SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY: PUTTUR
(AUTONOMOUS)

Control System (M.Tech)

Department of Electrical and Electronics Engineering (EEE)

I Year 1st Semester

S. No.	Subject Code	Name of the Course / Laboratory	No.of Periods per week			No. of Credits
			L	T	Lab/ Practice	
1	20HS0823	Research Methodology and IPR	2	-	-	2
2	20EE2001	Mathematical Methods in Control Systems	3	-	-	3
3	20EE2002	Non-Linear Systems	3	-	-	3
Programme Elective (PE)-I						
4	20EE2003 20EE2004 20EE2005	Robotics and Automation Digital Control Systems Non Linear control Systems	3	-	-	3
Programme Elective (PE)-II						
5	20EE2006 20EE2122 20EE2007	Systems Biology SCADA system and Applications Design Aspects in Control Systems	3	-	-	3
6	20EE2008	Control Systems Lab	-	-	4	2
7	20EE2009	Programmable Logic Controller Lab (Virtual Lab)	-	-	4	2
Audit Course- I						
8	20HS0818	English for Research Paper Writing	2	-	-	-
Contact Periods/Week			16		8	**18**
			Total 24/Week			

I Year 2nd Semester

S. No.	Subject Code	Name of the Course / Laboratory	No.of Periods per week			No. of Credits
			L	T	Lab/ Practice	
1	20EE2010	Optimal Control Theory	3	-	-	3
2	20EE2011	Industrial Automation	3	-	-	3
Programme Elective (PE)-III						
3	20EE2012 20EE2013 20EE2014	Advanced Control System Advanced Robotics Adaptive Learning and Control Systems	3	-	-	3
Programme Elective (PE)-IV						
4	20EE2015 20EE2016 20EE2116	Model Reduction in Control Systems Robust Control Advanced Digital Signal Processing	3	-	-	3
5	20EE2019	Mini Project	-	-	4	2
6	20EE2020	Advanced Control Systems Lab	-	-	4	2
7	20EE2111	Industrial Automation Lab (Virtual Lab)	-	-	4	2
Audit Course-II						
8	20HS0829	Constitution of India	3	-	-	-
Contact Periods/Week			14	-	12	**18**
			Total 26/Week			

II Year 1st Semester

S. No.	Subject Code	Name of the Course / Laboratory	No.of Periods per week			No. of Credits
			L	T	Lab/ Practice	
1	20EE2021 20EE2022 20EE2023	Elective-V Machine LearningTechniques Stochastic Control Computational Methods	3	-	-	3
2	20HS0824 20ME3026 20ME3027 20CE1028 20ME3028 20EE2128	Open Elective 1. Business Analytics 2. Industrial Safety 3. Advances in Operations Research 4. Cost Management of Engineering Projects 5. Composite Materials 6. Waste to Energy	3	-	-	3
3	20EE2024	Phase-I Dissertation	0	-	20	10
Contact Periods/Week			6		20	**16**
			Total 26/Week			

II Year 2nd Semester

S. No.	*Subject Code*	*Name of the Course / Laboratory*	*No.of Periods per week*			*No. of Credits*
			L	*T*	*Lab/ Practice*	
1	19EE2025	Phase-II Dissertation	-	-	32	16
			-	-	32	16
Contact Periods/Week			**Total / Week 32**			**16**

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(20HS0823) RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

COURSE OBJECTIVES

1. *Understand some basic concepts of research and its methodologies.*
2. *Identify appropriate research topics.*
3. *Enrich knowledge to their research field.*
4. *Process for filing Patent.*
5. *Know procedural knowledge to Legal System and solving the problem relating to intellectual property rights for further research work and investment in R & D.*

COURSE OUTCOMES

1. *Recognize appropriate research problem, errors in selecting a research problem, Scope and objectives of research problem.*
2. *Critically assess research methods pertinent to technology innovation research.*
3. *Identify, explain, compare, and prepare the key elements of a research proposal/report.*
4. *Skill to understand the need of intellectual property rights, IPR protection to inventors.*
5. *Develops procedural knowledge to Legal System and solving the problem relating to intellectual property rights for further research work and investment in R & D.*

UNIT- I

Research: Meaning of research problem - Sources of research problem - Criteria - Characteristics ofa 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

UNIT -II

Literature survey in Research: Effective literature studies approaches - analysis - Plagiarism - Research ethics.

UNIT- III

Project Report: Effective technical writing - how to write report – Paper - Developing a Research Proposal - Format of research proposal -A presentation and assessment by a review committee

UNIT -IV

Intellectual Property Rights: Nature of Intellectual Property – Patents, Designs, Trade and Copyrights - 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

UNIT -V

Patent Rights: Scope of Patent Rights - Licensing and transfer of technology –Patentinformation and databases - Geographical Indications - New Developments in IPR - Administration of Patent System - New developments inIPR - IPR of Biological Systems, Computer Software - Traditional knowledge, Case Studies - IPR and IITs.

TEXT BOOKS:

1. CR Kothari, *Research Methodology: Methods and Techniques* 3rd Edition, New Age International(P) Limited, Publishers, 2013
2. NeerajPandey&KhushdeepDharani *Intellectual Property Rights* Eastern Economy Edition, PHI Learning Private Limited, 2014.

REFERENCE BOOKS:

1. John W. Creswell *Research Design – Qualitative, Quantitative and Mixed Methods Approaches* 4th Edition, SAGE Publications, New Delhi 2014
2. Ranjit Kumar, 4thEdition, "*Research Methodology: A Step by Step Guide for beginners* SAGE Publications, New Delhi, 2014.
3. Ramakrishna B & Anil Kumar H.S *Fundamentals of Intellectual Property Rights- for students, Industrialist and Patent Lawyers* First Published, Notion Press, Chennai, 2017.
4. Ahuja VK *Intellectual Property Rights in India* Second Edition, Mittal Books India, 2015.
5. KC Kankanala, AK Narasani&V Radhakrishnan *Indian Patent Law and Practice* Oxford India Paperbacks,2012.

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(20EE2001) MATHEMATICAL METHODS IN CONTROL SYSTEMS

COURSE OBJECTIVES

1. *To give the students an understanding of foundational concepts in linear algebra and randomprocesses for use in control systems*
2. *To understand Probability, Random variables*

COURSE OUTCOMES

Students will be able to

1. *Apply matrix properties and functions to a given problem*
2. *Use eigen values and eigen vectors*
3. *Analyset responses of linear systems to any given input signal*
4. *Understand Probability and Random variables*
5. *Determine response of linear systems for stochastic inputs*
6. *Apply mathematical methods to control systems*

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

Characteristic functions and correlation matrices, Random Processes and properties

UNIT-V

Response of Linear systems to stochastic inputs, PSD theorem

TEXT BOOKS

1. G. Strang, “Introduction to Linear Algebra”, 4 th Edition, Wellesley-Cambridge Press, 2009
2. Papoulis & Pillai, “Probability, random variable and stochastic processes”, Mcgraw Hill, 2002.

REFERENCES

1. H. Stark & J.W. Woods, "Probability and random processes with application to Signal processing", Pearson Education Asia, 2002
2. J A Gubner: "Probability and Random processes for Electrical and Computer engineers", Cambridge Univ. Press. 2006

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(20EE2002) NON-LINEAR SYSTEMS

COURSE OBJECTIVES

1. *Introduce fundamental concepts of nonlinear dynamical systems*
2. *Understanding basic tools for mathematical analysis as well as applications*

COURSE OUTCOMES

Students will be able to

1. Understand the properties of nonlinear systems
2. *Explore tools for stability analysis*
3. *Evaluate control problems with significant nonlinearities*
4. *Identify the design problem*
5. *Able distinguish between the controls strategies*
6. *Correlate between design parameters and the system performance*

UNIT-I

Linear versus nonlinear systems, Describing function analysis: Fundamentals, common physical nonlinearities (saturation, dead zone, on-off non linearity, backlash, hysteresis) and their describing functions, Describing function analysis of nonlinear systems, Reliability of describing method analysis, Compensation and design of nonlinear system using describing function method.

UNIT-II

Phase plane analysis, Phase portraits, Singular points characterization, Analysis of non-linear systems using phase plane technique

UNIT- III

Existence of limit cycles, Linearization, Exact linearization, input s tate linearization, input-output linearization.

UNIT-IV

Concept of stability, stability in the sense of Lyapunov and absolute stability, Zero input and BIBO stability, Second (or direct) method of Lyapunov stability theory for continuous and discrete time systems. Aizerman's and Kalman's conjecture, Construction of Lyapunov funtion, Methods of Aizerman, Zubov, Variable gradient method, Lure problem.

UNIT-V

Perturbation theory & Averaging, Singular perturbation model and stability analysis, Basic results on Lie algebra. Controllability and Observability of nonlinear systems, Bifurcations.

Chaos. Synchronization

TEXT BOOKS

1. H. K. Khalil, "*Nonlinear systems"*, 3rd edition, Prentice Hall, 2001
2. J. J. E. Slotine and W. Li, "*Applied nonlinear systems"*, Prentice Hall, 1991
3. A. Nijemjer and A. van der schaft, "*Nonlinear dynamical control systems"*, Springer,

REFERENCES

1. M. Vidyasagar, "*Nonlinear Systems Analysis*, Society for Industrial and applied Mathematics", 2002
2. S. Strogatz, "*Nonlinear Dynamics and Chaos"*, Westview Press, 2001

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(20EE2003) ROBOTICS AND AUTOMATION

COURSE OBJECTIVES

1. *To study the various parts of robots and fields of robotics*
2. *To study the various kinematics and inverse kinematics of robots*
3. *To study the trajectory planning for robot*
4. *To study the control of robots for some specific applications*

COURSE OUTCOMES

Students will be able to

1. Understand basic concepts of Robotics
2. *Obtain forward, reverse kinematics and dynamics model of the industrial robot arm*
3. *Propose control law for a given application*
4. *synthesize control law for a given application*
5. Classify robots
6. decide specifications depending on the applications

UNIT-I

BASIC CONCEPTS:

Definition and origin of robotics, different types of robotics- Various generations of robots, degrees of freedom, Asimov‟s laws of robotics, dynamic stabilization of robots

UNIT-II

POWER SOURCES AND SENSORS:

Hydraulic, pneumatic and electric drives- Determination of HP of motor and gearing: ratio, variable speed arrangements, path determination, micro machines in robotics-Machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors

UNIT-III

MANIPULATORS, ACTUATORS AND GRIPPERS:

Construction of manipulators, manipulator dynamics and force control-Electronic and pneumatic manipulator control circuits, end effectors

UNIT-IV

KINEMATICS AND PATH PLANNING:

Solution of inverse kinematics problem-Multiple solution Jacobian work envelop, hill climbing techniques, Robot programming languages

UNIT-V

ROBOT CONTROL, MANUFACTURING AND NON MANUFACTURING APPLICATIONS:

Linear methods, Non-linear methods-manufacturing applications, robot cell design, selection of robot

TEXT BOOKS

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G. "Industrial Robotics", McGraw-Hill Singapore, 1996
2. Ghosh, "Control in Robotics and Automation: Sensor Based Integration", Allied Publishers, Chennai, 1998

REFERENCES

1. Deb.S.R., "Robotics technology and flexible Automation", John Wiley, USA 1992
2. Asfahl C.R., "Robots and manufacturing Automation", John Wiley, USA 1992

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(20EE2004) DIGITAL CONTROL SYSTEMS

COURSE OBJECTIVES

1. *To familiarize the student with the concept of discretization*
2. *Introduction to discrete-time system representations and digital control*
3. *Learn to design controller for digital systems*

COURSE OUTCOMES

Students will be able to

1. *Understands the advantages of digital systems over analog systems*
2. *Model digital filters and systems*
3. *Analyse digital systems in time domain*
4. *Analyse digital systems frequency domain*
5. *Model and analyse digital systems in state space representation*
6. *Design controllers for digital systems in state space representation*

UNIT-I

Introduction, Advantages of Digital control systems, Practical aspects of the choice of sampling rate and multi rate sampling, Basic discrete time signals, Quantization, Sampling theorem, Data conversion and Quantization, Sampling process, Mathematical modeling, Data reconstruction and filtering of sampled signals, zero-order hold.

UNIT-II

z-transform and inverse z-transform, Relationship between s-plane and z-plane Difference equation, Solution by recursion and z-transform, pulse transfer functions of the zero, order Hold and relationship between G(s) and G(z), Bilinear transformation

UNIT-III

Digital control systems, Pulse transfer function, z-transform analysis of open loop, closed loop systems, Modified z-Transform, transfer function, Stability of linear digital control systems, Stability tests, Root loci, Frequency domain analysis, Bode plots, Gain margin and phase margin , Design of Digital Control Systems based on Root Locus Technique.

UNIT-IV

Cascade and feedback compensation by continuous data controllers, Digital controllers Design using bilinear transformation, Realization of Digital PID controllers. State equations of discrete data systems, solution of discrete state equations, State transition Matrix: z- transform method. Relation between state equations and transfer

functions.

UNIT-V

Concepts on Controllability and Observability, Digital state observer: Design of the full order and reduced order state observer, Pole placement design by state feed back, Design of Dead beat Controller, case studies, Stability analysis of discrete time systems based on Lyapunov approach.

TEXT BOOKS

1. K. Ogata, Discrete Time Control Systems, PHI/Addison, Wesley Longman Pte. Ltd., India, Delhi, 1995.
2. B.C Kuo, Digital Control Systems, 2nd Edition, Oxford Univ Press, Inc., 1992. R-19

REFERENCES

1. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems,Addison, Wesley Longman, Inc., Menlo Park, CA, 1998.
2. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill,India,1997.
3. C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw Hill, 1985.
4. John S. Baey, Fundamentals of Linear State Space Systems, Mc. Graw,Hill, 1st edition

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(20EE2005) NON- LINEAR CONTROL SYSTEMS

COURSE OBJECTIVES

1. *To study concepts and techniques for stability analysis*
2. *Learning control design of nonlinear systems*

COURSE OUTCOMES

Students will be able to

1. *Distinguish linear and nonlinear control systems.*
2. *Distinguish absolute stability and relative stability*
3. *Understand the* Lyapunov stability.
4. *Application of deeper ideas from mathematics and specifically from geometry to engineeringproblems*
5. *Analyze nonlinear controllers with the aid of software tools*
6. *Design nonlinear controllers with the aid of software tools*

UNIT-I

Overview of nonlinear Control-Introduction to Advanced Calculus, Elementary notions of Topology, Smooth Manifolds, Sub-manifolds, Tangent Vectors, Vector Fields

UNIT-II

Lyapunov stability for autonomous and non-autonomous systems, Input-Output Stability and Input-to-State Stability Absolute Stability

UNIT-III

Passivity analysis and applications to control design,Lyapunov-based feedback, control design. Feedback linearization and backstepping

UNIT-IV

Sussmann,,s Theorem and global Decompositions, The Control Lie Algebra, the observation space, Local Co-ordinates, Transformations, Exact Linearization Via Feedback , The Zero dynamics, Local Asymptotic Stabilization, Asymptotic Output Tracking

UNIT-V

Disturbance Decoupling, High Gain Feedback, Additional Results on Exact Linearization, Observers with Linear Error Dynamics

TEXT BOOKS

1. H. K. Khalil, “Nonlinear Systems”, 3rd edition, Prentice Hall, 2001
2. H. K. Khalil, “Nonlinear Control”, Pearson, 2015
3. J. J. E. Slotine and W. Li, “Applied nonlinear systems”, Prentice Hall, 1991

REFERENCES

1. A. Nijemjer and A. van der schaft, “Nonlinear dynamical control systems”, Springer, 1989
2. M. Vidyasagar, “Nonlinear Systems Analysis, Society for Industrial and Applied Mathematics”, 2002
3. Alberto Isidori, “Nonlinear Control Systems”, Third Edition, Springer, 1995

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(20EE2006) SYSTEMS BIOLOGY

COURSE OBJECTIVES

1. *Introduction to Mathematical Model and Frame Work*
2. *Learning of core –Process ,Pulses and Oscillations*
3. *Introduction to Feed Forward Loops, Fundamental trade offs*

COURSE OUTCOMES

Students will be able to

1. *Understand and apply mathematical models to design a particular system*
2. *Apply feed-forward loops to design a biological control system*

UNIT-I

Mathematical models and frameworks: Law of mass action, Master Equation. Deterministic vs stochastic, Spatial aspects.

UNIT-II

Examples of core processes: Gene expression, Protein degradation, Phosphorylation Equilibrium solutions & their Bifurcations Switches & Bistability.

UNIT-III

Pulses and Oscillations, Circadian Rhythms and Clocks Spatial patterns, Morphogenesis and Development

UNIT-IV

Robustness to Perturbations, Integral Feedback Control, Homeostasis and Perfect Adaptation

UNIT-V

Feed-forward Loops, Fold Change Detection. Fundamental Tradeoffs, Internal Model Principle.

TEXT BOOKS

1. N. G. van Kampen, “Stochastic Processes in Physics and Chemistry”, North-Holland 3rd edition 2007
2. U. Alon, “An Introduction to Systems Biology, Chapman & Hall/ CRC Mathematical and Computational Biology”, 2006

REFERENCE BOOKS:

1. J. D. Murray, “Mathematical Biology parts I & II”, Springer 3rd edition, 2007
2. E. Klippet. al, “Systems Biology”, Wiley-Blackwell, 2009
3. S. Strogatz, “Nonlinear Dynamics and Chaos”, Westview Press, 2001
4. D. D. Vecchio & R. M. Murray, “Biomolecular Feedback Systems”, Princeton University Press, 2014

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(20EE2122) SCADA SYSTEM AND APPLICATIONS

COURSE OBJECTIVES

1. *To learn the hardware structure of PLC and its programming*
2. *To understand the working of SCADA System*
3. *To Know how SCADA and PLC help in power system automation*

COURSE OUTCOMES

1. *Can able to work with PLC*
2. *Can able to work with SCADA*
3. *Know different components in PLC and SCADA*
4. *Can Understand how PLC and SCADA help in power system automation*
5. *Able to understand the functioning of different hardware component in SCADA*
6. *Can able to understand the applications of SCADA in different industries*

UNIT-I

INTRODUCTION TO PLC

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

INTRODUCTION TO SCADA

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

UNIT-III

COMPUTER CONTROL OF POWER SYSTEMS

Need of computer control of power systems, concept of energy control center (or) load dispatch center and the functions, system monitoring, data acquisition and control, system hardware configuration, SCADA and EMS functions, network topology, state estimation, security analysis and control, operating states.

UNIT-IV

INDUSTRIES SCADA SYSTEM COMPONENTS

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

.**UNIT-V**

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
3. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003

REFERENCES

1. P.Kundur ; "Power System Stability and Control", EPRI Publications, California 1994.
2. Nagrath, I.J. and Kothari D.P., „Modern Power System Analysis", TMH, New Delhi, 1980
3. D.P.Kothari & J.S.Dhillon, Power System Optimization, PHI, 2004

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(20EE2007) DESIGN ASPECTS IN CONTROL SYSTEMS

COURSE OBJECTIVES

1. *The student is introduced to the tools and techniques of control system design*
2. *Introduction to various aspects of controller design philosophy*
3. *Learning PID Controller*

COURSE OUTCOMES

Students will be able to

1. Understand the system modelling.
2. Implement tuning procedures on controllers
3. Design compensators
4. Implement pole placement design
5. *Model a control system given its parameters*
6. *Decide gains of the controllers like PI,PID in a given control system*

UNIT-I

System Modelling-review of concepts,Modeling Concepts,State Space Models,Modeling Methodology,Modeling Examples,

UNIT-II

State space based identification, State space analysis of systems, Identification of simple systems, Identification of FOPDT model Identification of second order plus dead time model, Identification of SOPDT model with pole multiplicity Existence of limit cycle for unstable system, Identification procedures Identification of under damped systems identification Smith Predictor and its variations.

UNIT-III

PID Controllers – review PID Tuning – Ziegler Nichols, Cohen-Coon techniques

UNIT-IV

State feedback review – pole placement, Eigen structure assignment, Eigen structure – time response relation, Controller gain selection, controller robustness, disturbance rejection

UNIT-V

Frequency Domain Loop Shaping Lag, Lead and Lag-lead compensators Zero dynamics in servo control, Unstable zero dynamics – control design Observer – concept and design, Case studies – Applications

TEXT BOOKS:

1. Karl J. Astrom, Richard M. Murray, “Feedback Sytems : An Introduction for Scientists and Engineers”, Princeton University Press, 2010.
2. Thomas Kailath : “Linear Systems”, Prentice-Hall

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(20EE2008) CONTROL SYSTEM LAB

LIST OF EXPERIMENTS

1. Determination of Transfer functions of an Electrical System.
2. Time Response Characteristics of a Second order System (Typical RLC network).
3. Characteristics of Synchros:
   (a) Synchro transmitter characteristics.
   (b) Implementation of error detector using synchro pair.
4. Determination of Magnetic Amplifier Characteristics with different possible connections.
5. Process Control Simulator:
   (a) To determine the time constant and transfer function of first order process.
   (b) To determine the time response of closed loop second order process with Proportional Control.
   (c) To determine the time response of closed loop second order process with Proportional,Integral Control.
   (d) To determine the time response of closed loop second order process with Proportional,Integral,Derivative Control.
   (e) To determine the effect of disturbances on a process.
6. To study the compensation of the second order process by using:
   (a) Lead Compensator.
   (b) Lag Compensator.
   (c) Lead, Lag Compensator
7. Realization of AND, OR, NOT gates, other derived gates and ladder logic on Programmable Logic Controller with computer interfacing.
8. To determination of AC servomotor Characteristics.
9. To study the position control of DC servomotor with P, PI control actions.
10. Analog Computer:
    (a) To examine the operation of potentiometer and adder.
    (b) To examine the operation of integrator.To solve a second order differential equation.

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(20EE2009) PROGRAMMABLE LOGIC CONTROLLER (PLC) LAB
(Virtual Lab)

LIST OF EXPERIMENTS

1. Study hardware and software used in PLC
2. Implementation Logic Gates
3. Implementation Of DOL Starter
4. Implementation Of On-Delay Timer
5. Implementation Of Off-Delay Timer
6. Implementation Of Up-Down Counter
7. Implementation Of PLC Arithmatic Instructions
8. Implementation Of PID Controller

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(20HS0818) ENGLISH FOR RESEARCH PAPER WRITING

COURSE OBJECTIVES

1. *To understand that how to improve writing skills and level of readability.*
2. *.To learn about what to write in each section.*
3. *To understand the skills needed when writing a Title.*
4. *To ensure the good quality of paper at very first-time submission.*
5. *To know the strategies and techniques for preparing academic projects.*

COURSE OUTCOMES

1. *To recognize and demonstrate the style and conventions of research writing.*
2. *To improve the clarity and coherence of their written proposal.*
3. *Able to use a variety of sentence patterns.*
4. *To enhance their revision and proofreading skills.*
5. *To use effective strategies and techniques to construct their academic projects*.

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

Key skills needed when writing Title- Key skills needed when writing abstract- Key skills needed when writing an Introduction- Skills when writing a Review of the Literature.

UNIT-V

Skills needed when writing the Methods- Skills needed when writing the Results- Skills needed when writing the Discussion- Skills needed when writing the Conclusions.

TEXT BOOKS

1. Adrian Wallwork *English for Writing Research Papers*, Springer New York Dordrecht. Heidelberg London, 2011.
2. Adrian Wallwork *English for Academic Correspondence and Socializing*, Kindle Edition, 2011

REFERENCES

1. Day R *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006.
2. Highman N *Handbook of Writing for the Mathematical Sciences*, SIAM, Highman's Books, 1998.
3. Goldbort R *Writing for Science*, Yale University Press, 2006

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(20EE2010) OPTIMAL CONTROL THEORY

COURSE OBJECTIVES

1. *Introduce the basic and fundamental concepts of optimal control theory controller design*
2. *Introduction to computational aspects of optimal control*

COURSE OUTCOMES

Students will be able to

1.Understand optimal design of controllers
2. Understand the application fo calculus of variation to optimal design
3. *Combine the mathematical methods used in optimal control to derive the solution to variations of the problems studied in the course*
4. *Understand constraints specification in control problem*
5. *Use the standard algorithms for numerical solution of optimal control problems and use Matlab to solve fairly simple but realistic problems*
6. *Integrate the tools learnt during the course and apply them to more complex problems*

UNIT I

INTRODUCTION: The Mathematical Model of a Process, Physical Constraints. The Performance Measure , the Optimal Control Problem , Forms of the Optimal Control, State Variable Representation of System – System Classification and Output Equations , Solution of State Equation – Linear Systems, Typical Control Problems, Selection of Performance Measure , Controllability and Observability.

UNIT II

THE CALCULUS OF VARIATIONS – I: Fundamental Concepts, Maxima and Minima of Functions, Fundamental Theorem of Calculus of Variations. Functional of Single Function, The Simplest Variation Problem- Euler‟s Equation, Fixed End Point Problem- Free End Point Problem.

UNIT III

THE CALCULUS OF VARIATIONS – II: Functional Involving Several Independent Functions –Problem with Fixed End Points – Problems with Free End Points, Constrained Extreme a Constrained Minimization of Function and Functional.

UNIT IV

VARIATIONAL APPROACH TO OPTIMAL CONTROL PROBLEMS:
Necessary Conditions for Optimal Control Hamiltonian Function- Boundary Conditions in Optimal Control Problems – Linear Regulator Problems – Matrix Ricalti Equation – Linear

Tracking Problem.

PONTRYAGIN'S MINIMUM PRINCIPLE: State un Equality Constraints – Minimum Time Problem- Minimum Control Effort Problem- Minimum Fuel Problem – Minimum Energy Problem.

UNIT V

DYNAMIC PROGRAMMING: The Optimal Control Law, The principal of Optimality, Dynamic Programming applied to Routing Problems, An Optimal Control Systems-A recurrence Relation of Dynamic Programming – Computational Procedure for Solving Optimal Control Problems – Discrete Linear Regulator Problems, Hamilton – Jacobian-Bellman Equation Continuous Linear Regulator Problems.

TEXT BOOKS:

1. Donald E. Krik: Optimal Control Theory, Library of Congress Cataloging in Publication Data.
2. M.Gopal: Modern Control Systems Theory, New age International Publishers, 5th Edition, 1984

***REFERENCES*:**

1. A.P.Sage: Optimal System Control, Pearson Education Canada, 1977.
2. Ogata: Modern Control Systems Theory, Prentice Hall, 2010

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(20EE2011) INDUSTRIAL AUTOMATION

COURSE OBJECTIVES

1. *To introduce fundamental concepts of Automation in Production System, Material Handling Systems, Principles and Design Consideration*
2. *To introduce Traditional and Modern Quality Control Methods, Industrial Control Systems*

COURSE OUTCOMES

Students will be able

1. *Identify potential areas for automation and justify need for automation*
2. *Select suitable major control components required to automate a process or an activity*
3. *Translate and simulate a real time activity using modern tools*
4. *Able to discuss the benefits of automation.*
5. *Identify suitable automation hardware for the given application.*
6. *Recommend appropriate modeling and simulation tool for the given manufacturing application.*

UNIT-I

Automation in Production System, Principles and Strategies of Automation, BasicElements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines. (SLE: Analysis of Transfer Lines)

UNIT- II

Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. (SLE: Material Identification Methods).

UNIT- III

Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies. (SLE: Usage of SPC tools using excel or Minitab).

UNIT-IV

Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms. (SLE: Sensors, Actuators and other Control System

UNIT-V

Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Systems& RTU. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems (SLE: Display Systems in Process Control Environment.)

TEXT BOOKS:

1. Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.5 edition, 2009
2. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010

REFERENCES

1. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A.Wysk
2. Performance Modeling of Automated Manufacturing Systems,-Viswanandham, PHI, 1st Edition,2009.

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(20EE2012) ADVANCED CONTROL SYSTEMS

COURSE OBJECTIVES

1. *The course provides glimpses into the advanced methods of modeling and analysis of thedynamical systems*
2. *The course is a strong step in inculcating the research aptitude in the students*

COURSE OUTCOMES

Students will be able to

1. *Apply the concepts of linear algebra and their applications to control system*
2. *Analyze the system dynamics*
3. *Understand Lyapunov stability theory*
4. *Design linear quadratic controller*
5. *Implement Pole placement design.*
6. *Able to design compensators*

UNIT-I:

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

UNIT-II:

Modern Control Analysis: Concept and computation of systems modes, controllability theorem and its proof. Observability theorem and its proof, Controllable and observable subspaces

UNIT-III:

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

UNIT-IV:

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

UNIT-V:

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 BOOKS

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

REFERENCES:

1. M. Gopal, "Modern Control System Theory", , New Age International (P) Limited, New Delhi, 2000

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(20EE2013) ADVANCED ROBOTICS

COURSE OBJECTIVES

1. *This course gives an in-depth view into the mathematical methods for modeling and control of Robotic manipulator*
2. *Introduction to spatial descriptions and transformation*
3. *Analysis of Robots control*
4. *Introduction to various linear controls of manipulators*
5. *Introduction to robot programming and language systems*

COURSE OUTCOMES

Students will be able to

1. *Understand mathematical methods for modeling and control of Robotic manipulator*
2. *Understand spatial descriptions and transformation*
3. *Able to design a robotic control*
4. *Able to apply non-linear techniques to any control problem*
5. Able to model mobile robot
6. Understandrobot programming and language systems

UNIT-I
INTRODUCTION

Background-The Mechanics and Control of Mechanical Manipulators – Notation

UNIT-II
SPATIAL DESCRIPTIONS AND TRANSFORMATIONS

Descriptions: Positions, Orientations, and Frames -Mappings: Changing Descriptions From Frame to Frame -Operators: Translations, Rotations, and Transformations - Summary of Interpretations -Transformation Arithmetic-Transform Equations-Computational Considerations

UNIT-III
ROBOT CONTROL

Linear Control Techniques-Nonlinear Control Techniques-Holonomic and Non-holonomic Systems- Vision based Robotic Control

UNIT-IV
LINEAR CONTROL OF MANIPULATORS

Introduction-Feedback and Closed-Loop Control-Second-order Linear Systems-Control of Second-order Systems -Control-Law Partitioning-Trajectory-Following Control-Disturbance Rejection

UNIT-V

ROBOT PROGRAMMING LANGUAGES AND SYSTEMS

Introduction- The Three Levels of Robot Programming- A Sample Application-Requirements of A Robot Programming Language-Problems Peculiar To Robot Programming Languages

TEXTBOOKS

1. Mark W. Spong, Seth Huchinson and M. Vidyasagar, "Robot Modeling and Control", John Wiley and Sons, Inc., 2005
2. John J. Craig, “Introduction to Robotics: Mechanics & Control”, 3rd Edition, Prentice Hall, 2004.

REFERENCES

1. Richard Murray, A. Lee, S. Sastry, “A Mathematical Introduction to Robotic Manipulation”, CRC Press, 1994

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(20EE2014) ADAPTIVE LEARNING CONTROL SYSTEMS

COURSE OBJECTIVES

1. *To introduce adaptive and learning techniques for control design for uncertain dynamicalsystems*
2. *Introduction to learning based control*

COURSE OUTCOMES

Students will be able to

1. Understand detailed knowledge of classical system identification and the development
2.Undestand properties of various methods in system identification
3. Understand detailed knowledge of on-line parameter estimation
4. Understand knowledge of adaptive control systems and their development and properties
5. Understand the development and properties of adaptive control systems.
6. Understand knowledge of methods and tools for stability analysis of adaptive systems

UNIT-I

Introduction, use of Adaptive control, definitions, essential aspects, classification, Model Reference Adaptive Systems, different configurations, classification, mathematical description, Equivalent representation as a nonlinear time varying system, direct and indirect MRAC.

UNIT-II

Continuous time MRAC systems, Model Reference Adaptive System Design based on Gradient method, Design of stable adaptive controllers based on Kalman, Meyer, Yakubovich Lemma, Lyapunov theory, Hyper stability theory, Narendra‟s error model approach

UNIT-III

Discrete time MRAC systems, Hyper stability approach, Narendra‟s error model approach, Introduction, stability theorem, Relation to other algorithms, hybrid adaptive control, Self Tuning Regulators (STR), different approaches to self tuning, Recursive parameter estimation, implicit STR, Explicit STR.

UNIT-IV

STR design based on pole, placement technique and LQG theory, Gain scheduling, Stability of adaptive control algorithms, Adaptive control of a nonlinear systems, Adaptive predictive control, Robustness of adaptive control systems, Instability phenomena in adaptive systems.

UNIT-V

Concept of learning control systems, Different types of learning control schemes, LTI learning control via parameter estimation schemes, Convergence of learning control, Case Studies: Robotic manipulators, Aerodynamic curve identification, Electric drives,Satellite altitude control.

TEXT BOOKS

1. K.J.Astrom and Bjorn Wittenmark, Adaptive control, Pearson Edu., 2nd Edn.
2. Sankar Sastry, Adaptive control.

REFERENCES

1. V.V.Chalam, Adaptive Control System, Techniques & Applications, Marcel DekkerInc.
2. Miskhin and Braun, Adaptive control systems, MC Graw Hill
3. Karl Johan Åström, Graham Clifford Goodwin, P. R. Kumar, Adaptive Control, Filtering and Signal Processing
4. G.C. Goodwin, Adaptive control.
5. Narendra and Anna Swamy, Stable Adaptive Systems.

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(20EE2015) MODEL REDUCTION IN CONTROL SYSTEMS

COURSE OBJECTIVES

1. *Introduce the concept of model reduction of large scale dynamics models which from variousengineering disciplines.*
2. *Introduction to model reduction in control*

COURSE OUTCOMES

Students will be able to

1. *Apply model reduction techniques for a given control design problem*
2. *Design control loops for all techniques*
3. *Know modern methods*
4. *Apply SMC for model reduction*
5. *Understand higher order sliding modecontrol*
6. *Understand MOR for nonlinear systems*

UNIT-I

Introduction to Model Reduction, Source of Large Models – Circuits, EM systems, Mechanical Systems

UNIT-II

Classical Model Reduction Methods – Modal reduction

UNIT-III

Pade approximation and moment matching, Routh Approximants

UNIT-IV

Modern Methods - SVD (Grammian) based methods , Krylov based methods , SVD-Krylov based methods , MOR for Nonlinear Systems – SVD & POD Methods

UNIT-V

Model Reduction in Control, Sliding Mode Control – Review,SMC as model reducing control,Higher Order Sliding Mode.

TEXT BOOKS

1. A. C. Antoulas, “Approximation of Large Scale Dynamical Systems”, SIAM, 2005
2. Ed. AlfioQuarteroni&GianluigiRozza, “Reduced Order Methods for Modeling and ComputationalReduction”, Springer, 2014
3. M. Jamshidi, “Large-scale systems: modelling & control”, North Holland, New York, 1983.

REFERENCES

1. C. Edwards and S. Spurgeon, “Sliding Mode Control : Theory and Applications”, CRC Press,1998
2. B. Bandyopadhyay, S. Janardhanan and S. Spurgeon, “Advances in Sliding Mode”, Springer, 2013

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(20EE2116) ADVANCED DIGITAL SIGNAL PROCESSING

COURSE OBJECTIVES

1. *To understand the difference between discrete-time and continuous-time signals*
2. *To understand and apply Discrete Fourier Transforms (DFT)*

COURSE OUTCOMES

Students will be able to

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

UNIT-I

Short introduction, Analog to digital and Digital to Analog conversion, sampled and Hold circuit, Continuous time Fourier Transforms, Discrete time signals and systems, Discrete time Fourier transform, its properties and applications, Fast Fourier Transform (in time domain and Frequency domain), IDFT and its properties.

UNIT-II

z-Transform: Definition and properties, Rational z-transforms, Region of convergence of a rational z-Transform, The inverse z-Transform, z-Transform properties, Computation of the convolution sum of finite, length sequences, The transfer function

.

UNIT-III

Digital filter structures: Block Diagram representation, Equivalent structures, Basic FIR Digital Filter structures, Basic IIR Digital Filter structures, Realization of Basic structures using MATLAB, All pass filters, Computational complexity of Digital filter structures.

UNIT-IV

IIR Digital filter design: Preliminary considerations, Bilinear transformation method of IIR Filter design, Design of low pass IIR Digital filters, Design of High pass, Band pass and band stop IIR digital filters, Spectral Transformations of IIR filter, IIR digital filter design using MATLAB, Computer aided design of IIR digital filters.

FIR digital filter design: Preliminary considerations, FIR filter design based on windowed Fourier series, Computer aided design of Equiripple Linear phase FIR filters, Design of Minimum phase FIR filters, FIR digital filter design using MATLAB, Design of computationally efficient FIR digital filters.

UNIT-V

Analysis of Finite word length effects: The quantization process and errors, quantization of Fixed point numbers, Quantization of floating point numbers, Analysis of coefficient quantization effects, Analysis of arithmetic round off errors, Low sensitivity digital filters, Reduction of product round off errors using error feedback, Round off errors in FFT algorithms.The basic sample rate alteration devices, Multi rate structures for sampling rate conversion, Multistage design of decimator and interpolator, The Polyphase decomposition, Arbitrary rate sampling rate converter, Nyquist Filters and some applications of digital signal processing.

TEXT BOOKS

1. Digital Signal Processing, S.K. Mitra, Tata McGraw,Hill, Third Edition, 2006.
2. Principle of Signal Processing and Linear Systems, B.P. Lathi, Oxford International Student Version, 2009
3. Continuous and Discrete Time Signals and Systems, M. Mondal and A Asif, Cambridge, 2007

REFERENCES

1. Digital Signal Processing, Fundamentals and Applications,LiTan-Indian reprint,Elsevier,2008.
2. Discrete-Time Signal Processing, Alan V. Oppenheim, Ronald, W. Schafer, and John R.Buck, Pearson Education, 2008.

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(20EE2020) ADVANCED CONTROL SYSTEMS LAB

LIST OF EXPERIMENTS

The following experiments may be implemented in MATLAB/SIMULINK environment.

1. Preliminary Transformations:
   (a) Transfer function to State space models vice, versa.
   (b) Conversion of Continuous to Discrete time systems vice, versa.
   (c) Verification of controllability and observablity of a given system.
2. Design of state feedback controllers.
3. Stability analysis of a given system using:
   (a) Root Locus.
   (b) Bode plot.
   (c) Lyapunov stability.
4. Implementation of Kalman Filter.
5. Implementation of Least squares error method.
6. Implementation of PID controller and its effects on a given system.
7. Design of Lead, Lag, Lead, Lag compensators using frequency domain analysis.
8. Construction of Simulink model for an Induction motor.

Note: At least four problems may be implemented from the following

9. Solving steady state Ricatti Equation.
10. Construction of Simulink model foe single area and multi area Power system.
11. Solving an optimal control problem using Ricatti equation.
12. Implementation of Full order and minimum order Observer.
13. Implementation of Back,Propagation Algorithm.
14. Implementation of simple Fuzzy controller.
15. Implementation of storage and recall algorithm of Hopfield network model.

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(20EE2111) INDUSTRIAL AUTOMATION LAB

(Virtual Lab)

LIST OF EXPERIMENTS

1. Study hardware and software platforms for DCS
2. Simulate analog and digital function blocks
3. Study, understand and perform experiments on timers and counters
4. Logic implementation for traffic Control Application
5. Logic implementation for Bottle Filling Application
6. Tune PID controller for heat exchanger using DCS
7. FBD for autoclavable laboratory fermenter
8. Develop graphical user interface for the fermenter plant

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I M.Tech - II Sem.

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(20HS0829) CONSTITUTION OF INDIA

COURSE OBJECTIVES

1. *To know the premises informing the twin themes of liberty and freedom from a civil rights perspective.*
2. *To address the growth of Indian opinion regarding modern Indian intellectuals 'constitutional role*
3. *To address entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
4. *To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution*
5. *To acquire knowledge for various competitive examinations*

COURSE OUTCOMES

1. *Explain the key concepts of political economy*
2. *Analyse the significant developments in the political ideologies*
3. *Describe the salient features of the constitution of India interpret, integrate and critically*
4. *Analyse the political economy of Indian international relations and gain knowledge in Judiciary system*
5. *Apply their knowledge and skills acquired to write various competitive examinations*

UNIT-I

Introduction to the Constitution

UNIT-II

Historical Perspective of the Constitution of India- Salient features and characteristics of the Constitution of India

UNIT-III

Scheme of the fundamental rights-The scheme of the Fundamental Duties and its legal status-The Directive Principles of State Policy – Its importance and implementation

UNIT-IV

Parliamentary Form of Government in India – Powers and Functions-The President of India - Status and Powers -The historical perspectives of the constitutional amendments in India- Judiciary system - Powers and Functions

UNIT-V

Local Self Government – Constitutional Scheme in India -
Election Commission: Role and Functions

TEXT BOOKS

1. Government of India Ministry of Law and Justice (Legislative Department) *The Constitution of India, 1950 (Bare Act)* Government Publication, 2015
2. Dr. S. N. Busi *Dr. B. R. Ambedkar framing of Indian Constitution*, 1st Edition, Government Publication 2015

REFERENCES

1. M. P.Jain *Indian Constitution Law* Lexis Nexis 7th Edn., 2014.
2. D.D. Basu *Introduction to the Constitution of India* Lexis Nexis, 2015
3. P.M.Bakshi *Constitution of India* Universal Law Publishing.15th Edition,2018

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M.Tech, II Year 1st Semester (CS)

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(20EE2021) MACHINE LEARNING TECHNIQUES

Course Objectives

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To have a thorough understanding of the Supervised and Unsupervised learning techniques
3. To study the various probability based learning techniques
4. To understand graphical models of machine learning algorithms

UNIT-I

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT-II

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multilayer Perceptron in Practice – Examples of using the MLP – Overview – Deriving BackPropagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

UNIT-III

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms –Vector Quantization – Self Organizing Feature Map

UNIT-IV

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

UNIT-V

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain

Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

Text Books

1. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014
2. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014.

References

1. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖,First Edition, Cambridge University Press, 2012.
2. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition,

Course Outcomes

Students will be able to

1. Distinguish between, supervised, unsupervised and semisupervised learning
2. Apply the appropriate machine learning strategy for any given problem
3. Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
4. Design systems that uses the appropriate graph models of machine learning
5. Modify existing machine learning algorithms to improve classification efficiency

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M.Tech, II Year 1st Semester (CS)

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(20EE2022) STOCHASTIC CONTROL

Course Objectives

1. To understand dynamics of stochastic systems and their control strategies
2. Introduction to Filtering

UNIT-I

Overview of stochastic systems with examples, Modelling of Stochastic Systems: Continuous and Discrete-time models subjected to noise, Markov Decision Processes.

UNIT-II

Introduction to Stochastic Calculus and Stochastic Differential Equations.

UNIT-III

Stochastic Stability, Stochastic Optimal Control with complete and partial observations, finite and infinite horizon problems.

UNIT-IV

Linear and Nonlinear Filtering, Separation Principle, Linear quadratic Gaussian Problem.

UNIT-V

Linear and Nonlinear Filtering, Separation Principle, Linear quadratic Gaussian Problem.

UNIT-V

Applications: Finance, operations research, biology.

Text Books

1. Dimitri P. Bertsekas, “Dynamic Programming and Optimal Control”, Vol I (2005), Vol II (2012), Athena Scientific
2. Karl J. Astrom, “Introduction to Stochastic Control Theory”, Dover, 2006.

Referencs

1. B. Oeksendal, “Stochastic Differential Equations: An Introduction with Applications”, 2003.
2. P.R. Kumar, P. Varaiya, “Stochastic Systems: Estimation, Identification and Adaptive Control”, Prentice Hall,1986.

Course Outcomes

Students will be able to

1. Apply design Schotastic models for a given system
2. Design Stochastic Stability problems
3. Design linear and non-linear filtering systems

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M.Tech, II Year 1st Semester (CS)

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(20EE2023) COMPUTATIONAL METHODS

Course Objectives

1. Understand mathematical models of lower level engineering problems
2. Learn how to solve nonlinear equations numerically
3. Introduction to fundamental matrix algebra concepts
4. Solving simultaneous linear equations numerically

UNIT-I

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.

UNIT-II

Newton,,s divided difference, interpolation polynomials, Lagrange interpolation polynomials. Non-linear regression, multiple linear regression, general linear least squares.

UNIT-III

Vector spaces, Basis vectors, Orthogonal/Unitary transform, Fourier transform, Laplace transform.

UNIT-IV

Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function.

UNIT-V

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.

Text Books

1. Steven C. Chapra and Raymond P. Canale “Numerical Methods for Engineers”, McGrawHill
2. Hines and Montrogmery, John“Probability and Statistics in Engineering and Management Studies”,

Referencs

1. R. B. Bapat “Graphs and Matrices”, , TRIM Series, Hindustan Book Agency, 2011

Course Outcomes

Students will be able to

1. Know the concept and steps of problem solving - mathematical modelling , solution and implementation
2. Knowledge and understanding of, and the ability to use, mathematical techniques
3. Understand and apply mathematical reasoning

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II M.Tech – I Sem.

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(20HS0824) BUSINESS ANALYTICS

Course Objective:

- To understand the management and administration, functions of management, formal and informal organization, staffing, creativity and innovation, process of communication.

Course Outcomes:

Students will be able to:

1. Design, device, and query relational databases for operative data.
2. Design, implement, populate and query data warehouses for informational data.
3. To integrate very large data sets to make business decisions.
4. Evaluate the use of data from acquisition through cleansing, warehousing, analytics, and visualization to the ultimate business decision.
5. Evaluate the key concepts of business analytics.
6. Determine when to implement relational versus document oriented database structures.

UNIT-I

Introduction to Descriptive analytics, Descriptive Statistics, Probability Distributions, Inferential Statistics through hypothesis tests, Permutation & Randomization Test

UNIT-II

Regression, ANOVA (Analysis of Variance), Machine Learning Introduction and ConceptsDifferentiating, algorithmic and model based frameworks, Regression: Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbors', Regression &Classification

UNIT-III

Supervised Learning with Regression and Classification techniques- Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear DiscriminantAnalysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines, Ensemble Methods: Random Forest, Neural Networks, Deep learning

UNIT-IV

Unsupervised Learning and Challenges for Big Data Analytics- Clustering, Associative Rule Mining, Challenges for big data analytics

UNIT-V

Prescriptive analytics Creating data for analytics through designed experiments, creating data for analytics through Active learning, creating data for analytics through Reinforcement learning, Graph Visualization, Data Summaries, Model Checking & Comparison

TEXT BOOKS:

1. Hastie, Trevor, et al. The elements of statistical learning.Vol.2.No. 1. New York: springer,2009.
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010
3. Bekkerman et al. Scaling up Machine Learning

REFERENCES:

1. Tom White “Hadoop: The Definitive Guide” Third Edition, O‟reilly Media, 2012.
2. AnandRajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
3. Vincent Granville, Developing Analytic Talent: Becoming a Data Scientist, wiley, 2014.
4. Jeffrey Stanton & Robert De Graaf, Introduction to Data Science, Version 2.0, 2013.

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II M.Tech – I Sem.

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(20ME3026) INDUSTRIAL SAFETY

COURSE OBJECTIVES*:*

1. *To learn about mechanical and electrical hazards.*
2. *To learn about Fundamentals of Maintenance Engineering.*
3. *To learn about Wear and Corrosion and their prevention.*
4. *To know about Fault Tracking*
5. *To learn about Periodic and preventive maintenance.*

COURSE OUTCOMES:

Students undergoing this course are able to

1. *Understand the points of factories act 1948 for health and safety.*
2. *Understand the cost & its relation with replacement economy.*
3. *Understand the concepts of Wear and Corrosion Prevention*
4. *Understand the concepts of sequence of fault finding activities*
5. *Understand the Program and schedule of preventive maintenance of mechanical and electrical equipment.*
6. *Understand the Periodic Maintenance of Equipments*

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 fire fighting, 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. Higgins & Morrow, *Maintenance Engineering Handbook*, Da Information Services.
2. H. P. Garg, *Maintenance Engineering*, S. Chand and Company.

REFERENCE BOOKS:

1. Audels, *Pump-hydraulic Compressors*, Mcgrew Hill Publication.
2. Winterkorn, *Foundation Engineering Handbook*,Chapman & Hall London.

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(20ME3027) ADVANCES IN OPERATIONS RESEARCH

COURSE OBJECTIVES:

On successful Completion of this course the student will be able to

1. *Enumerate the fundamentals of Linear Programming*
2. *Learn classical optimization techniques*
3. *Develop the best strategy of Game and identifying the Queuing theory.*
4. *Understand about sequence and optimum Duration of the Project*
5. *Develop the importance of Replacement models and Inventory control*

COURSE OUTCOMES

On successful Completion of this course the student will be able to

1. *Create mathematical models of the real time situations.*
2. *Implement Transportation and Assignment problems to solve in real time industry*
3 *choose the best strategy of Game and capable of identifying the suitable queuing theory*
4. *Enumerate fundamental techniques and apply it to solve various optimization areas*
5. *Investigate, study, Apply knowledge in Replacement models and*
6. *Understand the Inventory control Models*

UNIT-I

Introduction to OR and Linear Programming-OR definition–Types of Operations Research models; Linear Programming- Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Degeneracy - Problems

UNIT-II

Transportation Problem – Formulation; Initial Basic Feasible Solution-North-West Corner Rule, Least Cost Method, Vogel‘s Approximation Method, Modified Distribution (MODI) Method, Unbalanced Transportation - Problems

Assignment Problem – Formulation, Optimal Solution -Traveling Salesman problem.

UNIT-III

Game Theory - Introduction – Minimax (Maxi mini) Criterion and Optimal Strategy, Saddle Point, Solution of Games with Pure Strategy and Mixed Strategies – 2 X 2 Games – Dominance Principle.

Queuing Theory- Introduction to queuing system–Service Channel, Arrival Pattern, Size of Population, Service Pattern, Queue Discipline, Customer Behavior, Probability Distribution-Birth & Death Process, Simple Problems on Single Service channel only.

UNIT-IV

Sequencing –Terminology - Johnson’s Algorithm for n-jobs x 2 Machines and n-jobs x 3 machines models - Problems

PERT & CPM: Introduction, Difference between PERT and CPM, Terminology- Activities, Events, Predecessor, Early Start, Early Finish, Late Start & Late Finish Times, Earliest

Occurrence and Latest Occurrence of the Event, Total Float, Free Float, Independent Float; CPM- Deterministic Model; PERT- Probabilistic Model, Critical Path, Optimal Project Duration, Least Possible Project Duration- Problems.

UNIT-V

Replacement – Failure Mechanism of Items**,** Types of Replacements- Individual Replacement policy, Group Replacement policy, Replacement of items fail suddenly – problems

Inventory - Necessity for maintaining inventory, inventory costs, classification of fixed order quantity inventory models, selective inventory management techniques.

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TEXT BOOKS:

1. S D. SHARMA *Operations Research* KNRN Publications. 17th edition 2015
2. Hamdy A Taha , *Operations Research* Pearson Publications, 9 th edition 2015

REFERENCES BOOKS

1. Manohar Mahajan *Operations Research*, Dhanpat Rai &Co 2016
2. Er. Prem kumar Guptha & Dr.D.S.Hira *Operations Research*, Schand publications 2012.
3. R Panneerselvam *Operations Research* PHI, 2nd edition, 2012.

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(20CE1028) COST MANAGEMENT OF ENGINEERING PROJECTS

Course Objectives:

- To study fundamentals of engineering project economics
- To understand dynamics of money over time
- To understand the significance of Benefit & Cost Analysis

Course Outcomes:

Student can access the present value and future value for money

- Student can apply the principals of Benefit & Cost Analysis and
- Break-Even comparison
- Student can calculate the depreciation cost for construction equipment and can estimate the cost for construction equipment
- Can prepare profit and loss, balance sheets etc

UNIT – I

Engineering economics : Basic principles – Time value of money, Quantifying alternatives for decision making, Cash flow diagrams, Equivalence- Single payment in the future (P/F, F/P), Present payment compared to uniform series payments (P/A, A/P), Future payment compared to uniform series payments (F/A, A/F), Arithmetic gradient, Geometric gradient.

UNIT – II

Comparison of alternatives: Present, future and annual worth method of comparing alternatives, Rate of return, Incremental rate of return, Break-even comparisons, Capitalized cost analysis, Benefit-cost analysis.

UNIT – III

Depreciation, Inflation and Taxes: Depreciation, Inflation, Taxes.

Equipment economics: Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis.

UNIT – IV

Cost Estimating: Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes, parametric estimate, and Life cycle cost.

UNIT – V

Financial management: Construction accounting, Chart of Accounts, Financial statements – Profit and loss, Balance sheets, Financial ratios, Working capital management.

TEXT BOOKS

1. Blank, L. T. and Tarquin, A. J., “Engineering Economy”, Fourth Edition, WCB/McGraw-Hill, 1998.
2. Bose, D. C., “Fundamentals of Financial management”, 2nd ed., PHI, New Delhi, 2010.

REFERENCE BOOKS:

1. Boyer, C. B. and Merzbach, U. C., “A History of Mathematics”, 2nd ed., John Wiley & Sons, New York, 1989.

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(20ME3028) COMPOSITE MATERIALS

COURSE OBJECTIVES

1. *To understand the mechanical behavior of composite materials*
2. *To get an overview of the methods of manufacturing composite materials.*
3. *To know the fundamentals of composite materials.*
4. *To understand the fabrication and process of composites.*
5. *To recognize the applications of composite materials.*

COURSE OUTCOMES

Upon completion of this course, the students will have an overview of

1. *Fundamental concept of composite materials.*
2. *Different types of composite materials.*
3. *Fabrication and processing of composite materials.*
4. *MMC & CMC*
5. *Mechanical behavior of composite materials.*
6. *Application of composite materials .*

UNIT-I

Introduction To Composites: Fundamentals of composites – need– enhancement of properties – classifications —Introduction to Reinforcement composites–types. Applications. Fiber production techniques for glass, carbon and ceramic fibers –Resin materials-Types.

UNIT-II

Polymer Matrix Composites: Fabrication of PMC's ,Fabrication of Fibers, Plastic Fiber Forms, Pre-pregs, Molding Compounds-Processes, Lay-Ups, Filament Winding, Pultrusion, and Recycling. Matrix – Reinforcement Interface, Wettability.

UNIT-III

MMC&CMC : Fabrication of MMC'S, Liquid Infiltration- Casting, Solid State Processes-Diffusion Bonding &In Situ Technique. Fabrication of CMC's, Hot-Pressing, Infiltration, In Situ Chemical reaction Techniques. CVD& CVI, Sol-gel.

UNIT-IV

Mechanics of Composites: Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, Von -Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates

UNIT-V

Applications Of Composites: Applications of advanced composite materials. Environmental effects in Composites, Green composites, Synthesis and Properties of Nano composites. Surface Composites & Surface metal matrix composites: Need, Synthesis, Properties and applications.

TEXT BOOKS:

1. Mathews F. L. and Rawlings R. D., "*Composite Materials: Engineering and Science*", 1st Edition, Chapman and Hall, London, England, 1994.
2. Chawla K. K., "*Composite materials*", Second Edition, Springer – Verlag, 1998.

REFERENCES:

1. Clyne, T. W. and Withers, P. J., "*Introduction to Metal Matrix Composites*", Cambridge University Press, 1993.
2. Strong, A.B., "*Fundamentals of Composite Manufacturing*", SME, 1989.
3. Sharma, S.C., "*Composite materials*", Narosa Publications, 2000.

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(20EE2128) WASTE TO ENERGY

COURSE OBJECTIVES

The objectives of this course:

1. *To learn different types of waste materials available for energy conversion*
2. *To understand Pyrolytic oil and gases*
3. *To introduce gasification methods for biomass*
4. *To learn concepts of biomass resources, combustion types and biogas plant technology*

COURSE OUTCOMES (COs)

On successful completion of this course, the student will be able to

1. *Analyse agro based, forest residue and industrial waste conversion processes.*
2. *Manufacture of Pyrolytic oils and gases*
3. *Manufacture of charcoal, yields and applications*
4. *Understand various types of gasifiers operation*
5. *Understand inclined and fluidized bed combustors operation*
6. *Understand types of biogas plants and biomass energy programme in India*

UNIT-I

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT-II

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

UNIT-III

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 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 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.

REFERENCES:

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