speed control of DC Motor fed from single-phase thyristor converter
5. Speed control of induction Motor fed from three-phase multi-pulse converter
6. Three phase five-level PWM converter fed DC motor drive control
7. Three-phase voltage source converter based Direct Torque Controlled induction motor drive
8. Space Vector PWM controlled PMSM drive