Appendix " Y" Item No. 44

**ELECTRICAL ENGINEERING**

**Syllabus for M.Tech. (Power Systems and Automation)**

**Common with V/VI and VI/VI (B.Tech+M.Tech) Dual Degree Course**

(effective from the 2020-21admitted batch)

**SEMESTER – I**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPS 1.1 Advanced Power System Operation &
 Control 3 -- 30 70 100 3

EEPS 1.2 Power System Dynamics & Stability 3 -- 30 70 100 3

EEPS 1.3 Professional Elective - I 3 -- 30 70 100 3

 a) Optimisation Techniques

 b) Artificial Intelligence Techniques.

 c) Evolutionary Algorithms and Applications
 Power System

EEPS 1.4 Professional Elective - II 3 -- 30 70 100 3

 a) HVDC Transmission

 b) Flexible AC Transmission Systems

 c) EHV AC Transmission

EEPS 1.5 Research Methodology and IPR 3 -- 30 70 100 2

EEPS 1.6 Audit Course – I 3 -- 30 70 100 --

EEPS 1.7 Power Systems Simulation Lab – I -- 3 50 50 100 2

EEPS 1.8 Power Systems and Protection Lab. -- 3 50 50 100 2

 TOTAL 18 06 280 520 800 18

**SEMESTER – II**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPS 2.1 Electrical Distribution Systems &
 Automation 3 -- 30 70 100 3

EEPS 2.2 Automation in Power Systems 3 -- 30 70 100 3

EEPS 2.3 Professional Elective - III 3 -- 30 70 100 3

 (a) Real Time Control of Power Systems

 (b) Advanced Power System Protection

 (c) FACTS Modelling and Simulation

EEPS 2.4 Professional Elective - IV 3 -- 30 70 100 3

 (a) Programmable Logic Controllers and
 Applications

 (b) Renewable Energy Technologies

 (c) Power Quality

EEPS 2.5 Audit Course – II 3 -- 30 70 100 2

EEPS 2.6 Power Systems Simulation Lab – II -- 3 30 70 100 --

EEPS 2.7 Smart Grid Laboratory -- 3 50 50 100 2

EEPS 2.8 Seminar -- -- 100 -- 100 2

 TOTAL 18 03 280 520 800 18

**Syllabus for M.Tech. (Power Systems and Automation)**

**Common with V/VI and VI/VI (B.Tech+M.Tech) Dual Degree Course**

(effective from the 2020-21admitted batch)

**SEMESTER – III**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPS 3.1 Professional Elective - V 3 -- 30 70 100 3

 a) Power System Deregulation

 b) Power System Reliability

 c) Smart Grid Technologies 3 -- 30 70 100 3

EEPS 3.2 Open Elective 3 -- 30 70 100 3

EEPS 3.3 Major Project (Phase-I Dissertation) -- -- -- 100 100 10

 **SEMESTER – IV**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPS 4.1 Major Project (Phase-II Dissertation) -- -- -- 100 100 16

**ELECTRICAL ENGINEERING**

Syllabus for M.Tech. (Power Systems and Automation)

Common with V/VI and VI/VI (B.Tech+M.Tech) Dual Degree Course

(effective from the 2020-21admitted batch)

**EEPS 1.1 ADVANCED POWER SYSTEM OPERATION AND CONTROL**

 Unit Commitment: Constraints in unit commitment, Generation of state, optimizing the states using Priority-list method, Unit commitment problem solution using Priority-list method and Dynamic Programming; Hydro-thermal Coordination: Characteristics of various types of hydro-electric plants and their models, Introduction to hydro-thermal Coordination, Scheduling energy with hydro-thermal coordination, Short-term hydro-thermal scheduling.

Reactive Power Control: Requirements in ac power transmission, factors affecting stability & voltage control, fundamental transmission line equation, surge impedance, Natural loading, uncompensated line on open circuit, uncompensated line under load, types of compensations on compensated transmission lines, passive and active compensators, uniformly distributed fixed and regulated shunt compensation, series compensation, compensation by sectioning.

Optimal Power Flow: Optimal power flow problem formulation for loss and cost minimisation, Solution of optimal power flow problem using Newton’s method and Linear Programming technique; Voltage Control: Automatic voltage regulator, Exciter types, Exciter modelling, Generator modelling, Static and Dynamic response of AVR loop.

 State Estimation: Maximum Likelihood Weighted Least Square State Estimation, State estimation of an AC networks, State estimation by orthogonal decomposition, Basic concepts about network observability, Pseudo-measurements, Bad data detection and identification.

Operation of Modern Power Systems: Principle of economics, utility functions, power exchanges, electricity market models, market power indices, ancillary services, transmission and distribution charges, principles of transmission charges, transmission pricing methods, demand-side management, regulatory framework.

1. Power Generation, Operation and Control, Allen J. Wood and Bruce F. Wollenberg, John Wiley & Sons, Inc., New York, 2nd edition, 1996.

2. Reactive Power Control in Electric Systems, T J E Miller, John Wiley & Sons, New York, 1982.

3. Electric Energy Systems Theory: An Introduction, Olle I. Elgerd, TMH Publishing Company Ltd., New Delhi, 2nd edition, 1983.

4. Power System Engineering, D P Kothari and I J Nagrath, McGraw Hill Education India Pvt. Limited, Chennai, 3e, 2019.

**EEPS 1.2: POWER SYSTEM STABILITY & CONTROL**

Modeling: Basic concepts, Review of classical methods, modeling of synchronous machine, Park’s transformation, Analysis of steady state performance, Excitation system, excitation system modeling, Excitation systems-standard block diagram, System representation by state equations, Prime mover control system, Transmission lines, SVC and Loads modeling, D-Q transformation using a-ß variables.

Dynamics of a Synchronous generator connected to infinite bus: System model, synchronous machine model, Application model(1.1), Calculation of initial conditions, System simulation, Consideration of other machine models, Inclusion of SVC model,.

Small Signal Stability Analysis: Analysis of single machine system, small signal analysis with block diagram representation, Characteristic equation and application of Routh-Hurwitz criterion, synchronizing and damping torque analysis, small signal model state equations

Application of Power System Stabilizers: Introduction, Basic concepts in applying PSS, Control signals, structure and tuning of PSS.

Analysis of Multi- Machine system: A simplified system model, detailed models, Case I and II, Inclusion of load and SVC dynamics, modal analysis of large power systems.

*TEXT BOOK:*

1. Power System Dynamics, stability and control by K.R.Padiyar, Interline Publishing private limited, Bangalore, India.

2. Power system control and stability by P M Anderson and A A Fouad, Ezalgotia publications.

**EEPS 1.3a : OPTIMISATION TECHNIQUES**

Introduction to Optimization: Introduction, Historical Development, Engineering Applications of Optimization, Statement of Optimization Problem.

Classical Optimization Techniques: Introduction, Single variable optimization, Multivariable optimization with no constraints; Multivariable optimization with Equality constraints – Solution by Direct Substitution method, Method of constrained variation, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn-Tucker conditions.

Linear Programming: Introduction, Applications of Linear Programming, Standard Form of a Linear Programming, Basic Terminology and Definitions, Exceptional cases, Simplex method, Big-M method, Two-phase method, Revised Simplex method, Duality, Decomposition Principle.

Non Linear Programming I: Unconstrained optimisation-Univariate method, Pattern Directions, Powell's method, Gradient of a function, Steepest descent method, Conjugate Gradient Method, Newton’s method, Marquardt Method, Quai-Newton Methods, Davidon-Fletcher-Powell Method, Broyden-Fletcher-Goldfarb-Shanno Method.

Non Linear Programming II: Constrained optimization- Characteristics of a Constrained Problem, Sequential linear programming, Basic approach in the methods of feasible directions, Zoutendijk’s method of feasible directions, Sequential Quadratic Programming.

*Books:*

1. Engineering Optimization: Theory and Applications' By S.S.Rao, New Age International Publishers, Revised Third Edition, 2005.

**EEPS 1.3b : ARTIFICIAL INTELLIGENCE TECHNIQUES**

 Expert System Principles: Introduction, Expert System Principles – Knowledge Base, Frame Structure, Meta-Knowledge – ES Language - Inference Engine, User Interface; Expert System Shell – Shell Features, External Interface, Program Development Steps; Design Methodology, Applications.

Fuzzy Logic Principles: Introduction, Fuzzy Sets, Membership Functions, Operations on Fuzzy Sets, Fuzzy System, Implication Methods - Mamdani Type, Lusing Larson Type, Sugeno Type; Defuzzification Methods - Center of Area (COA) Method, Height Method, Mean of Maxima (MOM) Method and Sugeno Method.

Fuzzy Control: Concept of Fuzzy Control, Historical Perspective, Control Principle, Control Implementation, General Design Methodology and Applications.

Neural Network Principles: Introduction, the Structure of a Neuron, the Concept of a Biological Neuron, Artificial Neuron, Activation Functions of a Neuron, Artificial Neural Network, Training of Feed forward Neural Network, Learning Methods, Alphabet Character Recognition by an ANN, Back Propagation Training, On-Line Training, Other Networks -Radial Basis Function Network, Kohonen's Self-Organizing Feature Map Network, Recurrent Neural Network for Dynamic System, Training an RNN by the EKF Algorithm.

Neural Network in Identification and Control: Time-Delayed Neural Network, Dynamic System Models, ANN Identification of Dynamic Models, Inverse Dynamics Model, Neural Network-Based Control, General Design Methodology, Neuro-Fuzzy Systems, ANN Based Fuzzy Inference System (ANFIS), Applications.

*Text books:*

1. M. W. Firebaugh, Artificial intelligence, Boyd and Fraser, Boston

2. S. Haykin, “Neural Networks”, Macmillan, NY

*Reference books:*

1. Bimal K. Bose, Modern Power Electronics and AC Drives by Prentice Hall PTR, NJ 07458

2. L.H. Tsoukalas, R. E. Uhrig, “Fuzzy and Neural Approaches in engineering”, Wiley NY

3. W. Hines, “MATLAB Supplement to Fuzzy and Neural Approaches in Engineering”, John Wiley. NY

 **1.3c : EVOLUTIONARY ALGORITHMS AND APPLICATIONS**

Fundamentals of Soft Computing Techniques: Definition-Classification of optimization problems-Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems – Soft computing techniques- Conventional Computing versus Swarm Computing – Classification of meta –heuristic techniques – Single solution based and population basedalgorithms – Exploitation and exploration in population based algorithms – Properties of Swarm intelligent Systems – Application domain – Discrete and continuous problems – Single objective and multi-objective problems.

Genetic Algorithm and Particle Swarm Optimization: Genetic algorithms – Genetic Algorithm versus conventional Optimization Techniques – Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators – Bird flocking and fish Schooling – anatomy of a particle- equations based on velocity and positions – PSO topologies – control parameters – GA and PSO algorithms for solving ELD problem without loss, Selective Harmonic Elimination in inverters and PI controller tuning.

 Ant Colony Optimization and Artificial Bee Colony Algorithms: Biological ant colony system – Artificial ants and assumptions – Stigmergic communications – Pheromone updating – local- global – Pheromone evaporation – ant colony system – ACO models – Touring ant solony system-max min ant system – Concept of Elitist Ants –Task partitioning in honey bees - Balancing foragers and receivers – Artificial bee colony (ABC) algorithms – binary ABC algorithms – ACO and ABC algorithms for solving Economic Dispatch without loss and PI controller tuning.

Shuffled Frog-Leaping Algorithms and Bat Optimization Algorithm: Bat Algorithm-Echolocation of bats – Behaviour of microbats – Acoustics of Echolocation- Movement of Virtual Bats – Loudness and Pulse Emission – Shuffled frog algorithm-virtual population of frogscomparison of memes and genes – memeplex formation – memplexupdation – BA and SFLA alogrithms for solving ELD without loss and PI controller tuning.

Multi Objective Optimization: Multi-Objective optimization introduction- Concept of Pareto optimality – Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to general two objective optimization problem.

*Text Books:*

1. Xin-she Yang, “Recent Advance in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.

2. Kalyanmoy Ded, “Multi-Objective Optimization using Evolutionary Algorithms”, John Wiley & Sons, 2001.

3. James Kennedy and Russel E Eberheart, “Swarm Intelligence”, The Morgan Kaufmann Series in Evolutionary Computation, 2001.

*References Books:*

1. Eric Bonabeau, Macro Dorigo and Guy Theraulaz, “Swarm Intelligence- From natural to Artificial Systems”, Oxford university Press, 1999.

2. David Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2007.

3. Konstantinos E. Parsopoulos and Michael N. Vrahatis, “Particle Swarm Optimization and Intelligence: Advances and Applications”, InformatIonscIence reference, IGI Global, , 2010.

4. N P Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2005.

**EEPS 1.4a : HIGH VOLTAGE DIRECT CURRENT TRANSMISSION**

General aspects of DC transmission and comparison of it with AC transmission: Introduction, General aspects of transmission, Transmission links, types- Monopolar, Homopolar, Bipolar and Back-to-Back, Constitution of dc and ac links. Technical aspects, Economic aspects, Reliability aspects and Environmental aspects of HVDC Transmission (HVDCT), Advantages and disadvantages of HVDCT, Applications of DC Transmission, HVDC light.

Converters: Definition, Thury system, Valves, Valve characteristics, Components of circuits, Properties of converter circuits, Pulse number, Single phase and three phase converters, Assumptions in converter circuit analysis, Analysis of Greatz circuit, Analysis of bridge with grid control without overlap, Analysis of bridge with grid control with overlap less than 600

HVDC Links and Converters: Characteristics of converter circuits – Rectifier and inverter characteristics, complete characteristics of rectifier and inverter, Equivalent circuit of HVDC Link, Brief description of 12-pulse, 24-pulse and 48-pulse converters transformer configurations, Choice of converter circuit for HVDC transmission,

HVDC Converter control: Desired features and means of control, control of the direct current transmission link, Constant current control, Constant ignition angle control, Constant extinction angle control, Converter firing-angle control-IPC and EPC, frequency control and Tap changer control, Starting, Stopping and Reversal of power flow in HVDC links.

Misoperation and Protection of DC links: Malfunction of converter valves, Arc-back, Arc-through, Misfire, Quenching, Commutation failure, Valve blocking and bypass, Short circuits within the converter station. DC reactors, valve dampers, line dampers, circuit breakers.

*Text Book:*

1. E.W. Kimbark, Direct current transmission, Vol. I, Wiley Interscience, New York, 1971.

2. P Kundur, Power System Stability and Control, McGraw Hill Inc., New York, 1994.

*Reference Books:*

1. K. R. Padiyar, HVDC Power Transmission Systems: Theory and System Interactions, New Age International Publishers, New Delhi, 2009.

2. Erich Uhlmann, Power Transmission by Direct Current, Springer-Verlag, Berlin/Heidelberg, 1975.

 **EEPS 1.4b : FLEXIBLE AC TRANSMISSION SYSTEMS**

Introduction: Electrical Transmission Networks, Conventional Control Mechanisms-Automatic Generation Control, Excitation Control, Transformer Tap-Changer Control, Phase-Shifting Transformers; Advances in Power-Electronic Switching Devices, Principles and Applications of Semiconductor Switches; Limitations of Conventional Transmission Systems, Emerging Transmission Networks, HVDC and FACTS options.

Flexible AC Transmission Systems (FACTS): Power Flow and Dynamic Stability Considerations, Importance of Controllable Parameters, Types of FACTS Controllers. Brief Description (only theoretical explanation, No analysis) and Definitions of FACTS Controllers.

FACTS Converters: Types of converter, Concept and operation of Voltage sourced converters, Current Sourced converters, Operation of Single-Phase and Three-Phase Bridge Converters, Description of Three-Level VSC and PWM Converters, Transformer Connections for 12-pulse, 24-pulse and 48-pulse operation.

Shunt, Series Type FACTS Controllers: Objective of Shunt Compensation, Methods of Controllable shunt Var Generation (Variable Impedance type, Switching Converter type and Hybrid type), Objective of Series Compensation, Methods of Controllable Series Var Generation (Variable Impedance type, Switching Converter type and Hybrid type).

UPFC and IPFC : Unified Power Flow Controller (UPFC) – Principle of operation, Transmission Control Capabilities, Independent Real and Reactive Power Flow Control; Principle of operation and Characteristics of Interline Power Flow Controller (IPFC), UPFC and IPFC control structures.

 *Text Books:*

1. Narain G. Hingorani and Laszlo Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems,IEEE Press, Wiley-Interscience, New Jersey, 2000.

2. R Mohan Mathur and Rajiv K Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, IEEE Press, Wiley-Interscience, New Jersey, 2002.

*Reference Books:*

1. K R Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International Publishers, New Delhi, 2007.

2. Anrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Pérez and César Angeles-Camacho, FACTS: Modelling and Simulation in Power Networks, John Wiley & Sons, West Sussex, 2004.

**EEPS 1.4c : EXTRA HIGH VOLTAGE AC TRANSMISSION**

Transmission Preliminaries : Role of EHV AC transmission, Standard transmission voltages, Average values of line parameters, Power-handling capacity and line loss, Giant power pools and number of lines, Cost of transmission lines and equipment, Mechanical considerations in line performance.

Voltage Gradients of Conductors : Electrostatics, Field of sphere gaps, Field of line charges and their properties, Charge-potential relations for multi-conductor lines, Surface voltage gradient on conductors, Gradient factors and their use, Distribution of voltage gradient on sub-conductors of bundle.

Corona Effects-I : I2R loss and Corona loss, Corona loss formulae, Charge-Voltage diagram and Corona loss, Attenuation of travelling waves due to Corona loss, Audible noise-Generation and characteristics, Limits for audible noise, Audible noise measurement and meters, Formulae for audible noise and use in design, Relation between single-phase and three-phase audible noise levels, Day-Night equivalent noise level,

Corona Effects-II : Corona pulses-generation and properties, Properties of pulse train and filter response, limits for Radio Interference Fields, Frequency spectrum of the RI field of line, Lateral profile of RI and modes of propagation, The CIGRE formula, RI excitation function, Measurement of RI, RIV and excitation function, Design of filter, Television interference.

Electrostatic and Magnetic Fields of EHV Lines : Electric shock and threshold currents, Capacitance of long object, Calculation of electrostatic field of AC lines, Effect of high Electrostatic field on Human, Animals and Plants, Meters and measurement of electrostatic fields, Electrostatic induction in unenergized circuit of DC line, Induced voltage in insulated ground wire, Magnetic field effects, Magnetic field of 3-phase and 6-phase line, effect of power frequency magnetic fields on human health.

Lightning and Lightning Protection : Lightning strokes to lines, Lightning stroke mechanism, General Principles of the lightning protection problem, Tower footing resistance, Insulator flashover and withstand voltages, probability of occurrence of lightning stroke currents, Lightning arresters and protective characteristics, Dynamic voltage rise and arrester ratings, Operating characteristics of lightning arresters, Insulation coordination based on lightning.

*Text book*

1. Rakosh Das Begamudre, “Extra High Voltage Transmission Engineering”, New Academic Science Limited, Kent, UK, 4th edition, 2013.

**EEPS 1.5 RESEARCH METHODOLOY AND IPR**

 Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property - Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights - Licensing and transfer of technology - Patent information and databases - Geographical Indications.

New Developments in IPR: Administration of Patent System - New developments in IPR; IPR of Biological Systems, Computer Software etc. - Traditional knowledge Case Studies, IPR and IITs.

*REFERENCES:*

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

**EEPS 1.6a : ENGLISH FOR RESEARCH PAPER WRITING**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

*REFERENCE BOOKS:*

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

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

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’sbook.

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

**EEPS 1.6b : DISASTER MANAGEMENT**

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

 Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People’s Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

*REFERENCES:*

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep & Deep Publication Pvt. Ltd., New Delhi.

 **EEPS 1.6c : SANSKRIT FOR TECHNICAL KNOWLEDGE**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Order - Introduction of roots - Technical information about Sanskrit Literature

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

*REFERENCES:*

1. Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

3. India’s Glorious Scientific Tradition” Suresh Soni, Ocean book s (P) Ltd., New Delhi.

**EEPS 1.6d : VALUE EDUCATION**

Values and self-development - Social values and individual attitudes - Work ethics, Indian vision of humanism - Moral and non - moral valuation - Standards and principles - Value judgements

Importance of cultivation of values - Sense of duty - Devotion, Self-reliance - Confidence, Concentration. Truthfulness, Cleanliness - Honesty, Humanity - Power of faith, National Unity – Patriotism - Love for nature, Discipline

Personality and Behaviour Development - Soul and Scientific attitude - Positive Thinking - Integrity and discipline - Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour - Universal brotherhood and religious tolerance - True friendship - Happiness Vs suffering, love for truth - Aware of self-destructive habits - Association and Cooperation - Doing best for saving nature

Character and Competence –Holy books vs Blind faith - Self-management and Good health - Science of reincarnation - Equality, Nonviolence, Humility, Role of Women - All religions and same message - Mind your Mind, Self-control - Honesty, Studying effectively

*REFERENCES:*

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

 **EEPS 1.6e : CONSTITUTION OF INDIA**

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution: Preamble - Salient Features Contours of Constitutional Rights & Duties - Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.

Organs of Governance: Parliament - Composition - Qualifications and Disqualifications - Powers and Functions – Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

Local Administration: District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials,? Importance of grass root democracy

Election Commission: Role and Functioning - Chief Election Commissioner and Election Commissioners - State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women.

*REFERENCES:*

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

4. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

 **EEPS 1.6f : PEDAGOGY STUDIES**

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers’ attitudes and beliefs and Pedagogic strategies.

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Research gaps and future directions: Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

*REFERENCES:*

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. ondon: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

**EEPS 1.6g : STRESS MANAGEMENT BY YOGA**

Yoga: Royal Road to Higher Consciousness: Consciousness or Chaitanya in Mandukya Upanishad, Bhagavad Gita, Yoga Sutras, Astavakra Gita; methods of accessing higher states of consciousness – overcoming body consciousness, overcoming mind consciousness; higher consciousness and person transformation; higher consciousness and parapsychic powers (siddhis).

Vedanta: A Philosophy of Pure Consciousness – Consciousness according to Advaita, Dvaita and Visistadvaita schools, Consciousness according to Nyaya, Vaisesika and Sankya Schools. Self - awareness – Ramana Maharshi; Buddhism: A Psychology of Consciousness: - viñña a,5 aggregates, 12 nidhanasm, cetasikas, nirvana.

The Mind-Body Relationship, the concept of Psychological Health in India, Scope of Health Psychology Emergence of Behavioural Medicine.

Stress – Stressors: Environmental, Social and Psychological, stress and illness, control and stress.

*REFERENCES:*

1. S. Menon, B.V.Sreekantan, Anindya Sinha, Philip Clayton, R Narasimha (2004). Science and Beyond: Cosmology, consciousness and technology in Indic traditions. National Institute of Advanced Studies, Bangalore

2. Nakamura (1989). Indian Buddhism, Motilal Banarsidass, Delhi.

3. Goleman, D & Gurin, J. (1993). Mind – Body Medicine, New York.

 **EEPS 1.6h : PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

Neetisatakam - Holistic development of personality

• Verses- 19,20,21,22 (wisdom)

• Verses- 29,31,32 (pride & heroism)

• Verses- 26,28,63,65 (virtue)

• Verses- 52,53,59 (dont’s)

• Verses- 71,73,75,78 (do’s)

Approach to day to day work and duties.

• Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48,

• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23,35,

• Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge.

• Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68

• Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model. Shrimad BhagwadGeeta:

• Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

• Chapter 4-Verses 18, 38,39

• Chapter18 – Verses 37,38,63

*REFERENCES:*

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath

3. Rashtriya Sanskrit Sansthanam, New Delhi.

**EEPS 2.1 : ELECTRICAL DISTRIBUTION SYSTEMS AND
AUTOMATION**

Distribution System Fundamentals : Brief description about electrical power transmission and distribution systems, Different types of distribution sub-transmission systems, Substation bus schemes, Factors effecting the substation location, Factors effecting the primary feeder rating, types of primary feeders, Factors affecting the primary feeder voltage level, Factors affecting the primary feeder loading.

Distribution System Substations and Loads : Substations: Rating of a distribution substation for square and hexagonal shaped distribution substation service area, Derivation of K constant, Radial feeder with uniformly and non-uniformly distributed loading. Loads: Various types of loads, Definitions of various terms related to system loading, detailed description of distribution transformer loading, feeder loading, Modelling of star and delta connected loads, two-phase and single-phase loads, shunt capacitors.

Distribution System Load Flow : Exact line segment model, Modified line model, approximate line segment model, Review of the two-winding transformer theory, two-winding auto transformer, Step-Voltage Regulators, Line drop compensator, Forward/Backward sweep distribution load flow algorithm.

Voltage Drop And Power Loss Calculation : Detailed analysis of non-three phase primary lines, concepts of four-wire multi-grounded common-neutral distribution system, Percent power loss calculation, Distribution feeder cost calculation methods, Capacitor installation types, types of three-phase capacitor-bank connections, Economic justification for capacitors.

Distribution automation functions: Electrical system automation, EMS functional scope, DMS functional of DMS – Steady state and dynamic performance improvement; Geographic information systems – AM/FM functions and Database management; communication options, supervisory control and data acquisition: SCADA functions and system architecture; Synchrophasors and its application in power systems.

*Books:*

1. William H. Kersting, “Distribution System Modelling and Analysis”, CRC Press, Newyork, 2002.

2. Turan Gonen, “Electric Power Distribution System Engineering”, McGraw-Hill Inc., New Delhi, 1986.

3. Juan M Gers, “Distribution System Analysis and Automation”, The Institution of Engineering and Technology, London, UK, 2013.

**EEPS 2.2 : AUTOMATION IN POWER SYSTEMS**

INTRODUCTION TO POWER SYSTEM AUTOMATION: Historical development of power system automation, Fundamentals of electrical protection and automatic power control system, development of protective relays, controller relays and relaying devices, elements of automation systems.

SCADA: Basis of a real-time control system (SCADA), Requirement and background, SCADA system principles, Data acquisition, monitoring and event processing, control functions, data storage, archiving and analysis; hardware system configurations, SCADA programming, SCADA master station.

COMMUNICATION IN POWER SYSTEM AUTOMATION: Basics of data communication, The OSI model, Media access control principles, CSMA/CD Ethernet MAC, Full duplex Ethernet, Communication protocols, Mode bus and Mode bus TCP/IP, Profibus, TCP/IP, DNP3, IEC 61850

POWER SYSTEM AUTOMATION ARCHITECHURES: Types of power system automation architecture, Automation of HV substations, automation of MV substations, principles and functions of distribution automation, substation automation and feeder automation.

Substation Automation: State and trends of substation automation, intelligent affordable substation monitoring and control, Standard for substation automation – Logical Nodes (LN), Logical Device (LD), Intelligent Electronic Devices (IEDs), Process level functions, Bay level functions, Station Level Functions, Station Bus and Process Bus

*Books*

1. 1. Helfrick – Cooper, Modern electric instrumentation and measurement technique, PHI 1994.

2. 2. T.S. Rathore, Digital measurement techniques, Narosa publishing House, 1996.

3. 3. John Webb, Ronald Reis - Programmable Logic Controllers , PHI, 2003.

4. 4. Klaus-Peter and Others – Substation Automation Handbook, Utility Automation Consulting Lohmann, ISBN 3-85758-951-5

5. P I Zabolotny, “Automation in Electrical Power Systems”, MIR Publishers, Moscow.

6. James Northcote-Green and Robert Wilson, “Control and Automation of Electrical Power Distribution Systems”, CRC Taylor & Francis, New York, 2007.

7. M K Khedkar and G M Dhole, “A Textbook of Electric Power Distribution Automation”, University Science Press, New Delhi, 2010.

**EEPS 2.3a : REAL TIME CONTROL OF POWER SYSTEMS**

 Power System Security: Introduction, Factors affecting the power system security, Contingency analysis procedure, Linear sensitivity factors: Line outage distribution factors and Generation shift factors, and its derivation; AC power flow method, contingency selection.

Voltage Control : Production and absorption of reactive power, Methods of voltage control, Shunt reactors, Shunt capacitors, Series capacitors, Synchronous condensers, Static Var systems, Principles of transmission system compensation, Modelling of reactive compensating devices, Application of tap-changing transformers to transmission systems, Distribution system voltage regulation, Modelling of transformer ULTC control systems.

Voltage Stability : Basic concepts related to voltage stability – Transmission system characteristics, Generator characteristics, Load characteristics, reactive compensating devices characteristics; Voltage collapse – Typical scenario, General characterisation, Classification of voltage stability; Voltage stability analysis – Modelling requirements, Dynamic analysis, Static analysis, Determination of shortest distance to instability, continuation power flow analysis, Prevention of voltage collapse.

Synchrophasor Measurement units: Introduction, Phasor representation of sinusoids, a generic PMU, GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.

Operation of Modern Power Systems : Principle of economics, utility functions, power exchanges, electricity market models, market power indices, ancillary services, transmission and distribution charges, principles of transmission charges, transmission pricing methods, demand-side management, regulatory framework.

*Text Books:*

1. Allen J. Wood, Bruce F. Wollenberg and Gerald B Sheble “Power Generation, Operation and Control”, John Wiley & Sons, Inc., New Jersey, 3nd edition, 2014.

2. Prabha Kundur, “Power System Stability and Control”, McGraw-Hill, Inc., New Delhi, 1994.

3. A G Phadke and J S Thorp, “Synchronized Phasor Measurements and Their Applications”, Springer, 2008.

4. Power System Engineering, D P Kothari and I J Nagrath, McGraw Hill Education India Pvt. Limited, Chennai, 3e, 2019.

**EEPS 2.3b : ADVANCED POWER SYSTEMS PROTECTION**

Static Relays classification and Tools : Composition of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multi-vibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators. Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings.

PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme – carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

Microprocessor based relays and Numerical protection: Introduction – over current relays – impedance relay – directional relay – reactance relay. Numerical Protection: Introduction – numerical relay – numerical relaying algorithms – mann – Morrison technique – Differential equation technique and discrete fourier transform technique – numerical over current protection – numerical distance protection.

*Books:*

1. Power System Protection with Static Relays – by TSM Rao, TMH.

2. Power System Protection & Switchgear by Badri Ram & D N Viswakarma, TMH.

3. Protective Relaying Vol-II Warrington, Springer.

4. Art & Science of Protective Relaying – C R Mason, Willey.

5. Power System Stability Kimbark Vol-II, Willey.

6. Electrical Power System Protection –C.Christopoulos and A.Wright-Springer.

7. Protection & Switchgear –Bhavesh Bhalaja, R.P Maheshwari, Nilesh G. Chothani-Oxford publisher.

**EEPS 2.3c : FACTS MODELLING AND SIMULATION**

Modelling of FACTS controllers : Modelling philosophy, Controllers based on conventional thyristors, Power electronics controllers based on fully controlled semiconductor devices, Control capabilities of controllers based on voltage source converters.

Power flow solutions : Newton-Raphson load flow method, Fast decoupled load flow method, Constrained power flow solutions – Load tap-changing transformers, Phase shifting transformers, Truncated adjustments, Special load tap changer configurations.

FACTS Simulation – I : Power flow solutions including FACTS controllers, Stativ Var compensator – Conventional power flow models, Shunt variable susceptance model, Firing Angle model, Integrattted transformer firing angle model, Nodal voltage control using static Var compensators, Control coordination between reactive sources; TCSC – Variable series impedance power flow model, Firing angle power flow model, Numerical properties of TCSC power flow model.

FACTS simulation – II : Static synchronous compensator power flow model, UPFC power flow model, HVDC-VSC – power flow equations, back-to-back model, full model.

FACTS simulation – III : Optimal Power Flow with power flow controllers – Load tap-changing transformer, Phase-shifting transformer, Static Var Compensator, TCSC and UPFC.

*Books*

1. Enrique Acha, Claudio R Fuerte-Esquivel, Hugo Ambriz-Perez and Cesar Angeles-Camacho, "FACTS modeling and simulation in power network”, John Wiley & Sons Ltd., Chichester, UK, 2004.

**EEPS 2.4a : PROGRAMMABLE LOGIC CONTROLLERS &
APPLICATIONS**

PLC Basics: PLC System, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils, Drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers, PLC Functions: Timer functions and Industrial applications, counter functionindustrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO FAL, ONS, CLR and Sweep functions and their applications, Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning , PID functions.

*Books:*

1. Programmable Logic controllers- Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI

2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

*References Books:*

1. Introduction to Programmable Logic Controllers-Gary Dunning – Cengage Learning.

2. Programmable Logic controllers- W. Bolton-Elsevier publisher.

**EEPS 2.4b : RENEWABLE ENERGY TECHNOLOGIES**

Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics – Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy based power systems.

Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated – Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation – Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation – Speed and Voltage Control.

Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation – General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines – Generators and Speed Control Used in Wind Power Energy; Analysis of Small wind energy conversion system.

Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics – Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O, INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy.

Fuel Cells: The Fuel Cell; Low– and High–Temperature Fuel Cells; Commercial and Manufacturing Issues – Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyser Systems; Advantages and Disadvantages of Fuel Cells – Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage.

*Text Books:*

1. Felix A. Farret, M. Godoy Simo’es, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.

2. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

3. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

**EEPS 2.4c : POWER QUALITY IMPROVEMENT**

 Introduction : Significance of power quality, Various power quality parameters, Voltage vs Current distortion, Harmonic indices – THD, TDD; Harmonic analysis, Harmonic phase sequence, Triplen harmonics, Interharmonics.

Harmonics effects : Sources of harmonics, Resonance, effects of harmonics on rotating machine, measuring instruments, ripple control systems, power system protection, consumer equipment, communication systems.

Harmonic elimination : Passive filters – design, advantages and disadvantages; Shunt active filters – Principle of operation, configurations, design and control strategies; Three phase four wire shunt active power filters.

Voltage Quality : Sources of Sags, Swell, Unbalance and Harmonics; Voltage quality standards, effects of Sags, Swell, Unbalance and Harmonics; Voltage sag due to faults, sag calculations, classification of voltage sags, voltage sag transformation due to transformers.

Voltage Quality Improvement : Principle of operation, configuration, design and control strategies of series active power filters, three phase four wire series active power filters, UPQC principle, topologies.

*Books*

1. Dugan Roger C, Santoso Surya, McGranaghan, Marks F Beaty and H Wayre, “ Electrical Power System Quality”, McGraw Hill, 3rd edition, 2012.

2. J Arrilaga and N R Watson, “Power System Harmonics”, John Wiley & Sons Ltd., 2nd edition, 2003.

3. Hirofumi Akagi, Edson Hirokazu Watanabe and Mauricio Aredes, “ Instantaneous Power Theory and Applications to Power Conditioning”, Wiley-IEEE Press, 2007.

4. Math H Bollen, “Understanding Power Quality Problems”, IEEE Press.

 **EEPS 3.1a : POWER SYSTEM DEREGULATION**

Need and conditions for deregulation, Introduction of Market structure, Market Architecture, Spot Market, forward markets and settlements. Review of Concepts: marginal cost of generation, least-cost operation, incremental cost of generation, Power System Operation.

Electricity sector structures Ownership/management, forms of Ownership and management, Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices.

Transmission network and market power, Power wheeling transactions and marginal costing, transmission costing, Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices.

Ancillary Services and System Security in Deregulation, Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

*Text Books:*

1. Power System Economics: Designing markets for electricity – S. Stoft, wiley.

2. Operation of restructured power systems – K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.

*Reference Books:*

1. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.

2. Market operations in electric power systems – M. Shahidehpour, H. Yaminand Z. Li, Wiley.

3. Fundamentals of power system economics – S. Kirschen and G. Strbac, Wiley.

4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry – N. S. Rau, IEEE Press series on Power Engineering.

5. Competition and Choice in Electricity – Sally Hunt and Graham Shuttleworth.

 **EEPS 3.1b : POWER SYSTEM RELIABILITY**

Basic probability theory – rules for combining probabilities of events – Bernoulli’s trails – probability density and distribution functions – binomial – distributions – expected value and standard deviation of binomial distribution.

Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method.

Reliability functions F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponential distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states.

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

Composite system reliability analysis, decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

*Reference Books:*

1. Reliability Evaluation of Engg. System – R. Billinton, R.N. Allan, Plenum Press, New York.

2. Reliability Modelling in Electric Power Systems – J.Engrenyi, John Wiley, 1978, Newyork.

3. An Introduction to Reliability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition.

 **EEPS 3.1c : SMART GRID TECHNOLOGIES**

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & Smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

Smart Grid Technologies: Part1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage, like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).

Micro grids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.

Power Quality Management in Smart Grid: Power Quality &EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN).

*Books:*

1. Ali Keyhani, Mohammed N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley.

2. clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press.

3. JankaEkanayake, Nick Jenkins, KithsiriLiyanage, Lianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley

4. Jean Claude Sabonnadiere, NouredinHadjsaid, “Smart Grids”, Wiley Blackwell 19

5. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; I edition 8 Jun 2010

6. S. Chowdhury, S.P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks. “ Institution of Engineering and Technology, 30 Jun 2009

7. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press

8. Andres Carvallo, John Cooper, “The Advanced Smart Grid: Edge Power Driving Sustainability: I”, Artech House Publishers July 2011.

**EEPS 3.2(a) (Open Elective)**

**BUSINESS ANALYTICS 3L:0P 3 Credits**

(effective from the 2020-21admitted batch)

**Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

**Trendiness and Regression Analysis:** Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**Organization Structure:** Organization Structure of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

**Forecasting Techniques:** Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**Decision Analysis:** Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

***REFERENCES:***

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press. Business Analytics by James Evans, persons Education.

**EEPS 3.2(b) (Open Elective)**

**INDUSTRIAL SAFETY 3L:0P 3 Credits**

(effective from the 2020-21admitted batch)

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering,Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

*TEXT BOOKS:*

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

**EEPS 3.2(c) (Open Elective)**

**COST MANAGEMENT OF ENGINEERING PROJECTS**

**3L:0P 3 Credits**

(effective from the 2020-21admitted batch)

**Cost:** Cost Elements, Pricing, Materials, Labour; Engineering, Equipment, Parts, and Tool; Economic Costs, Activity - Based Cost Management.

**Cost Estimating & Planning**: Estimating, Process Product Manufacturing, Discrete Product Manufacturing. Planning and Scheduling.

**Progress & Cost Control:** Progress Measurement and Earned Values, Earned Value for Variable Budgets, Tracking Cost and Schedule Performance, Performance and Productivity Management.

**Project Management:** Project Management Fundamentals, Project Organization Structure, Project Planning, Project Labour Cost Control, Leadership and Management of Project People, Quality Management, Value Analysis, Contracting for Capital Projects, Strategic Asset Management.

**Economic Analysis, Statistics & Probability:** Basic Engineering Economics, Applied Engineering Economics, Statistics & Probability, Basic Concepts in Descriptive Statistics, Risk Management.

*REFERENCES:*

Charles J. Austin Industrial Engineering & Technology Building, (AG/IT 216)

**EEPS 3.2(d) (Open Elective)**

**COMPOSITE MATERIALS 3L:0P 3 Credits**

(effective from the 2020-21admitted batch)

**Introduction:** Definition of composite 2 material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites.

**Performance of structural composites:** Basic analytical concepts (Qualitative black box approach and Quantitative analytical approach), Performance analysis by various models (Law of Mixtures, Shear lag model, Laminated plate model, Eshelby’s models and Other models, - thermo elasticity, plasticity and creep), Strengthening mechanisms, Stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, Analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, Estimation of the required minimum amount of fibre and critical amount of fibre to gain a composite strength, Analysis of strength of a composite during loading at an angle to the fibres, Nano-structured composites.

**Performance of Composite in Non- structural Applications:** Composites in Electrical, Superconducting and Magnetic Applications, Nano-composite devices.

**Industrial Application of Composite Materials:** Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components etc.

**Fracture & amp; Safety of Composite:** Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack growth rate), Fracture Mechanics of brittle matrix fibre composite, Fracture mechanics of metal matrix fibre composite, Experimental evaluation (composite), Elementary reliability analysis.

*REFERENCES:*

1. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

2. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.

3. 3. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5lGB, UK.

4. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993), Chapman &amp; Hall, London.

5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.

 **EEPS 3.2(e) (Open Elective)**

**WASTE TO ENERGY 3L:0P 3 Credits**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forestresidue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers –Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

*TEXT BOOKS:*

1. Non - Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**I/II M.TECH**

(With effect from 2019-2020 admitted batch onwards)

**M.Tech. (Electrical Engineering)**

**Specialization: Power Electronic Drives and Control (PEDC)**

***I SEMESTER***

 Sub. Code Name of the Subject Periods/ week Maximum Marks Credits

 T Lab Int. Ext. Total

EEPE 1.1 Power Electronic Converters 3 - 70 30 100 3

EEPE 1.2 Modeling and Analysis of Electrical Machines 3 - 70 30 100 3

EEPE 1.3 Elective-I

 a) Advanced Power Electronic Circuits

 b) Optimization Techniques

 c) Power electronics for renewable
 Energy Systems

 d) Dynamics of Electrical Machines 3 - 70 30 100 3

EEPE 1.4 Elective-II

 a) Digital Signal processing and its

 Applications

 b) PWM converter and

 Applications

 c) Power Semiconductor Devices &

 Modeling

 d) Static VAR Controllers and

 Harmonic Filtering 3 - 70 30 100 3

EEPE 1.5 Research Methodology & IPR 3 - 70 30 100 2

EEPE 1.6 Audit Course-I 3 - 70 30 100 0

EEPE 1.7 Power Electronics Laboratory - 3 50 50 100 2

EEPE 1.8 Electrical Machines Lab (or)
 Renewable Energy systems Lab - 3 50 50 100 2

 Total 18 6 520 280 800 18

**EEPE 1.1 POWER ELECTRONIC CONVERTERS**

3L:0P 3 Credits

Analysis of power semiconductor switched circuits with R, L, RL, RC loads, D.C. motor load, Battery charging circuit.

Single-Phase and Three-Phase AC to DC converters, Half controlled configurations-operating domains of three phase full converters and semi-converters, Reactive power considerations.

Analysis and design of DC to DC converters, Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converters, Cuk converters.

Single phase and three phase inverters, Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters.

AC to AC power conversion using voltage regulators, Choppers and cyclo-converters, Consideration of harmonics, Introduction to Matrix converters, Design aspects of converters, few practical applications.

*TEXT BOOKS:*

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, John’s Wiley and sons. Inc, New York.

2. M.H.Rashid, “Power Electronics”, Prentice Hall of India 1994.

**EEPE 1.2 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES**

3L:0P 3 Credits

Principles of Electromagnetic Energy Conversion, General expression of stored magnetic energy, Co-energy and force/torque, example using single and doubly excited system.

Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.

Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form, Application of reference frame theory to three phase symmetrical induction and synchronous machines, Dynamic direct and quadrature axis model in arbitrarily rotating reference frames.

Determination of Synchronous machine dynamic equivalent circuit parameters, Analysis and dynamic modeling of two-phase asymmetrical induction machine and single-phase induction machine.

Special Machines - Permanent magnet synchronous machine, Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines, Construction and operating principle, Dynamic modelling and self-controlled operation, Analysis of Switch Reluctance Motors, Brushless D.C. Motor for space Applications, Recent trends.

*TEXT BOOKS:*

1. Charles Kingsle,Jr., A.E. Fitzgerald, Stephen D.Umans, “Electric Machinery”, Tata Mcgraw Hill.

2. R. Krishnan, “Electric Motor & Drives: Modeling, Analysis and Control”, Prentice Hall of India.

3. Miller, T.J.E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press.

4. P.C.Krause “Analysis of Electric Machine” Wiley IEEE Press 3rd Edition.

**EEPE 1.3 (a)(Elective - I)
ADVANCED POWER ELECTRONIC CIRCUITS**

3L:0P 3 Credits

Boost type APFC and control, three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies.

Modes of operation –Push-Pull and Forward Converter Topologies - Voltage Mode Control, Half and Full Bridge Converters.

Fly-back Converter, Introduction to Resonant Converters, Load Resonant Converter, Zero Voltage Switching Clamped Voltage Topologies.

Resonant DC Link Inverters with Zero Voltage Switching, High Frequency Link Integral Half Cycle Converter.

Modelling and design of DC-DC Converters for various renewable energy conversion, Few power electronic circuits used in practice for controlling electric drives.

*TEXT BOOKS:*

1. Rashid “Power Electronics” Prentice Hall India 2007.

2. G.K.Dubey et.al “Thyristorised Power Controllers” Wiley Eastern Ltd., 2005, 06.

3. Dewan&Straughen “Power Semiconductor Circuits” John Wiley &Sons., 1975.

4. G.K. Dubey& C.R. Kasaravada “Power Electronics & Drives” Tata McGraw Hill., 1993.

*REFERENCES:*

1. Cyril W Lander “Power Electronics” McGraw Hill., 2005.

2. B. K Bose “Modern Power Electronics and AC Drives” Pearson Education (Asia)., 2007

Abraham I Pressman “Switching Power Supply Design” McGraw Hill Publishing Company.,2001

**EEPE 1.3 (b)(Elective - I)**

**OPTIMIZATION TECHNIQUES**

3L:0P 3 Credits

**Introduction to Optimization:** Introduction, Historical Development, Engineering Applications of Optimization, Statement of Optimization Problem.

**Classical Optimization Techniques:** Introduction, Single variable optimization, Multivariable optimization with no constraints; Multivariable optimization with Equality constraints – Solution by Direct Substitution method, Method of constrained variation, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn Tucker conditions.

**Linear Programming:** Introduction, Applications of Linear Programming, Standard Form of a Linear Programming, Basic Terminology and Definitions, Exceptional cases, Simplex method, Big M method, Two phase method, Revised Simplex method, Duality, Decomposition Principle.

**Non-Linear Programming I**: Unconstrained optimization Univariate method, Pattern Directions, Hook and Jeeves Method, Powell’s method, Gradient of a function, Steepest descent method, Conjugate Gradient Method, Newton’s method, Marquardt Method, Quai Newton Methods, Davidon Fletcher Powell Method, Broyden Fletcher Goldfarb Shanno Method.

**Non-Linear Programming II:** Constrained optimization Characteristics of a Constrained Problem, Sequential linear programming, Basic approach in the methods of feasible directions, Zoutendijk’s method of feasible directions, Sequential Quadratic Programming.

*TEXT BOOK:*

1. Engineering Optimization: Theory and Applications’ By S.S.Rao, New Age International Publishers, Revised Third Edition, 2005.

**EEPE 1.3 (c)(Elective - I)**

**POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS**

3L:0P 3 Credits

**INTRODUCTION:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost GHG Emission), Qualitative study of different renewable energy resources Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

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

**POWER CONVERTERS:** Solar: Block diagram of solar photo voltaic system Principle of operation: 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.

**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.

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

*TEXT BOOKS:*

1. Rashid.M. H “power electronics Hand book”, Academic press, 2001.

2. Rai. G.D, “Non-conventional energy sources”, Khanna publishes, 1993.

*REFERENCES:*

1. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.

2. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.

3. Non conventional Energy sources B.H.Khan Tata McGraw hill Publishing Company, New Delhi.

**EEPE 1.3 (d)(Elective - I)**

**DYNAMICS OF ELECTRICAL MACHINES**

3L:0P 3 Credits

Stability, Primitive 4 Winding Commutator Machine, Commutator Primitive Machine, Complete Voltage Equation of Primitive 4 Winding Commutator Machine.

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

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

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

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

*TEXT BOOKS:*

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.

**EEPE 1.4 (a)(Elective - II)**

**DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS**

3L:0P 3 Credits

**ANALYSIS OF SIGNALS:** Fourier series (Trigonometric and exponential, Fourier Transform (Full Details), Convolution concept, Sampling theorem, Analog to digital Conversion, Discrete time signals, Analysis of Discrete time systems, Z transform, inverse Z transform with properties.

**ANALYSIS OF SIGNALS IN DIGITAL DOMAIN**: Discrete Fourier Transform (DFT) and inverse DFT, FFT algorithm, frequency analysis of discrete time signal, power density, energy density, Application, Harmonic Analysis.

**FIR FILTER:** Symmetric, Anti symmetric Filter design using windows, frequency sampling techniques, brief idea about alternation theorem and equi ripple filter, design structure direct form and cascade form, structure realization. Application: Detection of fault in bearings.

**IIR FILTER:** Basic concepts of analog filter design using Bufferwortz and chebysheb applications IIR filter design methods such as impulse invariance, bilinear transform filter structures, A) Direct Form B) Parallel form C) Cascade form Application: Detection of filters to remove the noise for detecting commands on power transmission lines.

**BASICS OF DSP ARCHITECTURE:** Desirable features and architecture of DSP processors, multiplex and multiplier accumulator, modified bus structures and memory access schemes, multiple access memory, multi ported memory, piping, special addressing modes in DSP, ON chip peripherals, Effect of finite word length Study of DSP processors such as TMS320C5X, and others and their applications to power systems.

*TEXT BOOKS:*

1. Digital Signal Processing – John Proakis and Manolakis (Prentice Hall of India Pvt. Ltd.)

2. Digital Signal Processing A Computer based approach – S.K.Mitra (Tata McGraw Hill Publication)

*REFERENCES:*

1. Digital Signal Processors B. Venkat Ramani and Bhasker (Tata McGraw Hill Publishing Co., New Delhi)

2. Discrete – time signal processing – A.V. Oppenheim, Schafer, Buck (Pearson Prentice Hall)

3. Signals and Systems – A.V.Oppenheim, Willisky (Prentice Hall of India Pvt. Ltd.)

**EEPE 1.4 (b)(Elective - II)**

**PWM CONVERTER AND APPLICATIONS**

3L:0P 3 Credits

AC/DC and DC/AC power conversion, Overview of applications of voltage source converters and current source converters.

Pulse width modulation techniques for bridge converters, Bus clamping PWM, Space vector based PWM, Advanced PWM techniques.

Practical devices in converter, Calculation of switching and conduction power losses.

Compensation for dead time and DC voltage regulation, Dynamic model of PWM converter, Multilevel converters, Constant V/F induction motor drives.

Estimation of current ripple and torque ripple in inverter fed drives, Line-side converters with power factor compensation.

Active power filtering, Reactive power compensation, Harmonic current compensation, Selective harmonic elimination PWM technique for high power electric drives.

***TEXT BOOKS:***

1. Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John’s Wiley and Sons.

2. Erickson RW, “Fundamentals of Power Electronics”, Chapman and Hall.

3. Vithyathil. J, “Power Electronics: Principles and Applications”, McGraw Hill.

**EEPE 1.4 (c)(Elective - II)**

**POWER SEMICONDUCTOR DEVICES & MODELLING**

3L:0P 3 Credits

**REVIEWOFPOWERDEVICES:** Power Diodes, BJT, Thyristor, Power MOSFET, IGBT and GTOs – Device structure and theory of operation, characteristics, rating and specifications, gate drive requirement circuits, and applications.

**LINECOMMUTATEDCONVERTERS:** Three phase semi controlled & fully controlled converter, Dual converters, Power factor improvement methods, effect of source inductance, Rectifier Power Factor and Pulse Width Modulation Controlled Rectifier Circuits, single phase series converters, and twelve pulse converters.

**INVERTERS:** Principle of operation, performance parameters, single phase bridge inverters and three phase inverters, harmonic reduction, Three Phase Naturally Commutated, Controlled Bridge Rectifier, Inverter, Three Phase Step Wave Inverter Circuits, Three Phase Pulse Width Modulation, Controlled Inverter Circuits.

**VOLTAGE/CURRENTSOURCEINVERTERS:** Voltage source inverters single/multiple pulse/SPWM/modified SPWM methods. Current Source inverters single phase and three phase power circuit configuration and analysis, Comparison between VSI & CSI. MULTILEVELINVERTERS: Introduction, Types, Diode clamped multi-level inverters, features & applications.

**CYLCO-CONVERTERS:** Phase controlled cyclo-converters, envelope cyclo-converters, matrix Converters.

*TEXT BOOKS:*

1. Ned Mohan, Tore.M. Undeland and William.P Robbins, “Power Electronics converters, applications and design”, John Wiley 2003.

2. Rashid M.H. Power Electronics – Circuits Devices and applications, Prentice Hall India Third Edition.

*REFERENCES:*

1. “Power Converter Circuits” by William Shepherd, Li Zhang, Li Zhang Crowther, CRC Press, 2004.

2. B.K.Bose, “Modern Power Electronics & AC Drives”, Pearson Edition Asia, 2002.

3. Jai P Agarwal, “Power Electronic Systems – Theory and Design”, Pearson Education, 2001.

**EEPE 1.4 (d)(Elective - II)**

**STATIC VAR CONTROLLERS AND HARMONIC FILTERING**

3L:0P 3 Credits

Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems, Reactive Power Compensation and Dynamic Performance of Transmission Systems.

Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics, Sources of Harmonics in Distribution Systems and Ill Effects.

Static Reactive Power Compensators and their control, Shunt Compensators, SVCs of thyristor Switched and thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping, Use of STATCOMs and SSSCs for Transient and Dynamic Stability, Improvement in Power System.

Converters for Static Compensation, Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM), GTO Inverters, Multi-Pulse Converters and Interface Magnetics, Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM), Multi-level inverters of Cascade Type and their modulation, Current Control of Inverters.

Passive Harmonic Filtering, Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling, Three phase four wire shunt active filters, Hybrid Filtering using Shunt Active Filters, Dynamic Voltage Restorer and its control, Power Quality Conditioner.

Series Active Filtering in Harmonic Cancellation Mode, Series Active Filtering in Harmonic Isolation Mode.

*TEXT BOOKS:*

1. Ned Mohan et.al, “Power Electronics”,John Wiley and Sons,2006.

2. G. Massobrio, P. Antognet,” Semiconductor Device Modeling with Spice”, McGraw-Hill, Inc.,1988.

3. B. J. Baliga,” Power Semiconductor Devices”,Thomson, 2004

4. V. Benda, J.Gowar, D.A.Grant,” Power Semiconductor Devices. Theory and Applications”, JohnWiley& Sons1994.

**EEPE 1.5**

**RESEARCH METHODOLOGY AND IPR**

3L:0P 2 Credits

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property - Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights - Licensing and transfer of technology - Patent information and databases - Geographical Indications.

New Developments in IPR: Administration of Patent System - New developments in IPR; IPR of Biological Systems, Computer Software etc. - Traditional knowledge Case Studies, IPR and IITs.

*REFERENCES:*

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.

**EEPE 1.6 (a)**

**ENGLISH FOR RESEARCH PAPER WRITING**

3L:0P 0 Credits

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

*REFERENCES:*

1. Goldbort R (2006) Writing for Science, Yale University Press.

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

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book.

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

**EEPE 1.6 (b)**

**DISASTER MANAGEMENT**

3L:0P 0 Credits

Introduction toDisaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People’s Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

*REFERENCES:*

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies New Royal book Company.

2. Sahni, Pardeep et. al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies” Deep &Deep Publication Pvt. Ltd., New Delhi.

**EEPE 1.6 (c) SANSKRIT FOR TECHNICAL KNOWLEDGE**

3L:0P 0 Credits

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

Order - Introduction of roots - Technical information about Sanskrit Literature.

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

*REFERENCES:*

1. Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

3. India’s Glorious Scientific Tradition” Suresh Soni, Ocean book s (P) Ltd., New Delhi.

**EEPE 1.6(d) : VALUE EDUCATION**

Values and self-development - Social values and individual attitudes - Work ethics, Indian vision of humanism - Moral and non - moral valuation - Standards and principles - Value judgements

Importance of cultivation of values - Sense of duty - Devotion, Self-reliance - Confidence, Concentration, Truthfulness, Cleanliness - Honesty, Humanity - Power of faith, National Unity – Patriotism - Love for nature, Discipline.

Personality and Behaviour Development - Soul and Scientific attitude - Positive Thinking - Integrity and discipline - Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour - Universal brotherhood and religious tolerance - True friendship - Happiness Vs suffering, love for truth - Aware of self-destructive habits - Association and Cooperation - Doing best for saving nature

Character and Competence –Holy books vs Blind faith - Self-management and Good health - Science of reincarnation - Equality, Nonviolence, Humility, Role of Women - All religions and same message - Mind your Mind, Self-control - Honesty, Studying effectively.

*REFERENCES:*

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

**EEPE 1.6(e) : CONSTITUTION OF INDIA**

3L:0P 0 Credits

**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working).

**Philosophy of the Indian Constitution:** Preamble - Salient Features.

**Contours of Constitutional Rights & Duties -** Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.

**Organs of Governance:** Parliament - Composition - Qualifications and Disqualifications - Powers and Functions – Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions.

**Local Administration:** District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, ? Importance of grass root democracy.

**Election Commission:** Role and Functioning - Chief Election Commissioner and Election Commissioners - State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women.

*REFERENCES:*

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition,2015.

3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**EEPE 1.6(f) : PEDAGOGY STUDIES**

3L:0P 0 Credits

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

**Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Evidence on the effectiveness of pedagogical practices, Methodology for the in-depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers’ attitudes and beliefs and Pedagogic strategies.

**Professional development:** alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**Research gaps and future directions:** Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

*REFERENCES:*

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. ondon: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ ampaign.

7. www.pratham.org/images/resource%20working%20paper%202.p

**EEPE 1.6 (g) : STRESS MANAGEMENT BY YOGA**

3L:0P 0 Credits

**Yoga:** Royal Road to Higher Consciousness: Consciousness or Chaitanya in Mandukya Upanishad, Bhagavad Gita, Yoga Sutras, Astavakra Gita; methods of accessing higher states of consciousness – overcoming body consciousness, overcoming mind consciousness; higher consciousness and person transformation; higher consciousness and parapsychic powers (siddhis).

**Vedanta:** A Philosophy of Pure Consciousness – Consciousness according to Advaita, Dvaita and Visistadvaita schools, Consciousness according to Nyaya, Vaisesika and Sankya Schools. Self - awareness – Ramana Maharshi; Buddhism: A Psychology of Consciousness: - viññâ a,5 aggregates, 12 nidhanasm, cetasikas, nirvana.

The Mind-Body Relationship, the concept of Psychological Health in India, Scope of Health Psychology Emergence of Behavioural Medicine.

**Stress – Stressors:** Environmental, Social and Psychological, stress and illness, control and stress.

*REFERENCES:*

1. S. Menon, B.V.Sreekantan, Anindya Sinha, Philip Clayton, R Narasimha (2004). Science and Beyond: Cosmology, consciousness and technology in Indic traditions. National Institute of Advanced Studies, Bangalore.

2. Nakamura (1989). Indian Buddhism, Motilâl Banârsidass, Delhi.

3. Goleman, D & Gurin, J. (1993). Mind – Body Medicine, New York.

**EEPE 1.6 (h) : PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

Neetisatakam - Holistic development of personality

\* Verses- 19,20,21,22 (wisdom)

\* Verses- 29,31,32 (pride & heroism)

\* Verses- 26,28,63,65 (virtue)

\* Verses- 52,53,59 (dont’s)

\* Verses- 71,73,75,78 (do’s)

Approach to day to day work and duties.

\* Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48,

\* Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23,35,

\* Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge.

\* Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68

\* Chapter 12 -Verses 13, 14, 15, 16,17, 18 Personality of Role model. Shrimad BhagwadGeeta:

\* Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

\* Chapter 4-Verses 18, 38,39

\* Chapter18 – Verses 37,38,63

*REFERENCES:*

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram.

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath.

3. Rashtriya Sanskrit Sansthanam, New Delhi.

***EEPE 1.7 : POWER ELECTRONICS LABORATORY***

0L:3P 2 Credits

**EEPE 1.8 : ELECTRICAL MACHINES LAB (or) RENEWABLE ENERGY SYSTEMS LAB**

0L:3P 2 Credits

**I/II M.TECH**

**Common with Dual Degree Course V/VI (B.TECH+M.TECH)**

(With effect from **2019-2020** admitted batch onwards)

**M.Tech. (Electrical Engineering)**

Specialization: Power Electronic Drives and Control (PEDC)

**II SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPE 2.1 Electric Drives System 3 - 70 30 100 3

EEPE 2.2 Digital Control of Power Electronic
 and Drive Systems 3 - 70 30 100 3

EEPE 2.3 Elective-III 3 - 70 30 100 3

 a) Power Quality

 b) Switched Mode and Resonant
 Converters

 c) Industrial Load Modeling and
 Control

EEPE 2.4 Elective-IV

 a) Advanced Microcontroller based

 Systems

 b) Distributed Generation

 c) Smart Grids

 d) Optimal Control Theory 3 - 70 30 100 3

EEPE 2.5 Audit Course-II 3 - 70 30 100 0

EEPE 2.6 Electrical Drives Laboratory - 3 50 50 100 2

EEPE 2.7 Micro-controller Lab (or) Power Quality lab - 3 50 50 100 2

EEPE 2.8 Seminar - 3 - 100 100 2

 Total 15 9 450 350 800 18

**EEPE 2.1 : ELECTRIC DRIVE SYSTEM**

3L:0P 3 Credits

Dynamics of Electric Drives, Fundamentals of torque equation, Speed torque convention and multi-quadrant operation, components of load torques

Classification of load torques steady state stability, Load equation, Speed control and drive classification, closed loop control of drives.

DC motor Drive - Modelling of DC machines, Steady state characteristics with armature and speed control. Phase controlled DC motor drives, chopper controlled DC motor drives.

Poly-phase induction machines - Dynamic modeling of induction machines, Small signal equations, control characteristics of induction machines, Phase-controlled induction machines, Stator voltage control, Slip energy recovery scheme, frequency control and vector control of induction motor drives.

Traction motor: Starting, Speed-Time characteristics, Braking, Traction motors used in practice.

Industrial Drives-Digital Control of Electric Drives, Stepper motor, Servo motor and their Applications

*TEXT BOOKS:*

1. G.K, Dubey, “Power semiconductor controlled Drives”, Prentice Hall international, New Jersey, 1989.

2. R. Krishanam, “Electric motor drives modeling, analysis and control”, PHI-India-2009.

3. G. K. Dubey,”Fundamentals of electric Drives, Narosa Publishing House”, 2nd edition, 2011.

4. W. Leonhard, “Control of Electrical drives”, Springer, 3rd edition, 2001.

5. P.C. Krause –, “Analysis of Electric Machine”, Wiley-IEEE press 3rdedition.

6. K. Bose,”Modern Power Electronics and AC Drives”, Prentice Hall publication, 1st edition, 2001.

**EEPE 2.2 : DIGITAL CONTROL OF POWER
ELECTRONIC AND DRIVE SYSTEMS**

3L:0P 3 Credits

Review of numerical methods, Application of numerical methods to solve transients in D.C., Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits

Modelling of diode in simulation, Diode with R, R-L, R-C and R-L-C load with AC supply, Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation, Application of numerical methods to R, L, C circuits with power electronic switches, Simulation of gate/base drive circuits, simulation of snubber circuits.

State space modelling and simulation of linear systems, Introduction to electrical machine modelling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects

Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, Converters with self-commutated devices- simulation of power factor correction schemes

Simulation of converter fed DC motor drives, Simulation of thyristor choppers with voltage, Current and load commutation schemes, Simulation of chopper fed DC motor.

Simulation of single and three phase inverters with thyristors and self-commutated devices, Space vector representation, Pulse-width modulation methods for voltage control, Waveform control, Simulation of inverter fed induction motor drives.

*REFERENCE:*

1. Simulink Reference Manual, Math works, USA.

**EEPE 2.3 (a)(Elective - III) POWER QUALITY**

3L:0P 3 Credits

**Introduction:** Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring

**Long Interruptions:** Interruptions – Definition – Difference between failure, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency– Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

**Short Interruptions:** Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

**Voltage sag – characterization – Single phase/ Three phase:** Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags

**Power Quality and EMC Standards:** Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

*REFERENCE:*

1. “Understanding Power Quality Problems” by Math H J Bollen. IEEE Press.

**EEPE 2.3 (b)(Elective - III) SWITCHED MODE AND
POWER CONVERTERS**

3L:0P 3 Credits

**BASIC CONVERTERS:** Basic concepts, Principle of operation and analysis of Buck, Boost, Buck Boost converter for continuous and discontinuous current mode.

**DERIVED CONVERTERS**: Principle of operation and analysis forward, Flyback, Pushpull, Half bridge, Full bridge converters, cuk converters.

**RESONANT CONVERTERS:** Introduction, classification, Basic Resonant circuit concepts, Resonant switch converters, Zero voltage switching, clamped voltage topologies, Resonant DC link converters.

**CONVERTER APPLICATIONS:** Linear power supplies, Switching dc power supplies and its control; power line disturbances, power conditioners, uninterruptible power supplies.

**UTILITY INTERFACE:** Generation of current harmonics, current harmonics and power factor, need for improved utility interface, improved single phase utility interface, improved three phase utility interface, electromagnetic interface.

***Text Books****:*

1. Ned Mohan, Tore.M. Undeland and William.P Robbins, “Power Electronics converters, applications and design”, John Wiley 2003.

2. Rashid M.H. Power Electronics – Circuits Devices and applications, Prentice Hall India Third Edition.

3. B.K.Bose, “Modern Power Electronics & AC Drives”, Pearson Edition Asia, 2002.

*References:*

1. Philip T Krein,’ Elements of Power Electronics ‘,Oxford Press,1998.

2. Switched Mode Power Conversion, Course Notes, CCE, IISc, 2004.

**EEPE 2.3 (c)(Elective - III)**

**INDUSTRIAL LOAD MODELLING AND CONTROL**

3L:0P 3 Credits

Electric Energy Scenario-Demand Side Management-Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers, Classification of Industrial Loads Continuous and Batch processes - Load Modelling.

Electricity pricing – Dynamic and spot pricing –Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of load Models, Optimization and control algorithms - Case studies.

Reactive power management in industries, controls-power quality impacts, application of filters Energy saving in industries.

Cooling and heating loads, load profiling, Modelling- Cool storage, Types-Control strategies, Optimal operation, Problem formulation- Case studies.

Captive power units, Operating and control strategies, Power Pooling- Operation models, Energy banking, Industrial Cogeneration.

Selection of Schemes Optimal Operating Strategies, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries.

*REFERENCES:*

1. C.O. Bjork “Industrial Load Management - Theory, Practice and Simulations”, Elsevier, the Netherlands,1989.

2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28.

3. Y. Manichaikul and F.C. Schweppe ,” Physically based Industrial load”, IEEE Trans. on PAS, April 1981

4. H. G. Stoll, “Least cost Electricity Utility Planning”, Wiley Interscience Publication, USA, 1989.

5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995.

6. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA.

**EEPE 2.4 (a)(Elective - IV)**

**ADVANCED MICRO-CONTROLLER BASED SYSTEMS**

3L:0P 3 Credits

Basic Computer Organization, Accumulator based processes-Architecture-Memory Organization-I/O Organization.

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

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

PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication Digital Signal Processor (DSP) - Architecture – Programming, Introduction to FPGA.

Microcontroller development for motor control applications, Stepper motor control using micro controller.

*TEXTBOOKS:*

1. John.F.Wakerly: “Microcomputer Architecture and Programming”, John Wiley and Sons 1981.

2. Ramesh S.Gaonker: “Microprocessor Architecture, Programming and Applications with the 8085”, 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 PIC18F Series”, Elsevier, 2008.

7. Microchip datasheets for PIC16F877.

**EEPE 2.4 (b)(Elective - IV)**

**DISTRIBUTED GENERATION**

3L:0P 3 Credits

Introduction to Distributed generation, Renewable sources in distributed generation and current scenario in Distributed Generation.

Planning of DGs, Sitting and sizing of DGs optimal placement of DG sources in distribution systems, Grid integration of DGs Different types of interfaces, Inverter based DGs and rotating machine-based interfaces, Aggregation of multiple DG units.

Technical impacts of DGs, Transmission systems Distribution Systems De-Regulation Impact of DGs upon protective relaying, Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.

 Economic and control aspects of DGs Market facts, Issues and challenges Limitations of DGs, Voltage control techniques, Reactive power control, Harmonics Power quality issues, Reliability of DG based systems.

Introduction to micro-grids, Types of micro-grids: autonomous and non-autonomous grids Sizing of micro-grids, Modelling & analysis of Micro-grids with multiple DGs, Micro-grids with power electronic interfacing units.

Transients in micro-grids, Protection of micro-grids, Case studies, Advanced topics.

*TEXT BOOKS:*

1. H. Lee Willis, Walter G. Scott, “Distributed Power Generation – Planning and Evaluation”, Marcel Decker Press.

2. M.GodoySimoes, Felix A.Farret, “Renewable Energy Systems – Design and Analysis with Induction Generators”, CRC press.

3. Stuart Borlase. “Smart Grid: Infrastructure Technology Solutions” CRC Press.

**EEPE 2.4 (c)(Elective - IV)**

**SMART GRIDS**

3L:0P 3 Credits

**Introduction to Smart Grid, Evolution of Electric Grid:** Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust &Self-Healing Grid, Present development & International policies in Smart Grid.

**Introduction to Smart Meters, Real Time Prizing, Smart Appliances:** Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV).Vehicle to Grid, Smart Sensors. Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation.

**Geographic Information System (GIS):** Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).

**Concept of micro-grid, need & applications of micro-grid:** Formation of micro-grid, Issues of interconnection, Protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines, Captive power plants, Integration of renewable energy sources.

**Power Quality & EMC in Smart Grid:** Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit

*TEXTBOOKS:*

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE, 2011.

2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press, 2009.

3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and Applications”, Wiley 2012.

4. Stuart Borlas’e, “Smart Grid: Infrastructure, Technology and solutions “CRC Press.

5. A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer.

**EEPE 2.4 (d)(Elective - IV)**

**OPTIMAL CONTROL THEORY**

3L:0P 3 Credits

**Introduction:** Problem formulation State variable representation of systems – Performance measures for optimal control problems – selecting a performance measure.

**Dynamic programming:** The optimal control law principle of optimality and its application optimal control system-interpolation-recurrence relation of dynamic programming computational procedure for solving optimal control problems–characteristics of dynamic programming solution analytical results discrete linear regulator problems-Hamilton-Jacobi-Bellman-equation-continuous linear regulator problems.

**The Calculus of variations:** Fundamental concepts linearity of functional closeness of functions the increment of a functional The variation of a functional maxima and minima of functional the fundamental theorem of the calculus of variations Functional of a single function the simplest variational problems.

**The Variational approach to optimal control problems:** Necessary conditions for optimal control Linear regulator problem Pontryagin’s minimum principle and state inequality constraints.

**Iterative numerical techniques for finding optimal controls:** Two point boundary value problems The method of steepest descent Features of the steepest descent algorithm.

*TEXT BOOK:*

Optimal control theory An Introduction by Donald E.Kirk Prentice Hall Networks series.

**EEPE 2.5 (a)**

**ENGLISH FOR RESEARCH PAPER WRITING**

3L:0P 0 Credits

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

*Reference Books:*

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).

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

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book.

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

**EEPE 2.5 (b) DISASTER MANAGEMENT**

3L:0P 0 Credits

Introduction toDisaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

*References:*

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep &Deep Publication Pvt. Ltd., New Delhi.

**EEPE 2.5 (c) SANSKRIT FOR TECHNICAL KNOWLEDGE**

3L:0P 0 Credits

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences Order - Introduction of roots - Technical information about Sanskrit Literature Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

*References:*

1. Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.

2. Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

3. India’s Glorious Scientific Tradition” Suresh Soni, Ocean book s (P) Ltd., New Delhi.

**EEPE 2.5(d) VALUE EDUCATION**

3L:0P 0 Credits

Values and self-development - Social values and individual attitudes - Work ethics, Indian vision of humanism - Moral and non - moral valuation - Standards and principles - Value judgements

Importance of cultivation of values - Sense of duty - Devotion, Self-reliance - Confidence, Concentration. Truthfulness, Cleanliness - Honesty, Humanity - Power of faith, National Unity – Patriotism - Love for nature, Discipline.

Personality and Behaviour Development - Soul and Scientific attitude - Positive Thinking - Integrity and discipline - Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour - Universal brotherhood and religious tolerance - True friendship - Happiness Vs suffering, love for truth - Aware of self-destructive habits - Association and Cooperation - Doing best for saving nature

Character and Competence –Holy books vs Blind faith - Self-management and Good health - Science of reincarnation - Equality, Nonviolence, Humility, Role of Women - All religions and same message - Mind your Mind, Self-control - Honesty, Studying effectively

*References:*

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

**EEPE 2.5 (e) : CONSTITUTION OF INDIA**

3L:0P 0 Credits

**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)

**Philosophy of the Indian Constitution:** Preamble - Salient Features

**Contours of Constitutional Rights & Duties -** Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.

**Organs of Governance:** Parliament - Composition - Qualifications and Disqualifications - Powers and Functions – Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

**Local Administration:** District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, ? Importance of grass root democracy

**Election Commission:** Role and Functioning - Chief Election Commissioner and Election Commissioners - State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women.

*REFERENCES:*

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**EEPE 2.5 (f) PEDAGOGY STUDIES**

3L:0P 0 Credits

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

**Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers’ attitudes and beliefs and Pedagogic strategies.

**Professional development:** alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**Research gaps and future directions:** Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

*REFERENCES:*

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. ondon: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ ampaign.

7. www.pratham.org/images/resource%20working%20paper%202.p

**EEPE 2.5 (g) STRESS MANAGEMENT BY YOGA**

 3L:0P 0 Credits

**Yoga:** Royal Road to Higher Consciousness: Consciousness or Chaitanya in Mandukya Upanishad, Bhagavad Gita, Yoga Sutras, Astavakra Gita; methods of accessing higher states of consciousness – overcoming body consciousness, overcoming mind consciousness; higher consciousness and person transformation; higher consciousness and parapsychic powers (siddhis).

**Vedanta:** A Philosophy of Pure Consciousness – Consciousness according to Advaita, Dvaita and Visistadvaita schools, Consciousness according to Nyaya, Vaisesika and Sankya Schools. Self - awareness – Ramana Maharshi; Buddhism: A Psychology of Consciousness: - viññâ a,5 aggregates, 12 nidhanasm, cetasikas, nirvana

The Mind-Body Relationship, the concept of Psychological Health in India, Scope of Health Psychology Emergence of Behavioural Medicine.

**Stress – Stressors:** Environmental, Social and Psychological, stress and illness, control and stress.

*REFERENCES:*

1. S. Menon, B.V.Sreekantan, Anindya Sinha, Philip Clayton, R Narasimha (2004). Science and Beyond: Cosmology, consciousness and technology in Indic traditions. National Institute of Advanced Studies, Bangalore.

2. Nakamura (1989). Indian Buddhism, Motilâl Banârsidass, Delhi.

3. Goleman, D & Gurin, J. (1993). Mind – Body Medicine, New York.

**EEPE 2.5 (h) PERSONALITY DEVELOPMENT THROUGH
LIFE ENLIGHTENMENT SKILLS**

3L:0P 0 Credits

Neetisatakam - Holistic development of personality:

\* Verses- 19,20,21,22 (wisdom)

\* Verses- 29,31,32 (pride & heroism)

\* Verses- 26,28,63,65 (virtue)

\* Verses- 52,53,59 (dont’s)

\* Verses- 71,73,75,78 (do’s)

Approach to day to day work and duties:

\* Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48,

\* Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23,35,

\* Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge:

\* Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68

\* Chapter 12 -Verses 13, 14, 15, 16,17, 18

 Personality of Role model. Shrimad BhagwadGeeta:

\* Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

\* Chapter 4-Verses 18, 38,39

\* Chapter18 – Verses 37,38,63

*REFERENCES:*

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath

3. Rashtriya Sanskrit Sansthanam, New Delhi.

**EEPE 2.6 ELECTRICAL DRIVES LABORATORY**

0L:3P 2 Credits

**EEPE 2.7 MICRO-CONTROLLER LAB (or) POWER QUALITY LAB**

0L:3P 2 Credits

**EEPE 2.8 SEMINAR**

0L:3P 2 Credits

**I/II M.TECH**

**Common with Dual Degree Course V/VI (B.TECH+M.TECH)**

(With effect from 2019-2020 admitted batch onwards)

**M.Tech. (Electrical Engineering)**

**Specialization: Power Electronic Drives and Control (PEDC)**

**III SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPE 3.1 Elective-V a) SCADA Systems and
 Applications

 b) FACTS and Custom Power Devices

 c) Waste to Energy 3 - 70 30 100 3

EEPE 3.2 Open Elective

 a) Business Analytics

 b) Industrial Safety

 c) Cost Management of Engineering Projects

 d) Composite Materials

 e) HVDC 3 - 70 30 100 3

EEPE 3.3 Major Project (Phase – I Dissertation) - - 100 — 100 10

 Total 6 - 240 60 300 16

**EEPE 3.1 (a)(Elective - V)**

**SCADA SYSTEMS AND APPLICATIONS**

3L:0P 3 Credits

**Introduction to SCADA:** Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, & Industries.

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

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

**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.

*TEXT BOOKS:*

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.

**EEPE 3.1 (b)(Elective - V)**

**FACTS AND CUSTOM POWER DEVICES**

3L:0P 3 Credits

Reactive power flow control in Power Systems Control of dynamic power unbalances in Power System - Power flow control Constraints of maximum transmission line loading Benefits of FACTS Transmission line compensation Uncompensated line -Shunt compensation, Series compensation Phase angle control Reactive power compensation Shunt and Series compensation principles Reactive compensation at transmission and distribution level.

Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM Operation and control of TSC, TCR and STATCOM – Compensator control Comparison between SVC and STATCOM.

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators TCVR and TCPAR Operation and Control Applications, Static series compensation GCSC, TSSC, TCSC and Static synchronous series compensators and their Control.

SSR and its damping Unified Power Flow Controller Circuit Arrangement, Operation and control of UPFC Basic Principle of P and Q control Independent real and reactive power flow control- Applications

Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers Simulation of FACTS controllers Power quality problems in distribution systems, harmonics, loads that create harmonics modeling, harmonic propagation, series and parallel resonances mitigation of harmonics passive filters, active filtering – shunt , series and hybrid and their control Voltage swells , sags, flicker, unbalance and mitigation of these problems by power line conditioners IEEE standards on power quality.

*TEXT BOOKS:*

1. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age InternationalPublishers, 2007

2. X P Zhang, C Rehtanz, B Pal, “Flexible AC Transmission Systems- Modelling and Control”, SpringerVerlag, Berlin, 2006

3. N.G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible ACTransmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.

4. K.S.Sureshkumar ,S.Ashok , “FACTS Controllers & Applications”, E-book edition, Nalanda DigitalLibrary, NIT Calicut,2003

5. G T Heydt , “Power Quality”, McGraw-Hill Professional, 2007 6. T J E Miller, “Static Reactive Power Compensation”, John Wiley and Sons, Newyork, 1982.

**EEPE 3.1 (c)(Elective - V)**

**WASTE TO ENERGY**

3L:0P 3 Credits

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers –Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

*TEXT BOOKS:*

1. Non - Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**EEPE 3.2 (a)(Open Elective)**

**BUSINESS ANALYTICS**

3L:0P 3 Credits

**Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

**Trendiness and Regression Analysis:** Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**Organization Structure:** Organization Structure of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

**Forecasting Techniques:** Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**Decision Analysis:** Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

***REFERENCES:***

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

2. Business Analytics by James Evans, persons Education.

**EEPE 3.2 (b)(Open Elective)**

**INDUSTRIAL SAFETY**

3L:0P 3 Credits

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

*TEXT BOOKS:*

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

**EEPE 3.2 (c)(Open Elective)**

**COST MANAGEMENT OF ENGINEERING PROJECTS**

3L:0P 3 Credits

**Cost:** Cost Elements, Pricing, Materials, Labour; Engineering, Equipment, Parts, and Tool; Economic Costs, Activity - Based Cost Management.

**Cost Estimating & Planning**: Estimating, Process Product Manufacturing, Discrete Product Manufacturing. Planning and Scheduling.

**Progress & Cost Control:** Progress Measurement and Earned Values, Earned Value for Variable Budgets, Tracking Cost and Schedule Performance, Performance and Productivity Management.

**Project Management:** Project Management Fundamentals, Project Organization Structure, Project Planning, Project Labour Cost Control, Leadership and Management of Project People, Quality Management, Value Analysis, Contracting for Capital Projects, Strategic Asset Management.

**Economic Analysis, Statistics & Probability:** Basic Engineering Economics, Applied Engineering Economics, Statistics & Probability, Basic Concepts in Descriptive Statistics, Risk Management.

*REFERENCES:*

1. Charles J. Austin Industrial Engineering & Technology Building, (AG/IT 216)

**EEPE 3.2 (d)(Open Elective)**

**COMPOSITE MATERIALS**

3L:0P 3 Credits

**Introduction:** Definition of composite 2 material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites.

**Performance of structural composites:** Basic analytical concepts (Qualitative black box approach and Quantitative analytical approach), Performance analysis by various models (Law of Mixtures, Shear lag model, Laminated plate model, Eshelby’s models and Other models, - thermo elasticity, plasticity and creep), Strengthening mechanisms, Stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, Analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, Estimation of the required minimum amount of fibre and critical amount of fibre to gain a composite strength, Analysis of strength of a composite during loading at an angle to the fibres, Nano-structured composites.

**Performance of Composite in Non- structural Applications:** Composites in Electrical, Superconducting and Magnetic Applications, Nano-composite devices.

**Industrial Application of Composite Materials:** Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components etc.

**Fracture & amp; Safety of Composite:** Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack growth rate), Fracture Mechanics of brittle matrix fibre composite, Fracture mechanics of metal matrix fibre composite, Experimental evaluation (composite), Elementary reliability analysis.

*REFERENCES:*

1. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

2. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.

3. 3. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5lGB, UK.

4. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993), Chapman &amp; Hall, London.

5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.

**EEPE 3.2 (e)(Open Elective) HVDC**

3L:0P 3 Credits

**STATIC POWER CONVERSION:** Comparison of DC transmission and AC Transmission, Application of DC transmission, Description of DC transmission systems, planning for HVDC transmission, Modern trends in DC transmission, pulse number, analysis of GRAETZ circuit with and without overlap, equivalent circuit, inverter equations, power factor and reactive power management, 12 pulse converter unit.

**HVDC SYSTEM CONTROL:** Features of control, actual, individual and combined characteristics of rectifier and inverter, constant minimum ignition angle control, constant current control, constant extinction angle control, individual phase control, equidistant firing control, voltage dependent current order limit (VDCOL), basic philosophy of system control, direction of DC power flow, reversal of power flow, starting and stopping of DC link.

**POWER FLOW ANALYSIS:** DC system model for load flow studies, Load flow study of AC DC system sequential method, simultaneous method. Reactive power requirements in steady state, conventional control strategies, alternate control strategies, equipment for reactive power.

**FAULTS AND PROTECTION:** short circuit ratio, Effective short circuit ratio, dynamic over voltages, DC power modulation, commutation failure, disturbances on AC side, disturbances on DC side, Characteristic harmonics, derivation of relevant equations for 12 pulse converter. AC filters single tuned, doubled tuned filters, brief introduction to DC circuit breakers.

**MULTI TERMINAL DC TRANSMISSION:** Introduction, potential applications of MTDC systems, Types of MTDC systems, control and protection.

***TEXTBOOK:***

1. “HVDC Transmission” by K.R. Padiyar.

*REFERENCE BOOKS:*

1. “Direct current transmission” by E.W. Kimbark. Wiley Interscience 1971.

2. “High voltage Direct current transmission” by J. Arrillaga IEE control engineering series 2000.

**EEPE 3.3 MAJOR PROJECT (PHASE- I DISSERTATION)**

10 Credits

**II/II M. TECH**

**Common with Dual Degree Course VI/VI (B.TECH+M.TECH)**

(With effect from 2019-2020 admitted batch onwards)

**M.Tech (Electrical Engineering)**

**Specialization: Power Electronic Drives and Control (PEDC)**

**IV SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EEPE 4.1 Major Project (Phase – II Dissertation) - 100 100 16

 Total 100 100 16

Audit Course I & II

1. English for Research Paper Writing

2. Disaster Management

3. Sanskrit for Technical Knowledge

4. Value Education

5. Constitution of India

6. Pedagogy Studies

7. Stress Management by Yoga

8. Personality Development through Life Enlightenment Skills

**EEPE 4.1 MAJOR PROJECT (PHASE – II DISSERTATION)**

16 Credits

**I/II M.TECH**

**Common with Dual Degree Course V/VI (B.TECH+M.TECH)**

(With effect from **2019-2020** admitted batch onwards)

**M.Tech. (Electrical Engineering)**

**Specialization:** Control Systems Engineering **(**CSE**)**

**I SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EECS 1.1 Mathematical Methods in
 Control/Linear Systems 3 - 70 30 100 3

EECS 1.2 Digital Control Systems 3 - 70 30 100 3

EECS 1.3 Elective-I

 (Robotics and Automation /Advanced
 control systems/Sliding Mode Control) 3 - 70 30 100 3

EECS 1.4 Elective-II

 (Optimization Techniques/SCADA system
 & Applications/ Systems Biology) 3 - 70 30 100 3

EECS 1.5 Research Methodology and IPR 3 - 70 30 100 2

EECS 1.6 Audit Course –I 3 - 70 30 100 0

EECS 1.7 Control Lab I - 3 50 50 100 2

EECS 1.8 Control Lab II - 3 50 50 100 2

 Total 18 6 520 280 800 18

**EECS 1.1 MATHEMATICAL METHODS IN CONTROL/
LINEAR SYSTEMS**

3L:0P 3 Credits

Linear Spaces – Vectors and Matrices, Transformations, Norms, Matrix Factorization

Eigenvalue, Eigenvectors and Applications, SVD and Applications, Projections and Least Square Solutions

Probability, Random variables, Probability distribution and density functions, Joint density and conditional distribution, Functions of random variables and random vectors

Characteristic functions and correlation matrices, poisson function, central limit theorem, correlation function and covariance

Random Processes and properties, Response of Linear systems to stochastic inputs, Power Spectral Density theorem & simple applications

*TEXT BOOK:*

1. Papoulis &Pillai, “Probability, random variable and stochastic processes”, Mcgraw Hill, 2002

*REFERENCES:*

1. G. Strang, “Introduction to Linear Algebra”, 4 th Edition, Wellesley-Cambridge Press, 2009

2. 3. H. Stark & J.W. Woods, “Probability and random processes with application to signal processing”, Pearson Education Asia, 2002

3. 4. J A Gubner: “Probability and Random processes for Electrical and Computer engineers”, Cambridge Univ. Press. 2006

**EECS 1.2 : DIGITAL CONTROL SYSTEMS**

3L:0P 3 Credits

**Discrete –Time Systems:** The Structure of a Digital Control System, Analog Systems with Piecewise Constant Inputs, Difference Equations, The Z Transform, Z Transform Solution of Difference Equation, The Time Response of a Discrete Time System, Frequency Response of Discrete Time Systems.

**Modeling of Digital Control Systems:** ADC Model, DAC Model, Transfer Function of the ZOH, Effect of Sampler on Transfer Function of a Cascade, Transfer Function for the DAC, Analog Subsystem, ADC Combination, Closed Loop Transfer Function, Analog disturbances in a Digital System, Steady State Error and Error Constants.

**Stability of Digital Control Systems:** Definitions of Stability, Stable Z Domain Pole Locations, Stability Conditions, Stability Determination, Jury Test.

**State Space Representation:** Discrete Time State Space Equations, Solution of Discrete Time State Space Equations, Z Transfer from State Space Equations, Similarity Transformation, Stability of State Space Realizations, Controllability and Stabilizability, Observability and Detectability.

**State Feedback Control:** On State and Output Feedback, Pole Placement, Servo Problem, Principles of Observer, State Feedback and Pole Assignment Using Transfer Functions.

*TEXT BOOKS:*

1. Digital control systems by B.C.Kuo, Oxford University Press.

*REFERENCES:*

1. Digital Control Engineering: Analysis and Design,By M. Sami Fadali, Antonio Visioli, Academic Press; 1 edition (February 16, 2009).

2. Digital control systems by K.Ogata.

**EECS 1.3(a)(Elective - I) ROBOTICS AND AUTOMATION**

3L:0P 3 Credits

**Fundamentals of Robot Technology:** Basic structure, links and Joints, types of Joints, types of links, types of end effectors: Grippers: Mechanical, Vacuum cups, Magnetic, adhesive and miscellaneous. Tools as end effectors. Wrist configuration: concept of: yaw, pitch and roll.

**Robot classification:** According to 1) Co ordinate system: Cartesian, cylindrical, spherical, SCARA, Articulated 2) Control Method: Servo controlled and non servo controlled, their comparative study 3) Form of motion: P T P (point to point), C P (continuous path), pick and place etc. and their comparative study 4) Motion conversion: Rotary to rotary, rotary to linear and vice versa.

**Robot arm dynamics:** Newton Euler Equations, Kinetic and potential energy, Lagrangian analysis for a single prismatic joint working against gravity and single revolute joint. Joint vector, homogeneous co ordinates. Matrix operators for translation and rotation

**Robot Control:** Open loop and closed loop control, Linear control Schemes, PD and PID control, Torque and Force control of robotic manipulators, Adaptive control, Hybrid control, Impedance control. Manipulator Jacobian, Jacobian for prismatic and revolute joint. Jacobian Inverse, Singularities, Control of Robot manipulator: joint position controls (JPC), resolved motion position controls (RMPC) and resolved motion rate control (RMRC)

**Automation & Control:** definition, types, merits and Criticism, architecture of industrial automation systems, manufacturing plants and operations: automation strategies, basic elements of automated system, advanced automation functions, Levels of automation. Process and discrete manufacturing industries, continuous and Discrete Control systems:

*TEXT BOOKS:*

1. R. K. Mittal, I. J. Nagrath, “Robotics and Control”, Tata McGraw Hill Publishing Company Ltd., New Delhi.

*REFERENCE BOOKS:*

1. Arthur J. Critchlow, “Introduction to Robotics”

2. Robert J. Schilling, “Fundamentals of Robotics: Analysis and Control”, Prentice Hall of India, New Delhi

3. John J. Craig, “Introduction to Robotics: Mechanics and Control”, Pearson Education

4. Mikell P. Groover, Mitchell Weiss,Roger N. Nagel, Nicholas G. Odrey, “Industrial Robotics: Technology, Programming and Applications”,McGraw Hill Book Company

5. Richard D. Klafter, Thomas A. Chemielewski, Michael Neign “Robotic Engineering – An Integral Approach”, Prentice Hall of India Pvt. Ltd., New Delhi. Eastern Economy Edition.

6. K. S. Fu., R. C. Gonzalez, C. S. G. Lee, “Robotics: Control Sensing, Vision and Intelligence”, International Edition, McGraw Hill Book Co.

**EECS 1.3(b)(Elective - I) ADVANCDE CONTROL SYSTEM**

3L:0P 3 Credits

**Math Modelling of Dynamical Systems:** Newtonian and Lagrangian approaches, Concept of dynamical state of a system, Concept of equilibrium point, linearization of non-linear model

**Review of Linear Algebra concepts:** Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, Diagonalisation

**Modern Control Analysis:** Concept and computation of systems modes, controllability theorem and its proof, Observability theorem and its proof, Controllable and observable subspaces

**Stability Analysis:** Stability of linear systems, stability types and their definitions for any general system, Stability of an equilibrium point, Lyapunov stability theory for LTI systems, Quadratic forms and Lyapunov functions

**Modern Control Design:** Converting the math model to controllable canonical form and its use for pole placement, Concept of linear observer and its design, Design of reduced order observer, Compensator design using separation principle, Poles of compensator, Open loop and close-loop systems

**Optimal Control Theory:** Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, Linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter.

*TEXT BOOK:*

**1.**  M. Gopal, “Modern Control System Theory”, , New Age International (P) Limited, New Delhi, 2000

*REFERENCES:*

1. Bernard Friedland, “Control System Design: An Introduction to State-Space Methods”, Dover Publications, Inc. Mineola, New York, 2012

2. Thomas Kailath, “Linear Systems”, Prentice-Hall Inc., New Jersey, 1986

**EECS 1.3(C)(Elective - I) SLIDING MODE CONTROL**

3L:0P 3 Credits

**An Introduction to Sliding Mode Control:** Introduction, properties of sliding motion, typical controller design, pseudo sliding with a smooth control action, a state space approach.

**Sliding mode control:** Introduction, problem statement, existence of solution and equivalent control properties of the sliding motion, The reachability problem, the unit vector approach, continuous approximations.

**Sliding mode Design approaches:** Introduction, A regulator form based approach, a direct eigen structure assignment approach, Incorporation of a tracking requirement, Design study of Pitch pointing flight controller.

**Sliding mode controllers using output information:** Introduction, problem formulation, a special case of square plants, a general frame work, dynamic compensation, observer based dynamic compensation, a model reference system using only outputs.

**Sliding mode observers:** Introduction, sliding mode observers, synthesis of a discontinuous observer, the Walcott Zak observer revisited, sliding mode observers for fault detection.

*TEXT BOOK:*

1. Sliding Mode Control: Theory And Applications (Series in Systems and Control) by , C Edwards and S Spurgeon, Published by Taylor & Francis,

*REFERENCE:*

1. Sliding Mode Control In Engineering (Automation and Control Engineering) by WilfridPerruquetti , Jean Pierre Barbot published by Marcel Dekker, Inc, New York

**EECS 1.4(a)(Elective - II) OPTIMIZATION TECHNIQUES**

3L:0P 3 Credits

**Introduction to Optimization:** Introduction, Historical Development, Engineering Applications of Optimization, Statement of Optimization Problem.

**Classical Optimization Techniques:** Introduction, Single variable optimization, Multivariable optimization with no constraints; Multivariable optimization with Equality constraints – Solution by Direct Substitution method, Method of constrained variation, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn Tucker conditions.

**Linear Programming:** Introduction, Applications of Linear Programming, Standard Form of a Linear Programming, Basic Terminology and Definitions, Exceptional cases, Simplex method, Big M method, Two phase method, Revised Simplex method, Duality, Decomposition Principle.

**Non Linear Programming I**: Unconstrained optimization Univariate method, Pattern Directions, Powell’s method, Gradient of a function, Steepest descent method, Conjugate Gradient Method, Newton’s method, Marquardt Method, Quai Newton Methods, Davidon Fletcher Powell Method, Broyden Fletcher Goldfarb Shanno Method.

**Non Linear Programming II:** Constrained optimization Characteristics of a Constrained Problem, Sequential linear programming, Basic approach in the methods of feasible directions, Zoutendijk’s method of feasible directions, Sequential Quadratic Programming.

*TEXT BOOK:*

1. Engineering Optimization: Theory and Applications’ By S.S.Rao, New Age International Publishers, Revised Third Edition, 2005.

**EECS 1.4(b)(Elective - II) SCADA SYSTEMS & APPLICATIONS**

3L:0P 3 Credits

**Introduction to SCADA:** Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, & Industries

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

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

**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

*TEXT BOOKS:*

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.

**EECS 1.4(c)(Elective - II) SYSTEMS BIOLOGY**

3L:0P 3 Credits

**Neural Networks:** Artificial Neural Networks: Basic properties of Neurons, Neuron Models, Feedforward networks – Perceptrons, Multilayer networks – Exact and approximate representation, Back propagation algorithm, variants of Back propagation, Unsupervised and Reinforcementlearning; Competitive learning and self-organizing networks, Hybrid Learning.

**ANN based control:** Introduction: Representation and identification, modeling the plant, control structures – supervised control, Model reference control, Internal model control, Predictive control, Case study application to electrical engineering.

**Fuzzy Logic:** Overview of classical logic, Fuzzy sets vs Crisp set, Membership function, Methods of Membership function, Value Assignment, defuzzification – Methods of defuzzification, fuzzy rule based and Approximation, Aggrigation of Fuzzy rules, Fuzzy inference system –Mamadani and Sugeno methods.

**Fuzzy Controllers:** Preliminaries – Basic architecture and operation of Fuzzy controller – Analysis of static properties of fuzzy controller – Analysis of dynamic properties of fuzzy controller – simulation studies – case studies –application to electrical engineering.

**Neuro – Fuzzy Controllers:**Neuro – fuzzy systems: A unified approximate reasoning approach – Construction of role bases by self learning: System structure and learning algorithm – A hybrid neural network based Fuzzy controller with self learning teacher. Fuzzified CMAC and RBF network based self learning controllers, case studies –application to electrical engineering

***TEXT BOOKS****:*

1. Bose and Liang, Artificial Neural Networks, Tata Mcgraw Hill, 1996.

2. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Prentice Hall of India, New Delhi, 1992.

*REFERENCES:*

1. Klir G.J and Folger T.A, Fuzzy sets, Uncertainty and Information, PHI, New Delhi 1994.

2. Simon Haykin, Neural Networks, ISA, Research Triangle Park, 1995.

3. Bose, Nirmal K.; Bose, N. K.; Liang, Ping, Neural Network Fundamentals with Graphs, Algorithms, and Applications (McGraw Hill Series in electrical & Computer Engineering)

4. Robert Fuller , Introduction to Neuro Fuzzy Systems, Springer, 2000

5. J. S. R. Jang, C. T. Sun, and E.Mizutani , Neuro Fuzzy and Soft Computing

6. Berenji, Hamid R , Fuzzy and neural control (May 1, 1992)

7. Fuzzy logic with Fuzzy Applications – T.J.Ross – McGraw Hill Inc, 1997.

8. Fuzzy sets, Fuzzy logic, fuzzy systems by – loft Asker Zadeh

**EECS 1.5 RESEARCH METHODOLOGY AND IPR**

 3L:0P 2 Credits

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property - Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights - Licensing and transfer of technology - Patent information and databases - Geographical Indications.

New Developments in IPR: Administration of Patent System - New developments in IPR; IPR of Biological Systems, Computer Software etc. - Traditional knowledge Case Studies, IPR and IITs.

*REFERENCES:*

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. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

**EECS 1.6(a) ENGLISH FOR RESEARCH PAPER WRITING**

 3L:0P 0 Credits

Planning and Preparation, Word Order, Breaking up longsentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly bethe first- time submission

*REFERENCE BOOKS:*

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

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

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’sbook.

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

**EECS 1.6(b) DISASTER MANAGEMENT**

3L:0P 0 Credits

Introduction toDisaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis,Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in IndiaStudy Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And ManagementPreparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global andNational Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People’s Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

*REFERENCES:*

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep&Deep Publication Pvt. Ltd., New Delhi.

**EECS 1.6(c) SANSKRIT FOR TECHNICAL KNOWLEDGE**

3L:0P 0 Credits

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Order - Introduction of roots - Technical information about Sanskrit Literature

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

*REFERENCES:*

1. Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. Teach Yourself Sanskrit” PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

3. India’s Glorious Scientific Tradition” Suresh Soni, Ocean book s (P) Ltd., New Delhi.

**EECS 1.6(d) VALUE EDUCATION**

3L:0P 0 Credits

Values and self-development - Social values and individual attitudes - Work ethics, Indian vision of humanism- Moral and non - moral valuation - Standards and principles - Value judgements

Importance of cultivation of values- Sense of duty - Devotion, Self-reliance - Confidence, Concentration. Truthfulness, Cleanliness - Honesty, Humanity - Power of faith, National Unity –Patriotism - Love for nature,Discipline

Personality and Behaviour Development - Soul and Scientific attitude - Positive Thinking - Integrity and discipline - Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour - Universal brotherhood and religious tolerance - True friendship - Happiness Vs suffering, love for truth - Aware of self-destructive habits - Association and Cooperation - Doing best for saving nature

Character and Competence –Holy books vs Blind faith - Self-management and Good health - Science of reincarnation - Equality, Nonviolence,Humility, Role of Women - All religions and same message - Mind your Mind, Self-control - Honesty, Studying effectively

*REFERENCES:*

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

**EECS 1.6(e) : CONSTITUTION OF INDIA**

3L:0P 0 Credits

**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)

**Philosophy of the Indian Constitution:** Preamble - Salient Features

**Contours of Constitutional Rights & Duties -** Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.

**Organs of Governance:** Parliament - Composition - Qualifications and Disqualifications - Powers and Functions – Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

**Local Administration:** District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, ? Importance of grass root democracy

**Election Commission:** Role and Functioning - Chief Election Commissioner and Election Commissioners - State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women.

*REFERENCES:*

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**EECS 1.6(f) PEDAGOGY STUDIES**

3L:0P 0 Credits

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

**Thematic overview:**Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Evidence on the effectiveness of pedagogical practices,Methodology for the in depth stage: quality assessment of included studies, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers’ attitudes and beliefs and Pedagogic strategies.

**Professional development:** alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**Research gaps and future directions :** Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

*REFERENCES:*

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. ondon: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

**EECS 1.6(g) STRESS MANAGEMENT BY YOGA**

3L:0P 0 Credits

**Yoga:** Royal Road to Higher Consciousness: Consciousness or Chaitanya in Mandukya Upanishad, Bhagavad Gita, Yoga Sutras, Astavakra Gita; methods of accessing higher states of consciousness – overcoming body consciousness, overcoming mind consciousness; higher consciousness and person transformation; higher consciousness and parapsychic powers (siddhis).

**Vedanta:** A Philosophy of Pure Consciousness – Consciousness according to Advaita, Dvaita and Visistadvaita schools, Consciousness according to Nyaya, Vaisesika and Sankya Schools. Self - awareness – RamanaMaharshi; Buddhism: A Psychology of Consciousness: - viññâ a,5 aggregates, 12 nidhanasm, cetasikas, nirvana.

The Mind-Body Relationship, the concept of Psychological Health in India, Scope of Health Psychology Emergence of Behavioural Medicine.

**Stress – Stressors:** Environmental, Social and Psychological, stress and illness, control and stress.

*REFERENCES:*

1. S. Menon, B.V.Sreekantan, AnindyaSinha, Philip Clayton, R Narasimha (2004). Science and Beyond: Cosmology, consciousness and technology in Indic traditions. National Institute of Advanced Studies, Bangalore

2. Nakamura (1989). Indian Buddhism, MotilâlBanârsidass, Delhi.

3. Goleman, D &Gurin, J. (1993). Mind – Body Medicine, New York.

**EECS 1.6(h) PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

3L:0P 0 Credits

Neetisatakam - Holistic development of personality

\* Verses- 19,20,21,22 (wisdom)

\* Verses- 29,31,32 (pride & heroism)

\* Verses- 26,28,63,65 (virtue)

\* Verses- 52,53,59 (dont’s)

\* Verses- 71,73,75,78 (do’s)

Approach to day to day work and duties.

\* ShrimadBhagwadGeeta : Chapter 2-Verses 41, 47,48,

\* Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23,35,

\* Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge.

\* ShrimadBhagwadGeeta: Chapter2-Verses 56, 62, 68

\* Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model.ShrimadBhagwadGeeta:

\* Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

\* Chapter 4-Verses 18, 38,39

\* Chapter18 – Verses 37,38,63

*REFERENCES:*

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath

3. Rashtriya Sanskrit Sansthanam, New Delhi.

**EECS 1.7 CONTROL LAB – I 0L:3P 2 Credits**

**EECS 1.8 CONTROL LAB - II 0L:3P 2 Credits**

**I/II M.TECH**

**Common with Dual Degree Course V/VI (B.TECH+M.TECH)**

(With effect from **2019-2020** admitted batch onwards)

**M.Tech. (Electrical Engineering)**

**Specialization: Control Systems Engineering (CSE)**

**II SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EECS 2.1 Non Linear systems 3 - 70 30 100 3

EECS 2.2 Control System Design 3 - 70 30 100 3

EECS 2.3 Elective III

 (Optimal Control theory/ Advanced
 Robotics/ Adaptive Learning and

 Control/ Stochastic Filtering and 3 - 70 30 100 3 Identification )
EECS 2.4 Elective IV

 (Model Reduction in Control/ 3 - 70 30 100 3 Robust Control / Advanced DSP/
 Control Systems Components)

EECS 2.5 Audit Course -II 3 - 70 30 100 0

EECS 2.6 Advanced Control Lab I - 3 50 50 100 2

EECS 2.7 Advanced Control Lab II - 3 50 50 100 2

EECS 2.8 Seminar - 3 - 100 100 2

 Total 15 9 450 350 800 18

**EECS 2.1 NON LINEAR SYSTEMS**

3L:0P 3 Credits

**Introduction to Non Linear System:** Classification of non linearity, types of non linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non linear systems and comparison, isoclines, singular point, limit cycle.

**Phase Plane Analysis:** Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol’s equation, stability from phase portrait, time response from trajectories, isoclines method, Pell’s method of phase trajectory, and Delta method of phase trajectory construction.

**Frequency Domain Analysis:** Absolute stability, Describing function, DF of typical nonlinearities stability analysis using DF method, stability studies using DF method.

**Liapunov Stability:** Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Lyapunov function, Liapunov Stability: asymptotic stability, global asymptotic stability, instability.

**Linearization:** Linear systems, linearization of nonlinear systems about equilibrium point, feedback linearization and input/output linearization.

*TEXT BOOK:*

1. M.Vidyasagar, ‘Nonlinear systems Analysis’, 2nd Edition, 1991, prentice Hall Inc.

*REFERENCE BOOK:*

1. Control Systems Theory and Application: SamarjitGhosh, Pearson Education

2. Control System Engineering: Nagrath and Gopal, Wiley Eastern

3. Automatic Control System: George J. Thaler Brown, Jaico Publications

4. Nonlinear Systems: Hasan A. Khalil, Printece Hall of India

**EECS 2.2 : CONTROL SYSTEM DESIGN**

3L:0P 3 Credits

**Design of Linear Control Systems:** Review of compensation techniques to obtain desired performance, Reshaping of Bode & Root locus plots to obtain desired response, Initial condition and forced response, a simple lag – lead design.

**Integral square error compensation:** parameter optimization using Integral square error criterion with and without constraints, principles of State variable Feedback compensation of continuous time and discrete time systems, simple problems to understand the concept.

**MIMO Control design:** Principles of Linear Quadratic Optimal Regulators, Discrete Time Optimal Regulators, Observer Design, Linear Optimal Filters, State Estimate Feedback, Transfer Function Interpretation, simple problems to understand the concept.

**PID Controller:** PID controller, Simulation of multi loop control system using P, PI, PD, PID controller, Standard compensator structures (P, PD, PI and PID control).

**Design of digital control system:** Protocol of Digital controller design, Classical Compensation of Discrete time control systems: Forward path continuous, Forward path Digital Z plane Synthesis approaches, Deadbeat performance.

*Text Books:*

1. G. C. Goodwin, S. F. Graebe, M. E. Salgado, “Control System Design”, Prentice Hall of India

2. Gupta and Hasdorf, ‘Fundamentals of Automatic control Willey Eastern, 1970

3. B.C.Kuo, Automatic control systems’ (5th Edition), Prentice Hall of India, 1988.

*Reference Books:*

1. M. Gopal, “Digital Control and State Variable Method”, Tata McGraw Hill

2. 2.Hadi Saadat, “Computational Aids in Control System Using MATLAB”, McGraw Hill International

3. 3.Ogata K., “Modern Control Engineering”, 4th Edition, Prentice Hall

4. 4.Norman S. Nise, “Control Systems Engineering”, 3rd Edition, Wiley

**EECS 2.3(a)(Elective - III) OPTIMAL CONTROL THEORY**

3L:0P 3 Credits

**Introduction:** Problem formulation State variable representation of systems – Performance measures for optimal control problems – selecting a performance measure.

**Dynamic programming:** The optimal control law principle of optimality and its application optimal control system interpolation recurrence relation of dynamic programming computational procedure for solving optimal control problems –characteristics of dynamic programming solution analytical results discrete linear regulator problems Hamilton Jacobi Bellman equation continuous linear regulator problems.

**The Calculus of variations:** Fundamental concepts linearity of functional closeness of functions the increment of a functional The variation of a functional maxima and minima of functional the fundamental theorem of the calculus of variations Functional of a single function the simplest variational problems.

**The Variational approach to optimal control problems:** Necessary conditions for optimal control Linear regulator problem Pontryagin’s minimum principle and state inequality constraints.

**Iterative numerical techniques for finding optimal controls:** Two point boundary value problems The method of steepest descent Features of the steepest descent algorithm.

TEXT BOOK:

1. Optimal control theory An Introduction by Donald E.Kirk Prentice Hall Networks series.

**EECS 2.3(b)(Elective - III) ADVANCED ROBOTICS**

3L:0P 3 Credits

**Robotics:** Historical back ground, Definitions. Laws of Robotics, Robotics systematic robot anatomy Common Robot configurations, coordinate system, work envelop. Elements of robotic system and effector, actuators, controller, teach pendant, sensors Specification of robots, Applications, Safety measures.

**Robot Kinematics:** Forward and reverse Kinematics of 3 DOF Robot arms, Homogeneous transformations, Kinematics equation using homogeneous transformations.

**Actuators:** Hydraulic actuators. Pneumatic actuator, Electrical actuators, Directional control, Servo Control Flow control valves.

**End effectors:** Classification, Drive systems, Magnetic, Mechanical, Vacuum and Adhesive Grippers, force analysis in Grippers.

**Sensors**: Need for sensing systems, Sensory devices, Types of sensors, Robot vision system Robot Languages and Programming, Description of AI techniques used for Robot control.

*TEXT BOOKS:*

1. Kevin M. Lynch, Frank C. Park, Modern Robotics, Cambridge University Press

2. J.J.Craig, Introduction to Robotics, Pearson

**EECS 2.3(c)(Elective - III) ADAPTIVE LEARNING AND CONTROL**

3L:0P 3 Credits

**Model Reference Adaptive Control:** Motivational Example, Introduction to Direct Model Reference Adaptive Control, Direct Model Reference Adaptive Control of Scalar Linear Systems with Parametric Uncertainties, Historical Roots and Foundations of Model Reference Adaptive Control.

**State Feedback Direct Model Reference Adaptive Control:** Introduction, Command Tracking, Direct MRAC Design for Scalar Systems, Dynamic Inversion MRAC Design for Scalar Systems, MRAC Design for Multi Input Multi Output Systems.

**Model Reference Adaptive Control with Integral Feedback Connections:** Introduction, Control Design, MRAC Augmentation of an Optimal Baseline Controller.

**Robust Adaptive Control**: MRAC Design in the Presence of Bounded Disturbances, MRAC Design Modifications for Robustness.

**Methods in Adaptive Control:** Adaptive Back stepping, Adaptive Output Feedback Control, Adaptive Neuro Control., Examples of Adaptive Control. One case study and computer simulation.

*Text Books:*

1. Robust and Adaptive Control: With Aerospace Applications, Advanced textbooks in control and signal processing, by Eugene Lavretsky, Kevin A. Wise, publisher Springer 2012.

**EECS 2.3(d)(Elective - III) STOCHASTIC FILTERING AND
IDENTIFICATION – SYSTEM IDENTIFICATION AND
PARAMETER ESTIMATION**

3L:0P 3 Credits

**Stochastic Filtering:** Elements of the theory of stochastic processes and development of system models - optimal prediction and filtering for discrete linear systems - Optimal smoothing for discrete linear systems-Optimal estimation for continuous linear systems-Stochastic optimal control for discrete linear systems-Stochastic optimal control for continuous linear systems.

**Introduction & Classical Modals:** system models and model classification, identification problem, some fields of applications. Time response and frequency response methods of transfer function evolution, Impulse response identification using cross correlation test and orthogonal series expansion, methods of convolution, model learning technique.

**Least square Method:** Least square estimates and its properties, non recursive least square identification of dynamic system, extensions such as generalised least square repeated least square and instrumental variable method.

**Recurse Methods:** Recursive least square, minimum variance algorithms, stochastic approximation method, maximum likelihood method.

**Identification of state variable models:** State Estimatior using Kalman and extended kalman filter, simultaneous state and parameter estimation of linear systems.

**Non-Linear systems identification:** Identification of a volterra series models, identification of non-linear state models using extended kalman filter, quasilinearization method, invariant imbedding, gradient method, Numerical identification through model following approach.

*TEXT BOOK:*

1. Stochastic Optimal Linear Estimation and Control, J.S.Meditch, McGraW Hill Book Company, 1969.

*REFERENCE BOOKS:*

2. J.M.Mendel, ‘Discrete Techniques of parameter esimation’ Marcel Dekker, 1973.

3. F. Eykhoff, ‘system identification, parameter and state estimation, John Willey, 1974.

4. A.P.SageandJ.L.Melsa ‘identification’,Academic press, 1971.

**EECS 2.4(a)(Elective - IV) MODEL REDUCTION IN CONTROL**

3L:0P 3 Credits

**L.S.S.Modelling:** Time Domain: Introduction, Aggregation methods, exact and model aggregation by continued fraction, chained aggregation descriptive variables approach, descriptive variable systems, solvability and conditionality, time invariance, shuffle algorithm.

**L.S.S.Modelling Frequency Domain:**Introduction, Moment matching, Pade approximation, Routh approximation, continued fraction method, error minimization methods, mixed methods and unstable systems, Pade model method, Pade Routh method, multi input and multi output systems, reduction, matrix continued fraction method, Model continued fraction method, Pade model method, frequency comparison method.

**Time Scales and Singular Perturbations:** Introduction, problem statement and preliminaries, numerical algorithm, basic properties, relation to model aggregation, feedback control design, singularly perturbed linear systems, fast and slow sub systems, eigenvalue distribution, approximation to time scale approach, system properties, design of optimal controllers, fast and slow controllers, lower order controls.

**Model Order Reduction and Control:** Reduced Order Model Using Davison, Chidambara and Marshall Techniques, Suboptimal Control Using Davison and Chidambara Models, Control Law Reduction Approach Using Davison Model and Chidambara Models, Choice of Reduced Model Order.

**Aggregation Methods:** Aggregation of Control Systems Determination and Properties of Aggregated System Matrix, Error in Aggregation, Modal Aggregation- Reduced Order Model Stability of Feedback System, Aggregation by Continued Fractio

*TEXT BOOKS:*

1. ‘Large Scale Systems Modeling and Control’, Mohammad Jamshidi,1989, North Hollard (Series in systems science and engineering, vol.9).

2. ‘Large Scale Systems Modeling’, Magdi S. Mohamoud and Madan G. Singh, Pergamon Press (International series on Systems and Control), 1981

**EECS 2.4(b)(Elective - IV) ROBUST CONTROL**

3L:0P 3 Credits

**Introduction:** Introduction to Robust Control, Control Oriented Models for Linear Time Invariant Systems, Norms of Vectors and Matrices in Euclidean Spaces.

**State Feedback Optimal Control:** Introduction, Norms for Signals and Systems, Power signals, Norms for Systems, Computing Norms for Systems, Well Posedness and Stability, Stability and Performance Specifications in the Frequency Domain, Loop Shaping Using Frequency –Dependent Weights, State Feedback Optimal Control.

**Output Feedback Control:** Output Feedback Using Projective Controls, Linear Quadratic Gaussian with Loop Transfer Recovery, Summary, Loop Transfer Recovery Using the Lavretsky Method.

**Robust Control:** Modelling of uncertain systems - Unstructured Uncertainties-Additive, multiplicative and other forms. Parametric uncertainty, Interval Systems, Structured uncertainties, Linear fractional transformation Robust design specifications: Small gain theorem and robust stabilization, Performance considerations, Structured singular values. Design - Mixed sensitivity optimization, 2-Degree of freedom design, Sub-optimal solutions, H2/H Systems.

**Loop-shaping design procedures**: Robust stabilization against Normalized co-prime factor Perturbation, Loop shaping design procedures, m - Analysis and Synthesis - Consideration of robust performance, m -synthesis: D – K iteration method, Schur Compliment & Linear Matrix Inequalities: Some standard LMI problems – eigen - value problems, generalized eigen - value problems; Algorithms to solve LMI problems – Ellipsoid algorithm, interior point methods.

*Text Books:*

1. Robust and Adaptive Control: With Aerospace Applications, Advanced textbooks in control and signal processing, by Eugene Lavretsky, Kevin A. Wise, publisher Springer 2012

*REFERENCE BOOKS:*

2. D. W.Gu, P. Hr.Petkov and M.M.Konstantinov, ‘Robust Control esign with MATLAB’, Springer, 2005.

3. AlokSinha, ‘Linear Systems-Optimal and Robust Controls’,CRC Press, 2007.

4. S. Skogestad and Ian Postlethwaite, ‘Multivariable feedback control’, John Wiley & Sons, Ltd, 2005.

**EECS 2.4(c)(Elective - IV) ADVANCED DSP**

3L:0P 3 Credits

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

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

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

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

Introduction to Multirate Signal Processing – Decimation – Interpolation-introduction to STFT WT

*TEXT BOOK:*

1. John G. Prokis and Dimitris G. Hanolakis, ‘Digital Signal Processing, Principles, Algorithms & Applications’ 4th Edition, Pearson Education, 2006.

*REFERENCE BOOKS:*

2. Ludemann L. C., ‘Fundamentals of Digital Signal Processing’, Harper and Row publications,2009.

3. Antoniou A., ‘Digital Filters – Analysis and Design’, Tata Mc -Graw Hill, 2001.

4. Oppenheim and Schaffer, ‘Discrete time Signal processing’, Pearson Education, 2007

**EECS 2.4(d)(Elective - IV) CONTROL SYSTEM COMPONENTS**

3L:0P 3 Credits

**Gyroscopes and Potentiometers:** Working of gyroscopes, types of gyroscopes and their generalized mathematical model, applications of horizontal and vertical gyroscopes. Types of potentiometers, applications of potentiometers and selection of potentiometers.

**Tachometers and Synchros:** Construction details, e.m.f equation of tachometers, types of tachometers, characteristics of tachometers, tachometer applications. Constructional details and working of Synchros, Principles of Resolvers and Decoders.

**Stepper Motors and Servomotors:** Working principle of Stepper motor, types – permanent magnet stepper motor, reluctance type stepper motor, hybrid stepper motor, Applications of stepper motor. Servomotors types, DC servomotors, AC servomotors – transfer functions, speed control methods (armature controlled & field controlled).

**Magnetic Amplifiers and Servo Amplifiers:** construction, types of magnetic amplifiers – series, parallel and self-saturated magnetic amplifiers, Characteristics of magnetic amplifiers, features of servo amplifiers, DC and AC servo amplifiers.

**MEMS and Accelerometers:** Introduction to MEMS, definitions, classification and applications. Introduction to the Accelerometer and types of accelerometers.

*TEXT BOOK:*

1. Gibson T.E. and Tetuer F.B, “Control System Components”, McGraw Hill, New York 1993.

*REFERENCE BOOKS:*

1. Greenwood, “Mechanical details of product design”, McGraw Hill, New York, 1990.

2. NadimMaluf and Kirt Williams “An Introduction to Micro-electromechanical Systems Engineering” Second edition

**EECS 2.5(a) ENGLISH FOR RESEARCH PAPER WRITING**

3L:0P 0 Credits

Planning and Preparation, Word Order, Breaking up longsentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly bethe first- time submission

*REFERENCES:*

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

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

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’sbook.

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

**EECS 2.5(b) DISASTER MANAGEMENT**

3L:0P 0 Credits

Introduction toDisaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis,Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in IndiaStudy Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And ManagementPreparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global andNational Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People’s Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

*REFERENCES:*

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep&Deep Publication Pvt. Ltd., New Delhi.

**EECS 2.5(c) : SANSKRIT FOR TECHNICAL KNOWLEDGE**

3L:0P 0 Credits

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Order - Introduction of roots - Technical information about Sanskrit Literature

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

*REFERENCES:*

1. Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. Teach Yourself Sanskrit” PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

3. India’s Glorious Scientific Tradition” Suresh Soni, Ocean book s (P) Ltd., New Delhi.

**EECS 2.5(d) VALUE EDUCATION**

3L:0P 0 Credits

Values and self-development - Social values and individual attitudes - Work ethics, Indian vision of humanism- Moral and non - moral valuation - Standards and principles - Value judgements

Importance of cultivation of values- Sense of duty - Devotion, Self-reliance - Confidence, Concentration. Truthfulness, Cleanliness - Honesty, Humanity - Power of faith, National Unity –Patriotism - Love for nature,Discipline.

Personality and Behaviour Development - Soul and Scientific attitude - Positive Thinking - Integrity and discipline - Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour - Universal brotherhood and religious tolerance - True friendship - Happiness Vs suffering, love for truth - Aware of self-destructive habits - Association and Cooperation - Doing best for saving nature

Character and Competence –Holy books vs Blind faith - Self-management and Good health - Science of reincarnation - Equality, Nonviolence,Humility, Role of Women - All religions and same message - Mind your Mind, Self-control - Honesty, Studying effectively

*REFERENCES:*

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

**EECS 2.5(e) CONSTITUTION OF INDIA**

3L:0P 0 Credits

**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)

**Philosophy of the Indian Constitution:** Preamble - Salient Features

**Contours of Constitutional Rights & Duties -** Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.

**Organs of Governance:** Parliament - Composition - Qualifications and Disqualifications - Powers and Functions – Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

**Local Administration:** District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, ? Importance of grass root democracy

**Election Commission:** Role and Functioning - Chief Election Commissioner and Election Commissioners - State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women.

*REFERENCES:*

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

4. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**EECS 2.5(f) : PEDAGOGY STUDIES**

3L:0P 0 Credits

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

**Thematic overview:**Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers’ attitudes and beliefs and Pedagogic strategies.

**Professional development:** alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**Research gaps and future directions:**Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

*REFERENCES:*

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. ondon: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ ampaign.

7. www.pratham.org/images/resource%20working%20paper%202.p

**EECS 2.5(g) : STRESS MANAGEMENT BY YOGA**

3L:0P 0 Credits

**Yoga:** Royal Road to Higher Consciousness: Consciousness or Chaitanya in Mandukya Upanishad, Bhagavad Gita, Yoga Sutras, Astavakra Gita; methods of accessing higher states of consciousness – overcoming body consciousness, overcoming mind consciousness; higher consciousness and person transformation; higher consciousness and parapsychic powers (siddhis).

**Vedanta:** A Philosophy of Pure Consciousness – Consciousness according to Advaita, Dvaita and Visistadvaita schools, Consciousness according to Nyaya, Vaisesika and Sankya Schools. Self - awareness – RamanaMaharshi; Buddhism: A Psychology of Consciousness: - viññâ a,5 aggregates, 12 nidhanasm, cetasikas, nirvana

The Mind-Body Relationship, the concept of Psychological Health in India, Scope of Health Psychology Emergence of Behavioural Medicine.

**Stress – Stressors:** Environmental, Social and Psychological, stress and illness, control and stress.

*REFERENCES:*

1. S. Menon, B.V.Sreekantan, AnindyaSinha, Philip Clayton, R Narasimha (2004). Science and Beyond: Cosmology, consciousness and technology in Indic traditions. National Institute of Advanced Studies, Bangalore

2. Nakamura (1989). Indian Buddhism, MotilâlBanârsidass, Delhi.

3. Goleman, D &Gurin, J. (1993). Mind – Body Medicine, New York.

**EECS 2.5(h) PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

 3L:0P 0 Credits

Neetisatakam - Holistic development of personality:

\* Verses- 19,20,21,22 (wisdom)

\* Verses- 29,31,32 (pride & heroism)

\* Verses- 26,28,63,65 (virtue)

\* Verses- 52,53,59 (dont’s)

\* Verses- 71,73,75,78 (do’s)

Approach to day to day work and duties:

\* ShrimadBhagwadGeeta : Chapter 2-Verses 41, 47,48,

\* Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23,35,

\* Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge:

\* ShrimadBhagwadGeeta: Chapter2-Verses 56, 62, 68

\* Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model.ShrimadBhagwadGeeta:

\* Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

\* Chapter 4-Verses 18, 38,39

\* Chapter18 – Verses 37,38,63

*REFERENCES:*

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath

3. Rashtriya Sanskrit Sansthanam, New Delhi.

**EECS 2.6 : ADVANCED CONTROL LAB - I**

0L:3P 2 Credits

**EECS 2.7 : ADVANCED CONTROL LAB - II**

0L:3P 2 Credits

**EECS 2.8 : SEMINAR**

0L:3P 2 Credits

**I/II M.TECH**

**Common with Dual Degree Course V/VI (B.TECH+M.TECH)**

(With effect from 2019-2020 admitted batch onwards)

**M.Tech. (Electrical Engineering)**

Specialization: Control Systems Engineering (CSE)

**III SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EECS 3.1 Elective –V
 (Modelling and Control of Distributed
 Parameter Systems/ Computational 3 - 70 30 100 3 Methods/Industrial load Modelling
 and control)

EECS 3.2 Open Elective

 a) Business Analytics

 b) Industrial Safety

 c) Cost Management of 3 - 70 30 100 3

 Engineering Projects

 d) Composite Materials

 e) Waste to Energy

EECS 3.3 Major Project (Phase – I Dissertation) - - 100 — 100 10

 Total 6 - 240 60 300 16

 **EECS 3.1(a)(Elective - V) Modelling and Control of
Distributed Parameter Systems**

3L:0P 3 Credits

Overview: Motivation and examples (wave propagation, fluid flow, network traffic, electromagnetism)

Modeling of Distributed Parameter Systems: Parabolic and Hyperbolic PDEs, Analytic and Numerical Solution of PDEs

Lyapunov stability of DPS, Boundary control and Observer Design of DPS

Finite Difference discretization of DPS, Finite Element discretization of DPS, Boundary Elements discretization of DPS

Reduction of discretized models

Applications: Control of systems with time delays, control of fluid flow, network control

*REFERENCES:*

1. MiroslavKrstic and AndreySmyshlyaev, “Boundary Control of PDEs: A Course on Backstepping Designs”, SIAM, 2008

2. Panagiotis D. Christofides, Birkhauser”Nonlinear and Robust Control of PDE Systems”, 2001

Hassan K. Khalil”Nonlinear Systems”, Third Edition, Prentice Hall 2002

**EECS 3.1(b)(Elective - V) Computational Methods**

3L:0P 3 Credits

Formulation and solution of linear system of equations, Gauss elimination, LU, QR decomposition, Iteration methods (Gauss-Seidal), convergence of iteration methods, Singular value decomposition and the sensitivity of rank to small perturbation

Newton‘s divided difference, interpolation polynomials, Lagrange interpolation polynomials

Non-linear regression, multiple linear regression, general linear least squares

Vector spaces, Basis vectors, Orthogonal/Unitary transform, Fourier transform, Laplace transform

Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function

Graphs and Matrices, simple graph, cyclic graph, complete graph, properties of the Laplacian matrix and relation with graph connectivity, Non-negative matrices. Applications of graph theory to engineering problems Suggested reading

*REFERENCES:*

1. Steven C. Chapra and Raymond P. Canale “Numerical Methods for Engineers”, McGraw Hill

2. Hines and Montrogmery, John”Probability and Statistics in Engineering and Management Studies”,

3. R. B. Bapat “Graphs and Matrices”, , TRIM Series, Hindustan Book Agency, 2011

**EECS 3.1(c)(Elective - V) Industrial Load Modelling and Control**

3L:0P 3 Credits

Electric Energy Scenario-Demand Side Management-Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers, Classification of Industrial Loads Continuous and Batch processes - Load Modelling.

Electricity pricing – Dynamic and spot pricing –Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of loadModels, Optimization and control algorithms - Case studies.

Reactive power management in industries, controls-power quality impacts, application of filters Energy saving in industries.

Cooling and heating loads, load profiling, Modelling- Cool storage, Types-Control strategies, Optimal operation, Problem formulation- Case studies.

Captive power units, Operating and control strategies, Power Pooling- Operation models, Energy banking, Industrial Cogeneration.

Selection of Schemes Optimal Operating Strategies, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries.

*REFERENCES:*

1. C.O. Bjork “Industrial Load Management - Theory, Practice and Simulations”, Elsevier, the Netherlands,1989

2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28

3. Y. Manichaikul and F.C. Schweppe ,” Physically based Industrial load”, IEEE Trans. on PAS, April 1981

4. H. G. Stoll, “Least cost Electricity Utility Planning”, Wiley Interscience Publication, USA, 1989.

5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995

6. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA

**EECS 3.2(a)(Open Elective) BUSINESS ANALYTICS**

3L:0P 3 Credits

**Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

**Trendiness and Regression Analysis:** Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**Organization Structure:** Organization Structure of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

**Forecasting Techniques:** Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**Decision Analysis:** Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

REFERENCES:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

2. Business Analytics by James Evans, persons Education.

**EECS 3.2(b)(Open Elective) INDUSTRIAL SAFETY**

3L:0P 3 Credits

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree forproblems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

*TEXT BOOKS:*

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

**EECS 3.2(c)(Open Elective) COST MANAGEMENT OF
ENGINEERING PROJECTS**

3L:0P 3 Credits

**Cost:** Cost Elements, Pricing,Materials, Labour; Engineering, Equipment, Parts, and Tool; Economic Costs, Activity - Based Cost Management.

**Cost Estimating& Planning**: Estimating,Process Product Manufacturing, Discrete Product Manufacturing.Planning and Scheduling.

**Progress & Cost Control:**Progress Measurement and Earned Values, Earned Value for Variable Budgets,Tracking Cost and Schedule Performance, Performance and Productivity Management.

**Project Management:**Project Management Fundamentals, Project Organization Structure, Project Planning, Project Labour Cost Control, Leadership and Management of Project People, Quality Management, Value Analysis, Contracting for Capital Projects, Strategic Asset Management.

**Economic Analysis, Statistics &Probability:**Basic Engineering Economics, Applied Engineering Economics, Statistics & Probability,Basic Concepts in Descriptive Statistics, Risk Management.

*REFERENCES:*

1. Charles J. Austin Industrial Engineering & Technology Building, (AG/IT 216)

**EECS 3.2(d)(Open Elective) COMPOSITE MATERIALS**

3L:0P 3 Credits

**Introduction:** Definition of composite 2 material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites.

**Performance of structural composites:** Basic analytical concepts (Qualitative black box approach and Quantitative analytical approach), Performance analysis by various models (Law of Mixtures, Shear lag model, Laminated plate model, Eshelby’s models and Other models, - thermoelasticity, plasticity and creep), Strengthening mechanisms, Stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, Analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, Estimation of the required minimum amount of fibre and critical amount of fibre to gain a composite strength, Analysis of strength of a composite during loading at an angle to the fibres, Nano-structured composites.

**Performance of Composite in Non- structural Applications:** Composites in Electrical, Superconducting and Magnetic Applications, Nano-composite devices.

**Industrial Application of Composite Materials:** Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components etc.

**Fracture & amp; Safety of Composite:** Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack growth rate), Fracture Mechanics of brittle matrix fibre composite, Fracture mechanics of metal matrix fibre composite, Experimental evaluation (composite), Elementary reliability analysis.

*REFERENCES:*

1. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

2. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.

3. 3. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5lGB, UK.

4. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993), Chapman &amp; Hall, London.

5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.

**EECS 3.2(e)(Open Elective) WASTE TO ENERGY**

3L:0P 3 Credits

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

*TEXT BOOKS:*

1. Non - Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**EECS 3.3 MAJOR PROJECT (PHASE- I DISSERTATION)**

10 Credits

 **II/II M.TECH**

**Common with Dual Degree Course VI/VI (B.TECH+M.TECH)**

(With effect from **2019-2020** admitted batch onwards)

**M.Tech. (Electrical Engineering)**

**Specialization: Control Systems Engineering (CSE)**

**IV SEMESTER**

 Sub. Code Subject Name Periods/ week Maximum Marks Credits

 T P Int. Ext. Total

EECS 4.1 Major Project (Phase – II Dissertation) - 100 100 16

 Total 100 100 16

Audit Course I & II

1. English for Research Paper Writing

2. Disaster Management

3. Sanskrit for Technical Knowledge

4. Value Education

5. Constitution of India

6. Pedagogy Studies

7. Stress Management by Yoga

8. Personality Development through Life Enlightenment Skills

**EECS 4.1 : MAJOR PROJECT (PHASE – II DISSERTATION)**

**16 Credits**