Autonomous Program Structure
Final Year B. Tech. Eigth Semester
(Instrumentation and Control)
Academic Year: 2019-2020 Onwards

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
IN 4201	Process Data Analytics	3	0	0	50	50	0	0	100	3
PEIN 4201	Program Elective-I	3	0	0	50	50	0	0	100	3
OE 4201	Open Elective-II	3	0	0	50	50	0	0	100	3
IN 4202	Process Data Analytics Lab	0	0	2	0	0	50	0	50	1
IN 4203	Project Phase-II	0	2	16	100	0	50	0	150	10
IN 4204	Project based Online Course**	2	0	0	50	0	0	0	50	2
	Total	**11**	**2**	18	300	**150**	**100**	**0**	550	22
	Grand Total	**31**			550				**550**	22

****The student shall register and complete the project based online course preferably in semester- I but may complete the same till the end of semester-II.**

PEIN 4201: Program Elective-I	**OE 4201: Open Elective-II**
1. Process Modelling and Optimization	1. Instrumentation in Agriculture and Food Industry
2. Digital Control	2. Advanced Digital Signal and Image Processing
3. Building Automation	3. System On Chip
4. Power Plant and Safety Instrumentation	

DEAN ACADEMICS
MKSSS's Cummins College of Engineering for Women Karvenagar, Pune-411052

Principal
MKSSS's Cummins College of Engg. For Women, Karvenagar, Pune-52

APPROVED BY
Governing Body Members
MKSSS's Cummins College of Engineering for Women Karvenagar, Pune-411052

IN 4201: Process Data Analytics

Teaching Scheme
Lecture: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester:50
Marks Credit: 3

Prerequisite: Concepts of Mathematics and Computational techniques

Course Objectives:
1. To explore the statistical analysis techniques for various kinds of data.
2. To understand the concepts and types of Artificial Intelligence and Machine Learning Algorithms.
3. To be familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms.

Course Outcomes: The student will be able to
1. Apply standard statistical inference procedures to draw conclusions from data analysis.
2. Identify the characteristics of learning methods that are used to solve the given problem.
3. Identify the performance parameters of various data analysis techniques.
4. Compare and select various machine learning algorithms for solving given problem.

Unit 1: Introduction to statistical analysis (07)
Statistical Analysis, introduction, methods, definitions Descriptive Statistics, Probability distributions Inferential Statistics, Two Sample Tests, Type 1 and Type 2 Errors Inferential Statistics through hypothesis tests, Permutation & Randomization Test ANOVA and Test of Independence

Unit 2: Regression Analysis and related tools (07)
Introduction, Methods, Types. Linear and Multiple Regression Methods Regression : Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification ANOVA and Test of Independence Introduction to R and Python programming Introduction to Advanced Pattern Recognition

Unit 3: Introduction to Artificial Intelligence and Machine Learning (07)
Introduction to machine learning and concepts and comparison with biological intelligence. Differentiating algorithmic and model based frameworks. Introduction to Neural Networks and Fuzzy Logic as techniques for Machine Learning

Unit 4: Supervised Learning Methods (07)
Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines, Deep Learning

Unit 5: Unsupervised Learning Methods (07)
Clustering, Associative Rule Mining, Introduction to Big Data and Challenges for big data analytics

Unit 6: Classifiers (07)
Cases Studies of Classifiers implemented by various methods for applications in the field of Process Industry, Biomedical Field, Network domain and similar other domains

Text Books:

1. Montgomery, Douglas C. and Runger, George C. (2014) Applied Statistics and
2. Probability for Engineers, 6 th edition, John Wiley & Sons, Inc (ISBN- 978-1118539712).
3. An Introduction to R, by Venables and Smith and the R Development Core Team.
4. Data Analysis and Graphics Using R; An Example-based Approach, by John Maindonald and John Braun. Cambridge Series in Statistical and Probabilitistic Mathematics, 2003.
5. Sheldon M. Ross,"Introduction to Probability and Statistics for Engineers and Scientists", 4th edition, Academic Press; 2009.

Reference Books:

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Arshdeep Bahga, Vijay Madisetti, "Big Data Science & Analytics: A Hands-On Approach", VPT, 2016
3. E. Alpaydin, "Machine Learning", MIT Press, 2010.
4. K. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. C. Bishop, "Pattern Recognition and Machine Learning, Springer", 2006.
6. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
7. John Mueller and Luca Massaron, "Machine Learning For Dummies", John Wiley & Sons, 2016.
8. Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015
9. Hastie, Trevor, et al. "The elements of statistical learning". Vol. 2. No. 1. New York: springer, 2009.
10. Montgomery, Douglas C., and George C. Runger. "Applied statistics and probability for engineers" John Wiley & Sons, 2010.

PEIN 4201A: Process Modeling and Optimization

Teaching Scheme
Lecture: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50
Marks Credit: 3

Prerequisite: Process Instrumentation , Automatic Control System, Control system Design

Course Objectives:
1. Understand and develop system's mathematical models.
2. Learn the use of Numerical methods in solving the model equations.
3. To learn to various optimization techniques.

Course Outcomes: The student will be able to
1. define and list types of mathematical models.
2. develop mathematical model of process.
3. simulate and analyze the system performance.
4. apply the optimization techniques and analyze the results.

Unit 1: Modeling Aspects & Mathematical Models (06)

Definition of process model, physical and mathematical modeling, deterministic and stochastic process. Introduction, uses of mathematical models, classification of mathematical methods, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state, equilibrium, kinetics

Unit 2: Mathematical Modeling of Mechanical & Chemical Engineering Systems (06)
Process models of some typical systems in differential equations form, , dead time, first and second order models, higher order models, Behaviour of firt order and second order system

Unit 3: Mathematical Models (06)
Mathematical Models of Tanks in series, Tanks in parallel Reaction dynamics, Modeling the chemical reactions, CSTR models, Plug flow reactor model, modeling of flash drum, distillation columns, evaporators, dryers, heat exchangers.

Unit 4: Basic concept of Optimization (06)
Optimization: Concept, need, Essential features of optimization Problem, Concepts of objective functions, Equality and Inequality Constraints, Payback period, Return of Investment, Net present Value, Internal Rate of Return. Classification of optimization problem based on Existence of constrains, Nature of design variables, Physical Structure of the problem, Equation Involved, Permissible values, of design variable, Deterministic Nature of the variables, separability of the variable, Number of objective functions. Continuity of functions, Convex and Concave functions, Convex Region, Extremum of the objective functions, quadratic approximation, Feasible region.

Unit 5: Optimization of Unconstrained Functions & Linear Programming (06)
One-Dimensional search numerical methods for optimizing a function of one variable , scanning and bracketing procedures, Newton, Quasi‑Newton and Secant methods,Runge Kutta method.

Unit 6: Unconstrained Multivariable Optimization (06)
Simplex method, Direct Methods, Indirect

Methods, Steepest Descent method.
Linear Programming : Basics of Linear Programming, Simplex Algorithm

Text Books:

1. W. L. Luyben, Process, Modeling, Simulation and Control for Chemical Engineers• by McGraw Hill, 1973.
2. Thomas Edgar, David Himmelblau, Optimization of Chemical Processes• Second edition, McGraw Hill, 2001.

Reference Books:

1. W. F. Stoecker, Design of Thermal Systems International Education, McGraw hill 1989.
2. J. Malley, Practical Process Instrumentation and Control • McGraw Hill.
3. Deo Narsingh ,System Simulation with digital Computer • Prentice Hall India, New Delhi.
4. Singiresu S.Rao,Engineering Optimization (Therory & Practice),third Edition,New Age International(p) Ltd,Publishers.

PEIN 4201B: Digital Control

Teaching Scheme
Lecture: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50
Marks Credit: 3

Prerequisites: Basics of Control System

Course Objectives:

1. To learn and understand control system design.
2. Design various digital controllers and study the response of those controllers.
3. To learn and understand stability of system in z-plane.
4. Introduce optimal control design and it's need.

Course Outcomes: The student will be able to
1. analyze a given system in various planes S-W-Z and its mapping.
2. analyze stability of a system in S-plane and Z-plane
3. design a system using classical method and state space.
4. design optimal control for a discrete system.

Unit 1: Introduction to Discrete Time Control System (06)
Basic building blocks of Discrete Time Control system, Sampling Theorem, Choice of Sampling Rate and Multirate Sampling, Z Transform and Inverse Z Transform for applications for solving Differential Equations, Impulse Sampling, Reconstruction: Data Hold, Mathematical Model of Zero Order Hold

Unit 2: Pulse Transfer Function and Digital Controllers (06)
The Pulse Transfer Function, Pulse Transfer Function of Open Loop and Closed Loop Systems, Pulse Transfer Function of Digital PID Controller, Velocity and Position forms of Digital PID Controller, Deadbeat Response and Ringing of Poles, Design of Deadbeat Controller**.**

Unit 3: Stability Analysis of Discrete Time Control System (06)
Stability regions in S-plane, W-plane and Z-plane and Mapping between the three planes, Stability Tests for Discrete System, Jury Stability Criterion, Bilinear Transformations.

Unit 4: Design of Discrete Time Control System- State Space Approach (06)
Different Canonical forms, Relation between State Equations and Pulse Transfer Function, Solution of Discrete Time State Space Equations, Cayley-Hamilton Theorem, Discretization of Continuous Time State Equation, Pulse Transfer Function Matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization.

Unit 5: Pole Placement and Observer Design (06)
Concept of Controllability and Observability, Pole Placement Design by State Feedback, Design of feedback gain matrix using sufficient condition, Ackerman’s formula, State Observers Types.

Unit 6: Introduction to Optimal Control (06)
Basics of Optimal Control, Performance Indices, Quadratic Optimal Control and Quadratic Performance Index.

Text Books:

1. Discrete Time Control systems by K. Ogata, Prentice Hall, Second Edition,2003.
2. Digital Control and State Variable Methods by M. Gopal, Tata McGraw Hill, 2003.
3. Digital Control by Kannan Moudgalya, John Wiley and Sons, 2007.

Reference Books:

1. Digital Control of Dynamic Systems by G.F.Franklin, J.David Powell, Michael Workman 3rd Edition, Addison Wesley, 2000.
2. Digital Control Engineering by M. Gopal, Wiley Eastern Ltd, 1989.
3. Digital Control by Forsytheand W. and Goodall R.N McMillan,1991.
4. Digital Control Systems by Contantine H. Houpis and Gary B. Lamont, 2nd Edition, McGraw-Hill International, 2002.

PEIN 4201C: Building Automation

Teaching Scheme
Lectures: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester:50
Marks Credit: 3

Prerequisite: Basics of Electronics and Instrumentation

Course Objectives:
1. To understand Building automation systems
2. To understand the working of various Building automation components.
3. To learn the Building automation with applications.

Course Outcomes: The student will be able to
1. Investigate the system requirements for developing building automation systems.
2. Compare and choose the suitable building automation systems for the applications.
3. Design building automation system for required application.
4. Evaluate the performance of designed building automation system.

Unit 1: Introduction to Building Automation Systems (07)
Intelligent building, Intelligent architecture and structure, Facilities management vs. intelligent buildings, Lifecycle of building, Evolution of intelligent buildings. BAS System Hierarchy –Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, Operator Workstation (OWS). Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS. Process of BAS design, Role of different stakeholders (Architect, contractor, consultant, application engineer and engineer) in BAS system design, Comfort parameters for human being- temperature, humidity, flow, pressure, clean air, CO2%.

Unit 2: Fire Alarm Systems I (07)
Introduction, Block diagram of FAS, Fire –Meaning, Fire Development Stages, Fire Sensors & Detectors, Detector Placement, Detectors Required For Various Applications, Notification appliances: types, specifications, installations guidelines. Fire Extinguishing Principles, Fire Extinguishers & Its Classification.

Unit 3: Fire Alarm Systems II (07)
FAS types and Architectures , FAS Loops and classification, comparision of loops, FAS Communication Protocols, Various Fire Standards, Power Supply and voltage drop Calculations, Cause & effect matrix.

Unit 4: Security Systems (07)
Introduction, Access Control – Concept, Generic Model, Components, Types, Features, Card Technologies, Communication Protocols, Controllers, Concept of Antipassback, Biometrics Systems: Issues With Biometrics, Need and Applications, components of biometric systems
CCTV Systems: Introduction, Applications, CCTV Camera types, Camera Basics, Types of CCTV systems: Traditional and Advanced CCTV Systems, Video Recording, Drawbacks, Digital Video Recording, Features, Functionalities, Digital Vs Analog Recording, Digital Video Management System .

Unit 5: HVAC Water Systems **(07)**

Design, working of different types of chilled water system- single chiller system, series chiller system, parallel chiller system. Working of different components of chilled water system- decoupler line, bypass line, primary circuit, secondary circuit, and condenser pumps. Concept of free cooling- direct waterside, series waterside, parallel waterside free cooling.

Hot Water Systems: Concept of geothermal system, Working, design of different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger with hot water input, geothermal system, solar system and combination of all listed systems.

Unit 6: HVAC Air Systems **(07)**

Concept of Air handling unit. Design, working of different components in AHU- damper, filter, cooling coil, heating coil, fan, heat recovery wheel, humidifier. Working, configuration, characteristics for different types of dampers. Damper Sizing, Design and working of different types of AHU. Operation of different modes.Concept of Variable Air Volume (VAV) system-Design, working, use of different types of VAV- CAV, Design, working, use of radiation coil, chilled beam, CRAC unit, VRV systems, unit heater, Fan coil unit and unit ventilator.

Text Books:

1. Robert Gagnon, Design of Special Hazards and Fire Alarm Systems.
2. Damjanovski, Vlado, CCTV, Butterworth-Heinemann , 3rd ed.
3. Benantar M., Access Control System
4. Montgomery R, Fundamentals of HVAC Control Systems , Elsevier Publications
5. Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6. James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7. "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

Reference Books:

1. "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2. "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers
(product code: B0009 for online shopping)
3. "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4. "Handbook – Industrial Ventilation Application", 2004 , Indian Society of Heating, Refrigerating & Air Conditioning Engineers

PEIN 4201D: Power Plants and Safety Instrumentation

Teaching Scheme
Lectures: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester:50
Marks Credit: 3

Course Prerequisite: Basics of process control fundamentals, knowledge of Unit operations and basics of control strategies

Course Objectives:
1. To expose the students to the detail process of various types of power plants.
2. To impart knowledge on various measurements and instrumentation involved in various types of power plants.
3. To provide the knowledge on specific measurement techniques and control systems practiced in boiler and turbine units.

Course Outcomes: The student will be able to
1. identify the different unit operations, process control equipments involved in different types of power plants like thermal, nuclear and hydroelectric power plants
2. select appropriate measurement techniques for measurement of various process parameters involved in power plants
3. analyze and develop various control loops for processes involved in power plants
4. assess various automation tools to develop automation strategy to Thermal power plant

Unit 1: Introduction to thermal power plant **(07)**
Thermal power plant process: Coal and ash circuit, Air and flue gas circuit, Water and steam circuit, Water treatment plant, DM plant, cooling water circuit
Main equipments: Boiler, steam turbines, generator, boiler feed pump, condensate extraction pump, deaerator etc
Measurements in power plants and sensors used: Measurement of feed water flow, air flow, steam flow and coal quantity, drum level measurement, Steam pressure and temperature measurement, flue gas analyzer, fuel composition analyzers, flame monitoring, Turbine speed and vibration measurement

Unit 2: Boiler and Turbine Controls **(07)**
Boiler control: steam pressure control with load index, coal mill control, furnace draft control, drum-level controls, super heater temperature control, fuel/air ratio, oxygen, CO and CO_2 trimming, combustion efficiency, excess air, parallel and cross limited combustion control.
Turbine control: Turbine speed and load control, transient speed rise, automatic load frequency control, Turbine oil cooling system, Turbine run up system, Thermal stress control, Vibration, eccentricity, axial shift.
Instrumentation in Generator cooling systems, Generator control system

Unit 3: Application of DCS in Thermal power plant control **(07)**
Automation strategy, Automatic boiler control, diagnostic functions and protection, Electro-hydraulic governor system, Automatic startup system, Distributed control to improve reliability Need of condition monitoring systems, Fault tolerant control system in thermal power plants

Unit 4: Nuclear power plant **(07)**

Nuclear power plant method of power generation, Basic physics of nuclear reactors Atomic structure, isotopes, radioactivity, basics of fission reaction, moderation, criticality Components of nuclear reactor Radiation sources and protection safety objectives Rad-waste management Safety Practices in Indian NPPS, Radiological Protection to workers and public, Dose limits, Health physics

Unit 5: Nuclear power plant Instrumentation **(07)**

Control loops for different types of nuclear reactors, Process sensors for nuclear power plants for radiations detection, temperature measurement etc, Safety in nuclear power plant, reliability aspects

Unit 6: Hydroelectric power plant Instrumentation **(07)**

Hydroelectric power plant process, Types of water turbines, Governing system in water turbine of hydro power plant, Regulation & monitoring of voltage & frequency of output power, Electrical sub-station controls, SCADA solution to improve reliability, Safety system in hydro power, Pollution & effluent monitoring & control, Energy Management

Text Books:

1. Power Plant Instrumentation , K. Krishnaswamy, M. Ponnibala
2. Computer Based Industrial Control, Krishna Kant
3. Power Plant Engineering, Domkundwar
4. Power Plant Engineering, Manoj Kumar Gupta

Reference books:

1. Power Plant Instrumentation and Control Ajay Debnath, Swapan Basu Academic Press Elsevier
2. Process Control, Liptak
3. Boiler Control Systems, David Lindsley, Mc-Graw Hill
4. Power Plant Instrumentation and Controls, Philip Kiameh
5. G.F. Knoll, “Radiation Detection & Measurement”, 2nd edition, John Wiley & Sons, 1998.
6. Energy Management Handbook: W.C. Turner
7. Pollution: M.N.Rao and H.V. Rao.

OE 4201A: Instrumentation in Agriculture & Food Industry

Teaching Scheme
Lectures: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50
Marks Credit: 3

Prerequisite: Basics of sensors and transducers, knowledge of Unit operations and basics of process control, PLC and pneumatic and hydraulic instrumentation

Course Objectives:
1. To know the scope of Instrumentation in agriculture field
2. To Know greenhouse, food packaging automation schemes
3. Understand sensors used in agriculture field and weather monitoring stations
4. To get acquainted with food quality standards

Course Outcomes: The student will be able to
1. Identify the different unit operations, process control equipments involved in different types of process industries
2. Select appropriate measurement techniques for measurement of various process parameters related to soil, green house, Dam and agro-metrology
3. Develop various control loops and circuits for greenhouse, dam instrumentation and machines used in agriculture
4. Assess various automation tools to develop automation strategy to Dam, Green house, food processing and packaging in accordance to various food standards

Unit 1: Introduction **(07)**
Necessity of instrumentation & control for agriculture, engineering properties of soil: fundamental definitions & relationships, index properties of soil, permeability & seepage analysis, shear strength, Mohrs circle of stress, active & passive earth pressures, stability & slopes, Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples

Unit 2: Instrumentation in Process industry **(07)**
Flow diagram of sugar plant & instrumentation set up for it, flow diagram of fermenter & control(batch process), flow diagram of dairy industry & instrumentation set up for it, juice extraction control process & instrumentation set up for it

Unit 3: Instrumentation in Irrigation and Green house System **(07)**
Irrigation systems: necessity, irrigation methods: overhead, center pivot, lateral move, micro irrigation systems, soil moisture measurement methods: resistance based method, voltage based method, thermal based method, details of gypsum block, irrigation scheduling, irrigation efficiencies, Application of SCADA for DAM parameters & control. Green houses & instrumentation: ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge carbon dioxide enrichment measurement & control

Unit 4: Instruments in Agriculture **(07)**
Automation in earth moving equipments & farm equipments, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation. Agrometeorological instrumentation weather stations, surface flux measurement, soil water content measurement using time‑domain reflectometry(TDR).

Unit 5: Food Processing **(07)**

Definition, Food quality measurement , food safety and standards bill 2005, central committee for food standards, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products, Design consideration: cold storage, atmospheric controller and preservatives; biosensors.

Unit 6: Automation in Food Industry

Application of SCADA & PLC in food packing industry, Trends in modern food processing, Equipments for creating and maintaining controlled atmosphere.

Text Books:

1. D. Patranabis, "Principles of Industrial instrumentation", TMH (2010), ISBN-13: 978-0070699717
2. Michael. A.M, " Irrigation : Theory and Practice" , Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677
3. Curtis D. Johnson, " Process control and instrumentation technology", , 8th Edition, 2015 ,Person, ISBN: 9789332549456, 9332549451
4. Akalank Kumar Jain , Vidhi Jain "Food Safety and Standards Act, Rules & Regulations", Akalank Publications; 13th Edition edition (2015), ISBN-13: 978-8176393584

Reference books:

1. Rosana G. Moreira, "Automatic Control for Food Processing Systems (Food Engineering Series)", Springer; 2001 edition (28 February 2001), ISBN-13: 978-0834217812
2. Bela G. Liptak , "Instrument Engineers' Handbook, Process Control and Optimization", CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.
3. Robert H. Brown, " CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE)", CRC Press; 1 edition (30 June 1988), ISBN-13: 978-084933862

OE 4202B: Advanced Digital Signal and Image Processing

Teaching Scheme
Lectures: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50
Marks Credit: 3

Prerequisites: Basics of Digital Signal and Digital Image Acquisition

Course Objectives:
1. To study concepts and properties of Multirate DSP.
2. To learn concepts of Adaptive Filters.
3. To learn basic concepts and enhancement technique of Digital Image.
4. To study various applications of digital image processing in biometrics.

1. Identify types of digital signal and system based on the characteristics of different digital signals and systems
2. Apply Z Transform to find the solution of finite difference equation.
3. Analyze discrete time systems using Fourier Transform to find the frequency characteristics
4. Design FIR filters using the principles of digital signal processing for various applications.
5. Design IIR filters using the principles of digital signal processing for various applications.

Course Outcomes: The student will be able to
1. Apply the basic concepts of Multirate DSP for given application
2. design of adaptive filters.
3. apply concepts of Digital image processing for advanced systems.
4. apply various image enhancement techniques for real time applications.

Unit 1: Multirate digital signal processing **(06)**
Basic multirate operation (up sampling, down sampling), Efficient structures for decimation and interpolation, Decimation and interpolation with polyphase filters,Noninteger sampling rate conversion , Efficient multirate filtering Applications.

Unit 2: Stochastic Processes and Spectral estimation **(06)**
Introduction, WSS signals and linear systems, spectral factorization, models of stochastic processes Spectral estimation: Periodogram‐based nonparametric methods: Periodogram, Bartlett's method, Welch's method, Blackman‐Tukey method. Parametric methods for power spectrum estimation: AR,MA and ARMA modeling.

Unit 3: Adaptive filtering **(06)**
Principles of Adaptive filtering , LMS and RMS Algorithms, Applications in noise and echo cancellation, Homomorphic Signal Processing , homomorphic system for convolution, properties of complex‐spectrum, Applications of homomorphic deconvolution.

Unit 4:Fundamentals of Digital Image Fundamentals **(06)**
Digital image representation, fundamental steps in image processing, Elements of digital image processing systems, Image fundamentals: Gray, Colour and Black and white. Color image models : RGB, CMY, HIS, etc models. Various Image Format, Sampling and quantization, Relationship between pixels, Statistical parameters (w.r.t. DIP) : Mean, standard deviation, variance, SNR, PSNR etc.

Unit 5: Image Enhancement **(06)**

Enhancement by point processing, spatial filtering, enhancement in the frequency domain. Contrast intensification: linear stretching, non-linear stretching, histogram specification, low contrast stretching. Smoothing: Image averaging, mean filter, order statistics filter, edge preserving smoothing. Sharpening: High pass filtering, homomorphic filtering.
Image Transforms: Basic transformations, Perspective transformation, 2-D Transforms: Fourier transform, Discrete cosine transform, Short time Fourier transform, Gabor transform, Radon transform, SVD, Wavelet Transforms, Hough Transform, Watershed Transform

Unit 6: Image segmentation and Image Compression (06)
Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Introduction Classifiers. Introduction to image compression.

Text Books:
1. J. Proakis , Charles M. Rader, Fuyun Ling, Christopher L. Nikias, Advanced Digital Signal Processing, (Macmillan Coll Div) (1992)
2. Glenn Zelniker, Fred J. Taylor, Advanced Digital Signal Processing, (CRC Press) (1994)
3. Gonzalez and Woods, Digital Image Processing with Matlab, Pearson Education,
4. Arthur Weeks Jr., Fundamentals of Digital Image Processing, Prentice-Hall International.

Reference Books:
1. A.V.Oppenheim and R.W.Schafer, Discrete time Signal Processing, (Prentice Hall) (1992)
2. Haykins, Adaptive Filter theory, (Prentice Hall) (1986)
3. Madhuri Joshi, Digital Image Processing, Prentice-Hall International.
4. A.K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.
5. K. R. Castleman, Digital Image Processing, Prentice-Hall International.
6. Pratt William, Digital Image Processing, John Wiley & Sons

OE 4201C: System On Chip

Teaching Scheme
Lectures: 3 Hr/Week

Examination Scheme
In Semester: 50 Marks
End Semester:50
Marks Credit: 3

Prerequisite: Basics of MEMS
Course Objective: The students will,
1. study the various microfabrication processes and the materials used for microfabrication.
2. learn characterization of MEMS sensors like pressure and gas
3. understand the concept of micro fluidics and micro reactor

Course Outcome: The student will be able to
1. list and define the various microfabrication processes
2. compare to select the materials for micro fabrication
3. design and develop the engineering stages involved in MEMS sensor and microfludics
4. To analyze the performance of the designed MEMS sensor

Unit 1: Microfabrication Process – Lithography **(06)**
Types of Lithography – photo, e-beam, X-ray; Soft Lithography

Unit 2: Microfabrication Process – Direct write, Pattern transfer **(06)**
Direct write – focused ion beam, Laser; Pattern transfer – etching types – wet and dry

Unit 3: Material used for Microfabrication **(07)**
Study of various materials used for micro fabrication – Si, GaAs, Si_3N_4, SiO_2, Au, Pt, Ti; Polymers – PMMA, PTFE, Polyaniline, SU8, Polystyrene, PDMS

Unit 4: Device Engineering I **(06)**
Pressure sensor, Gas sensor – Design, Material selection, Modelling

Unit 5: Device Engineering II **(07)**
Study of microfluidics – definition, techniques involved, advantages and applications; Study of micro reactor – definition, types

Unit 6: Characterization **(06)**
Various principles, tools and methods involved in characterization of MEMS sensors

Text Books:
1. Introduction to Microfabrication by Sami Franssila
2. Foundation of MEMS by Chang Liu 2nd Ed.
3. Fundamentals and Applications of Microfluidics by Nam-Trung Nguyen, Steven T. Wereley 2nd Ed.

Reference Books:
1. Microsystem Design by Stephen D. Senturia

IN 4202: Process Data Analytics Lab

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
Oral: 50 marks
Credit: 1

Prerequisite: Concepts of Mathematics and Computational techniques

Course Objectives:
1. To explore the statistical analysis techniques for various kinds of data.
2. To understand the concepts and types of Artificial Intelligence and Machine Learning Algorithms.
3. To be familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms.

Course Outcomes: The student will be able to
1. Compare standard statistical procedures for data analysis.
2. Select appropriate data analysis techniques and tools for given data.
3. Analyze the given process industry data using various data analysis techniques and tools.
4. Evaluate the data analysis technique and tool used for data analysis.

List of Experiments: (students are expected to perform any 8 experiments)
1. Introduction to linear and multiple regression function in MATLAB
2. Applying linear & multiple regression to process data from a typical process plant
3. Implement ANOVA for a database
4. Data Analysis using K nearest neighbour Regression
5. Introduction to programming in R
6. Linear regression in R
7. Implementation of Neural Networks for standard data set
8. Implementation of Fuzzy logic for classification of standard data set
9. Implement a classifier for application in field of process industry using data from a standard source

IN 4203: Project Phase II

Teaching Scheme
Tutorial: 2 Hr/Week
Practical: 16 Hr/Week

Examination Scheme
In semester: 100 Marks
Oral: 50 Marks
Credit: 10

Course Outcomes: The student will be able to

1. Identify and define technical problem related to various fields.
2. Implement and test the designed stages involved in solving the defined problem statements.
3. Work in a team and abide by the norms of professional ethics.
4. Prepare and present technical documentation of the developed system.

The students are expected to work in suitable size groups. The work contribution of each group member should be approaching towards the final solution. The work should be completed in the stipulated time.