ANDHRA UNIVERSITY
DEPARTMENT OF ELECTRICAL ENGINEERING
SCHEME AND SYLLABI
(With effect from 2025-2026 admitted batch onwards)
M.Tech (Control Systems Engineering)
Common with Dual Degree Course (B.TECH + M.TECH)

SEMESTER-I

Code	Name of the subject	Periods/week		Max. Marks		Total	Credits
		Theory	Lab	Ext.	Int.		
EECS 1.1	Programmable logic controllers and Applications	3	-	70	30	100	3
EECS 1.2	Control System Design	3	-	70	30	100	3
EECS 1.3	Professional Elective-I (a) Modeling of Dynamic Systems (b) Artificial Intelligence and Machine Learning Techniques (c) Intelligent and Knowledge Based Systems	3	-	70	30	100	3
EECS 1.4	Professional Elective-II (a) Digital Control Systems (b) SCADA system & Applications (c) IOT in Electrical Systems (d) Stochastic Filtering and System Identification.	3	-	70	30	100	3
EECS 1.5	Research Methodology and IPR	3	-	70	30	100	2
EECS 1.6	Audit Course– I: a) English for Research Paper Writing b) Disaster Management c) Sanskrit for Technical Knowledge d) Value Education	3	-	70	30	100	0
EECS 1.7	Control System Design Lab	-	3	50	50	100	2
EECS 1.8	Intelligent Systems Lab	-	3	50	50	100	2
	Total	18	6	520	280	800	18

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SEMESTER-II

Code	Name of the subject	Periods/week		Max. Marks		Total	Credits
		Theory	Lab	Ext.	Int.		
EECS 2.1	Non-linear Control Techniques	3	-	70	30	100	3
EECS 2.2	Optimal & Robust Control	3	-	70	30	100	3
EECS 2.3	Professional Elective III (a) Systems Biology (b) Robotics & Automation (c) Sliding Mode Control	3	-	70	30	100	3
EECS 2.4	Professional Elective IV (a) Process Control (b) Control Systems Components (c) Model Reduction in Control	3	-	70	30	100	3
EECS 2.5	Audit Course–II: a) Constitution of India b) Pedagogy Studies c) Stress Management by Yoga d) Personality Development through Life Enlightenment Skills	3	-	70	30	100	0
EECS 2.6	Process Control Lab	-	3	50	50	100	2
EECS 2.7	Advanced Control Lab	-	3	50	50	100	2
EECS 2.8	Seminar	-	3	-	100	100	2
	Total	15	9	450	350	800	18

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SEMESTER-III

Code	Name of the subject	Periods/week		Max. Marks			Credits
		Theory	Lab	Ext.	Int.	Total	
EECS3.1	Elective–V (a)Modelling and Control of Distributed Parameter Systems (b) Computational Methods (c) Industrial load Modelling and Control	3	-	70	30	100	3
EECS3.2	Open Elective a) Business Analytics b) Industrial Safety c) Cost Management of Engineering Projects d) Composite Materials e) Waste to Energy	3	-	70	30	100	3
EECS3.3	Major Project (Phase–I Dissertation)	-	-	50	50	100	10
	Total	6	-	240	60	300	16

SEMESTER-IV

Code	Name of the subject	Periods/week		Max.Marks			Credits
		Theory	Lab	Ext.	Int.	Total	
EECS4.1	Major Project (Phase–II Dissertation)	-		100	----	100	16
	Total			100	----	100	16

EECS 1.1 : PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS

Unit-I: 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.

Unit-II: 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.

Unit-III: PLC Registers: Characteristics of Registers module addressing holding registers input registers, output registers. PLC Functions Timer functions and industrial applications counters counter function industrial applications, Architecture functions, Number comparison functions, number conversion functions.

Unit-IV: 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 axes and three axis Robots with PLC, Matrix functions.

Unit-V: 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

REFERENCE BOOKS:

- Programmable Logic Controllers – Principle and Applications by John W Webb and Ronald A Reiss Fifth edition, PHI
- Programmable Logic Controllers – Programming Method and Applications by JR Hackworth and F.D Hackworth – Jr- Pearson, 2004.

EECS 1.2 : CONTROL SYSTEM DESIGN

Design of Linear Control Systems: Review of compensation techniques to obtain desired performance, Re-shaping 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.

Model Reference Adaptive Control: Introduction -Simple Direct MRAC Schemes -Scalar Example: Adaptive Regulation -Adaptive Tracking -Vector Case. MRC for SISO Plants- Problem Statement MRC Schemes: Known Plant Parameters.

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, Dead beat 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'(5thEdition),Prentice Hall of India, 1988.

Reference Books Books:

1. M.Gopal,“Digital Control and State Variable Method”,Tata McGraw Hill
2. Hadi Saadat, “Computational Aidsin Control System Using MATLAB”, McGraw Hill International
3. Ogata K.,“Modern Control Engineering”,4th Edition, Prentice Hall
4. Norman S.Nise,“Control Systems Engineering”,3rd Edition, Wiley

EECS 1.3a : MODELING OF DYNAMIC SYSTEMS

Unit I:: State Variable Analysis: Concept Of State Variables & State Models, State Model For Linear Continuous Time Systems, State-Space Representation Using Physical Variables, State-Space Representation Using Phase Variables. Controllable Companion Form, Observable Companion Form. The transfer function of a state-space model. Stability analysis using a linearized model Transfer function model.

Unit-II:: Model analysis tools: Frequency response methods -The frequency response of a system- Stability margins -Elimination of fast dynamics -Nonlinear system -Energy-based methods-The energy function -Second-order systems - Lyapunov methods -Contraction .

Unit-III:: Model analysis tools: Passivity - Energy considerations -Positive real transfer functions - Passivity and positive real transfer functions- Passivity of PID controllers -Closed loop stability of positive real systems - Passive electrical one-port - Electrical analog of PID controller - Passive electrical two-port.

Unit-IV:: Motors and actuators:: Electromechanical systems -Electrical motors - Gear model- -Transformation of rotation to translation- Torque characteristics-Electromechanical energy conversion - Magnetic energy of a linear inductive element-Dynamic model of the general AC motor - Lagrangian description of electromechanical systems -Energy and co-energy- Analogy of electrical and mechanical systems- -Lagrange formulation of general AC motor-Lagrange formulation of induction motor-Lagrange formulation of DC motor.

Unit-V:: Friction:: Background - Static friction models -Models for the individual phenomena -Combination of individual models -Problems with the static models -Problems with signum terms at zero velocity -Karnopp's model of Coulomb friction -More on Karnopp's friction model -Passivity of static models -Dynamic friction models -The Dahl model -Passivity of the Dahl model -The Bristle and LuGre model - Passivity of the LuGre model -The Elasto-Plastic model -Passivity of the Elasto-Plastic model.

Text Books :

(1) Modeling and Simulation for Automatic Control Olav Egeland and Jan Tommy Gravdahl, Norwegian University of Science and Technology Trondheim, Norway. Online Open Book.
(2) M. Gopal, "Modern Control System Theory", New Age International (P) Limited,New Delhi, 2000.
(3). Ogata K., "Modern Control Engineering", 4th Edition, Prentice Hall

EECS 1.3b : ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Introduction to AI & ML: History of AI, Comparison of AI with Data Science, Need of AI in Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation, **Approaches to AI:** Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical, **Approaches to ML**: Supervised learning, Unsupervised learning, Reinforcement learning.

Feature extraction: Statistical features, Principal Component Analysis, **Feature selection:** Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Engineering.

Classification: Decision tree, Random forest, Naive Bayes, Support vector machine, **Regression:** Logistic Regression, Support Vector Regression. Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Engineering.

ML Model development: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions.

Reinforced Learning: Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning. Characteristics of **Deep Learning**, Artificial Neural Network, Convolution Neural Network. Application of Reinforced and Deep Learning in Engineering.

Text books:

1. Mathematics for Machine Learning, Marc Peter Deisenroth, A Aldo Faisal and Cheng Soon Ong, Cambridge University Press, 2024.
2. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, 2020.
3. Artificial Intelligence: Building Intelligent systems, Parag Kulkarni and Prachi Joshi, PHI, New Delhi, 2015.
4. Artificial Intelligence: A Modern Approach, Stuart Russel and Peter Norvig, 3rd edition, Pearson New International Edition, 2014.

Reference books:

1. Emerging Trends and Applications of Machine Learning, Solanki, Kumar, Nayyar, IGI, Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

EECS 1.3c : INTELLIGENT AND KNOWLEDGE BASED SYSTEMS

INTELLIGENT AND KNOWLEDGE BASED SYSTEMS (Elective - IV)

UNIT-I: Problem solving: State space representation, problem reduction, constraint satisfaction networks. Heuristics. Knowledge Representation, Predicate calculus, resolution-refutation, Prolog.

UNIT-II: Rule based systems: forward and backward chaining. Handling of uncertainty: probabilistic techniques, fuzzy logic. Reasoning with incomplete information: non monotonic reasoning. Elements of temporal logic.

UNIT-III: Structured Knowledge Representation schemes: Semantic Networks, Frames, Inheritance and default reasoning. Description Logic.

UNIT-IV: Expert Systems: Architecture of the expert systems. Expert system shells. Knowledge acquisition. Consistency of the knowledge base. Planning.

UNIT-V: Case studies. Distributed AI and agent based systems

TEXT BOOK:

1. Pratihar D.K., Jain L.C., An introduction to intelligent autonomous systems: Foundation and Applications , Springer-Verlag, Germany

REFERENCE BOOKS:

1. Hui N.B., Pratihar D.K., Design and development of intelligent autonomous robots

2. Vundavilli P.R., Pratihar D.K., Gait planning of biped robots using soft computing: an attempt to incorporate intelligence,

3. Intelligent Autonomous Systems: Foundation and Applications, edited by D.K. Pratihar, L.C. Jain, Springer-Verlag, Germany, pp. 57-85, 2010

EECS 1.4a : DIGITAL CONTROL SYSTEMS

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.

Modelling 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, M. Sami Fadali, Antonio Visioli, Academic Press, 1 edition, (February16,2009).
2. Digital control systems, K. Ogata,

EECS 1.4b : SCADA SYSTEMS AND APPLICATIONS

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, and 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-IEC61850.

SCADA Communication: Various industrial communication technologies -wired and wireless methods and fibre 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.

EEPS 1.4c: IoT IN ELECTRICAL SYSTEMS

Introduction to IoT: Introduction, History, Applications of IoT, Technical Details of IoT, Recent Developments, Challenges.

IoT and its Requirements for Renewable Energy Resources: Introduction, Industrial IoT, RES and IoT, Challenges of IoT in EMS Post-implementation, Solution to IoT Challenges.

Power Quality Monitoring of Low Voltage Distribution System Toward Smart Distribution Grid Through IoT: Introduction, Introduction to Various PQ Characteristics, Introduction to IoT, Smart Monitoring using IoT for the Low Voltage Distribution System, Power Quality Monitoring of Low Voltage Distribution System – Case Study.

Health Monitoring of a Transformer in a Smart Distribution System using IoT: Introduction, Introduction to the Transformer, Failure of the Distribution Transformer, Transformer Health Monitoring System through IoT, Case Study.

Introduction To Machine Learning Techniques: Why and What is Machine Learning, Some Crucial Algorithmic Mathematical Models in Machine Learning, Pre-Eminent Python Libraries Intended for Machine Learning, Machine Learning Techniques in State of Affairs of Power Systems.

Machine Learning Techniques for Renewable Energy Resources: Introduction, Overview of Machine Learning, Deep Learning Architecture, LSTM network based prediction-Case Study

Application of optimization technique in modern hybrid power systems

Introduction, modern power system, Optimization techniques and proposed technique-case study

Machine Learning Techniques in modern hybrid power systems-A Case Study:

Introduction, Technical issues in modern hybrid power systems, application of ML and Optimization techniques in modern hybrid power systems, a prediction case study of ML in MHPS, Optimization block in MHPS

TEXT BOOK:

IoT, Machine Learning And Block Chain Technologies For Renewable Energy And Modern Hybrid Power Systems, By C. Sharmeela, P.Sanjeev Kumar, P.Sivaraman, Meera Joseph, River Publishers 2022.

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

Audit Course - I

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

Text Book:

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

EECS 2.1 : NON-LINEAR CONTROL TECHNIQUES

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.

Lyapunov Stability: Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Lyapunov function, Lyapunov 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: Samarjit Ghosh, 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 : OPTIMAL & ROBUST CONTROL

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- 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.

Robust Control: Introduction to Robustness, Analysis of Robustness, concept of LQG, LTR, H_2 and H-infinity controllers

Text books:

1. Optimal control theory- An Introduction by Donald E.Kirk-Prentice Hall Networks series.
2. Optimal control Third Edition FRANK L. LEWIS, DRAGUNA L. VRABIE and VASSILIS L. SYRMOS, JOHN WILEY & SONS, INC.

Reference Book

3. Robust and Optimal Control by K. Zhou, J. C. Doyle and K. Glover, Prentice-Hall, Englewood Cliffs, NJ, 1995

EECS 2.3a : SYSTEMS BIOLOGY

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, Un supervised and Reinforcement learning; Competitive learning and self-organizing networks, Hybrid Learning.

ANN based control: Introduction: Representation and identification, modelling 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, fuzzification – Methods of de-fuzzification, fuzzy rule based and Approximation, Aggregation of Fuzzy rules, Fuzzy inference system–Mamdani 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 Books:

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 (Mc Graw-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 (May1, 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 2.3b : ROBOTICS & AUTOMATION

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, homo generous 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", Mc Graw 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 2.3c : SLIDING MODE CONTROL

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), C Edwards and S Spurgeon, Published by Taylor & Francis.

Reference Books:
1. Sliding Mode Control In Engineering (Automation and Control Engineering), Wilfrid Perruquetti, Jean-Pierre Barbot published by Marcel Dekker, Inc, NewYork.

EECS 2.4a : PROCESS CONTROL

Process Control: Design aspects – Hardware elements of process control system. Mathematical modeling of processes- Fundamental laws and equations – level, thermal, flow, gas and mixing process. Interacting and non – interacting process – self regulation – inverse response – degrees of freedom – linearization – transfer function representation of process – variable gain, variable time constant.

Feedback Control of Processes: Basic control actions – characteristics of ON/OFF, P, P+I, P+D, P+I+D control modes – non-linear PID control – position and velocity forms of PID controllers – anti-reset windup – bumpless transfer – practical forms of P+I+D control modes, selection of control modes for different processes – control schemes for flow, level, pressure and temperature. Methods of controller tuning, Ziegler – Nichols continuous cycling, damped oscillations, process reaction curve method – Cohen and Coon method, time – integral criteria.

Advanced Control Systems: Feedback control of systems with large dead time, dead time compensation – cascade control – feed forward and ratio control – adaptive and inferential control systems – internal model control – model predictive control – introduction to MPC schemes.

Design of Control Systems for Multivariable Process: Design equations – degrees of freedom – poles and zeros – number of controlled and manipulated variables – generation of alternative loop configurations – extension to systems with interacting units. Interaction of control loops – relative gain array – selection of loops – design of non-interacting control loops. Decoupling control.

Control of Typical Processes: Distillation column, control of top and bottom product composition, reflux ratio. CSTR, four – tank system and PH process. Piping and Instrumentation Drawing (P&I D) of control loops.

REFERENCES

1. Ramesh C Panda and T. Thyagarajan, An Introduction to Process modelling, Identification and control for Engineers, Narosa Publishing House, First edition, 2017.

2. B. Wayn Bequette, Process Control: Modeling, Design and Simulation, Prentice Hall International series, Third edition, 2003.

3. George Stephanopoulos, Chemical Process Control, An Introduction to the Theory and Practice, Prentice Hall International Inc., First edition, 2008.

4. Donald R. Coughanowr, Process Systems Analysis and Control, Third Edition, McGraw Hill Inc., 2013.

5. Peter Harriott, Process Control, Tata McGraw Hill 26th Reprint, 2005.

6. D. Patranabis, Principles of Process Control, Tata McGraw Hill, Third Edition, 2013.

7. William L. Luyben, Michael L. Luyben, Essentials of Process Control, Tata McGraw Hill, 1997.

EECS 2.4b : CONTROL SYSTEMS COMPONENTS

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 motors, 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,NewYork1993.

Reference Books:

1. Greenwood ,“Mechanical details of product design”, Mc GrawHill,NewYork,1990.
2. Nadim Maluf and Kirt Williams “An Introduction to Micro electro mechanical Systems Engineering” Second edition.

EECS 2.4c : MODEL REDUCTION IN CONTROL

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 Fraction.

Text Books:

1. 'Large Scale Systems Modelling and Control', Mohammad Jamshidi, 1989, North Hollard (Series in systems science and engineering, vol.9).
2. 'Large Scale Systems Modelling', Magdi S. Mohamoud and Madan G. Singh, Pergamon Press (International series on Systems and Control),1981

Audit Course - II

EEPS 2.5a : 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 2.5b : 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 2.5c : 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: - viññā 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, Motilāl Banārsidass, Delhi.
3. Goleman, D & Gurin, J. (1993). Mind – Body Medicine, New York.

EEPS 2.5d : PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Neeti satakam - 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.

EECS 3.1a : MODELLING AND CONTROL OF DISTRIBUTED PARAMETER SYSTEMS

Overview: Motivation and examples (wave propagation, fluid flow, network traffic, and electromagnetism)

Modelling 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

Reference Books:

1. Miroslav Krstic and Andrey Smyshlyaev, “Boundary Control of PDEs: A Course on Back stepping Designs”, SIAM, 2008.
2. Panagiotis D.Christofides,Birkhauser”Nonlinear and Robust Control of PDE Systems”, 2001.
3. Hassan K.Khalil ”Non-linear Systems”, Third Edition, Prentice Hall, 2002.

EECS 3.1b : COMPUTATIONAL METHODS

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, cyclicgraph, complete graph, properties of the Laplacian matrix and relation with graph connectivity, Non-negative matrices. Applications of graph theory to engineering problems Suggested reading.

Reference Books:

1. Steven C. Chapra and Raymond P. Canale “Numerical Methods for Engineers”, Mc Graw 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 3.1c : INDUSTRIAL LOAD MODELLING AND CONTROL

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.

Reference Books:

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 Inter science Publication, USA, 1989.
5. I. J. Nagarath and D. P. Kothari, Modern Power System Engineering, Tata Mc Graw Hill publishers ,New Delhi, 1995.
6. IEEE Bronze Book "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc., USA.

OPEN ELECTIVES

EEPS 3.2a : BUSINESS ANALYTICS

UNIT: I

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.

UNIT: II

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.

UNIT: III

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.

UNIT: IV

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.

UNIT: V

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

UNIT: VI

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.

EEPS 3.2b : INDUSTRIAL SAFETY

UNIT: I

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.

UNIT: II

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.

Unit-III: 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.

UNIT: IV

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.

UNIT: V

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 3.2c : COST MANAGEMENT OF ENGINEERING PROJECTS

UNIT: I

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

UNIT: II

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

UNIT: III

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

UNIT: IV

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.

UNIT: V

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)

EEPS 3.2d : COMPOSITE MATERIALS

UNIT: I

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

UNIT: II

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.

UNIT: III

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

UNIT: IV

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.

UNIT: V

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

EEPS 3.2e : WASTE TO ENERGY

UNIT: I

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

UNIT: II

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

UNIT: III

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.

UNIT: IV

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.

UNIT: V

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.