Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(*An Autonomous Institute affiliated to Savitribai Phule Pune University*)

Structure & Syllabus of

M.Tech. (Instrumentation and Control Engineering)

Pattern 'A-17'
Effective from Academic Year 2017-18
(F.Y. M.Tech.)

Prepared by: - Board of Studies in Instrumentation & Control Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS **Chairman – Academic Board**

Content

Vision statement of Institute

To be globally acclaimed Institute in Technical Education and Research for holistic Socio-economic development

Mission statement of Institute

- To impart knowledge and skill based Education in collaboration with Industry, Academia and Research Organization
- To strengthen global collaboration for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with the spirit of Entrepreneurship
- To Inculcate and Strength Research Aptitude amongst the Students and Faculty

Vision statement of Department

To be recognized as leading contributor in imparting technical education and research in Instrumentation & Control engineering for development of the society.

Mission statement of Department

- To deliver knowledge of Instrumentation and Control Engineering by strengthening involvement of Research institutions and industries in academics
- To build conducive environment for advanced learning through participation of faculty and students in collaborative research, consultancy projects, student exchange programs and internships
- To develop competent Engineers with entrepreneurial skills to address socio-economic needs.

Program Educational Objectives (PEO)

Programme: B. Tech. (Instrumentation and Control Engineering)

The Graduates would demonstrate

1. Core competency in Instrumentation and Control Engineering to cater to the industry and research needs.
2. Multi-disciplinary skills, team spirit and leadership qualities with professional ethics, to excel in professional career and/or higher studies.
3. Preparedness to learn and apply contemporary technologies for addressing impending challenges for the benefit of organization/society.
4. Knowledge of recommended standards and practices to design and implement automation solutions.

Program Outcomes

Engineering Post-Graduates will be able to:

PO1: An ability to independently carry out research /investigation and development work to
solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the
specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Program Specific Outcomes (PSOs)

Graduates shall have the ability to:

1. Evaluate the performance of suitable sensors / Process components/ Electronic / Electrical components for building complete automation system.

2. Analyze real-world engineering problems in the area of Instrumentation and Control.

3. Design or Develop measurement / electronic / embedded and control system with computational algorithms to provide practical solutions to multidisciplinary engineering problems.

F.Y. M.Tech - Instrumentation and Control Engineering Structure Pattern A-17
with effect from Academic Year 2017-18 Semester –I

Course Code	Course Type	Course Name	Teaching Learning Scheme					Assessment Scheme (100 mark scale)								
			Th	Lab	Project Lab	Hrs. / Week	Credits	ISA THP–30 marks THL- 100 marks converted to 30 TH – 5 HA of 6 marks each							MSE-100 marks converted to 35	ESE-100 marks converted to 35
								P1	P2	P3	CA	MSA	ESA	HA		
IC501THP	THP	Measurement System Design	3		2	5	4	10	10	10	---	---	---	---	35	35
IC503THP	THP	Process Control	3		2	5	4	10	10	10	---	---	---	---	35	35
IC505THP	THP	Industrial Automation	3		2	5	4	10	10	10	---	---	---	---	35	35
ES501TH	TH	Linear Algebra and Statistics	4			4	4	---	---	---	---	---	---	30	35	35
HS551TH	TH	Quantitative Aptitude - I	2			2	2	---	---	---	---	---	---	30	35	35
ES502TH	TH	Research Methodology	2			2	2	---	---	---	---	---	---	30	35	35
		Total	**17**		**6**	**23**	**20**	---	---	---	---	---	---	---	---	---

F.Y. M.Tech - Instrumentation and Control Engineering Structure Pattern A-17
with effect from Academic Year 2017-18 Semester –II

Course Code	Course Type	Course Name	Teaching Learning Scheme					Assessment Scheme (100 mark scale)								
			Th	Lab	Project Lab	Hrs. / Week	Credits	ISA THP–30 marks THL- 100 marks converted to 30 TH – 5 HA of 6 marks each							MSE-100 marks converted to 35	ESE-100 marks converted to 35
								P1	P2	P3	CA	MSA	ESA	HA		
IC502THP	THP	Control Theory	3		2	5	4	10	10	10	---	---	---	---	35	35
IC504THP	THP	Process Dynamics and Identification	3		2	5	4	10	10	10	---	---	---	---	35	35
IC506THP	THP	Real Time Signal Processing	3		2	5	4	10	10	10	---	---	---	---	35	35
IC508THP		Batch Process Control														
IC510THP		Estimation Techniques														
IC512THP	THP	Mechatronics	3		2	5	4	10	10	10	---	---	---	---	35	35
IC514THP		Digital Image Processing														
IC516THP		Internet of Things														
HS552TH	TH	Quantitative Aptitude - II	2		---	2	2	---	---	---	---	---	---	30	35	35
HS553TH	TH	Engineering Economics	2		---	2	2	---	---	---	---	---	---	30	35	35
		Total	**16**		**8**	**22**	**20**	---	---	---	---	---	---	---	---	---

Second Year M.Tech - Instrumentation and Control Engineering Structure Pattern A-17
with effect from Academic Year 2018-19 Semester –I

Course Code	Course Type	Course Name	Teaching Learning Scheme					Assessment Scheme (100 mark scale)				
			Th	Lab	Project Lab	Hrs. / Week	Credits	ISA – 100 marks converted to 30			MSE	ESE-100 marks converted to 50
								CA	MSA	ESA		
IC601PRJ	PRJ	Dissertation					25					
IC601INT	INT	Industry Internship										
IC603INT	INT	Dissertation cum Internship										
		Total					25	---	---	---	---	---

Second Year M.Tech - Instrumentation and Control Engineering Structure Pattern A-17
with effect from Academic Year 2018-19 Semester –II

Course Code	Course Type	Course Name	Teaching Learning Scheme					Assessment Scheme (100 mark scale)				
			Th	Lab	Project Lab	Hrs. / Week	Credits	ISA – 100 marks converted to 30			MSE	ESE-100 marks converted to 50
								CA	MSA	ESA		
IC602PRJ	PRJ	Dissertation					25					
IC602INT	INT	Industry Internship										
IC604INT	INT	Dissertation cum Internship										
		Total					25	---	---	---	---	---

SEMESTER I

FF No. : 654

IC501THP :: MEASUREMENT SYSTEM DESIGN

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit I: Basics of Measurement system (5 Hrs)
Measurement system Architecture: primary sensing element, variable conversion element, data presentation element, types of inputs, sensor dynamics, and static characteristics: static calibration, dynamic characteristics of sensor and system performance, errors in measurement and their statistical analysis, Units and standards.

Unit II : Process Sensor selection and signal conditioning (7 Hrs)
Sensor specifications and selection criteria for different process applications, Review of all major process parameters, Requirements of signal conditioning, Design of signal amplifiers such as preamplifiers, instrumentation amplifiers, bridge amplifiers, Filters, isolation amplifiers, Sample and hold circuit, modulators and demodulators, Analog to digital converters ICs etc.

Unit III : Sensor and signal conditioning Development (10 Hrs)
Sensor Designing criteria, development of related Signal conditioning circuitry, precautions required against environmental conditions, safety aspects, Sensor dynamics and mathematical analysis i.e. governing equations etc. for Capacitance level measurement, Bubbler method, Orifice designing, Rotameter, Pitot tube, LVDT, Ultrasonic flow and level measurement, thermocouples, RTDs, Thermistor, Strain gauge bridge, Piezo sensors, PH probes, Humidity sensors etc.

Unit IV: Special signal conditioning ICs (7 Hrs)
Study and designing of signal conditioning circuits using precision operational amplifier ICs such as AD620, AD524, AD594(thermocouple IC), Voltage to current converter ICs. XTR110, Isolation amplifier, IC HCNR200, etc.

Unit V: Enclosures importance and environmental testing (6 Hrs)
Functions of enclosures types of enclosures, materials for enclosure design, and various types Enclosure such as MEMA and DIN , IPxx types of enclosures, Enclosure selection criteria.
Environmental tests such as temperature, dust, humidity and others. Mechanical testing such as shock, vibration, impact etc. EMI and EMC testing such as ESD, noise susceptibility, transients etc.

Unit VI: Reliability Engineering (5 Hrs)
Definition, quality and reliability, causes of failures and unreliability, Types of failures, bath tub curve, Maintainability and availability. MTTF, MTBF etc. Designing for higher reliability and redundancy techniques.

Text Books:

1. "Instrumentation Devices and Systems", Rangan, Sharma, Mani. Tata McGraw Hill
2. "Measurement Systems.", Earnest Doebelin Tata McGraw Hill
3. "Design with Operational Amplifiers and Integrated Circuits.", Sergio Franco, Tata McGraw Hill
4. "Electronic Instruments and Instrumentation Technology.", M M S Anand, Prentice Hall of India.
5. "Noise Reduction Techniques in Electronic Systems", Henry W. Ott. Wiley.
6. "Reliability Engineering", Balgurusawmy, Tata McGraw Hill

Reference Books:

1. "Process Measurement ", Bela Liptak

List of Project areas:

1. Sensor selection, designing and finding Characteristics of the sensor for the given application
2. Designing of signal conditioning circuits for the given applications
3. Environmental testing enclosure designing

Course Outcomes:

The student will be able to –

1. To impart knowledge of measurement system (PO-1, 2,4,5 PSO-2)
2. To impart knowledge about principles and selection of sensors/ transducers and signal conditioning. (PO 1,2,4,5 PSO-2)
3. Emphasis on real time interfacing study of process parameter sensor and application (PO-1, 2,4,5 PSO-2,3)
4. To study sate of the art designing of signal conditioning circuits (PO-1, 2,4,5 PSO-2,3)
5. Various types of enclosure designing and instrument testing methods. (PO-1, 2,4,5 PSO-2,3)
6. Study of Reliability engineering aspect (PO-1, 2,4,5 PSO-2)

FF No. : 654

IC503THP :: PROCESS CONTROL

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit I **(7 Hrs)**

Fundamentals of Process Control

Elements of process control loop, Process Characteristics and their significance. Process gain, Process reaction curve, process time constant, step analysis method, finding time constant, dead time.

Unit II **(7 Hrs)**

Feedback Controller Tuning

Types of Controllers, Tuning methods, Selection of controller for specific application, Controller settings- evaluation criteria – 1/4th decay ratio, IEA, ISE, ITAE - determination of optimum settings for mathematically described process using time response and frequency response.

Unit III **(7 Hrs)**

Stability Analysis and Performance of Feedback Control systems

Concept of stability, Stability analysis of linear and linearised systems, principles, Bode Method, Controller tuning based on stability

Control Performance via closed loop frequency Response, Control system factors influencing control Performance

Unit IV **(7 Hrs)**

Control strategies

Multi loop process control systems, Feedback-feed forward control, Cascade Control, Ratio Control, Selective Control, and Split-range Control with industrial applications

Unit V **(6 Hrs)**

Analysis of Multivariable Systems

Process Interaction, Effects of Interaction, Block representation and transfer function matrix interaction, relative gain array, resiliency, Morari resiliency index, Niederlinsky index

Unit VI **(6 Hrs)**

Multivariable Control

Singular Value Analysis, Selection of manipulated and Controlled Variables, Tuning of multiloop PID control systems, Decoupling and Multivariable control Strategies

Text Books:

1. "Process Control", F. G. Shinskey, McGraw Hill Book Company.
2. "Process, Modeling, Simulation and Control for Chemical Engineers", W. L. Luyben, McGraw Hill.
3. "Process Control Modeling, Design, and Simulation", B. W. Bequette, PHI

Reference Books:

1. "Process Control", Bela G Liptak, CRC Press, 2005
2. "Chemical Process Control", Stephanopoulos George, PHI.

Course Outcomes:

1. Determine process dynamics for systems
2. Design controllers for different process control applications
3. Investigate the stability of systems
4. Apply control strategies to single and multivariable processes
5. Analyze multivariable systems
6. Design decouplers for multivariable systems

FF No. : 654

IC505THP :: INDUSTRIAL AUTOMATION

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Project Assignment: 2 Hours/Week

Unit 1: Industrial Control Devices **(7 Hours)**

Switches: construction, symbolic representation, working, application of toggle switch, slide switch, DIP switch, rotary switch, thumbwheel switch, selector switch, push button, limit switch, emergency switch, micro-switches, review of process switches, switch specifications.

Relays: construction, working, specifications, terminologies and applications of Electro-mechanical relay, hermetically sealed relay, reed relay, solid-state relays and timing relay.

Contactors: construction, working, specifications and applications of contactors. Comparison between relay and contactor.

Development of electrical wiring diagram using standard symbols of above components.

Unit 2: Automation and PLC Hardware **(6 Hours)**

Industrial Automation: Fundamentals of Industrial Automation, Need and role of Automation, Evolution of Automation, Elements of process control loop, Current Trends, Automation Strategy evolution, Control system audit, Automation Tools and strategies and their location in plant.

PLC introduction : Types of Processes, Comparison, Evolution of PLC, Definition, Functions, Advantages, Architecture, DI-DO-AI-AO examples and ratings, I/O module, working of PLC, Scan time, Types and Specifications. Choosing PLC for application. Installation of PLC, Rack installation, Grounding and shielding, physical, Electrical, Maintenance requirements, planning, verifying, Troubleshooting, Fault diagnosis techniques. PLC Interface to Hydraulic/Pneumatic circuits. Choosing PLC for application, Types and Specifications of PLC, PLC system documentation.

Unit 3: Basics of PLC Programming **(8 Hours)**

PLC programming**:** Development of Relay Logic Ladder Diagram, Introduction to PLC Programming software Creating new application, addressing, Basic Instruction such as Set and Reset, Concept of Latching, PLC Timers and Counters, Applications Based on timers and Counters PLC Interfacing, PLC Programming languages as per IEC 61131-3 like LD, IL, ST, FBD, SFC

Unit 4: Advanced PLC Programming **(6 Hours)**

Advanced PLC Instructions such as Comparison Instruction, Data movement instructions, Logical Instruction, Mathematical Instruction, Special Mathematical instructions, Program flow control instructions. BIN, BCD Instructions, Upload / Download / Monitoring of Programming using advanced instructions for different applications, PID Control using PLC. Applications using advanced plc programming, HMI types, Interfacing with PLC.

Mechanical Components : Springs (compression, extension, torsion, flat, leaf and motor spring), Gears (spur, bevel, gear trains).

Unit 5: DCS and SCADA **(7 Hours)**

DCS Introduction, Location of DCS in Plant, functions, advantages and limitations, Comparison of DCS with PLC, DCS components/ block diagram, Architecture, Functional requirements at each level, Database management. Layout of DCS, Controller Details, Redundancy, I/O Card Details, Junction Box and Marshalling Cabinets, Operator Interface, Workstation Layout, different types of control panels, types of Operating Station, Programming as per IEC 61131-3, Advantages, Overview of Programming Languages, Device Signal Tags, Configuration, Programming for Live Process, Selection of DCS, DCS plant layout., SCADA Concept of SCADA systems, Programming techniques for : Creation of pages, Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters.

Unit 6: Special Purpose Motors **(6 Hours)**

Stepper motor: principle, types, terminologies, half-stepping and micro-stepping techniques, characteristics, specifications, applications.

Servomotors: construction, working, features, advantages, disadvantages, characteristics of AC and DC servomotor, comparison with stepper motor. AC and DC position and speed control. Synchros for error detector, position measurement and control.

DC Micro motors: types, construction, working, characteristics and applications.

List of Project areas:

1. Industrial control devices
2. Programmable Logic Controllers
3. Advanced PLC programming
4. Distributed Control Systems programming
5. HMI and SCADA programming

Text Books:

1. John Webb, “Programmable Logic Controllers”, Prentice Hall of India.
2. Frank D Petruzella, “Programmable logic controller “, McGraw-Hill Education.
3. Gary Dunning, “Introduction to Programmable Logic controllers”, Delmar Thomson Learning.
4. SCADA by Stuart A Boyer : ISA 1999
5. S. K. Singh, “Computer Aided Process Control”, Prentice Hall of India.
6. Krishna Kant, “Computer Based Process Control”, Prentice Hall of India.

Reference Books:

1. Richard Cox, “Programmable Controllers”, International Thomson Computer Press.
2. B. G. Liptak, “Instrument Engineer’s Handbook – Process Software and Digital Network”, CRC Press
3. “Distributed Computer Control for Industrial Automation”, Poppovik Bhatkar, Dekkar Publication.

Course Outcomes:

The students will be able to:

1. Comprehend and develop electrical wiring diagrams using industrial control devices for given application.
2. Understand basics of PLC hardware and automation systems.
3. Develop PLC programs for different applications.
4. Apply advanced instructions and mechanical components to solve complex problems of automation.
5. Understand the basics of DCS and SCADA systems.
6. Comprehend the special purpose motors and their applications.

FF No. : 654

ES501TH :: LINEAR ALGEBRA AND STATISTICS

Credits: 04 **Teaching Scheme:** Theory: 4 Hours/Week

Unit 1: Vector Spaces **(6 Hours)**
Rank of a matrix and solution of Linear Systems, Vectors in n-dimension, Vector spaces and subspaces, Linear dependence and independence, Spanning set, Basis.

Unit 2: Linear Transformation: **(7 Hours)**
Linear Transformation, Range and kernel of LT, Isomorphism, Column space, Row space, Null space, Rank Nullity theorem, Orthogonal transformations and its geometrical interpretation. Co-ordinate systems, Change of basis.

Unit 3: Inner product spaces **(7 Hours)**
Inner Product, length, and orthogonality, orthogonal sets, orthogonal projections, The Gram–Schmidt process. Least square problem, Applications of linear models. Inner Product spaces, Applications of Inner Product spaces.

Unit 4: Eigen values and Eigen vectors **(6 Hours)**
Eigen values and Eigen vectors. symmetric matrices, Complex eigen values, minimal polynomial.

Unit 5: Applications of eigen values and eigen vectors **(7 Hours)**
Application of eigen values and eigen vectors to Discrete and continuous dynamical system.

Unit 6: Digonalization **(7 Hours)**
Diagonalization over real and complex field, canonical representation, spectral decomposition, Quadratic forms, constrained optimization, The singular value decomposition, Applications to image processing and statistics.

Text Books:
1. Ron Larson and David C. Falvo; Linear Algebra: An Introduction; First Indian reprint 2010; Brooke/Cole, a part of Cengage Learning (Indian Edition).
2. B.S. Grewal; Higher Engineering Mathematics; 40th Edition 2007; Khanna Publishers.
3. Seymour Lipschutz, John Schiller; Introduction to Probability and statistics; 6th reprint 2008; Schaum's Outline, Tata McGraw-Hill.

Reference Books:
1. Gilbert Strang; Linear Algebra and its Applications; 10th Indian reprint 2011;Cengage Learning (Indian Edition).
2. David C. Lay ; Linear Algebra and its Applications; 12th impression 2011; Pearson Education Inc,.

Course Outcomes:

The student will be able to –

1. Acquire the knowledge of vector spaces, linear transformations, Eigen values and eigen vectors, complex numbers and random variables. (PO1,2,4,PSO2)
2. Set up, solve and interpret linear systems, use matrix transformations. (PO1,2,4,PSO2)
3. Apply knowledge of inner product spaces to compute length of a vector, angle, distance between two vectors, to compute orthogonal basis using Gram-Schmidt process, compute and apply the knowledge of eigen-values and eigenvectors. (PO1,2,4,PSO2)
4. Represent complex numbers algebraically and geometrically, find roots algebraic equations and apply the knowledge of functions of complex numbers in problem solving. (PO1,2,4,PSO2)
5. Analyze and interpret probability distributions and perform regression analysis for statistical data. (PO1,2,4,PSO2)

FF No. : 654

IC551TH :: QUANTITATIVE APTITUDE - I

Credits: 02 **Teaching Scheme:** Theory: 2 Hours/Week

Unit 1: Numbers, Surds and Indices & Logarithms **(7 Hours)**
Numbers, Average, Decimal fractions, Problem on ages, Simplification, Problems on numbers, Square roots & cube roots, Logarithms, Surds and Indices, HCF and LCM of Numbers.

Unit 2: Time ,distance and work **(7 Hours)**
Time and distance, Problems on trains, Boats and Streams, Time and Work , Pipes and Cisterns, Alligation or mixture

Unit 3: Measures of Statistical Data **(6 Hours)**
Percentage, Profit and loss, Ratio and Proportion, Simple interest, Compound interest, Partnership, Chain Rule.

Unit 4: Logical Reasoning **(7Hours)**
Race and Games , Odd Man Out and Series, Number Series, Analogies, Logical Problems, Letter and Symbol Series, Statement and Conclusion, Artificial Language

Unit 5: Area, Volume, Permutation and Combinations **(7 Hours)**
Area, Volume and Surface Areas, Calendar, Clocks, Permutations and Combinations, Probability, Heights and Distances.

Unit 6: Data Interpretation **(6 Hours)**
Tabulations: Tabulations of Imports and Exports of Data, Analysis of Tabulated Data, Bar Graphs: Vertical or Horizontal Bars, Pie Charts: Pie Graphs, Central angle, Line Graphs.

Text Books

1. Quantitative Aptitude For Competitive Examinations", Dr. R. S. Aggarwal, S. Chand.
2. "How to Prepare for Quantitative Aptitude", Arun Sharma, Tata Mcgraw-Hill.

Reference Books

1. Quantitative Aptitude Quantum Cat Common Admission Test", K. Sarvesh Verma., Arihant.
2. "Quantitative Aptitude for Competitive Examinations", Abhijit Guha, Fourth Quarter.

Course Outcomes

The students will be able to:

1. improve their employability skills
2. improve aptitude, problem solving skills and reasoning ability
3. critically evaluate various real life situations by resorting to analysis of key issues and factors.
4. demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions

FF No. : 654

ES502TH: RESEARCH METHODOLOGY

Credits: 02 **Teaching Scheme:** Theory: 2 Hours/Week

SEMESTER II

FF No. : 654

IC302THP :: CONTROL THEORY

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment : 2 Hours / Week

Unit I – Control system Analysis using State Variable methods
Introduction, State variable representation, conversion of state variable model to transfer function, conversion of transfer function to canonical state variable models, solution of state equations, concept of controllability and observability, Controllability and Observability tests

Unit II – State variable analysis of Digital Control system
State description of sampled continuous time plants, Sampling theorem, pulse transfer function, modified Z-transform, state description of system with Dead time, solution of State difference equation, controllability and Observability for discrete system., stability analysis.

Unit III – Controller Design
Stability improvement by state feedback, pole placement design, state regulator design, state observer design, Digital control system with state feedback, deadbeat control

Unit IV - Linear Quadratic Optimal Control
Concept of Lyapunov stability, lyapunov functions for linear systems, parameter optimization and optimal control problems, quadratic Performance index, control configuration, optimal state regulator, optimal digital control systems

Unit V – Non linear system analysis and control
Common non linear system behavior, describing function fundamentals, describing functions of common non linearities, stability analysis by the describing functions, concept of phase plane analysis, system analysis on the phase plane, Adaptive control

Unit VI - Advance Control Strategies and Applications
Model reference adaptive control, sliding mode control, Neural Network, fuzzy logic model, Model Predictive Control

Text Books:
1) M Gopal, “Digital Control and state Variable Methods – Conventional and Intelligent Control system”, 3rd edition, Tata McGraw Hill, 2009
2) I.J. Nagrath, M. Gopal, “Control Systems Engineering”, 5th Edition, New Age International Publishers 2014

Reference books
1) Ogata K., "Discrete Time Control Systems", Prentice Hall of India, Delhi, 2004.
2) Chen C. T., "Linear Systems: Theory & Design". Oxford University Press New York, 1999.
3) Goodwin , Graebe S F & Salgado M E, "Control System Design", Prentice hall of India, Delhi.2002.
4) Ogata K., "Modern Control Engineering". Prentice Hall Of India Pvt.ltd, 1992.

5) G.F.Franklin, J.David Powell, Michael Workman, "Digital control of Dynamic Systems", 3rd Edition, Addison Wesley, 2000.

Course Outcomes

The students will be able to

1) Learn State space representations towards analyzing and designing systems
2) Analyze the discrete systems through the use of Z- Transform, Determine the transfer function of a system containing a sampler and zero-order-hold. Analyze stability
3) Design a Controller or digital process control system, Determine the time and frequency domain responses of sampled-data control systems to arbitrary inputs.
4) Design a optimal controller, optimal state regulator
5) Describe non linearities mathematically, analyze on phase plane
6) Learn advanced control strategies

Lab Assignment and Course Projects

1) Lab Assignment 1 - finding transfer function of the process loops
2) Lab Assignment 2 – Tuning of PID controller by 3 different methods
3) Lab Assignment 3 – PID Implementation for process loop
4) Project 1 – Design and Implementation of State feedback controller for process loop
5) Project 2 – Design and Implementation of optimal controller or MPC for process loop

FF No. : 654

IC504THP :: PROCESS DYNAMICS AND IDENTIFICATION

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Lab : 2 Hours/Week

Unit I **(9 Hrs)**
Control loops for unit operations
Development of control loops, Instrumentation scheme for Boiler, Heat Exchanger, Evaporator, Dryer, Distillation Column

Unit II **(8 Hrs)**
Model Predictive Control
Differences from Other Controllers, Types Basic concept of MPC, Dynamic Matrix Control, Quadratic DMC, Limitations of MPC, Advantages of MPC, Industrial MPC applications

Unit III **(5 Hrs)**
Adaptive control system
Introduction, Standard approaches, Self adaptive systems, Predictive approach, adaptive control by parameter estimation

Unit IV **(8 Hrs)**
Fuzzy Logic in Control applications
Introduction, Definitions, Considerations for design of controller based on fuzzy logic and neural networks, Design of PI controller using fuzzy logic for Process Control application, Case studies.

Unit V **(8 Hrs)**
Neural Networks in Control applications
Introduction, Definitions, Considerations for design of controller based on fuzzy logic and neural networks, Design of PI controller using fuzzy logic for Process Control application, Case studies.

Unit VI **(4 Hrs)**
Statistical Process Control
Introduction, Statistical distribution, Control charts, data collection and recording, Control chart analysis, Case studies in Chemical and Pulp and Paper industry.

Total Contact Hours : 42

Projects will be based on:
1. Implementation of MPC using Matlab/DCS/Lab view/Simulink
2. Implementation of Fuzzy Logic on control Loops in Process Control Lab using DCS/Lab view/ Matlab
3. Implementation of Neural networks on control Loops in Process Control Lab using DCS/Lab view/Matlab

Text Books:

1. "Process Control", F. G. Shinskey, McGraw Hill Book Company.
2. "System Identification Theory for Users", L. Ljung, Prentice Hall Inc
3. "Tuning of Industrial Control Systems", A. B. Corripio, ISA
4. "Fuzzy logic with engineering applications", Timothy J Ross, McGraw Hill.
5. "Statistical Process Control", C. L. Mamzic, ISA

Reference Books:

1. "Process Control", Bela G Liptak, CRC Press, 2005
2. "Chemical Process Control", Stephanopoulos George, PHI.

Course Outcomes:

1. Select control loops for different unit operations
2. Understand Model Predictive Control
3. Design Adaptive control system for given application
4. Apply fuzzy logic for given application
5. Develop neural network for given application
6. Identify the use of Statistical control in process applications

FF No. : 654

IC506THP :: REAL TIME SIGNAL PROCESSING

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit I: Introduction (7 Hours)
Basic model of a Real-time systems (RTS), Characteristics of RTS, Applications of RTS, Safety & relability, types of Real time tasks, Timing constraints – events in a RTS, Classification of timing constraints & examples, Modelling time constraints.

Unit II: Real Time Task Scheduling (7 Hours)
Types of real time tasks & their characteristics, Task scheduling – concept, terminologies, scheduling algorithm, Clock-driven scheduling, hybrid schedulers, event-driven scheduling, EDF scheduling, RMA, Issues of RMA, issues in using RMA in practical situation.

Unit III: Resource Sharing & Task Scheduling in multiprocessors (7 Hours)
Resource sharing among Real-Time Tasks, priority inversion, priority inheritance protocol (PIP), Highest Locker Protocol (HLP), Priority ceiling protocol (PCP), Issues in resource sharing, handling task dependencies, multiprocessor task allocation, dynamic allocation of tasks, fault-tolerant scheduling of tasks, clocks in distributed RTS, Centralized & Distributed Clock synchronization.

Unit IV: Commercial Real – Time Operating systems (7 Hours)
Time services, Features of RTOS, Unix as RTOS, Unix based RTOS, Windows as RTOS, POSIX, Contemporary RTOS – PSOS, VRTX, VxWorks, QNX, uCOS – II, RT Linux, Lynx, Windows CE. Benchmarking RTS – Rhealstone metric, interrupt processing overhead, tridimensional measure, determining kernel preemptability.

Unit V: Real – Time Communication (6 Hours)
Basic concepts, types of networks, QoS, traffic categorization, Real – time communication (RTC) in LAN, Soft & Hard RTC in a LAN, Bounded access protocol for LANs, performance comparison, RTC over packet switched networks, QoS framework, Routing, Resource Reservation, Rate control, QoS models, Applications of RTC.

Unit VI: Real – Time Databases (6 Hours)
Basic concepts of databases, Real time databases (RTB) – application design issues, Characteristics of temporal data – temporal consistancy, Concurrency Control in RTB – locking - based concurrency control, Optimistic concurrency control protocols, speculative concurrency control, comparison of concurrency control protocols, Commercial RTB.

List of Project areas:

1. Portable multi-parameter logger for versatile applications.
2. Sensor nodes design & construction of storage house parameter monitoring system.
3. PIR sensor triggered motion detection & video surveillance systems for security applications.
4. On board Diagnostic system for automobiles diagnostics.
5. Realtime Wireless Vibration monitoring system.
6. Remote condition monitoring system of realtime light intensity & temperature data.

Text Books:

1. Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
2. Jane W. Liu, "Real-Time Systems" Pearson Education, 2001.
3. Krishna and Shin, "Real-TIme Systems," Tata McGraw Hill. 1999.

Reference Books:

1. Alan C. Shaw, Real-Time Systems and Software, Wiley, 2001.
2. Philip Laplante, Real-TIme Systems Design and Analysis, 2nd Edition, Prentice Hall of India.

Course Outcomes:

The student will be able to:

1. Explain fundamentals real time systems.
2. Appreciate the use of task scheduling in real time systems.
3. Understand Resource Sharing & Task Scheduling in multiprocessors.
4. Understand commercial real-time operating systems.
5. Understand the use of real-time communication in RTOS.
6. Understand the use of real-time database in RTOS.

FF No. : 654

IC508THP :: BATCH PROCESS CONTROL

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit 1: Introduction to batch control system (6 Hours)
Batch control system terminology, characteristics of batch processes, hierarchical batch model, control structure for batch systems, Role of standards in batch control systems, study of international standards and practices.

Unit 2: Standards for Batch Process (6 Hours)
Role of standards in batch control systems, study of International Standards and Practices such as S 88, S 95, USA FDA regulation, 21CFR 11 etc.

Unit 3: Control of batch Process (7 Hours)
General control requirements, safety interlocking, regulatory & discrete controls, sequential control of batch processes, control activities and process management, information handling for a batch process.

Unit 4: Design of batch control systems (7 Hours)
Batch management, recipe management, and production scheduling & information management. batch control system design, system requirements, system hardware/reliability requirement.

Unit 5:Specifications and data management (7 Hours)
Batch control system specifications and implementation, Information/display requirements, cost justification and benefits, data management.

Unit 6: Implementation & case studies (7 Hours)
Generic implementation of batch processes, case study of batch control system implementation for applications in food and beverages, pharmaceuticals etc.

List of Project areas:

1. Control and alarm strategy required for a given batch process.
2. Standards required for the given process.
3. Reliability required for the given process.
4. Specification and safety requirement for the given process

Text Books:
1. Thomas .G. Fisher William M. Hawkins, ―Batch Control Systems, ISA series, 1st ed., 2008
2. Process/ Industrial Instruments and Controls Handbook, Gregory K. Macmillan, MCGrawHill

Reference Books:
1. Thomas .G. Fisher William M. Hawkins, ―Batch Control Systems, ISA series, 2nd ed., 2012

Course Outcomes:

The student will be able to –

1. Understand the fundamentals of batch control system (PO-1, 2,4,5 PSO-2)
2. Understand the role of standards for batch process (PO 1,2,4,5 PSO-2)
3. Comprehend the control and management aspects of batch processes (PO-1, 2,4,5 PSO-2)
4. Design control strategies to batch processes (PO-1, 2,4,5 PSO-2)
5. Specify controls and data management system (PO-1, 2,4,5 PSO-2)
6. Implement control system for any given batch process (PO-1, 2,4,5 PSO-2)

FF No. : 654

IC510THP :: ESTIMATION TECHNIQUES

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit I **(7 Hrs)**

Random Variables and Distribution Functions

Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, uniform, binomial, geometric, Poisson, continuous uniform, exponential, gamma, Weibull, normal, lognormal, inverse Gaussian distributions

Unit II **(7 Hrs)**

Non-parametric methods of identification

Time domain and frequency domain methods of system identification: Time response analysis and correlation analysis, frequency response analysis, Fourier analysis and spectral analysis, estimating the disturbance spectrum.

Unit III

Parametric estimation method-I **(7 Hrs)**

Principles of parametric estimation methods, minimizing prediction errors, linear regressing and least squares method, Prediction error method, correlating prediction errors with past data.

Unit IV

Parametric estimation method-II **(7 Hrs)**

Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.

Unit V **(6 Hrs)**

Integral Transforms

Generalized transforms,, orthogonality, 1D and 2D transforms like Fourier, DCT, Wavelet and their properties

Unit VI **(6 Hrs)**

Case studies

Text Books:

1. "An Introduction to Probability and Statistics" , V.K. Rohatgi & A.K. Md. E. Saleh.
2. "Lennart Ljung: System Identification - Theory For the User", 2nd, PTR Prentice Hall, Upper Saddle River, N.J., 1999.

Reference Books:

1. Yucai Zhu, "Multivariable System Identification for Process Control", Elsevier, 2001
2. P. Van Overschee and B. de Moor. "Subspace Identification for Linear Systems: Theory, Implementation, Applications". Kluwer Academic Publishers, Boston, 1996

FF No. : 654

IC512THP :: MECHATRONICS

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit I **(6 Hrs)**

Overview of Mechatronics

Introduction to mechatronics and design approach, block diagram, multidisciplinary scenario, system Interfacing, instrumentation and control systems, open loop and closed loop systems, microprocessor-based controllers and microelectronics, introduction to automation, micro- and nanotechnology

Mechanical components: springs (compression, extension, torsion, flat, leaf and motor spring), gears (spur, bevel, gear trains), mechanisms, bearings, gears, rack and pinion, ratchets, pawl, crank, sliders, cranks, cams, followers, chain and sprocket.

Mechanical components like couplings, belt, chain, pulleys, Geneva wheels, four-bar linkages.

Unit II **(8 Hrs)**

Hydraulic Components

Hydraulics: principle, block diagram, advantages, disadvantages, applications, hydraulic fluid properties and its selection.

Hydraulic components: hydraulic power pack, hydraulic pumps, actuator (cylinders and motors), hydraulic valves, filters, piping, heat exchangers and motors.

Hydraulic circuits: development of hydraulic circuits using standard symbols. Hydraulic circuits like meter in, meter out, reciprocating, speed control, sequencing of cylinders, direction control, deceleration, regenerative circuit, etc. troubleshooting in hydraulic circuits. Introduction to circuit design.

Unit III **(7 Hrs)**

Pneumatic Components

Pneumatics: principle, block diagram, advantages, disadvantages, applications.

Pneumatic components: pneumatic power Supply, types of pneumatic relay, FRL unit, pneumatic actuator (cylinders and air motors), pneumatic valves, Fluidic elements and its applications, development of pneumatic circuits, troubleshooting in pneumatic circuits.

Pneumatic circuits: development of pneumatic circuits using standard symbols, sequence diagram (step-displacement) for implementing pneumatic circuits, different pneumatic circuits like reciprocating, sequencing, anti-cycle repetition, block transfer, speed regulation, job sorting, electro-pneumatic circuits, etc.

Unit IV **(7 Hrs)**

Robot Fundamentals, Sensors and Actuators

Robot definition and classification, brief history of robotics, types of robots, advantages and disadvantages of robots, robot components, Robot terminologies like position, orientation, degree of freedom, configuration, workspace (reach), kinematics, dynamics, accuracy, repeatability, path, trajectory, robot joints, robot coordinates, robot reference frames, robot applications and social issues.

Robot sensors: sensor characteristics, position sensors, velocity sensors, acceleration sensors, force and pressure sensors, proximity sensors, light and infrared sensors, torque sensors, microswitches.

Robot actuators: characteristics of actuating systems, comparison of actuating systems, electric motors, microprocessor control of electric motors, magneto-strictive actuators, shape-memory type metals, speed reduction techniques.

Unit V **(6 Hrs)**

Robot Kinematics:

Position Analysis: robots as mechanisms, matrix representation, homogeneous transformation matrices, representation of transformations, inverse of transformation matrices, forward and inverse kinematics of robots, Denavit-Hartenberg representation of forward kinematic equations of robots, inverse kinematic solution of robots. Inverse kinematic programming of robots. Robot dynamic analysis.

Unit VI **(6 Hrs)**

Trajectory Planning

Path vs. trajectory, joint-space vs. Cartesian-space descriptions, basics of trajectory planning, joint-space trajectory planning. Cartesian-space trajectories, continuous trajectory recording, Higher order trajectories. Robot differential motions and velocities.

Total Contact Hours : 40

Text Books

1. “Industrial Hydraulics”, Pipenger, Tata McGraw Hill Publications.
2. “Pneumatic Systems: Principles and Maintenance”, Majumdar,
3. “Introduction to Robotics: Analysis, Systems, Applications”, Saeed B. Niku, Prentice Hall of India, New Delhi, 2002.
4. “Robot Engineering An Integrated approach”, Klafter R.D., Chmielewski T.A. and Negin M., Prentice Hall of India, New Delhi, 1994.

Reference Books

1. “Industrial Hydraulic Technology", Parker Motion & Control, Training Department.
2. “Pneumatics”, Festo Didactic.
3. “Industrial robotics Technology, programming and applications”, Groover M.P, McGraw-Hill Book Co., 1995.

Course Outcomes: The Students will be able to :

1. Explain the working of mechanical, hydraulic, pneumatic and robotic components.
2. Develop hydraulic and pneumatic circuits for given application.
3. Select and size the hydraulic and pneumatic components to solve a problem.
4. Identify, formulate and solve a problem using mechanical, hydraulic, pneumatic system and robot kinematics.
5. Estimate the robotic trajectory planning and robot dynamics parameters for given application.

FF No. : 654

IC514THP :: DIGITAL IMAGE PROCESSING

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit 1: Preliminaries of Image Processing (06 Hours)
Image Formation Model, Image Sampling And Quantization, Representation Of Digital Images, Introduction to Information Theory, Entropy, Registration of Images, Basic Relationship Between Pixels, Distance Measures, Image operations of pixel basis and Various 2D Transforms Fourier Transform, Discrete Cosine Transform, Wavelet transform.

Unit 2: Image Filtering, Enhancement and Segmentation (08 Hours)
Introduction and Overview, Point Processing methods, contrast enhancement, Histogram based methods, Linear filtering in spatial domain, frequency domain filtering, edge detection, Point and line detection, region and object segmentation.

Unit 3: X-Ray Imaging and Computed Tomography (06 Hours)
Introduction and Overview, Imaging with X-Ray, Radiation Dose Attenuation-Based X-Ray Imaging, Processing methods for X ray images, Computed Tomography, reconstruction methods; artifacts.

Unit 4: Magnetic Resonance Imaging (06 Hours)
Introduction and Overview, Physical and Physiological Principles of MRI, MR Imaging, Formulation of MRI Reconstruction. Functional MRI, Processing and Feature Extraction of MRI, Sources of Noise and Filtering Methods in MRI, Feature Extraction, Comparison of MRI with Other Imaging Modalities, Registration with MR Images

Unit 5: Ultrasound Imaging (08 Hours)
Introduction and Overview, Generation and Detection of Ultrasound Waves, Physical and Physiological Principles of Ultrasound, Resolution of Ultrasound Imaging Systems, Ultrasound Imaging Modalities, Attenuation Tomography, Ultrasound Time-of-Flight Tomography, Reflection Tomography Modes of Ultrasound Image Representation, Image Artifacts, Image Reconstruction, Processing and Feature Extraction of Ultrasonic Images, Image Registration

Unit 6: Positron Emission Tomography (06 Hours)
Introduction and Overview, Physical and Physiological Principles of PET, PET Signal Acquisition, PET Image Formation, Applications of PET, Processing and Feature Extraction of PET Images, Sources of Noise and Blurring in PET, Image Registration with PET

List of Project areas:
1. Design image processing algorithms for detecting abnormalities in typical X ray / CT images.
2. Implement optimized reconstruction algorithm for CT images.
3. Develop processing and feature extraction algorithms of Ultrasonic Images.
4. Develop processing and feature extraction algorithms of PET Images.

Text Books:

1. Jain A.K., "Fundamentals of Digital Image Processing", PHI, 1st Ed., 1989.
2. B. H. Brown, R H Smallwood, D C Barber and D R Hose, "Medical Physics and Biomedical Engineering, Institute of Physics Publishing Ltd., 1999.

Reference Books:

1. J. T. Bushberg, J. A. Seibert, E.M. Leidholdt, and J. M. Boone, Lippencott, "The Essential Physics of Medical Imaging", 2nd Ed., by Williams and Wilkins, Publ. 2002.
2. B. H. Brown, R H Smallwood, D C Barber and D R Hose, Medical Physics and Biomedical Engineering, Institute of Physics Publishing Ltd., 1999.

Course Outcomes:

The student will be able to –

1. Apply various transforms on images and analyse the effect of sampling and quantization on images. (PO-1, 3, 5, 12, PSO-2, 3)
2. Design image enhancement, smoothing sharpening techniques. (PO-1, 3, 5, PSO-2,3)
3. Analyse X ray and CT images using image processing techniques. (PO-1, 2,3, 4,6, 7,12, PSO-1,2,3)
4. Design Processing and Feature Extraction algorithms for MRI Images. (PO-1, 2, 4, 5, 12, PSO-1, 2, 3)
5. Apply Processing and Feature Extraction algorithms for Ultrasonic Images. (PO-1, 2,3, 4, 12, PSO-1,2,3)
6. Design Processing and Feature Extraction algorithms for PET Images. (PO-1, 2,3, 4, 12, PSO-1,2,3)

FF No. : 654

IC516THP :: INTERNET OF THINGS

Credits: 04 **Teaching Scheme:** Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit – 1: Introduction **(6 Hours)**

What is the Internet of Things? : History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks : IoT Definitions, IoT Architecture, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities

Unit 2: **Embedded suite for IoT** **(6Hours)**

Physical device – Arduino / Raspberry Pi Interfaces, Hardware requirement of Arduino / Pi, Connecting remotely to the Arduino /Raspberry Pi , GPIO Basics, Controlling GPIO Outputs Using a Web Interface,– Programming , APIs / Packages, Arduino Interfaces, Integration of Sensors and Actuators with Arduino, Introduction to Python programming

Unit – 3: Connectivity Technologies and Communication Protocols in IOT **(6 Hours)**

RFID: Introduction, Principle of RFID, Components of an RFID system, Issues EPCGlobal Architecture Framework: EPCIS & ONS, Design issues, Technological challenges, Security challenges, IP for IoT, Web of Things. Wireless Sensor Networks: WSN Architecture, the node, Connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, Data link layer protocols, routing protocols and infrastructure establishment. **Protocols in IOT :** CoAP, XMPP, AMQP, MQTT, Communication Protocols: IEEE 802.15.4, Zig-bee, 6LoWPAN, Bluetooth

Unit-4: Resource Management In The Internet of Things **(6 Hours)**

Clustering, Software Agents, Clustering Principles in an Internet of Things Architecture, Design Guidelines, and Software Agents for Object Representation, Data Synchronization. Identity portrayal, Identity management, various identity management models: Local, Network, Federated and global web identity, user-centric identity management, device centric identity management and hybrid-identity management, Identity and trust. Cloud Computing, Fog Computing

Unit-5: Internet of Things Privacy, Security and Governance **(6 Hours)**

Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT.

Unit-6: Business Models For The Internet of Things **(6 Hours)**

Business Models and Business Model Innovation, Value Creation in the Internet of Things, Business Model Scenarios for the Internet of Things. Internet of Things Application : Smart Metering Advanced Metering Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards.

Text Books

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.
2. Pethuru Raj, Anupama C. Raman, The Internet of Things Enabling Technologies, Platforms, and Use Cases, CRC Press Taylor & Francis Group, International Standard Book Number-13: 978-1-4987-6128-4
3. Rajkumar Buyya, Amir Vahid Dastjerdi Internet of Things – Principals and Paradigms, Morgan Kaufmann is an imprint of Elsevier, ISBN: 978-0-12-805395-9
4. Parikshit N. Mahalle & Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).

Reference Books

1. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications
2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications
3. Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things",. Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.
4. Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An information processing approach", Elsevier, ISBN: 978-81-8147-642-5.
5. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
6. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer

Course Outcomes : At the end of this course, students will be able to:

1. Learn and demonstrate concepts of Internet of Things (PO 1, 3,)
2. Develop and demonstrate embedded tools usage for IOT. (PO 1, 3)
3. Understand, develop and demonstrate the connectivity technologies and protocols in IOT. (PO 1, 3,)
4. Learn and demonstrate concepts of resource management, cloud and fog computing in the Internet of Things. (PO 1, 3)
5. Discuss Security issues in IOT (PO 1, 3)
6. Understand business models for the Internet of Things and demonstrate applications of IOT. (PO 1, 3)

Project Areas

1) Wi-Fi communication using Arduino / Raspberry Pi
2) GSM communication using Arduino / Raspberry Pi
3) Bluetooth communication using Arduino / Raspberry Pi
4) Android platform for IOT applications
5) Any one application of IOT utilizing IOT platforms

FF No. : 654

HS552TH :: QUANTITATIVE APTITUDE - II

Credits: 02 **Teaching Scheme:** Theory: 2 Hours/Week

Unit 1: Area, Volume, Permutation and Combinations (7 Hours)
Area, Volume and Surface Areas, Calendar, Clocks, Permutations and Combinations, Probability, Heights and Distances.

Unit 2: Data Interpretation (7 Hours)
Tabulations: Tabulations of Imports and Exports of Data, Analysis of Tabulated Data, Bar Graphs: Vertical or Horizontal Bars, Pie Charts: Pie Graphs, Central angle, Line Graphs.

Unit 3: Probability (7 Hours)
Introduction to probability, Structure of probability, Results of probability, Revision of probability: BAYES' RULE, and examples; Random variable and probability distribution: Discrete and Continuous distribution, Expected value and variance of a distribution.

Unit 4: Correlation & Regression Analysis (7 Hours)
Regression analysis (Linear only), Correlation analysis, Karl Pearson's correlation coefficient, Spearman's Rank correlation coefficient

Text Books
1. Quantitative Aptitude For Competitive Examinations", Dr. R. S. Aggarwal, S. Chand.
2. "How to Prepare for Quantitative Aptitude", Arun Sharma, Tata Mcgraw-Hill.
3. Probability & Statistics for Engineers- Richard Johnson – Prentice Hall of India,
4. Statistics for Management- Richard Levin , Rubin - Prentice Hall of India,

Reference Books
1. Quantitative Aptitude Quantum Cat Common Admission Test", K. Sarvesh Verma., Arihant.
2. "Quantitative Aptitude for Competitive Examinations", Abhijit Guha, Fourth Quarter.

Course Outcomes

The students will be able to:
1. improve their employability skills
2. improve aptitude, problem solving skills and reasoning ability
3. critically evaluate various real life situations by resorting to analysis of key issues and factors.
4. demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions

FF No. : 654

HS553TH :: ENGINEERING ECONOMICS

Credits: 02 **Teaching Scheme:** Theory: 2 Hours/Week

(07 Hrs)

Unit I
Engineering Economic Analysis

Introduction, Concept of Money – Its Functions & worth. Inflation – Concept, Causes, Remedies to control inflation, Value of Currency, Factors governing exchange rates, Currency Fluctuations. Concept of Taxes, Types of Taxes – Direct & Indirect, Depreciation. Effect of above concepts on decision making.
Significance of above concept in real life decision making

Unit II **(07 Hrs)**
Time Value of Money& Life Cycle Costing

Concept of Interest, Time Value of Money – Basis for comparison of alternatives, Discount Rate, Compound Rate, Present Worth, Future Worth, Annual Worth, Annuity, Perpetuity. Life Cycle Costing - Introduction, methodology, applications of LCC in industrial world, differentiation with traditional costing methods, Capital Budgeting: DCF & NDCF Techniques: Payback, Discounted Payback, ARR, IRR, NPV, Annual Worth, Cost Benefit Ratio
Numerical Applications on Time Value of Money

Unit III **(07 Hrs)**
Concept of Demand and Supply

Law of Demand & Supply: Meaning and Determinants of Demand. Demand Function. Law of Demand, Market Demand, Elasticity of demand. Types of elasticity. Measurement of elasticity. Significance and uses of the elasticity. Meaning and Determinants of Supply, Law of supply. Equilibrium of demand and supply i.e. price determination.
Exceptions of Law of Demand & Supply

Unit IV **(07 Hrs)**
Concept of Utility, Competition

Law of Diminishing Marginal Utility – Concept, Law of Diminishing Marginal Utility Price Determination, Competition – Concept, Types (Monopoly, Oligopoly, etc.), Benefits to Buyer & Seller, Economies of Scales, Law of Variable Proportions

Cases related with above concepts

Text Books

1. Theusen H.G., Engineering Economic Analysis, Prentice Hall of India
2. Henry M. Steiner, Engineering Economic Principles, McGraw Hill
3. S.M. Mahajan, Engineering Economics, Everest Publishing House, Pune
4. Samuelson PA, Nordhaus WD, Economics, Tata McGraw Hill

Reference Books

1. Colin Drury, "*Management and Cost Accounting*", English Language Book Society, Chapman and Hall London.
2. Khan M. Y., Jain P. K., "*Financial Management",* Tata McGraw Hill

Course Outcomes:

Our students will be able to:

1. Analyze the effect of inflation, currency fluctuations, and taxes on decision making
2. Compare and select investment alternatives based on costs and time value of money
3. Analyze the impact of demand and supply on pricing of product and competition
4. Understand the concept of utility and competition and its relevance in business environment