COURSE STRUCTURE AND SYLLABUS FOR M.TECH. DEGREE PROGRAMME IN INSTRUMENTATION TECHNOLOGY

(Applicable from 2021 Admission)

DEPARTMENT OF INSTRUMENTATION

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

COCHIN - 682022

DEPARTMENT OF INSTRUMENTATION

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

M. Tech. in Instrumentation Technology

Course Structure and Syllabus

Programme Educational Objectives

PEO1: To equip the graduates with adequate skill and knowledge in the area of instrumentation technology so as to excel in their jobs in advanced industries, teaching and research.

PEO2: To transform the engineering graduates to experts in the area of instrumentation technology, to analyze and design novel products and solutions for the modern industry.

PEO3: To train the engineering graduates to improve communication skill, exhibit professionalism and hence to work in a team.

Programme outcomes

PO1: Enhance the ability in the area of instrumentation technology and hence utilize the same for evaluating, modelling and analyzing various engineering problems in the area.

PO2: Equip the students to select modern engineering tools and techniques and use them with dexterity.

PO3: Develop the ability to analyze various problems in the field of instrumentation leading to better solutions than the existing solutions

PO4: Develop the ability to propose feasible and optimal solutions for the industry problems giving due consideration for safety, economy and environmental factors.

PO5: Develop skills to design, develop and propose theoretical and practical methodologies for carrying out detailed research in the area of instrumentation.

PO6: Develop willingness and ability to take up administrative challenges including management of various interdisciplinary projects.

PO7: Develop the ability to communicate clearly and effectively, adhering to various standards and practices for documentation and presentation.

PO8: Develop the ability to maintain a lifelong learning process by way of participating in various professional activities.

PO9: Develop willingness and ability to upkeep professional ethics and social values in career.

Curriculum for M.Tech. in Instrumentation Technology

Semester I

Sl. No.	Course code	Name of the course	Core/Elective	Credits	Hours per week			Marls
					L	T	P	
1	21-473-0101	Intelligent Techniques in Instrumentation	C	3	4			100
2	21-473-0102	Advanced Sensor Technology	C	3				100
3	21-473-0103	Adaptive and Robust Control	C	4	4	1		100
4	21-473-0104	Sensor Technology Lab	C	1			3	50
5	21-473-0105	Control system and Computing Lab	C	1			3	50
6		Elective - I	E	3				100
7		Elective - II	E	3				100
Total				18				600

List of Electives

1. 21-473-0106 Advanced Digital Signal Processing
2. 21-473-0107 Process Dynamics and Control
3. 21-473-0108 Advanced Analytical Instruments
4. 21-473-0109 Optimisation Techniques
5. 21-473-0110 Robotics and Automation
6. 21-473-0111 Non Linear Control Systems
7. 21-473-0112 Advanced Biomedical Instruments

Semester II

Sl. No.	Course code	Name of the course	Core/Elective	Credits	Hours per week			Marls
					L	T	P	
1	21-473-0201	Multi-sensor Data Fusion	C	3	4			100
2	21-473-0202	Wireless Sensor Networks	C	3	3	1		100
3	21-473-0203	Seminar	C	1			3	50
4	21-473-0204	Soft computing Lab	C	1			3	50
5	21-473-0205	Advanced Process control Lab	C	1			3	50
6		Elective - III	E	3				100
7		Elective - IV	E	3				100
8		Elective V	E	3				100
Total				18				650

List of Electives

1. 21-473-0206 Digital Image Processing
2. 21-473-0207 Mechatronics

3. 21-473-0208 MEMS and Microsystems
5 21-473-0209 Optoelectronics and Instrumentation
6. 21-473-0210 Non Destructive Testing and Analysis.
7. 21-473-0211 Navigation Guidance and Control
8. 21-473-0212 Embedded System Design
9. 21-473-0213 Remote Sensing and Geographical Information Systems
10. 21-473-0214 Internet of Things.

Semester III

Sl. No.	Course code	Name of the course	Core/Elective	Credits	Marls
1	21-473-0301	Open Elective- I*	E	3	100
2	21-473-0302	Project Progress Evaluation	C	15	400
Total				18	500

Semester IV

Sl. No.	Course code	Name of the course	Core/Elective	Credits	Marls
1	21-473-0401	Open Elective - II*	E	3	100
1	21-473-0402	Project Dissertation Evaluation	C	15	400
Total				18	500

* The students shall select these courses from the list of courses available from approved national agencies such as SWAYAM, subject to the approval of the department council. The students are responsible to pay the course fee, if any, attend these online courses, pass the exam and produce the certificate. The percentage of marks/credit will be given according to the marks obtained in the above examination.

Total credits for the course = 18+18+18+18 = 72

Syllabus for M.Tech. in Instrumentation Technology

21-473-0101 INTELLIGENT TECHNIQUES IN INSTRUMENTATION

Course Outcomes:

On completion of this course the student will be able to:

CO1: Describe and Illustrate the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and their limitations.

CO2: Select appropriate learning rules for each of the architectures and recognise several neural network paradigms and its applications

CO3: Examine the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.

CO4: Illustrate the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.

CO5: Outline the concept of genetic algorithm and its applications.

CO6: Illustrate and Compare the various Swarm Intelligent Techniques its applications.

CO7: Construct different applications of these models to solve engineering and other problems.

MODULE 1

Introduction to ANNs: Classical AI and Neural Networks, Human brain and the biological neuron, Artificial Neurons, Neural Networks and architectures, feed forward and feedback architectures, geometry of binary threshold neurons and their networks, Supervised and unsupervised learning, concepts of generalization and fault tolerance Supervised learning: Perceptrons and LMS, Back propagation Neural Networks, Fast variants of Back propagation

MODULE 2

Statistical pattern recognition perspective of ANNs: Bayes theorem, Implementing classification decisions with the Bayes theorem, interpreting neuron signals as probabilities, Multilayered networks, error functions, posterior probabilities, error functions for classification problems, Support vector machines, RBFNNs, regularization theory, learning in RBFNNs, Image classification application, PNNs

MODULE 3

Recurrent Neural Networks: Dynamical systems, states, state vectors, state equations, attractors and stability, linear and non linear dynamical systems, Lyupanov stability, Cohen

Grossberg theorem, Attractor neural networks: Associative learning, associative memory, Hopfield memory, Simulated annealing and the Boltzmann Machine, BAM, ART principles, Self Organizing Maps.

MODULE 4

Fuzzy Systems: Fuzzy sets, Membership functions, Measures of fuzziness, Fuzzification and defuzzification, Fuzzy relations, Neural Networks and Fuzzy logic, Fuzzy neurons, Fuzzy perceptron, Fuzzy classification networks using Backpropagation, Fuzzy ART

MODULE 5

Genetic algorithms and Evolutionary programming: Genetic algorithms – operators, working, Genetic algorithm based machine learning classifier system. Swarm Intelligent Systems: Ant Colony Systems (ACO): Biological concept, artificial systems - Applications, Particle Swarm Intelligent Systems – PCO method, Applications.

Text Books

1. Neural Networks, A Class room approach, Satish Kumar, Tata McGraw Hill, 2004
2. Artificial Intelligence and Intelligent Systems, N.P Padhy, Oxford University Press, 2005.

References

1. Introduction to Artificial Systems, J M Zurada, Jaico Publishers
2. Neural Networks –A Comprehensive Foundation, Simon Haykins, PHI
3. Advanced Methods in Neural Computing, Wasserman P.D, Van Nostrand Reinhold, NewYork.
4. Fuzzy Logic with Engineering Applications, Timothy J. Ross: TMH
5. Methods of Optimization”. G. R Walsh, John Wiley & Sons.
6. Fuzzy Logic and Genetic Algorithms, Rajasekharan & Pai Neural Networks, PHI
7. Artificial Intelligence, Elaine Rich, Kevin Knight, Tata McGraw Hill, 2006
8. Artificial Neural Networks, Yegnanarayana, PHI, 1999
9. Introduction to Artificial Intelligence, E.Cherniak, D. McDermott, Addison – Wesley Pub. 1987
10. Fundamentals of Neural Networks- Architectures, Algorithms and Applications- L. Fausett, Pearson Education, 2007.

21-473-0102 ADVANCED SENSOR TECHNOLOGY

Course Outcomes:

On completion of this course the student will be able to:

CO1: Use basic concepts for converting chemical parameters into electrical quantities.

CO2: Design and develop sensors using optical methods.

CO3: Design and develop instruments for biophysical sensing of human body.

CO4: Evaluate the performance and maintenance of biomedical sensors.

CO5: Provide design solutions for sensors in space and environmental applications.

MODULE 1

Chemical Sensors: Blood –Gas and Acid –base physiology Electrochemical sensors, Chemical Fibro sensors, Iron-Selective Field-Effect Transistor (ISFET), Immunologically Sensitive Field Effect Transistor (IMFET) , Integrated flow sensor and Blood Glucose sensors.

Optical Sensors: Fiber optic light propagation, Graded index fibers, Fiber optic ommunication driver circuits, Laser classifications, Driver circuits for solid –state laser diodes, Radiation sensors and Optical combinations.

MODULE 2

Biomedical Sensors: Sensors Terminology in human body, Introduction, Cell, Body Fluids Musculoskeletal system, Bioelectric Amplifiers, Bioelectric Amplifiers for Multiple input Circuits, Differentional Amplifiers, Physiological Pressure and other cardiovascular measurements and devices.

MODULE 3

Electrodes: –Electrodes for Biophysical sensing, Electrode model circuits, Microelectrodes, ECG,EEG,electrodes ECG signals, waveforms, Standard lead system, Polarization Polarizable, Non polarizable electrodes and body surface recording electrodes. Ultrasonic Transducers for Measurement and therapy – radiation detectors – NIR spectroscopy.

MODULE 4

Advanced Sensor Design: Fluoroscopic machines design, Nuclear medical systems, EMI to biomedical sensors, types and sources of EMI, Fields, EMI effects. Computer systems used in Xray and Nuclear Medical equipments. Calibration, Typical faults, Trouble shooting, Maintenance procedure for medical equipments and Design of 2& 4 wire transmitters with 4 – 20 mA output.

MODULE 5

Aerospace Sensor: Laser Gyroscope and accelerometers. Sensors used in space and environmental applications.

Text Books

1. Sensors Hand Book *Sabaree Soloman - Sensors Hand Book*, McGraw Hill,1998
2. Smith H.M. - *Principles of Holography*, John Wiley & Sons, New York, 1975
3. J.G. Webster *Medical instrumentation Application and Design,* Houghton Mifilin Co. 2004

References

1. Carr and Brown - *Introduction to Medical Equipment Technology*, Addison Wesley. 1999
2. Culshaw B and Dakin J (Eds) *Optical Fibre Sensors, Vol. 1 & 2 Artech House*, Norwood. (1989)-
3. P. Garnell– *Guided Weapon Control Systems* – Pergamon Press. 1980

21-473-0103 ADAPTIVE AND ROBUST CONTROL

Course Outcomes:

On completion of the course students will be able to:

CO1: Describe the different methods for system identification that constitute building models, design identification experiments and model validation.

CO2: Account for and apply stochastic concepts used in system identification methods and to explain different model structures and their necessity in engineering practice.

CO3: Describe and show working knowledge of identification methods like least squares method and prediction error method, and describe the principles behind recursive estimation and its application.

CO4: Describe and the design of different deterministic adaptive controllers including self tuning controllers and auto tuning of PID controllers.

CO5: Account for the design of adaptive smith predictor, pole placement controller, and different non-deterministic controllers.

CO6: Describe the basic principles of robust control system design.

CO7: Account for frequency domain and state space formulation of robust stabilization.

MODULE 1

System Identification: Introduction, dynamic systems, models, system identification procedure. Simulation and Prediction. Non-parametric time and frequency domain methods. Linear dynamic system Identification: Overview, excitation signals, general model structure, time series models, models with output feedback, models without output feedback. Convergence and consistency.

MODULE 2

Parameter estimation methods, minimizing prediction errors, linear regressions and Least squares method, Instrumental – variable method, prediction error method. Recursive algorithms. Closedloop Identification.

MODULE 3

Adaptive Control: Close loop and open loop adaptive control. Self-tuning controller. Auto tuning for PID controllers: Relay feedback, pattern recognition, correlation technique.

MODULE 4

Adaptive Smith predictor control: Auto-tuning and self-tuning Smith predictor. Adaptive advanced control: Pole placement control, minimum variance control, generalized predictive control.

MODULE 5

Robust control. Definition and problem statement, the H(n) norm, $H\infty$ norm, frequency domain formulation, state space formulation robust stabilization H2 optimal control, $H\infty$ control.

Text Books

1. Ljung .L, System Identification: Theory for the user, Prentice Hall, Englewood Cliffs.
2. Astrom .K, Adaptive Control, Second Edition, Pearson Education Asia Pte Ltd.

References

1. Chang C. Hong, Tong H. Lee and Weng K. Ho, Adaptive Control, ISA press, Research Triangle Park.
2. Nelles. O, Nonlinear System Identification, Springer Verlag, Berlin.

21-473-0104 SENSOR TECHNOLOGY LAB

Course Outcomes:

After the completion of the lab the student will be able to:

CO1: Obtain response characteristics of various sensors and transducers.

CO2: Evaluate the performance of various sensors.

CO3: Design and implement programmes in LabView.

Co4: Acquire sensor data with LabView software using different interfacing hardware.

List of experiments

1. Familiarisation of LabVIEW
2. Creating Virtual Instrumentation for simple applications
3. Programming exercises for loops, clusters, charts and graphs
4. Programming exercises on case and sequence structures, file Input / Output.
5. Developing voltmeter using DAQ cards.
6. Developing signal generator using DAQ cards.
7. Response characteristics of thermistor
8. Current measurement using Hall effect transducer
9. Controller using optical transducer (LDR)
10. Response characteristics and coefficients of RTD
11. Phase detection electronics circuit for capacitive transducer with 7556 dual timer
12. Active bridge circuit, active low and high pass filter
13. LABVIEW and DAQ card for LVDT transducer, pressure measurement at remote location using RFID activated transducer.

Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers.

21-473-0105 CONTROL SYSTEM AND COMPUTING LABORATORY

Course Outcome:

After the completion of the lab the student will be able to

CO1: Use the software MATLAB and MATLAB Control System Toolbox

CO2: Represent physical systems as transfer functions and derive open loop and closed loop transfer functions

CO3: Compare first order and second order systems and its performance

CO4: Design control components like PID controller, compensator etc.

List of experiments: (8 -10 experiments to be done)

1. Familiarization with MATLAB and MATLAB Control System Toolbox.
2. Transfer functions
3. Time domain analysis and steady state errors
4. Proportional Integral Derivative Control
5. Stability analysis using Bode plots and Nyquist plots
6. State Space analysis - Controllability, Observability and system gain
7. Pole placement and Root locus
8. Compensation design using Lag, Lead compensators
9. Compensators using Lead – Lag approaches
10. Models of Practical systems like electric Power System
11. Familiarization of digital Control System Analysis
12. Analysis of stability in digital domain.

Text Book

1. D. Frederick and J. Chow, Feedback control problems using MATLAB, Brooks/Cole Thomson Learning, 2000

References

1. MATLAB documentation.
2. Control System Tool Box documentation
3. Ogata Modern Control Engineering, Tata McGraw Hill, 1998

21-473-0106 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	1	-	3

Curse Outcomes:

On completion of this course, the students will be able to:

CO1: Explain multirate signal processing techniques, its application and design a sampling rate convertor

CO2: Explain the principle of adaptive filtering and its applications

CO3: Explain the architecture of different types of DSP processors

CO4: Compare and contrast different advanced techniques for spectrum estimation

CO5: Compare and contrast LMS and RLS adaptive filters

CO6: Develop DSP algorithms on a general purpose DSP processor.

MODULE 1

Review of Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT) and Discrete Cosine Transform (DCT). Convolution and Correlation. Time frequency analysis and its need. Short time Fourier Transform.

MODULE 2

Multirate digital signal processing: Basic multirate operations. Efficient structures for decimation and interpolation. Decimation and interpolation and interpolation with polyphase filters. Sampling rate conversion by non-integer factor. Design of practical sampling rate converters. Multirate filtering applications.

MODULE 3

Spectrum Estimation and Analysis: Principles of spectrum estimation. Periodogram method, modified Periodogram methods, the Blackman-Tukey methods, fast correlation method. Autoregressive spectrum estimation: Autoregressive model and filter. Power spectrum density of AR series. Some practical applications.

MODULE 4

Adaptive Filtering: Principles of adaptive filtering. Least mean square (LMS) adaptive algorithm its implementation and limitations. Recursive least square (RLS) adaptive algorithm, its implementation and limitations. Basic Wiener filter theory. Applications of adaptive filters in noise cancellations, echo cancellation.

MODULE 5

Digital Signal Processors: Basic computer architectures for signal processing. General purpose digital signal processors; fixed point digital signal processors and floating point digital signal processors. Implementation of DSP algorithms on general purpose digital signal processors.

Text Books

1. Emmanuel C. Ifeachor and B. W. Jervice, “ Digital Signal Processing”, Pearson Education, New Delhi.

2. Li Tan, “Digital Signal Processing” Published by Elsevier Inc., New Delhi.

References

1. B. Widrow and S. D Stearns, “Adaptive Signal Processing”, Pearson Education, New Delhi.

2. Simon Hykins, “Adaptive Filter Theory”, Prentice Hall, New Jersey.

21-473-0107 PROCESS DYNAMICS AND CONTROL

L	T	P	C
3	1	-	3

Curse Outcomes:

On completion of this course, the students will be able to:

CO1: Obtain mathematical models of industrial processes from fundamental principles.

CO2: Explain various controller modes and their effects.

CO3: Enumerate various control schemes for typical industrial processes.

CO4: Describe the operational principles of actuators and control valves.

CO5: Explain selection of type of controller including advanced control schemes.

CO6: explain various issues of plant wide control and interaction of plant design and control system design.

MODULE 1

Review of Process and Control Systems:

Control Systems, Process control principles, servomechanism, Process control block diagram, identification of elements, Dynamics of liquid process, gas process, flow process, thermal process, mixing process - Batch process and continuous process - Self regulation.

MODULE 2

Design aspects of Process Control System

Classification of variables, Design elements of a control system, control aspects of a process. The input – output model, degrees of freedom and process controllers. Modes of operation of P, PI and PID controllers. Effect of variation of controller variables. Typical control schemes for flow, pressure, temperature and level processes.

MODULE 3

Control System components:

I/P and P/I converters - Pneumatic and electric actuators - valve positioner - control valve Characteristics of control valve - valve body - globe, butterfly, diaphragm ball valves - control valve sizing - Cavitation, flashing in control valves - Response of pneumatic transmission lines and valves. Actuators – Pneumatic, Hydraulic, Electrical/ Electronic.

MODULE 4

Dynamic behavior of feedback controlled process:

Stability considerations. Simple performance criteria, Time integral performance criteria: ISE, IAE, ITAE, Selection of type of feedback controller. Logic of feed forward control, problems in designing feed forward controllers, feedback control, Ratio Control, Cascade

Control, Over ride control, auctioneering control, split range control. Processes with large dead time. Dead time compensation. Control of systems with inverse response.

MODULE 5

Introduction to plant wide control:

Plant wide control issues, hypothetical plant for plant wide control issues, internal feedback of material and energy, interaction of plant design and control system design.

Text Books

1. Curtis Johnson, *Process Control Instrumentation Technology* , Prentice Hall of India. 1996
2. George Stephanopoulos, *Chemical Process Control*, Prentice Hall of India. 2005
3. Caughanour and Koppel, *Process systems analysis and control*, Tata McGraw Hill. 1991

References

1. Dale E. Seborg, *Process Dynamics and Control*, John Wiley. 2009
2. Eckman D.P, *Automatic process control*, Wiley Eastern, 1986
3. Peter Harriot, *Process control*, Tata McGraw Hill. 1964.
4. Patranabis D, *Principles of process control*, Tata McGraw Hill. 2000.
5. F.G. Shinkskey, *Process controls Systems*, McGraw Hill. 1986.

21-473-0108 ADVANCED ANALYTICAL TECHNIQUES

L	T	P	C
3	1	-	3

Curse Outcomes:

On completion of this course, the students will be able to:

CO1: Give an account of various methods of analysis using x-rays.

CO2: Explain the instrumentation and analysis of different spectroscopic methods.

CO3: Outline the principles and technics of advanced analytical methods.

CO4: Explain the methods and applications of advanced microscopy techniques.

CO5: Comprehensively analyse biosensors, microchip technology, HPLC etc.

MODULE 1

X-ray methods of analysis -Basic principles -Sources -Detectors X-ray absorption methods - X-ray fluorescence technique-X-ray diffraction methods - Electron probe microanalysis.

MODULE 2

Electron and ion Spectroscopy -X-ray and UV photoelectron spectroscopy -ESCA - Electron impact spectroscopy -Auger electron spectroscopy -Ion scattering spectroscopy - Ion scattering spectroscopy -Rutherford back scattering -0 Principles - Instrumentation and analysis.

MODULE 3

Advanced topics in magnetic resonance spectrometry -Fourier transform techniques - Nuclear quadruple resonance spectroscopy -Cl3 NMR- 2nd NMR -Advanced topics in mass spectrometry -Quadruple mass analyser- ESR Spectroscopy - Experimental Techniques, Analysis, Applications.

MODULE 4

Electron microscopy- TEM = SEM -Principles, instrumentation and analysis, Scanning tunneling microscopy, Atomic force microscopy -Principles, instrumentation and analysis - Applications. Photoacoustic and photothermal spectrometers -Principles and instrumentation spectroflourimeters and phosphorimeters -Electrochemical instruments - Conductivity, meters - Coulometers -Amperometers -Radiochemical instruments.

MODULE 5

Flow injection and sequential injection analysis - Biosensor and microchip technology - Microfluidics Lab on Chip - GLMS Instrumentation - HPLC

Text Book

1. Willard, Merrit, Dean and Settle -Instrumental Methods of Analysis -CBS. ;I 2. G. W. Ewing- Instrumental methods of chemical analysis -McGraw Hill.

References

1. A. Skoog and M. West -Principles of Instrumental analysis -Hall Sanders International

2. R.S. Khandpur -Handbook of Analytical instruments - Tata McGraw Hill.

3. Jack Cazes - Analytical Instrumentation Handbook, Third Edition November 30, 2004 by CRC Press ISBN 9780824753481

21-473-0109 OPTIMIZATION TECHNIQUES

L	T	P	C
3	1	-	3

Curse Outcomes:
On completion of this course, the students will be able to:

CO1: Give an account of optimisation problem of single variable and multivariable functions.

CO2: Solve constrained optimisation problems using different methods.

CO3: Explain dynamic programming for multistage optimisation.

CO4: Solve multi-objective problems.

CO5: Give an account of Stochastic optimisation and genetic algorithms.

CO6: Give an account of ant colony optimisation and particle swam optimisation.

CO7: Write programmes to solve sample optimisation problems.

MODULE 1.

Introduction to optimization, functions of single variable, functions of several variables, formulation of optimization problems. Review of classical methods, linear programming, nonlinear programming.

MODULE 2

Constraint optimality criteria, constrained optimization, constraint direct search method, linearization methods for constrained problems, transformation method. Nonlinear programming: problem formulation, Quadratic Approximation Methods for Constrained Problems Unconstrained minimization techniques.

MODULE 3

Dynamic programming: sub-optimization, multistage optimization problem. Multi-objective and goal programming: problem formulation, solution of a multi-objective problem. Case studies

MODULE 4

Introduction to Stochastic Optimization Techniques, types: Local Search, Population Based, Introduction to Genetic Algorithms, Motivation from Nature, Genetic Algorithms: Working Principle: Representation, Fitness Assignment, Reproduction, Crossover, Mutation, Constraint Handling, Real Parameter Genetic Algorithms, Combined Genetic Algorithm, Advanced Genetic Algorithms, Applications.

MODULE 5

Ant Colony Optimization: Introduction, Ant System, Ant Colopny System, ANTS, Significant Problems, Convergence Proofs. Discrete Particle Swarm Optimization (PSO):

Introduction, PSO Elements: Position and State Space, Objective Function, Velocity, PSO Algorithm, Examples and Results, Applications.

Text Books

1. Singiresu S. Rao, ‘Optimization Techniques’, New Age International Publishers.
2. D. P. Kothari and J. S. Dhillon, ‘Power System Optimization, Tata McGraw Hill.

References

1. C. Mohan and Kusum Deep, ‘Optimization Techniques, New Age International Publishers.
2. Godfrey C. Onwubolu, B. V. Babu, “New Optimization Techniques in Engineering”, Springer-Verlag.
3. Marco Dorigo, Thomas Stützle, “Ant colony optimization”, MIT Press.
4. Thomas Wiesi, “Global Opimization Algorithms”, ebook. http://www.it-weise.de/.

21-473-0110 ROBOTICS AND AUTOMATION

L	T	P	C
3	1	-	3

Course Outcomes:

On completion of this course the student will be able to:

CO1: Define the terms used in robotics and Identify components used in robots.

CO2: Describe robot configuration

CO3: Select appropriate sensors for Robot applications. Interpret the sequence tasks in robotic control.

CO4: Utilize kinematics analysis of robotic manipulators and Perform Workspace analysis of a Robotic System.

CO5: Describe the Differential Motion and Statics of robotic manipulators

CO6: Describe simple grippers and actuators.

CO7: Illustrate the applications of robots in various industrial applications.

MODULE 1

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.

MODULE 2

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.

MODULE 3

Manipulators, Actuators and Grippers: Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

MODULE 4

Kinematics and Path Planning: Solution of inverse kinematics problem – multiple solution jacobian work envelop – hill climbing techniques – robot programming languages.

MODULE 5

Case Studies: Multiple robots – machine interface – robots in manufacturing and nonmanufacturing 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 Integr*ation, 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

3. Klafter R.D., Chimielewski T.A., Negin M *Robotic Engineering – An integrated approach,* Prentice Hall of India, New Delhi. 1994

4. Mc Kerrow P.J. *Introduction to Robotics*, Addison Wesley, USA. 1991

5. Issac Asimov I *Robot Ballantine Books*, New York. 1986

21-473-0111 NONLINEAR CONTROL SYSTEMS

L	T	P	C
3	1	-	3

Course Outcomes:

On completion of the course, the students will be able to:

CO1 Identify and interpret various types of nonlinearities present in physical systems.

CO2 Illustrate concepts from nonlinear control systems such as phase plane analysis, stability, limit cycles and describing functions.

CO3 Assess the stability of nonlinear control systems utilizing the concepts of Lyapunov theory.

CO4 Illustrate concepts of feedback linearization and examine the I/O linearization of SISO and MIMO systems.

CO5 Explain different concepts of sliding mode control utilizing practical examples from VSSC.

CO6 Examine the control of multi input physical systems considering specific examples in adaptive robot trajectory control and attitude control.

MODULE 1

Introduction: Nonlinear system behaviour, concepts of phase plane analysis, singular points, constructing phase portraits, phase plane analysis of non linear systems, existence of limit cycles, concepts of stability, describing function analysis – assumptions and definitions, describing functions of common nonlinearities.

MODULE 2

Lyapunov theory: Lyapunov direct method, positive definite functions and lyapunov functions, invariant set theorems, lyapunov analysis of linear time invariant systems, the variable gradient method, performance analysis, control design based on lyapunov's direct method, Lyapunov analysis of non autonomous systems, existence of Lyapunov functions.

MODULE 3

Feedback Linearization: Feedback linearization and the canonical form, Input – state linearization, input – output linearization of SISO and MIMO systems.

MODULE 4

Sliding Control: Sliding surfaces, continuous approximations of switching control laws, modeling performance trade offs, VSSC – examples.

MODULE 5

Control of multi input physical systems: Adaptive robot trajectory control, spacecraft control, attitude control.

Text Book

1. R. Marino and P. Tomei *Nonlinear control design - Geometric, Adaptive and Robust*,Prentice Hall,1995

References

1. J.J.E.Slotine and W.Li *Applied Nonlinear control*, Prentice Hall, 1998
2. Alberto Isidori *Non linear Control systems*, Springer Verlag, , 1999

21-473-0112 ADVANCED BIOMEDICAL INSTRUMENTS

L	T	P	C
3	1	-	3

Course Outcome:

On completion of the course the student will be able to:

CO1 Evaluate and analyse the behaviour of bioelectric potentials

CO2 Describe various X-ray imaging techniques.

CO3 Explain Ultrasonic imaging systems

CO4 Identify laser application in the biomedical field

CO5 Employ instrumentation in computer aided diagnosis

MODULE 1

Development of Biomedical Instrumentation, biometrics, Man-instrument system-components-block diagram, Physiological systems of the body (brief discussion), Problems encountered in biomedical measurements. Sources of bioelectric potentials – resting and action potentials –propagation of action potentials bioelectric potentials- examples (ECG, EEG, EMG, ERG, EOG, EGG, etc.) Biopotential electrodes–theory-microelectrodes- skin surface electrodes- needle electrodes biochemical transducers- transducers for biomedical applications.

MODULE 2

Heart-Iung machine -Artificial heart valves -Pacemakers and Defibrillators - Anaesthesia machine -0 .Blood cell counter -digital thermometer -Audiometer - Electron Microscope -up based ventilator biomaterials.

X- ray machine -Radiography, fluoroscopy -image intensifiers -Conventional X-ray Imaging - Angiography -Computed tomography -linear tomography -tomography scanner-applications. Magnetic Resonance Imaging systems -Basic NMR components.

MODULE 3

Ultrasonic imaging systems -Physics of ultrasonic waves, medical ultrasound. construction of an ultrasonic transducer. different modes of operations of ultrasound -A scan, B scan - Echocardiograph (M mode), Real time ultrasonic imaging system, Computer controlled ultrasonic imaging - Applications.

MODULE 4

Laser application in machine -Laser- Pulsed Ruby Laser, Nd- AG laser, Argon Laser, C02 laser, Helium-neon laser -applications -Advantages of laser surgery -Laser based Doppler blood flow meter- Endoscope -Cardio scope -Laproscope -Endoscopic laser coagulator cryogenic surgery. Medical thermography- Physics of themography.

MODULE 5

Medical thermography -Physics of theromography -Them1ographic equipment Quantitative medical thermography -Infrared, Liquid crystal and Microwave Thermography- Medical applications of thermography. Computer applications in Medicine - Computer aided ECG analysis- Computerized Catheterisation Laboratory -Computerised Patient monitoring system..

Text Books

1. Leslie Cromwel -Biomedical instrumentation and measurements -Prentice Hall.
2. L.A. Geddes and L.E. Baker -Principles of Applied biomedical instrumentation -John Wiley and sons.

References

1. B. Jacobson and J.G. Webster -Medicine and Clinical Engineering -Prentice Hall of. India
2. Macka Sturat Biomedical telemetering- John Wiley.
3. R.S. Khandpur -Handbook of biomedical engineering -Tata McGraw Hill.

21-473-0201 MULTISENSOR DATA FUSION

Course Outcomes: -

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

CO1: Recognize the elementary applications and techniques for data fusion in military and civilian systems.

CO2: Summarize the different data fusion models.

CO3: Explain the taxonomy of algorithms for multi sensor data fusion systems

CO4: Use Kalman filter in Data Fusion.

CO5: Illustrate the data information filters.

CO6: Illustrate high performance data structures.

CO7: Design and implement data fusion systems.

MODULE 1

Introduction

Sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

MODULE 2

Algorithms for Data Fusion

Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.

MODULE 3

Estimation

Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters. Decision level identify fusion. Knowledge based approaches.

MODULE 4

Advanced Filtering

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.

MODULE 5

High Performance Data Structures

Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

Text Books

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston.
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey.

References

1. Arthur Gelb, Applied Optimal Estimation, M.I.T. Press.
2. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company.

21-473-0202 WIRELESS SENSOR NETWORKS

Curse Outcome:

After the completion of this course, the students will be able to

CO1: Explain the Fundamental Concepts and applications of wireless sensor networks

CO2: Explain the architectures, functions and performance of wireless sensor network systems and platforms

CO3: Explain various network level protocols for MAC, routing, time synchronization, aggregation, consensus and distributed tracking and design issues.

CO4: Explain the various levels of information processing in wireless sensor network

CO5: Identify the research problems sensor networks pose in process control applications

CO6: Compare varies platforms and tools used in wireless sensor network.

MODULE 1:

Introduction: Introduction and overview of Wireless Sensor Networks (WSN), Commercial and Scientific Applications of WSN, Category of Applications of WSN, Challenges for WSN, Enabling Technologies for WSN.

MODULE 2 :

Architecture : Single node Architecture: Hardware Components, Energy Consumption of Sensor nodes, Operating Systems and Execution Environments, Examples of Sensor Nodes, Network Architecture: WSN Scenarios, Optimization Goals and figures of Merits, Design principles for WSNs, Service Interfaces for WSNs, Gateway Concepts.

MODULE 3:

Protocols: Physical Layer: Wireless Channel and Communication Fundamentals, Physical Layer & Transceiver Design Considerations in WSN, MAC Protocols: Fundamentals, MAC Protocols for WSNs, IEEE802.15.4 MAC Protocol, Routing Protocols: Gossip and agent based unicast protocols, Energy Efficient Unicast, Broadcast and Multicast, Geographic Routing, Transport Control Protocols: Traditional Protocols, Design Issues, Examples of Transport Protocols, Performance of Transport Control Protocols.

MODULE 4:

Information Processing: Sensor Tasking and Control: Information-Based Sensor Tasking, Joint Routing Information Aggregation, Sensor Network Databases: Challenges, Query Interfaces, In-Network Aggregation, Data Centric Storage, Data Indices and Range queries, Distributed Hierarchical Aggregation, Temporal Data.

MODULE 5:

Platform & Tools: Operating Systems for Sensor Networks: Introduction, Design Issues, Examples of Operating Systems, Node Level Simulators, Performance and Traffic

Management Issues: WSN Design Issues, Performance Modelling of WSNs, Emerging Applications and Future Research Directions.

Text Books

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", John wiley & Sons.
2. Holger Karl, Andreas Willig, "Protocols and architectures for wireless sensor networks", John wiley & Sons.

References

1. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks; An Information Processing Approach", Elsevier.
2. C. S. Raghavendra, Krishna M. Shivalingam, Taieb Znati, "Wireless sensor networks", Springer Verlag.

H. Edgar, Jr. Callaway, "Wireless Sensor networks, Architectures and Protocols", CRC Press.

21-473-0203 SEMINAR

Course Outcome:

After the completion of the course the students should be able to:

CO1: Carryout literature survey on new research areas.

CO2: Organise and illustrate technical documentation with sufficient literal standards.

CO3: Abide by professional ethics while reporting findings and stating claims.

CO4: Demonstrate communication skills through oral presentation using modern presentation tools.

All the students of II semester will be required to deliver a seminar on the topic relevant to recent trends in "Control and Instrumentation Systems" using power point presentation. Topics are selected in consultation with their supervisors. Presentation will be of 20 minutes duration followed by a question answer session before a duly constituted evaluation committee of Faculty Members of the department. A report of the seminar in the form of hard copy must also be submitted in the office after approval by the committee.

21-473-0204 SOFT COMPUTING LAB

Course Outcomes: -

At the end of this course, students will demonstrate the ability to:

CO1: Understand the fundamental theory and concepts of neural networks

CO2: Illustrate the soft computing techniques like neural network and fuzzy logic and their roles in building intelligent systems.

CO2: Illustrate and implement the various learning rules

CO3: Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.

CO4: Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic

CO5: Design and Implement real life examples using fuzzy logic and genetic algorithms

Course content:

The following experiments are to be demonstrated using any of the software tools like MATLAB, Python etc.

1. Write a program to implement Perceptron Training Algorithm.
2. Write a program to Implement Hebb's Rule
3. Write a program to Implement Delta Rule
4. Write a program to implement Back-propagation algorithm
5. Write a program to implement a Hopfield Net
6. Write a program to implement a BAM
7. Write a program to Implement PCA
8. Write a program to Implement SVM
9. Write a program for pattern classification / pattern recognition
10. Write a program to study Fuzzy Vs Crisp Logic.
11. Write a program to study and implement fuzzy set operations.
12. Write a program to illustrate the various fuzzy operations
13. Write a program to study and implement fuzzy relational operations.

14. Write a program to design and implement fuzzy temperature controller.
15. Write a program to design and implement Fuzzy Traffic light controller.
16. Write a program to study and implement the concept of Fuzzy C – means Clustering.
17. Write a program to implement Genetic Algorithms
18. Write a program to solve TSP (Travelling Salesman Problem) using genetic algorithm.

Text Books

1. S.N. Sivanandam, S. Sumathi, S.N. Deepa *Introduction to Neural Networks using MATLAB - Tata Mc Graw Hill 2006.*

2. *Willi Richert, Luis Pedro Coelho," Building Machine learning with python", Packt Publishing, 2013.*

References

1. Jyh Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani - *"Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning",* Prentice Hall. 1997

2. Chin –Teng Lin and C.S. George Lee - "*Neural Fuzzy Systems" – A neuro fuzzy synergism to intelligent systems* Prentice Hall International. 1996

3. Yanqing Zhang and Abraham Kandel - *"Compensatory Genetic Fuzzy Neural Networks and Their Applications"* World Scientific. 1998

21-473-0205 ADVANCED PROCESS CONTROL LAB

Course outcomes:

After completion of the course the student should be able to:

CO1: Design and simulate PID controller for various processes

CO2: Acquire and process data using different data acquisition systems

CO3: Tune the controllers with different methods.

CO4: Analyse and implement various advanced control loops.

CO5: Analyse the stability of process control systems.

CO6: Implement signal conditioning circuits.

8 -10 Experiments from Both Cycles (4-5 from each)

Cycle - I

1. Design and simulation of PID controller for Temperature process station.
2. To acquire and display a continuously changing physical variable in the system using Lab View/Matlab/ Custom software.
3. Program to implement online data processing and data logging.
4. Experimentation of a Multi process Trainer.
5. To implement discrete control strategy using both analog and digital Siemens PLC.
6. To study on the interface of PLC with PC for data acquisition applications.
7. To develop stand alone executable signal conditioning files as library files in LabView/Matlab.
8. Experimentation of Control loops for Inverted Pendulum.
9. Implementation of Digital PID Controller.
10. Signal Conditioning Circuit for Temperature Measurement.
11. System Identification by the Method of Approximation.
12. Controller tuning by Frequency domain analysis.

Cycle - II:

1. To analyse the stability of a level control system with time delay in frequency domain analysis.
2. To auto tune a PID controller using a relay switch method for process control systems
3. To study the phenomenon of the reset windup and to compensate it with anti reset windup
   technique for a first order process.
4. To analyse the stability of the discrete control system and to compare it with the continuous control system using IMC.

5. To study the robustness of the simple first order time delay process with frequency response analysis.
6. Design and simulation of split range controller.
7. Computer calibration of temperature and pressure measuring instruments
8. Design and simulation of cascade controller.
9. Experimental Study of DCS and SCADA in a process control system.
10. To study the action of ON/OFF, P, PI, PID control for pressure process station.
11. Stability analysis of process control systems.
12. Study of performance and automation of a flexible manufacturing trainer.

Text Book

1. Curtis D. Johnson –*Microprocessors in Process Control*, PHI. 1993 **Reference**

1. George Stephanopoulos *Chemical Process Control.* 2005
2. Coughner *Process Analysis & Control*, Tata Mcgraw Hill. – 1991

21-473-0206 DIGITAL IMAGE PROCESSING

L	T	P	C
3	1	-	3

Curse Outcome: After the completion of this course, the students will be able to

CO1: Explain the fundamentals of image representation

CO2: Discuss the importance of image enhancement and the varies image enhancement methods

CO3: Explain various image compression algorithms

CO4: Explain the basic principles of colour image processing

CO5: Choose the different transforms suitable for image processing

CO6: Compare and contrast various image restoration methods

CO7: Identify the techniques for image segmentation based on applications

MODULE 1

Digital Image fundamentals: representation, elements of visual perception, simple image formation model, image sampling and quantization, basic relationship between pixels, imaging geometry.

Review of Matrix theory results: Row and Column ordering, Doubly Block Toeplitz for 2 D linear convolution, Doubly Block Circulant Matrices for circular convolution, Kronecker products, unitary and orthogonal matrices.

Unit**ary Transforms for Image processing:** General unitary Transforms, DFT, DCT, DST, Hadamard Transform, Haar Transform, , Karhunen Loeve Transform.

MODULE 2

Image Enhancement: Spatial Domain Methods: point processing - intensity transformations, histogram processing, image subtraction, image averaging. Spatial filtering- smoothing filters, sharpening filters, Frequency Domain methods- low pass filtering, high pass filtering, homomorphic filtering, generation of spatial masks from frequency domain specifications

MODULE 3

Image restoration: Degradation model, Diagonalization of circulant and doubly block circulant matrices, Algebraic approaches- Inverse filtering, Wiener filtering, Constrained Least Squares restoration, Interactive restoration, Geometric transformations.

MODULE 4

Image Compression: Fundamentals, redundancy: coding, interpixel, psychovisual, fidelity criteria, Models, Elements of information theory, error free compression - variable length, bit plane, lossless predictive, lossy compression- lossy predictive, transform coding, Fundamentals of JPEG image compression, Wavelet based compression techniques- EZW, SPIHT, JPEG 2000.

MODULE 5

Image Segmentation: Detection of discontinuities- point, line, edge and combined detection, edge linking and boundary description, local and global processing using Hough Transform- Thresholding, Region oriented segmentation – basic formulation, region growing by pixel aggregation, region splitting and merging, use of motion in segmentation.

Color Image Processing: color models- RGB, CMY, YIQ, HIS, Pseudo coloring, intensity slicing, gray level to color transformation.

Text Books

1. Digital Image Processing- Gonzalez and Woods, Pearson education, 2002.
2. Fundamentals of Digital Image Processing – A K Jain, Pearson education, 2003.

References

1. Digital Image Processing- W K Pratt, John Wiley, 2004
2. Digital Signal and Image Processing- Tamal Bose, John Wiley publishers.
3. Two dimensional signal and Image Processing- J S Lim, Prentice Hall.

21-473-0207 MECHATRONICS

L	T	P	C
3	1	-	3

Curse Outcomes:

On completion of this course, the students will be able to:

CO1: Explain what is meant by mechatronics and appreciate its relevance in engineering design.

CO2: Evaluate sensors and signal conditioning used in the measurement of basic mechanical engineering quantities.

CO3: Design simple systems for sequential control involving pneumatic or hydraulic actuators.

CO4: Evaluate the operational characteristics of electrical actuation systems.

CO5: Identify interface requirements and how they can be realised for microcontroller and PLC based systems.

MODULE 1

Introduction: definition, trends, control systems, micro-controller based controllers, PC based controllers.

MODULE 2

Design of sensor and signal conditioning for Displacement, position, velocity, force, pressure, temperature.

MODULE 3

Precision mechanical actuation: Pneumatic, Electro-pneumatic, Hydraulic, Electro-hydraulic actuation systems, ball screw and nut, linear motion guides, linear bearings, bearings, harmonic transmission, motor/drive selection.

MODULE 4

Electro mechanical drives: relays and solenoid, stepper motors, DC-brushed / brushless motors, DC servo motors, breaking methods, PWM, Bi-polar driver, MOSFET drivers, SCR drivers, Variable Frequency Drives.

MODULE 5

Micro-controller and interfacing: Digital signal interfacing techniques, Analog signal interfacing with ADC and DAC. Programmable logic and motion controller: programming, interfacing of sensors and actuators to PLC, Simultaneous control of axes integration of axes and I/Os.

Text Book

1. Devid G. Alciatore, Michael B. Histand , ‘Introduction to Mechatronics and measurement systems’, 2nd Edition, McGraw-Hill.

References

1. Bella G Liptak, ‘Instrument Engineer ’Handbook, Vol. 1, 2 and 3, CRC Press.
2. Ajay V. Deshmukh, ‘Microcontrollers’, 1st edition, Tata McGraw-Hill.

21-473-0208 MEMS AND MICROSYSTEMS

L	T	P	C
3	1	-	3

Course Outcomes:

After the completion of the course the student should be able to:

CO1: Explain the basics of MEMS

CO2: Design MEMS based structures

CO3: Give an outline of various materials for MEMS.

CO4: Describe various fabrication and micro-manufacturing processes

CO5: Explain the basics of RF MEMS

CO6: Explain the basics of Bio-MEMS

MODULE 1

Introduction, Planar Vs 3d structures, Microsystem sensors, actuators and fluidics overview, Basics of microsysytem engineering- doppig, diffusion, plasma physics, electrochemistry.

MODULE 2

Engineering mechanics of micrsystem, Stating bending of thin plates, mechanical vibration, thermomechanics, fracture mechanics, thin film mechanics, basics of finite element stress analysis

MODULE 3

Materials for MEMS- substrate and wafers, silicon, properties, silicon compounds, Silicon piezoresistors, gallium arsenide, Quartz, piezoelectric crystals, Polymers, Packaging materials.

MODULE 4

Microsystem fabrication processes- Photolithography, Ion implantation, diffusion, oxidation, CVD, PVD, Epitaxy, Physical and chemical etching, Micromanufacturing- bulk micromanufacturing, surface micromachining, LIGA process, mocrosystem packaging

MODULE 5

RF MEMS- Basic ideas, Micromachined switches, antennas, inductors, capacitors, BioMEMS- Multi-parameter BioMems for clinical monitoring, neural implants, microfluidic platforms, DNA based systems.

Text Books

1. Fundamentals of Microfabrication, Madou, CRC Press
2. MEMS and Microsystems, Tai-RanHsu, McGraw-Hill

References

1. RF MEMS, Theory, Design and Techology, Gabriel M. Rebeiz, Wiley
2. BioMEMS, Gerald A. Urban, Springer

21-473-0209 OPTOELECTRONICS AND INSTRUMENTATION

L	T	P	C
3	1	-	3

Course Outcome:

After the completion of the course the student will be able to

CO1: Describe the principle and operation of interferometers.

CO2: Explain various methods of modulation of light

CO3: Outline the basic theory of lasers.

CO4: Explain the operation of different types of lasers and their applications.

CO5: Give an account of fibre optics and various fibre optic components.

CO6: Give an account of fibre optic communication systems.

CO7: Illustrate various sensor applications of optical filers.

MODULE 1

Interferometers – Faby-Perot, Michelson interferometer, Interference filters, Optical spectrum analyzer, Modulation of light, electro-optic, magneto-optic and acousto-optic

MODULE 2

Lasers- Principle of operation, Einstein relations, Population inversion, optical feedback, resonant cavity, laser modes, Q-switching, mode locking, 3 and 4 level systems, properties of lasers.

MODULE 3

Classes of lasers- Solid state, gas lasers and dye lasers, operation and working, semiconductor lasers, Applications, holography, industrial biomedical , pollution monitoring

MODULE 4

Optical fiber- Light guidance through fibers, step index fiber, graded index fiber, multi mode, single mode, numerical aperture, dispersion, loses in fiber, measurement fiber characteristics, OTDR, couplers, splicers, connectors.

MODULE 5

Optical fiber communication system, components, modulation, demodulation, fiber optic sensors, pressure, temperature displacement acceleration strain, fiber bragg grating, photonic band gap materials.

Text Books

1. J. Wilson and J.F Hawkes, Optoelectronics-An introduction, Pentice Hall
2. K. Tyagarajan and A.K.Ghatak, Lasers- Theory and Applications, Springer

References

1. T. Ray, Optoelectronics and Fiber Optics Technology,
2. R. Kashyap, Fiber Bragg Grating Academic Press

21-473-0210 NON DESTRUCTIVE TESTING AND ANALYSIS

L	T	P	C
3	1	-	3

Course Outcome:

After the completion of the course the student will be able to

CO1 Illustrate and elaborate on the operating principles, sensor design, characteristics, various limitations, and applications of Acoustic Emissions based non-destructive evaluation and testing.

CO2 Discuss about electromagnetic testing, eddy current probes and various methodologies in measurement such as alternating current measurement.

CO3 Discuss about Laser testing methods such as profilometry, holography, interferometry, and other advanced laser inspection techniques.

CO4 Assess various leak testing methods and implement the best possible method for a given application.

CO5 Discuss about the various advanced non-destructive testing techniques such as Neutron Radiographic Testing, Radiographic Testing method and other thermal imagining methods

CO6 Explain various ultrasonic testing methodologies including ultrasonic pulsed techniques and NDT sensors such as multilayer ultrasonic thickness gauge etc.

CO7 Illustrate the principles of vibration analysis and impact testing using ultrasonic imaging utilizing signal processing tools

MODULE 1

Introduction - Acoustic Emissions- Principles and Theory. Signal Propagation. The AE Process Chain, The AE Measurement Chain, Physical Considerations. Time Considerations. AE Parameters. AE Theory, AE Transducers, Acoustic Emission Sensors and Couplers, AE Sensor Construction. Acoustic Emission Technology, , Applications. Advanced Equipment.

MODULE 2

Electromagnetic Testing Method, Eddy Current Sensing Probes, Flux Leakage Sensing Probes, Alternating Current Field Measurement (ACFM) Method, Calibration and Testing, Laser Testing methods- Profilometry Methods, Holography, Interferometry. Confocal Measurement, Scanning Laser Profilometry, Optical Inspection Systems, Visual and optical testing.

MODULE 3

Leak Testing Methods- Ultrasonic Leak Testing. Bubble Leak Testing. Dye Penetrant Leak Testing, Pressure Change Leak Testing, Mass Spectrometer Leak Testing, “Sniffer” Techniques, Liquid Penetrant Tests, Magnetic Particle Testing.

MODULE 4

Neutron Radiographic Testing, Radiographic Testing Method, Industrial Radiography, Portable Linear Accelerators, Fluoroscopy Techniques. Thermal/Infrared Testing Method, Heat and Light Concepts. Color Change Thermometry Infrared Imaging Systems.

MODULE 5

Ultrasonic Testing - Noncontacting Ultrasonic Testing, Ultrasonic Pulsers/Receivers, Multilayer Ultrasonic Thickness Gauge. Time-of-Flight Diffraction, **Vibration Analysis Method,** Principles/Theory. Stress Analysis, Vibration Analysis/Troubleshooting, Impact Testing and Frequency Response, Machine Diagnosis

Text Book

1. Introduction to Nondestructive Testing: A Training Guide, 2nd Edition, Paul E. Mix, Wiley, 2005

References

1. Practical Non-destructive Testing, Baldev Raj, T. Jayakumar, M. Thavasimuthu, Woodhead Publishing, 2002.
2. Nondestructive Testing of Deep Foundations - Bernard Hertlein , Allen Davis, 2006, Publisher John Wiley and Sons Ltd
3. Theory and Practice of Infrared Technology for Nondestructive Testing - Xavier P. V. Maldague, 2001 , Publisher John Wiley & Sons Inc
4. NDT Data Fusion - Xavier Gros, Publisher ELSEVIER SCIENCE & TECHNOLOGY

21-473-0211 NAVIGATION GUIDANCE AND CONTROL

L	T	P	C
3	1	-	3

Course Outcome:

After the completion of the course the student will be able to:

CO1: Explain the modelling and dynamics of Aircrafts.

CO2: Explain the dynamics and control of aerospace vehicles.

CO3: Classify and compare various navigation schemes

CO4: Demonstrate knowledge and understanding of fundamentals of the various guidance techniques and their properties

CO5: Design controllers for aerospace vehicles.

MODULE 1

Modeling and dynamics of Aircraft: Longitudinal dynamics –displacement autopilot- pitch rate feedback for damping- control stick steering acceleration control system – Glide slope control system. Lateral dynamics of an Aircraft, Yaw damper- Method of obtaining co ordination- beta feedback-beta beta dot feedback – acceleration feedback. Yaw orientational control system- Roll angle control system - Landing.

MODULE 2

Dynamics of Aerospace vehicles: Missiles Missile Control Systems; Dynamics and Control of Rigid and Elastic Rockets; Control-Structure Interaction; Longitudinal and Lateral Autopilots for Rigid Aircraft;

MODULE 3

Navigation: Terrestrial navigation, Celestial navigation, Terrestrial radio navigation, satellite based navigation, inertial navigation, Integrated Navigation.

MODULE 4

Guidance: Introduction to Guidance, Navigation and Avionics; Radar Systems, Command and Homing Guidance Systems. Mission consideration and analysis of flight path, Optimal guidance Laws, Inertial Guidance

MODULE 5

Control of Aerospace Vehicles: Design of Controllers for Aerospace Vehicles; Classical, Pole assignment, Eigen Structure Assignment, Optimal Control, LQR, LQG/LTR, Observers and Kalman Filters

Text Books

1. Garnell, P. *Guided Weapon Control Systems, Peraganon*. 1980.
2. Blakelock, J H. *Automatic Control of Aircraft and Missiles*, John Wiley. 1991

3. Greensite A L, *Analysis and Design of Space Vehicle Flight Control System*, Spartan Books. 1970

References

1. Skolnik R E. *Introduction to Radar System*, Mc Graw Hill. 1982
2. Lin, C F. *Modern Guidance, Navigation and Control Processing*, Prentice-Hall.1991
3. D'Azzo J J and Hougis, C H, *Linear Control System Analysis and Design*, (4*e*) Mc Graw Hill,.
4. Maceijowski, *Multi-Variable Feedback Design, Addison Wesley*. 1987
5. A. Sinha. *Linear Systems: Optimal and Robust Control*, 1/e, CRC Press. 2007.
6. D. S. Naidu, *Optimal Control Systems*, 1/e, CRC Press. 2003
7. B. Hofmann-Wellenhof, K. Legat, M. Wieser, *Navigation Principles of Positioning and Guidance*. Springer Wien New York. 2003.

21-473-0212 EMBEDDED SYSTEM DESIGN

L	T	P	C
3	1	-	3

Course Outcome :

After the completion of the course the student will be able to:

CO1: Explain the basic concept of embedded system and factors to be considered in an embedded system design

CO2: Explain architecture of single purpose and general purpose processors

CO3: Explain the function and working of real-time operating system in embedded systems

CO4: Explain the architecture of 8051 microcontroller

CO5: Explain the architecture of ATxmega 128A1 microcontroller

CO6: Design 8051 based systems and write programs for the same

CO7: Design ATxmega 128A1 based systems and write programs for the same

MODULE 1

Introduction to embedded systems: Categories of embedded systems, overview of embedded system architecture, Microcontroller programming and structured design, Factors to be considered in selecting a microcontroller, recent trends in embedded systems.

MODULE 2

Custom Single purpose Processor: RT level combinational components, RT level sequential components. Custom single purpose processor design; RT level Custom single purpose processor design, General purpose processor: basic architecture, data path, control MODULE.

MODULE 3

Real Time Operating System (RTOS) based Embedded System Design: Operating system basics, Types of operating systems, Tasks, process and threads, Multiprocessing and Multitasking, Task scheduling, Threads, processes and scheduling: putting them altogether, Task communication, Task synchronization, Device Drivers, How to choose an RTOS.

MODULE 4

Overview of 8051 microcontrollers. Designing with 8051, why 8051 microcontroller, Programming with 8051 microcontroller, different addressing modes supported by 8051 microcontroller., The 8051 instruction sets. Some examples of System design using 8051/8052 microcontroller.

MODULE 5

Introduction to AVR family of microcontrollers, Introduction to AtXmega 128A1 Microcontroller, AVR CPU, EBI- external bus interference, DMAC, system clock and clock option, Power management, Programmable multilevel interrupt controller, I/O ports, instruction set. Design examples using AtXmega128A1.

Text Books

1. "Embedded System Design- A Unified Hardware/ Software Introduction", Frank Vahid and Tony Givar gis, John Wiley & Sons.
2. "Introduction to Embedded Systems", Shibu K V, Tata McGraw Hill.

References

1. "The 8051 Microcontroller and Embedded systems", Mazidi M L, Mazidi J G, Mckinlay R D, Pearson Education Inc, New Delhi.
2. "Embedded C Programming and the Atmel AVR", Barnett R, O'Cull L, Cox S, Thomson Delmar Learning, Canada.
3. "X-Mega- A Manual"- Atmel Corporation.

21-473-0213 REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEMS

L	T	P	C
3	1	-	3

Course Outcome :

After the completion of the course the student will be able to:

CO1: Describe Remote Sensing concepts, physical fundaments and components and adequately use vocabulary, terminology and nomenclature of the discipline.

CO2: Compute an image visually and digitally with digital image processing techniques.

CO3: Explain the concepts and fundamentals of GIS

CO4: Explain technical issues related to digital representation of geographic data and data quality and standards

CO5: Apply knowledge of GIS and understand the integration of Remote Sensing and GIS

MODULE 1

Remote Sensing

Aerial photography and photogrammetry: basic principles, photographic systems, visual interpretation and mapping. Ground truth verification radiometer and its application.

Basic concepts of remote sensing: Idealized remote sensing system. Physics of remote sensing, electromagnetic spectrum, black body concept, atmospheric windows, geometry of scanners, CCD arrays and platforms, history of space imaging characteristics of space platform like LANDSAT, SPOT, IRS, etc. Characteristics of sensors like MSS, TM, LISS I and LISS II. Outputs from various sensors.

MODULE 2

Classification of digital data and information:

Supervised, unsupervised. Extractionprocedure for different applications and terrain evaluation. Thematic interpretation, transfer of interpreted thematic information to base map. Ground verification.

Application of remote sensing: Civil Engineering, Earth Science, Forestry, Agriculture, Oceanography, Fisheries, Water resources, Town planning and land use/land cover mapping.

MODULE 3

Geographic Information System

Introduction: Map and use of maps through time, thematic and multiple theme maps, Development of GIS as an introduction and decision making system

An Overview of GIS: Definition, Objectives and basic concepts, Contributing disciplines and technologies.

MODULE 4

Digital Representation of Geographic Data: Technical issues related to digital representation of geographic data, Data quality and standards, Assessment of data quality, Managing spatial errors, Data standards and GIS development.

Components of GIS: Computer hardware, peripherals and software

MODULE 5

Integration of Remote Sensing and GIS: Extracting metric information from Remotely Sensed images, Extracting thematic information from Remotely Sensed images, Integration of information from remote sensing in GIS . GIS application areas.

Text Books

1. Paul R Wolf , *Elements of photogrammetry* –- Mc Graw-Hill
2. Lille sand & Kiefer, *Remote sensing and image interpretation*, John Wiley and Sons
3. Floyd F. Sabins *Remote sensing principles and interpretation* - - WH Freeman & Co.

References

1. John R Jensen, *Introductory digital image processing* - - Prentice Hall
2. George Joseph, *Fundamentals of Remote Sensing*- -Universities Press-Technical
3. L R A Narayan *Remote Sensing and its Applications*- - Universities Press-Science/Reference
4. M. Anji Reddy, *Remote Sensing and Geographic information systems* – BS Publishers.

21-473-0214 INTERNET OF THINGS

L	T	P	C
3	1	-	3

Course Outcome: -

At the end of this course, students will demonstrate the ability to:

CO1: Identify the IoT networking components with respect to OSI layer.

CO2: Realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks

CO3: Select the building blocks of Internet of Things.

CO4: Select IoT protocols and software.

CO5: Build schematic for IoT solutions.

CO6: Design and develop IoT based sensor systems.

CO7: Evaluate the wireless technologies for IoT.

CO8: Illustrate the application areas of IoT

MODULE 1

Technologies involved in IOT Development:

Internet/Web and Networking Basics: OSI Model, Data transfer referred with OSI Model, IP Addressing, Point to Point Data transfer, Point to Multi Point Data transfer & Network Topologies, Sub-netting, Network Topologies referred with Web, Introduction to Web Servers, Introduction to Cloud Computing

IOT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards.Network Fundamentals: Overview and working principle of Wired Networking equipment's – Router, Switches, Overview and working principle of Wireless Networking equipment's – Access Points, Hubs etc. Linux Network configuration Concepts: Networking configurations in Linux Accessing Hardware & Device Files interactions.

MODULE 2

IOT Architecture:

History of IOT, M2M – Machine to Machine, Web of Things, IOT protocols - M2M Area Network Physical Layers - IEEE 802.15.4 - The IEEE 802 Committee Family of Protocols - The Physical Layer - The Media-Access Control Layer - Uses of 802.15.4 - The Future of 802.15.4: 802.15.4e and 802.15.4g

Applications: Remote Monitoring & Sensing, Remote Controlling,Performance Analysis.

The Architecture: The Layering concepts, IOT Communication Pattern, IOT protocol Architecture, The 6LoWPAN Security aspects in IOT

MODULE 3

IOT Application Development:

Application Protocols: MQTT, REST/HTTP, CoAP, MySQL

Back-end Application Designing: Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools

MODULE 4

Case Study & advanced IOT Applications:

IOT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IOT electronic equipments. Use of Big Data and Visualization in IOT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)

MODULE 5

Key Applications of The Internet of Things

Real World Design Constraints - Smart Metering Advanced Metering Infrastructure - e-Health Body Area Networks - City Automation - Automotive Applications - Home Automation - Smart Cards - Tracking (Following and Monitoring Mobile Objects) - Over-The-Air-Passive Surveillance Ring of Steel - Control Application Examples - Industrial Automation- Smart Cities

Text Books

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
3. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann

References

1. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning
2. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga
3. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
4. Asoke K Talukder and Roopa R Yavagal, “Mobile Computing,” Tata McGraw Hill, 2010.
5. Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition
6. Designing The Internet of Things : Adrian Mcewen, Hakin Cassimally , Wiley- India, 2013

7. Data and Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition
8. F. Adelstein and S.K.S. Gupta, “Fundamentals of Mobile and Pervasive Computing,” McGraw Hill, 2009.
9. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010

21-473-0301 PROJECT PROGRESS EVALUATION

Course Outcome: -

At the end of this course, students will demonstrate the ability to:

CO1: Demonstrate aptitude for research and independent learning.

CO2: Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3: Gain the expertise to use new tools and techniques for the design and development.

CO4: Develop the ability to write good technical report, to make oral presentation of the work, and to publish the work in reputed conferences/journals.

The Project is aimed at training the students to analyze any problem in the field of Instrumentation systems independently. The project may be analytical, computational or experimental or a combination of them based on the latest developments in the relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the seminar undertaken in Semester II.

During the project period, every student has to present the progress of their works before the duly constituted committee of internal teachers of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation at the end of the semester.

21-473-0401 PROJECT DISSERTATION EVALUATION

Course Outcome:

At the end of this course, students will demonstrate the ability to:

CO1: Demonstrate aptitude for research and independent learning.

CO2: Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3: Gain the expertise to use new tools and techniques for the design and development.

CO4: Develop the ability to write good technical report, to make oral presentation of the work, and to publish the work in reputed conferences/journals.

Dissertation is a continuation of the project work done by the student during Semester III. The dissertation report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical computation and experimental aptitude of the students as applicable. During the dissertation period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members is a part of Mid Term Evaluation. A report of the dissertation in the form of hard copy must be submitted in the office at least two weeks before the final viva voce is conducted by the evaluation committee.

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