KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE- 638 052
(Autonomous)

M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (FULL TIME)
CURRICULUM
(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14AMT19	Applied Mathematics for Control Engineers	3	1	0	4	40	60	100
14CIT11	Transducers and Smart Instruments	3	0	0	3	40	60	100
14CIT12	Process Dynamics and Control	3	1	0	4	40	60	100
14CIT13	Linear System Theory	3	1	0	4	40	60	100
14CIT14	Intelligent Techniques and its Applications	3	0	0	3	40	60	100
14CIT15	Multirate and Sparse Signal Processing	3	1	0	4	40	60	100
	PRACTICAL							
14CIL11	Process Dynamics and Control Laboratory	0	0	3	1	100	0	100
				Total	**23**			

CA- Continuous Assessment, ESE- End Semester Examination

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M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (FULL TIME)
CURRICULUM
(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14CIT21	Applied Industrial Instrumentation	3	0	0	3	40	60	100
14CIT22	Industrial Automation and Networking	3	0	0	3	40	60	100
14CIT23	Non-Linear System Analysis and Control	3	1	0	4	40	60	100
	Elective – I (Professional)	3	0	0	3	40	60	100
	Elective – II (Professional)	3	0	0	3	40	60	100
	Elective – III (Professional)	3	0	0	3	40	60	100
	PRACTICAL							
14CIL21	Modeling and Simulation Laboratory	0	0	3	1	100	0	100
14CIL22	Industrial Automation Laboratory	0	0	3	1	100	0	100
				Total	**21**			

CA- Continuous Assessment, ESE- End Semester Examination

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M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (FULL TIME)
CURRICULUM

(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective – IV (Professional)	3	0	0	3	40	60	100
	Elective – V (Professional)	3	0	0	3	40	60	100
	Elective – VI (Open)	3	0	0	3	40	60	100
	PRACTICAL							
14CIP31	Project Work - Phase I	0	0	12	6	50	50	100
				Total	**15**			

CA- Continuous Assessment, ESE- End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
14CIP41	Project Work - Phase II	0	0	24	12	100	100	200
				Total	**12**			

CA- Continuous Assessment, ESE- End Semester Examination

Total Credits: 71

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M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (PART TIME)
CURRICULUM
(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14AMT19	Applied Mathematics for Control Engineers	3	1	0	4	40	60	100
14CIT13	Linear System Theory	3	1	0	4	40	60	100
14CIT12	Process Dynamics and Control	3	1	0	4	40	60	100
	PRACTICAL							
14CIL11	Process Dynamics and Control Laboratory	0	0	3	1	100	0	100
				Total	**13**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14CIT21	Applied Industrial Instrumentation	3	0	0	3	40	60	100
14CIT22	Industrial Automation and Networking	3	0	0	3	40	60	100
14CIT23	Non-Linear System Analysis and Control	3	1	0	4	40	60	100
	PRACTICAL							
14CIL22	Industrial Automation Laboratory	0	0	3	1	100	0	100
				Total	**11**			

CA – Continuous Assessment, ESE – End Semester Examination

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(Autonomous)

M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (PART TIME) CURRICULUM

(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14CIT11	Transducers and Smart Instruments	3	0	0	3	40	60	100
14CIT14	Intelligent Techniques and its Applications	3	0	0	3	40	60	100
14CIT15	Multirate and Sparse Signal Processing	3	1	0	4	40	60	100
				Total	**10**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective – I (Professional)	3	0	0	3	40	60	100
	Elective – II (Professional)	3	0	0	3	40	60	100
	Elective – III (Professional)	3	0	0	3	40	60	100
	PRACTICAL							
14CIL21	Modeling and Simulation Laboratory	0	0	3	1	100	0	100
				Total	**10**			

CA – Continuous Assessment, ESE – End Semester Examination

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(Autonomous)

M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (PART TIME)
CURRICULUM

(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – V

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective – IV (Professional)	3	0	0	3	40	60	100
	Elective – V (Professional)	3	0	0	3	40	60	100
	Elective – VI (Open)	3	0	0	3	40	60	100
	PRACTICAL							
14CIP31	Project Work - Phase - I	0	0	12	6	50	50	100
				Total	**15**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – VI

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
14CIP41	Project Work - Phase - II	0	0	24	12	100	100	200
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

Total Credits: 71

LIST OF ELECTIVES					
Course Code	**Course Title**	**Hours/Week**			**Credit**
		L	**P**	**T**	
14CIE01	System Identification and Adaptive Control	3	0	0	3
14CIE02	Advanced Instrumentation System Design *	3	0	0	3
14CIE03	Instrumentation in Automobiles and Building Automation	3	0	0	3
14CIE04	Bioprocess Instrumentation and Control	3	0	0	3
14CIE05	Instrumentation and Control in Process Industries	3	0	0	3
14CIE06	Industrial Drives and Control	3	0	0	3
14MMT21	Robotics and Control	3	0	0	3
14CIE07	Robust Control	3	0	0	3
14CIE08	Multisensor Data Fusion	3	0	0	3
14COE16	Electromagnetic Interference and Compatibility	3	0	0	3
14CIE09	Microcontroller based System Design *	3	0	0	3
14CIE10	Real Time Embedded Systems	3	0	0	3
14MME03	MEMS Design	3	0	0	3
14CIE11	Advanced Digital Image Processing	3	0	0	3
14CIE12	Advanced Digital System Design	3	0	0	3
14CIE13	Embedded FPGA based Control Design	3	0	0	3
14CIE14	Nano Electronics and its applications	3	0	0	3
14CNE02	Wireless Sensor Networks	3	0	0	3

* - Open Elective

14AMT19 APPLIED MATHEMATICS FOR CONTROL ENGINEERS

3 1 0 4

UNIT – I **9**

Vector Spaces: Real Vector Spaces – Subspaces – Linear Independence – Basis and Dimension – Row Space, Column Space & Nullspace – Rank and Nullity.

UNIT – II **9**

Matrix Theory: Matrix factorizations – LU decomposition – The Cholesky decomposition – QR factorization – Least squares method – Generalized inverses – Singular value decomposition – Toeplitz matrices and Circulant matrices.

UNIT – III **9**

Calculus of Variations: Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT – IV **9**

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT –V **9**

Random Process: Classification – Stationary Random process – Markov process – Gaussian process – Markov chain – Auto Correlation – Cross correlation– Response of linear system to random input.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS:

1. Howard Anton, Chris Rorres, "Elementary Linear Algebra" John Wiley & Sons, Ninth Edition, 2011.
2. Richard Bronson, "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
4. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, "Probability and Statistics for Engineers & Scientists", 8th Edition, Asia, 2007.
5. Ochi, M.K, "Applied Probability and stochastic Processes", John Wiley & Sons, 1992.

Course Outcomes:

On completion of the course the students will be able to

- apply linear algebra concepts in signal processing
- solve variational problems
- perform numerical calculations for stochastic processes in discrete and continuous time

14CIT11 TRANSDUCERS AND SMART INSTRUMENTS

3 0 0 3

UNIT – I **9**

Review of measurement science and conventional transducers: Types of errors – Limiting error – probable error – propagation of error – odds and uncertainty – Static and Dynamic characteristics – Resistive, Inductive and Capacitive transducers.

Review of Industrial Instrumentation: Measurement of Force, Torque, Velocity, Acceleration, Pressure, Temperature, Flow, Level, Viscosity, Humidity and Moisture (Qualitative Treatment Only).

UNIT – II **9**

Sensors For Spatial Variables, Optical Variables and Chemical Variables: Spatial variable measurement: Laser Interferometer Displacement sensor-synchro / Resolver displacement transducer. Optical variables measurement: Vision and image sensors. Thermal composition measurement: Thermogravimetry -Thermometric Titrimetry - Thermomechanical Analysis -Differential Thermal Analysis and Differential Scanning -Calorimetry -Specialized Techniques .

UNIT – III **9**

Environmental Measurement Sensors and Tactile Sensors: Environmental measurement: Meteorological measurement – Air pollution measurement – Water quality measurement – Satellite imaging and sensing.

Tactile sensing: Sensing Classification- Mechanical Effects of Contact - Simplified Theory for Tactile Sensing -Requirements for Tactile Sensors - Technologies for Tactile Sensing.

UNIT – IV **9**

Smart Sensors: Primary and Secondary sensors – Amplification – Filters – Converters – Compensation – Information coding / processing – Data communication - standards for smart sensor interface – Smart transmitter with HART communicator – Handheld communicator - Smart valves and positioners.

UNIT – V **9**

Recent Trends in Sensor Technologies: Film sensors : Thick film and thin film – Integrated image sensors – Bio sensors – Integrated micro arrays – RF - IDs – Sensor arrays– Sensor network – Multisensor data fusion – Soft sensor.

TOTAL : 45

REFERENCE BOOKS:

1. John G Webster, "Measurement, Instrumentation and Sensors Handbook", CRC press, 1998
2. Bela G Liptak, "Instruments Engineers' Handbook Process Measurement and Analysis", Elsevier, 2005
3. Patranabis D, "Sensors and Transducers", Prentice Hall of India, 2006
4. Krishnaswamy. K, and Vijayachitra.S., "Industrial Instrumentation", New Age International Publishers, New Delhi, 2004.
5. Ranganathan, S., "Transducer Engineering", Allied Publishers, New Delhi, 2003

Course Outcomes:

On completion of the course the students will be able to

- understand concepts of measurement and types of transducers
- selection of sensors for various applications
- exposure to various smart sensors and the sensor technologies

14CIT12 PROCESS DYNAMICS AND CONTROL

3 1 0 4

Pre-requisites: Process Control, Control System

UNIT – I **9**

Process Modeling: Introduction to process control – objectives of modeling – models of industrial process hydraulic tanks: Non-interacting system and Interacting system – fluid flow systems – single conical tank – single spherical tank – mixing process – chemical reactions – thermal systems: CSTR, heat exchangers and distillation column.

UNIT – II **9**

Control Actions: Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Electronic controllers –Pneumatic Controllers. **Controller Tuning:** Evaluation criteria: IAE, ISE, ITAE and One quarter decay ratio. Controller tuning: Process Reaction Curve method, Z-N method, One quarter decay ratio method. Time response and Frequency response methods.

UNIT – III **9**

Multivariable Systems: Multivariable Systems – Transfer Matrix Representation – State Space Representation – Poles and Zeros of MIMO System – Multivariable frequency response analysis – Directions in multivariable systems –Singular value decomposition. **Multi-Loop Regulatory Control:** Introduction – Process Interaction – Pairing of Inputs and Outputs.

UNIT – IV **9**

RGA: Relative Gain Array (RGA) – Properties and Applications of RGA – Decoupling Control – Multi-loop PID Controller – Biggest Log Modulus Tuning Method. **Multivariable Regulatory Control:** Multivariable IMC– Multivariable Dynamic Matrix Controller –Multivariable Model Predictive Control – Generalized Predictive Controller – Multiple Model based Predictive Controller.

UNIT – V **9**

Advanced Control Schemes: Feedback and Feed forward control –Ratio control –Cascade control – Split-range control –Inferential control – Override Control – Auctioneering Control - Adaptive control. **Case–Studies:** Control Schemes for Distillation Column, CSTR, Three-tank hybrid system, pH, and Bio reactor.

Lecture: 45, Tutorial: 15, TOTAL : 60

REFERENCE BOOKS:

1. Stephanopoulos, G, “Chemical Process Control-An Introduction to Theory and Practice”, Prentice Hall of India, New Delhi, 2008.
2. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
3. Dale E. Seborg, Thomas F Edgar and Duncan A Mellichamp, “Process Dynamics and Control”, Wiley John and Sons, 2010.
4. Norman A Anderson, “Instrumentation for Process Measurement and Control”, CRC Press LLC, Florida, 1998.
5. Krishnaswamy K., “Process Control”, New Age International Publishers, New Delhi, 2006.
6. Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw-Hill international Edition, 2009.

Course Outcomes:

On completion of the course the students will be able to

- understand the basic concepts of process modeling and do the modeling for various processes
- enhance the knowledge on various control actions and controller tuning methods
- understand the concepts of multivariable systems and various regulatory control techniques
- apply various advanced control methods for different cases

14CIT13 LINEAR SYSTEM THEORY

3 1 0 4

UNIT – I **9**

State Variable Analysis in Continuous Domain: Review of state variable representation and state variable models in continuous systems. Conversion from transfer function to various state space model – conversion of state space to transfer function-non-uniqueness of state model – Eigen values and Eigen vectors - State transition matrix and its properties. Solutions of state equations — Free and forced responses.

UNIT – II **9**

State Variable Analysis in Discrete Domain: Review of Z-Transform- Review of Sampling Theory -Sample and Hold circuits -–Pulse Transfer Function – Modified Z Transform -Stability of Sampled Data Control System – Jury's Stability Test - State equations for sampled data system and their solutions.

UNIT – III **9**

State Feedback Controllers and Observers: Controllability and observability – relation between transfer function and state model - effect of sampling time on controllability and observability - state feedback controllers. State estimators: full and reduced order observer. Steady state error in state model-PI feedback controller- Deadbeat Observers- Deadbeat Controllers.

UNIT – IV **9**

Optimal Control Formulation: Review of matrix theory, functionals of a single function and several functions-necessary conditions and boundary conditions.The performance measures for optimal control problems-Hamiltonian approach-necessary conditions for optimal control- Linear Quatratic regulator problem-infinite time regulator problem.

UNIT – V **9**

The Minimum Principle: Pontryagin's minimum principle and state inequality constraints: Minimum time problem, Minimum control energy problems.

Dynamic Programming: Principle of optimality - recurrence relation of dynamic programming for optimal control problem - dynamic programming application to discrete and continuous systems - Hamilton Jacobi Bellman equation. Relationship between Dynamic Programming and Minimum Principle.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS:

1. Gopal, M., "Digital Control and State Variable Methods", Tata McGraw-Hill, New Delhi, 2008.
2. Richard C.Dorf & Robert H.Bishop "Modern Control Systems", Pearson Publications, Eleventh Edition, 2013.
3. Kirk Donald, "Optimal Control Theory – An Introdcution", Dover Publications, 2004
4. Desineni Subburam Naidu, "Optimal Control Systems", CRC Press, 2003

Course Outcomes:

On completion of the course the students will be able to

- analyze continuous and discrete state model of systems
- design feedback controllers
- formulate and analyze optimal control problems

14CIT14 INTELLIGENT TECHNIQUES AND ITS APPLICATIONS

3 0 0 3

UNIT – I **9**

Neural Networks: Artificial Neural networks: An Introduction-Supervised learning Network: Perceptron Network, Back Propagation Network-Unsupervised Learning networks: Kohonen Self-Organizing Feature Maps, Adaptive Resonance Theory Networks.

UNIT – II **9**

Sequential Learning Neural Networks: A Review of Radial Basis Function Neural Networks: An overview, Review of RBF Neural Networks, Applications of RBF Neural Networks - A Novel Sequential Learning Algorithm for Minimal Resource Allocation Neural Networks: RANEKF algorithm, Problems with RANEKF, Pruning strategy, Learning Algorithm for Minimal Resource Allocation Network.

UNIT – III **9**

Fuzzy Systems: Fuzzy Sets: Introduction, Basic Definitions and Terminology, Set theoretic operations, MF formulation and parameterization-Fuzzy rules and Fuzzy Reasoning: Introduction, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning- Fuzzy Inference Systems: Introduction, Mamdani, Sugeno and Tsukamoto Fuzzy models.

UNIT – IV **9**

Derivative-based Optimization: Introduction – Descent Methods – The Method of Steepest Descent – Newtons Methods: Classical Newton's method

Derivative-Free Optimization: Genetic Algorithm: Introduction – Biological Background - Terminologies and Operators of GA: Genes, Fitness, Populations, Data Structures, Search Strategies, Encoding, Breeding, Search Termination, Fitness Scaling.

UNIT – V **9**

Advanced Applications: Fuzzy Control Systems: Classical Fuzzy Control Problem: Inverted Pendulum. ANFIS Applications: Introduction, Printed Character Recognition, Inverse Kinematics problem – Soft computing for color recipe prediction: Introduction, Color receipe prediction. Genetic Algorithm Optimization Problems: Scheduling Problems: Genetic Algorithm for Job Shop Scheduling Problem, Transportation Problems: Genetic Algorithm in solving Transportation Location-Allocation Problems with Euclidean Distances.

TOTAL: 45

REFERENCE BOOKS:

1. Dr.S.N.Sivanandam, Dr.S.N.Deepa, "Principles of Soft Computing", Wiley India, 2012.
2. N.Sundhararajan, P.Saratchandran and Lu Ying Wei, "Radial Basis Function Neural Networks with Sequential Learning-MRAN and its applications", World Scientific Publishing, 1999.
3. J.S.R Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", Pearson Education, 2004.
4. Dr.S.N.Sivanandam, Dr.S.N.Deepa, "Introduction to Genetic Algorithms", Springer, 2008.
5. Timothy J.Ross, "Fuzzy Logic with Engineering Applications",McGraw-Hill International Editions, 1997.

Course Outcomes:

On completion of the course the students will be able to

- apply the neural algorithms for classification, function approximation and control applications
- design fuzzy rule based systems for control applications
- apply the optimization techniques in neural and fuzzy systems

14CIT15 MULTIRATE AND SPARSE SIGNAL PROCESSING

3 1 0 4

Pre-requisites: Digital Signal Processing

UNIT – I **9**

Discrete Random Signal Processing: Discrete time random processess – Random processess: Ensemble averages - The autocovariance and autocorrelation matrices – Parseval's theorem – Wiener Khintchine relation - Filtering random processess – Spectral factorization – Special type of random processes.

UNIT – II **9**

Wiener Filter: The FIR Wiener filter – Filtering – Noise cancellation. IIR Wiener filter – Non causal IIR Wiener filter – Causal IIR Wiener filter.

Adaptive Filter: Concepts of adaptive filter – FIR adaptive filters – LMS algorithm – Applications: Noise cancellation, Adaptive recursive filter.

UNIT – III **9**

Multirate Digital Signal Processing: Introduction- Decimation by a factor D – Interpolation by a factor I – Sampling rate conversion by Rational Factor I/D – Implementation of sampling rate conversion – Multistage implementation of sampling rate conversion – Sampling rate conversion of Bandpass Signals - Sampling rate conversion by an Arbitrary Factor – Applications of Multirate Signal Processing.

UNIT – IV **9**

Uniform and Two Channel Filter Banks: Digital Filter Banks – Two-channel Quadrature Mirror Filter Bank: Elimination of Aliasing, Condition for perfect reconstruction, Polyphase form of the QMF bank, Linear phase FIR QMF bank, IIR QMF bank, Perfect reconstruction two channel FIR QMF bank, Two channel QMF banks in subband coding – M-Channel QMF Bank.

UNIT – V **9**

Sparse Signal Processing: Introduction - Sparse signals-Compressible signal - Over complete dictionaries - Coherence between the bases - Compressed sensing and signal reconstruction - Sensing in the presence of noise - Restricted isometry property.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS:

1. Monson H.Hayes, "Statistical Digital Signal Processing and Modelling", Wiley India Edition, Georgia Institute of Technology – Atlanta, USA, 2002.
2. John G.Proakis and Dimitris G.Manolakis, "Digital Signal Processing – Principles, Algorithms and Applications", Fourth Edition, Pearson, Massachusetts Institute of Technology, Cambridge, USA, 2007.
3. K.P.Soman, R.Ramanathan, "Digital Signal and Image Processing – The Sparse Way", ISA publishers, Amrita University, Coimbatore, 2012.
4. P. P. Vaidyanathan, "Multirate systems and filter banks", Pearson, California Institute of Technology, USA, 2006.
5. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
6. Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.

Course Outcomes:

On completion of the course the students will be able to

- understand Discrete random signal processing, Wiener and Adaptive filters
- apply signal processing techniques in Multirate, Uniform and Two channel filter banks
- develop a simple algorithm to measure, process and represent sparse signals

14CIL11 PROCESS DYNAMICS AND CONTROL LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. For the First Order Linear System,
   a) Determine the mathematical modeling,
   b) Design composite controllers,
   c) Obtain the response of the systems with different test inputs and
   d) Check the servo and regulatory operations.
2. For the First Order Non-Linear System,
   a) Determine the mathematical modeling,
   b) Design composite controllers,
   c) Obtain the response of the systems with different test inputs and
   d) Check the servo and regulatory operations.
3. For the Second Order Linear System,
   a) Determine the mathematical modeling,
   b) Design composite controllers,
   c) Obtain the response of the systems with different test inputs and
   d) Check the servo and regulatory operations.
4. For the Second Order Non-Linear System,
   a) Determine the mathematical modeling,
   b) Design composite controllers,
   c) Obtain the response of the systems with different test inputs and
   d) Check the servo and regulatory operations.
5. Develop control schemes for the heat exchanger and verify their performances by simulation
6. Develop control schemes for the pH neutralization plant and verify their performances by simulation
7. Study the characteristics of control valve and devise a suitable control valve for laminar and turbulent flow

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Stephanopoulos, G, "Chemical Process Control-An Introduction to Theory and Practice", Prentice Hall of India, New Delhi, 2008.
2. Bequette, B.W., "Process Control Modeling, Design and Simulation", Prentice Hall of India, 2004.
3. Process Control Lab Manual, Department of EIE, Kongu Engineering College, 2014.

Course Outcomes:

On completion of the course the students will be able to

- do modeling and identify the suitable controller design for various processes
- check servo and regulatory performances of the selected process
- develop control schemes for various processes

14CIT21 APPLIED INDUSTRIAL INSTRUMENTATION

3 0 0 3

UNIT – I **9**

Piping and Instrumentation Diagrams: Application to Industries, identification system guidelines, instrument index, loop identification number, identification letter tables, instrument line symbols, measurement and control devices and/or function symbols, multipoint, multifunction, and multivariable devices and loops - functional diagrams and function symbols: ISA functional diagramming, Equivalent P&ID Loop, Functional Instrument and Electrical Diagrams, Functional Diagramming Symbols - P&I Diagrams for rotating and static equipments.

UNIT – II **9**

Miscellaneous Instrumentation: Boroscopes – Linear and angular position detection – machine vision technology – noise sensors – rapture discs – proximity sensors and limit switches, Tachometers and angular speed sensors – Thickness and dimension measurement – shock analysis – weighing systems – weight sensors.

UNIT – III **9**

Analytical Instrumentation in Process Industries: Analyzer Application and Selection- Air Quality Monitoring- Biological Oxygen Demand- Chemical Oxygen Demand- and Total Oxygen Demand-Calorimeters- Carbon Dioxide- Carbon Monoxide- Chlorine- Coal Analyzers- Moisture analyzers-Nitrogen analyzers- odor detection- ozone in gas and water- Particulates- Opacity- Dust- and Smoke-Particle size and distribution monitors- water quality monitoring.

UNIT – IV **9**

Instrument Installation: Installation documentation, safety in design, pipe and tube material, electrical Installations in Potentially Explosive Locations, installation of head flow meters. **Calibration:** Calibration of pressure and temperature sensors, hysteresis, automatic calibration instrument, calibration of smart instruments.

Testing: Testing of temperature, pressure sensors, response time testing, and LCSR testing.

UNIT – V **9**

Instrumentation for Safety: Electrical and intrinsic safety, Excess flow and regular check valves, Explosion suppression and deluge systems, Flame arrestors, conservation vents and emergency vent Flame, fire, smoke, leak and metal detectors, Relief valves and rapture disks, start-up and shutdown interlocks.

TOTAL : 45

REFERENCE BOOKS:

1. Bela G. Liptak, **“P**rocess Measurement and Analysis.” Volume I, Fourth Edition, CRC Press, 2003.
2. Considine D. M, “Hand book of Applied Instrumentation”, Tata McGraw-Hill, New Delhi, 1993.
3. Bela G. Liptak, “Instrumentation in the Processing Industries: Brewing, Food, Fossil Power, Glass, Iron and Steel. Mining and Minerals, Paper, Petrochemical, Pharmaceutical.” First Edition, Chilton Book Company, 1973.
4. Krishnaswamy, K. and Ponnibala. M, “Power Plant Instrumentation” Prentice Hall Pvt Ltd, Second Edition, 2013.

Course Outcomes:

On completion of the course the students will be able to

- understand the concepts of P&I diagrams, Functional diagrams, miscellaneous Instruments, and analytical instruments in Processing Industries
- apply the concepts of Instrumentation Installation, calibration and Testing of the measuring Instruments
- apply the concepts of Instrumentation Safety

14CIT22 INDUSTRIAL AUTOMATION AND NETWORKING

3 0 0 3

Pre-requisites: Digital Logic Circuits, Process Control, Control System

UNIT – I **9**

Programmable Logic Controllers: Evolution– Advantages – Architecture – Various Programming Languages of PLC – Ladder Logic versus Relay Logic.

PLC Programming: Timer Functions: Types, Programming. Counter Functions: Types, Programming. Advanced Functions – Arithmetic Functions – Logic Functions – Comparison Functions - Program Control Instructions, Sequencer Instructions.

UNIT – II **9**

Distributed Control Systems: Evolution – Advantages – Different architectures – Local Control Unit (LCU) – Operator Interface: Low level and High level Operator interfaces – Engineering interface: Low level and High level Engineering interface – Types of DCS Displays.

UNIT – III **9**

Applications of PLC: Bottle Filling System – Material Handling System – Spray Painting System – Pneumatic Stamping System.

Applications of DCS : DCS in Power plants – Iron and Steel plants – Chemical plants – Cement plants – Pulp and Paper plants.

UNIT – IV **9**

Serial Interfaces: Standards- EIA-232 overview – EIA-232 interface standard (CCITT V.24 interface standard) – The major elements of EIA-232 – Half-duplex operation of the EIA-232 interface – RS-485 overview – The RS-485 interface standard – RS-422 -Current loop.

UNIT – V **9**

Communication Protocols:

Field bus: Introduction –Architecture – Basic requirements of field bus standard – Field bus topology – interoperability – interchangeability. **Modbus**: Modbus protocol - Function codes - Modbus Plus protocol overview. Overview about Profi Bus. **Industrial Ethernet**: 10 Mbps Ethernet- 100 Mbps Ethernet- Gigabit Ethernet- Industrial Ethernet.

TOTAL : 45

REFERENCE BOOKS:

1. Webb. John W., Reis. Ronald A., “Programmable Logic Controllers: Principles and Applications”, Third Edition, Prentice Hall, New Jersey, 2002.
2. Lucas, Michal P., “Distributed Control Systems”, Van Nostrand Reinhold Co.,1986.
3. Frank D.Petrezeulla, “Programmable Logic Controllers”, Tata McGraw Hill, New York, 2005.
4. Popovic D. and Bhatkar V.P., “Distributed Computer Control for Industrial Automation”, Marcel Dekkar Inc., New York, 1990.
5. Steve Mackay, Edwin Wright, Deon Reynders, “Practical Industrial Data Networks: Design, Installation and Troubleshooting”, Elsevier, 2004.
6. Deon Reynders, Steve Mackay, Edwin Wright, “Practical Industrial Data Communications” Elsevier Publications, 2005.

Course Outcomes:

On completion of the course the students will be able to

- understand the programming concepts of PLC and DCS
- apply PLC and DCS in various applications for automation purpose
- perform effective communication through interfacing standards

14CIT23 NON-LINEAR SYSTEM ANALYSIS AND CONTROL

3 1 0 4

UNIT – I **9**

Phase Plane Analysis: Behaviour of non-linear systems: Jump resonance, sub-harmonic oscillation. Singular points - Phase plane analysis of linear and nonlinear systems - Construction of phase portraits using isoclines- Limit cycle analysis.

UNIT – II **9**

Describing Function Techniques: Typical non-linearities - Describing function of nonlinearities – Review of Nyquist criterion for linear system - Nyquist stability criteria for nonlinear system – Limit cycle oscillations- Accuracy of describing function method.

UNIT – III **9**

Stability Analysis: Stability in the sense of Lyapunov - Second method of Lyapunov - Lyapunov stability analysis of linear time invariant systems and non linear system- Krasovski's theorem-Variable gradient method of generating Lyapunov functions. Lyapunov analysis for non autonomous systems.

UNIT – IV **9**

Feedback Linearization: Feedback linearization and canonical form – Input-state linearization, input-output linearization.

Sliding Mode Control: Sliding surfaces- Filippov's Construction of the Equivalent Dynamics- Direct Implementations of Switching Control Laws- Continuous Approximations of Switching Control Laws.

UNIT – V **9**

Adaptive Control: Basic concepts **–** Model reference adaptive control-self tuning controller-Adaptive Control of First-Order Systems- Adaptive Control of Linear Systems with Full State Feedback-Adaptive Control of Nonlinear Systems- Robustness of Adaptive Control Systems.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS:

1. Gopal, M., "Digital Control and State Variable Methods", Tata McGraw-Hill, New Delhi, 2008.
2. Richard C.Dorf & Robert H.Bishop "Modern Control Systems", Pearson publications, 11^{th} Edition 2013.
3. Slotine and Li, "Applied Nonlinear Control", Prentice-Hall, 1991.
4. Khalil, Hasan K., "Nonlinear Systems", Macmillan Publishing, 1992.

Course Outcomes:

On completion of the course the students will be able to

- analyze behaviour of nonlinear systems
- apply the concepts of Lyapunov theorem
- design nonlinear controller

14CIL21 MODELING AND SIMULATION LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Obtain the time response of an armature controlled DC shunt motor by deriving state model in continuous time. Discretize the state model and obtain the discrete time response for a step voltage
2. Design a state feedback controller for a liquid level control system.
3. Design a LQR controller for the control of inverted pendulum.
4. Watermark your roll number within your photograph.
5. Develop a Fuzzy Logic system for image classification. Also train and test the Neural Network for the same.
6. Non Linear modeling and temperature control of CSTR process.
7. Design and model suitable filter for speech signal processing.
8. Analyze the harmonic content in power signal using LabVIEW.

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

- Richard C. Dorf, Robert H. Bishop "Modern Control Systems", 11^{th} Edition, Prentice Hall, 2007.
- Timothy J Ross, "Fuzzy logic with Engineering Applications", Wiley, 2006.
- Jayaraman.S, Esakkirajan.S, and Veerakumar.T, "Digital Image Processing", Tata McGraw-Hill, New Delhi, First Edition, 2009.

- Softwares: MATLAB, LabVIEW.

Course Outcomes:

On completion of the course the students will be able to

- design a feedback and optimal controller
- develop a suitable artificial intelligent technique for classification of linearly and non linearly separable problems
- design and model filters for signal processing applications

14CIL22 INDUSTRIAL AUTOMATION LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Design of signal conditioning circuit for transmitter and interfacing with PLC and DCS
2. Control of level and flow with PLC and DCS
3. Multi loop control systems (cascade) with DCS
4. Control scheme for industrial drives with PLC and DCS
5. Signal conditioning circuits with ADC-DAC using HSMC (High Speed Mezzanine Card)
6. Actuator control with PLC and DCS
7. Control of conical tank systems with PLC and DCS
8. Miniproject with minimum two Digital Inputs and Digital Outputs or Analog Inputs and Analog Outputs using PLC or DCS

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

- John W. Webb and Ronald A Reis., "Programmable Logic Controllers", 5th Edition, Prentice Hall Publications, New Delhi, 2013.
- Lukas, Michael P., "Distributed Control Systems", Van Nostrand Reinfold Company, 2002.
- Yokogowa DCS and Ge Fanuc PLC Manuals.
- Siemens and ABB PLC Manuals.

Course Outcomes:

On completion of the course the students will be able to

- design signal conditioning circuits for transmitters and interface with PLC and DCS.
- control various process variables with PLC and DCS
- apply PLC and DCS in Process Industries

14CIE01 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

(Common to Control and Instrumentation Engineering & Applied Electronics)

3 0 0 3

UNIT – I **9**

System Identification:

Introduction: Dynamic systems, Models for Linear Time-invariant Systems, Time varying systems and nonlinear systems, The system identification procedure. **Non-parametric methods**- Transient analysis, Frequency analysis, Correlation analysis and Spectral analysis.**Parametric methods**: Least Square- Prediction error method -Maximum Likelihood – Instrumental Variable methods

UNIT – II **9**

Recursive methods and Closed Loop Identification :

Recursive methods: Recursive least squares method- The recursive prediction error method - Recursive instrumental variable method- Input signal design for identification. **Identification of systems operating in closed loop**: Identifiability considerations – Direct and indirect identification – Joint input / output identification.

UNIT – III **9**

State Estimation:

Linear Optimal State Estimation: Kalman filter **-** Stability Analysis **Non-Linear State Estimation:** Extended Kalman filter – Bucy filter **Adaptive Strate Estimation:** Parameter Identification via Extented Kalman filter

UNIT – IV **9**

Adaptive Control Schemes:

Internal Model Control (IMC) schemes: Known parameters -Adaptive Internal Model Control schemes – Stability and robustness analysis. **Robust adaptive control:** Problem formulation - Ordinary direct adaptive control with dead zone – New robust direct adaptive control - Robust adaptive control with least prior knowledge. Indirect adaptive periodic control: Problem formulation – Adaptive control scheme and control law.

UNIT – V **9**

Applications of Adaptive Control:

Optimal adaptive tracking for nonlinear systems: Problem statement – Adaptive tracking – adaptive back stepping – Inverse concepts – Design of strict feedback system. **Adaptive inverse for actuator compensation**: Plants with actuator non-linearities – Parameterized inverses – State feedback designs– Output feedback inverse control and designs – Designs for multivariable systems and non-linear dynamics. Stable MIMO adaptive fuzzy/ neural control.

TOTAL : 45

REFERENCE BOOKS:

1. Torsten Soderstrom T and Petre Stoica, "System Identification", Prentice Hall International, Second Edition, London, 2001.
2. Gang Feng and Rogelio Lozano, "Adaptive Control Systems", Newnes publisher, First Edition, Jordan Hill, 1999.
3. Lennart Ljung, "System Identification: Theory for the User", Prentice-Hall, Second Edition, New Jersey, USA, 1999.
4. Karl J.Astrom and Bjorn Wittenmark, 'Adaptive Control", Pearson Education, Second Edition, New Delhi, 2003.
5. Eveleigh,V.W. "Adaptive Control and optimization Techniques", Tata McGraw Hill Newyork,1967.

Course Outcomes:

On completion of the course the students will be able to

- understand the basics of system identification
- gain the knowledge of identification methods
- apply the concepts of closed loop method and state estimation
- know the adaptive control schemes and their applications

14CIE02 ADVANCED INSTRUMENTATION SYSTEM DESIGN

3 0 0 3

UNIT – I **9**

Principles of Analog Signal Conditioning: Signal level and bias changes, linearization, conversion, filtering and impedance matching, concept of loading - Passive circuits: Divider circuit, Bridge circuit, RC filters - OP Amp circuits for instrumentation: Voltage follower, V/I, I/V, differential amplifier instrumentation amplifier, Differentiator, integrator, and linearization- Design guidelines.

UNIT – II **9**

Design of signal conditioning circuits: Temperature transmitter, RTD, thermocouple, thermistor, cold junction compensation for thermocouple, strain gauge- Design considerations.

UNIT – III **9**

Design of orifice: liquids, gas, stream - Design of rotatometer- Design of control valve: Valve capacity, valve sizing, pressure drop, cavitations & flashing, rangeability – Control valve selection factors – Sequencing control valves -Viscosity correction.

UNIT – IV **9**

Design of analog controllers: Electronic controller: Error detector, single mode controller, composite mode controllers- Design of pneumatic controller – Design consideration.

UNIT – V **9**

Converters: ADC, DAC, V to F (LM331 and 555 timer) and F to V – Types and Structure, conversion, resolution and other characteristics. Characteristics of digital data- Digitized value, Data acquisition systems - Data Logger. Alarms: Single variable and multi variable - SMPS design.

TOTAL : 45

REFERENCE BOOKS:

1. C. D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Prentice Hall, 2006.
2. Norman A Anderson," Instrumentation for Process Measurement and Control" CRC Press LLC, Florida, 1998
3. Liptak B.G, "Instrumentation Engineers Handbook (Process Control)", CRC Press, Volume 2, Fourth Edition, 2005.
4. D. Roy Choudhury, Shail B.Jain " Linear Integrated Circuits", New AGE International Publishers, Fourth Edition, 2010.

Course Outcomes:

On completion of the course the students will be able to

- understand basic concepts of Instrumentation systems
- design of signal conditioning circuits for various measuring Instruments
- implement amplifiers and filters in Signal conditioning circuits and design of Analog and Pneumatic controllers

14CIE03 INSTRUMENTATION IN AUTOMOBILES AND BUILDING AUTOMATION

3 0 0 3

UNIT – I **9**

Basics of Automobile and Engine Control Management: Fuel control - Ignition control - Exhaust control - Angular and linear position sensors and control valves - Pressure sensors - Cam shaft and crank shaft sensors - Wheel speed sensors.

UNIT – II **9**

Power transmission strategies and control, Interior and exterior lighting systems: Sensing and instrumentation – Aerodynamics - Security and Safety controls: Keyless sensors for passive entry - Support accessories.

UNIT – III **9**

Ergonomics and safety: Driver information system - Lighting system components - Battery monitoring and control Air conditioning - Steering control techniques - Automatic gear control systems - ABS, GPS, Emission standards.

UNIT – IV **9**

Introduction to Building Automation System: Fundamentals: Introduction to HVAC- Basic Processes (Heating, Cooling) Basic Science - Air Properties - Psychometric Chart - Heat Transfer mechanisms - Human Comfort: Human comfort zones - Effect of Heat, Humidity - Heat loss.

UNIT – V **9**

Processes: Heating Process & Applications: Boiler, Heater - Cooling Process and Applications: Chillers - Ventilation Process and Applications - Central Fan System – AHU - Exhaust Fans - Unitary Systems - VAV, FCU - Energy Saving concept & methods - Lighting control- Building efficiency improvement - Green Building (LEED) concept and examples .

TOTAL : 45

REFERENCE BOOKS:

1. William B. Riddens, “Understanding Automotive Electronics”, Sixth Edition, Butterworth Heinemann Woburn, 1998.
2. Jiri Marek , Hans-Peter Trah, Yasutoshi Suzuki, and Iwao Yokomori, “Sensors Applications, Sensors for Automotive Technology”, Volume 4, Wiley-VCH, 2003.
3. Reinhold A. Carlson, Robert A. Di Giandomenico, “Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs)”, R.S. Means Company, Inc.1991.
4. Michael F. Hordeski, “HVAC Control in the New Millennium”, First edition, Fairmont Press, 2001.
5. John Levenhagen, and Donald Spethmann, “HVAC Controls and Systems”, First edition, McGraw-Hill Professional, 1993.
6. NJATC, “Building Automation Control Devices and applications”, First edition, Amer Technical Pub., 2008.

Course Outcomes:

On completion of the course the students will be able to

- understand the concepts of sensors and instrumentation in automobile and building automation systems
- analyze the concepts of safety
- develop efficient systems in automobile and building automation systems

14CIE04 BIOPROCESS INSTRUMENTATION AND CONTROL

3 0 0 3

UNIT – I **9**

Biosensors: Physical and chemical sensors – Biosensors: On-line sensors for cell properties - off-line Analytical methods - Electrochemical sensors.

UNIT – II **9**

Fermenters: Sensors in fermenters - Agitation and capacity coefficient in fermenters - Control of pH, dissolved oxygen - Dissolved carbon dioxide - Temperature of fermenters - Rheological measurement and control application of microcomputers in the study of microbial process.

UNIT– III **9**

Sensor Interfacing: Elements of Digital computers - Computer Interfaces and peripheral devices - Fermentation software systems.

UNIT – IV **9**

Filtering and Estimation: Data smoothing and interpolation - State and parameter estimation - Direct regulatory control - Cascade control of metabolism.

UNIT – V **9**

Bioprocess control: Programmed batch bio-reaction - Design and operation strategies for batch plants - Continuous process control - Applications of fibre optic sensors and electro chemical sensors in bio process control.

TOTAL : 45

REFERENCE BOOKS:

1. Bailey J.E. and Ollis,D.F. " Biochemical Engineering Fundamentals" 2nd Edition, McGraw Hill Book CO.,Singapore,1986
2. T.K.Ghose, "Process Computations in Biotechnology", Tata McGraw Hill Publ.Co.,New Delhi, 1994.
3. A.Fischer, "Advances in Biochemical Engineering," Vol. 13, 1973, Springer Verlag, Germany
4. Aiba, Humphry and Millis, " Bio Chemical Engineering ", 2nd Edition., Academic press, 1973.
5. Scragg, "Bioreactors in Biotechnology - A Practical Approach", Ellis Horwood Ltd., U.K., 1991
6. John V.Twork and A.M.Yacynych, "Sensors in Bioprocess control", Library of Congress Cataloging, 1990.

Course Outcomes:

On completion of the course the students will be able to

- understand the basic concepts of bio sensors and fermenters
- apply sensor interfacing and filtering and estimation methods for various applications
- perform effective bio process control in various plants

14CIE05 INSTRUMENTATION AND CONTROL IN PROCESS INDUSTRIES

3 0 0 3

UNIT – I **9**

Applicability of Miscellaneous Control Strategies: Proportioning or Ratio Control-Solid Material Conveying Systems-Heat Generation: Furnace Control (single fuel and multi fuel combustion control) - Product Quality Control- pH Measurement and Control -Conductivity Measurement and Control.

UNIT – II **9**

Product Distillation: Basics of the distillation process - Conversion process - Distillation column control systems – Condensers: Control of the outflow of energy - Basic controls for a distillation column - Starting up and shutting down a distillation column - Conditions for normal running.

UNIT – III **9**

Product Blending: In-line product blending – Blending system in hazardous and non hazardous environment – Microprocessor based blending system – Design of a blending system – Communication between blending controller and personal computer – Online and off line mode.

UNIT – IV **9**

Instrumentation and Control in Brewing Industry: Kiln instrumentation and control - Position of the dampers at the start of the malt finishing operation - Cereal cooking – Lautering control - Brew kettle control – Fermentation - Specific gravity measurement.

UNIT – V **9**

Project Management and Administration: The technologist versus the manager (administrator) - the requirements of the administrator - Starting of a project - Pre-project involvement for the product manufacturer - The manufacturing site - Project justifications - Technical aspects - Process engineering aspects - Commercial aspects – System documentation - Project schedule and administration.

TOTAL : 45

REFERENCE BOOKS:

1. Douglas O.J.Desá, “Applied Technology and Instrumentation for Process control”, First edition, CRC Press., 2004
2. Bela G. Liptak, “Instrumentation in the Processing Industries: Brewing, Food, Fossil Power, Glass, Iron and Steel. Mining and Minerals, Paper, Petrochemical, Pharmaceutical”, First edition, Chilton Book Company, 1973.
3. Considine D. M, “Hand book of Applied Instrumentation”, Tata McGraw-Hill, New Delhi, 1993.
4. Bela G. Liptak, “Process control and optimization”, Fourth edition, CRC Press, 2006.

Course Outcomes:

On completion of the course the students will be able to

- understand instrumentation and control in product quality measurement, distillation, blending and brewing industry
- apply Instrumentation control schemes in Process Industries
- perform project management and administration in Process Industries

14CIE06 INDUSTRIAL DRIVES AND CONTROL

3 0 0 3

Pre-requisites: Electrical Machines

UNIT – I **9**

Phase Controlled DC Motor Drives: Single phase controlled converter - Three phase controlled Converter with Freewheeling, Converter configuaration for a Four quadrant DC Motor Drive, Two quadrant Three Phase Converter Controlled DC Motor Drive, Two quadrant DC Motor Drive with Field Weakening, Converter selection and Characteristics.

UNIT – II **9**

Chopper Controlled DC Motor Drives: Principles of operation of chopper, Four quadtrant chopper fed DC drives, Chopper for Inversion, Closed loop operation of Speed and Current controlled chopper fed DC drives, Applications: Forklift trucks, Hoists and Elevators.

UNIT – III **9**

Voltage Fed Converter AC Drives: Three phase Inverters: Six Step control- Phase shift voltage control-Voltage and frequency control. Multi stepped Inverters- 12 step inverter. PWM Techniques: Sinusoidal PWM- Selected harmonic elimination PWM- Space vector PWM.

UNIT – IV **9**

Current Fed Converter AC Drives: Operation of a Six step Thyristor inverter- Inverter operating modes, Load commutated inverters- Three phase inverter, Forced commutated inverters- Auto sequential current fed inverter, Harmonic heating and Torque pulsation, Comparison between current fed and voltage fed converters.

UNIT – V **9**

Control and Estimation of Induction Motor Drives: Induction motor control with small signal model, Open loop V/F control,Speed control with slip regulation, Speed control with torque and flux control, Adaptive control: Self tunning control- Sliding trajectory control of a vector drive.

TOTAL : 45

REFERENCE BOOKS:

1. Bose.B.K., “Power Electronics and Motor Drives - Advances and Trends”, IEEE Press, 2006.
2. Buxbaum, A. Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer-Verlag, Berlin,1990.
3. Vedam Subrahmanyam, “Thyristor control of Electric drives”, Tata McGraw Hill, 1988.
4. R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” , Prentice Hall of India, 2002.
5. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, John Wiley and Sons Inc., 2006.

Course Outcomes:

On completion of the course the students will be able to

- understand the basic concepts of converter and chopper fed drives
- know the various DC/AC fed industrial drives
- analyze the characteristics of various Industrial drives

14MMT21 ROBOTICS AND CONTROL

(Common to Mechatronics & Control and Instrumentation Engineering)

3 0 0 3

Prerequisites: Bridge Course Mechanical, Applied Mathematics for Mechatronics

UNIT – I **9**

Introduction: History of robotics, Components and structure of industrial robots – Work space – Robot specifications - Degree of freedom- Joint types - Types of robots – Accuracy, Resolution and Repeatability - End effectors and grippers design – Dexterity -Robot applications.

UNIT – II **9**

Concepts of Finite Transformation: Descriptions: Position, Orientations and translation – Mapping: Changing from frame to frame – Operators: Translations, Rotation and Transformation, Further Properties of Rotations.

Robot Kinematics: Homogeneous Transformation matrices, Representation of links using Denavit - Hartenberg parameters, Forward kinematics and Inverse kinematics – Position, Velocity and acceleration analysis-applications.

UNIT– III **9**

Velocity and Static force: Introduction, Linear and angular velocities of a rigid body, Velocity propagation – Derivation of Jacobian matrix for Serial manipulator, Singularities, Static force of serial manipulator.

UNIT – IV **9**

Robot Dynamics: Acceleration of a rigid body, Inertia of a link, Legrangian formulation, Euler formulation - Recursive Newton Euler formulation – Derivation of equations of motion for manipulators – Inverse dynamics of manipulator.

UNIT – V **9**

Robot Control : Point to point – Continuous path and controlled path motions – Joint trajectory vs Cartesian trajectory – Trajectory planning – Trajectory following - Disturbance rejection – PD and PID control – Computer torque control – Adaptive control – Feedback linearization for under actuated systems.

TOTAL: 45

REFERENCE BOOKS:

1. Craig, John J., “Introduction to Robotics: Mechanics and Control”, Third edition, Copyright©2009 Dorling Kindersley (India) Pvt. Ltd., license of Pearson Education in South Asia.
2. Mark W.Spong and M. Vidyasagar “Robotics Dynamics and control”, John Wiley Publication, 2008.
3. Groover, M.P., “Industrial Robotics, Technology, Programming and Applications”, Second edition Tata Mcgraw-Hill, 2012.
4. Deb, Sathya Ranjan, “Robotics Technology and Flexible Automation”, Second edition, Tata Mcgraw-Hill Publication, New Delhi, 2010.
5. S.K Saha “Introduction to Robotics”, First Edition, Tata Mcgraw-Hill, 2008.
6. Saeed B. Niku “Introduction to Robotics: Analysis, Control, Applications”, SecondEdition, Wiley India Pvt Ltd, 2012.
7 Robert J. Schilling “Fundamentals Of Robotics: Analysis And Control”, First Edition, Prentice-Hall, 2009.

Course Outcomes:
On completion of the course students will be able to

- know the basics components and total functionality of an industrial Robot
- ability to solve the kinematics and the linear and angular velocities of a serial manipulator
- solve dynamic equations for different manipulator configurations
- recognize the roll of motion planning and different schemes of control techniques

14CIE07 ROBUST CONTROL

3 0 0 3

UNIT – I **9**

Introduction: Introduction to concepts of model uncertainty, including both parametric and dynamic uncertainty. Fundamental concept of robustness and the relationship between physical systems and mathematical models. Mathematical background including norms for vectors, matrices, signals, and systems. Singular value decomposition and its application to perturbation analysis.

UNIT – II **9**

Robustness Problems: Linear fractional transformations and canonical forms. Performance measured via (induced) norms. Robust stability and performance problems. Solution of SISO robustness problems.

UNIT – III **9**

Analysis of robustness: Stability analysis- Gamma stability- testing sets- Kharitonon's theorem-Stability radius. Introduction to the structured singular value for robustness analysis of MIMO systems.

UNIT – IV **9**

Computer- Aided Analysis Techniques: Conversion of robustness problems to canonical MΔform. The small gain theorem and approximate computation of μ via efficient upper and lower bounds. Computer -aided tools for μ analysis based on the μ Tools Matlab toolbox.

UNIT – V **9**

Synthesis and Controller Design: Optimal controller design including H2 and H∞ optimal control. Scaled H∞ optimal control problems and μ synthesis. Computer -aided tools to implement D, G-K iteration for advanced controller design.

Design case studies: Control of an inverted pendulum-continuously stirred tank.

TOTAL : 45

REFERENCE BOOKS:

1. U.Mackenoth, "Robust Control Systems", Springer, Verlag, London 2010.
2. K. Zhon, John C. Doyle, "Essentials of Robust Control", Prentice Hall Int. 1998
3. S. P. Bhattacharya, H. Chapellat, "Robust Control - The Parametric Approach", Prentice Hall, 1995
4. Ben M. Chen , "Robust and H∞ Control", Springer,Verlag, London, 2000

Course Outcomes:

On completion of the course the students will be able to

- gain fundamental knowledge and mathematical background of robustness
- understand the concepts of SISO and MIMO robustness problems
- analyze and design optimal control problems

14CIE08 MULTISENSOR DATA FUSION

3 0 0 3

UNIT – I **9**

Multi sensor data fusion: 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.

UNIT – II **9**

Mathematical tools: Algorithms: Ternary trees, Priority Kd trees co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

UNIT – III **9**

Algorithms: Taxonomy of algorithms for multi sensor data fusion - Data association - Identity declaration. Estimation: Kalman filtering - Practical aspects of Kalman filtering extended Kalman filters - Decision level identify fusion - Knowledge based approaches.

UNIT – IV **9**

Filtering and Estimation methods: 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.

UNIT – V **9**

High performance data structures: Tessellated, trees, graphs and function.- Representing ranges and uncertainty in data structures - Designing optimal sensor systems within dependability bounds - Implementing data fusion system.

TOTAL : 45

REFERENCE BOOKS:

1. David L. Hall, "Mathematical techniques in Multisensor data fusion", Artech House, Boston, 1992
2. R.R. Brooks and S.S. Iyengar, "Multisensor Fusion: Fundamentals and Applications with Software", Prentice Hall Inc., New Jersey, 1998
3. Belur V. Dasarathy, Multisensor, "Multisource Information Fusion-Architectures, Algorithms, and Applications" ,SPIE,2004
4. James V. Candy, "Signal Processing: The Model Based Approach", Tata McGraw –Hill, 1987
5. H.B.Mitchell, "Multi sensor Data Fusion", Springer, 2007.
6. Lawrence A.Klein, "Sensor and Data Fusion: A tool for Information Assessment and Decision Making", Library of Congress Cataloging, 2004.

Course Outcomes:

On completion of the course the students will be able to

- understand the basic concepts of multi sensor data fusion
- apply Mathematical Tools, Algorithms and Filtering and Estimation methods for data fusion
- enhance the knowledge about high performance data structures

14COE16 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

(Common to Communication Systems, VLSI Design, Applied Electronics & Control and Instrumentation Engineering)

3 0 0 3

Pre-requisites: Microwave Communication

UNIT – I **9**

EMI Environment : EMI/EMC concepts and definitions, Sources of EMI, conducted and radiated EMI, Transient EMI, Time domain Vs Frequency domain EMI, Units of measurement parameters, Emission and immunity concepts, ESD

UNIT – II **9**

EMI Coupling Principles: Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply coupling

UNIT – III **9**

EMI/EMC standards and measurements : Civilian standards - FCC, CISPR,I EC, EN, Military standards - MIL STD 461D/462, EMI Test Instruments /Systems, EMI Shielded Chamber, Open Area Test Site, TEM Cell, Sensors/Injectors/Couplers, Test beds for ESD and EFT, Military Test Method and Procedures (462).

UNIT – IV **9**

EMI control techniques : Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting

UNIT – V **9**

EMC design of PCBs : PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models

TOTAL : 45

REFERENCE BOOKS:

1. Ott, Henry W., "Noise Reduction Techniques in Electronic Systems", John Wiley & Sons, New York, 1988
2. Paul, C.R., “Introduction to Electromagnetic Compatibility”, John Wiley & Sons, New York, 1992
3. Kodali, V.P., "Engineering EMC Principles, Measurements and Technologies", IEEE Press, London, 1996.
4. Keiser, Bernhard., "Principles of Electromagnetic Compatibility", Third Edition, Artech House, Dedham, 1986.

Course Outcomes:

On completion of the course the students will be able to

- formulate the various aspects EMI/EMC coupling
- identify a suitable EMI testing and controlling techniques
- develop the EMC design of PCBs

14CIE09 MICROCONTROLLER BASED SYSTEM DESIGN

3 0 0 3

UNIT – I **9**

8051 Architecture and Programming: Architecture – Memory organization – Addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication

UNIT – II **9**

8051 Assembly language programming: Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming- Interrupt Programming – RTOS for 8051 – RTOSLite – Full RTOS –Task creation and run – LCD digital clock/thermometer using Full RTOS

UNIT – III **9**

PIC18 Microcontroller and its Peripherals: Architecture –WREG register-PIC File register- PIC Status register– memory organization – addressing modes – instruction set – PIC18 programming in Assembly & C –I/O port- I/O Port Programming – I/O Bit Manipulation Programming- Data Conversion, RAM & ROM Allocation

UNIT – IV **9**

Assembly Language programming of PIC18 Microcontroller : Timer programming – Programming Timer 0 &1-Counter Programming - Programming Timer 2&3 – Serial Port Programming-PIC18 Microcontroller to RS232-Interrupts-Timer Interrupts - External Hardware Interrupts- Serial Communication Interrupts- Interrupt Priority- I2C bus-A/D converter-UART- CCP modules

UNIT – V **9**

System Design with PIC18 Microcontroller: ADC, DAC and Sensor Interfacing –Flash and EEPROM memories-Semiconductor Memory-Interfacing LCD Display – Keypad Interfacing – Relay and Optoisolators Interfacing- Stepper Motor Interfacing– DC Motor Interfacing-PWM interfacing

TOTAL : 45

REFERENCE BOOKS:

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey , " PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education, 2008
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.Mckinley "The 8051 Microcontroller and Embedded Systems using Assembly and C ,Second Edition, Pearson 2011.
3. John Iovine, "PIC Microcontroller Project Book ", Tata McGraw Hill, 2000
4. Myke Predko, "Programming and customizing the 8051 microcontroller", Tata McGraw Hill, 2001.

Course Outcomes:

On completion of the course the students will be able to

- understand the basics of 8051 microcontroller and its programming
- know the programming of RTOS for 8051
- learn the basics of PIC18 microcontroller Programming
- apply the programming skills for interfacing peripherals with PIC18 controller and for real time applications

14CIE10 REAL TIME EMBEDDED SYSTEMS

3 0 0 3

UNIT – I **9**

Introduction: Basic real time concepts : Terminology – Real time system design issues – Examples for real time systems. Hardware considerations : Basic architecture – Hardware interfacing – Central Processing unit – Memory – Input/output – Performance enhancement.

UNIT – II **9**

Real time operating system: RTOS : Real time kernels – Theoretical foundations of RTOS – Intertask communication and synchronization – Memory management : Process stack management – Run time ring buffer – TCB model – Swapping – Overlays – Block or page management – Replacement algorithms – Memory locking – Selecting real time kernels

UNIT – III **9**

Software requirements engineering: Engineering process requirements – Types of requirements – Requirement specifications – Formal methods in software specification – Structured analysis and design – Object oriented analysis and UML - Organizing the requirements document – organizing and writing the requirements – Requirements validation and review

UNIT – IV **9**

Software system design: Properties of software – Basic software engineering principles – Design activity – Procedural oriented design : Parnas partitioning – Structured design – Design using FSM – Object oriented design: Benefits – Design pattern – Design using UML

UNIT – V **9**

Engineering considerations: Metrics - Faults, Failures and bugs - Fault tolerance: Spatial Fault-Tolerance - Software Black Boxes - Built-In-Test Software - CPU and memory testing – RAM – ROM - The Kalman Filter.

Systems integration : Goals – Unification – Verification – Tools – A simple integration strategy – Patching – Probe effect.

TOTAL : 45

REFERENCE BOOKS:

1. Phillip A.Laplante, "Real –Time Systems Design and Analysis", IEEE press, A John wiley & sons, inc., Publication, Third edition, 2004
2. Raj Kamal, "Embedded Systems Architecture, Programming and Design", Tata Mc-Graw-Hill,2003
3. R.J.A.Buhr, D.L.Bailey, "An Introduction to Real Time Systems: Design to networking with C/C++", Prentice- Hall, International, 1999.
4. Grehan Moore and Cyliax, "Real Time Programming: A guide to 32 Bit Embedded Development Reading", Addison- Wisley-Longman, 1998.

Course Outcomes:

On completion of the course the students will be able to

- understand the basic concepts of Real time and Real time operating systems
- know the software requirements in Embedded systems
- understand the various engineering considerations involved in the design of real time systems

14MME03 MEMS DESIGN

(Common to Mechatronis, Applied Electronics, Control and Instrumentation Engineering & VLSI Design)

3 0 0 3

Pre requisites: Sensors and Instrumentation, Bridge course mechanical

UNIT – I **9**

Materials for MEMS and Scaling Laws: Overview - Microsystems and microelectronics - Working principle of Microsystems – Si as a substrate material - Mechanical properties - Silicon compounds - Silicon piezoresistors - Gallium aresenside - Quartz-piezoelectric crystals - Polymer -Scaling laws in Miniaturization.

UNIT – II **9**

Micro Sensors, Micro Actuators: Micro sensors – Types- Micro actuation techniques- Microactuators – Micromotors – Microvalves – Microgrippers – Micro accelerometer – introduction – Types - Actuating Principles, Design rules ,modeling and simulation, Verification and testing –Applications- Fundamentals of micro fluidics- Micro-pump- Types, Actuating Principles, Design rules ,modeling and simulation, Verification and testing –Applications

UNIT – III **9**

Mechanics for Microsystem Design: Static bending of thin plates - Mechanical vibration - Thermo mechanics - Thermal stresses - Fracture mechanics - Stress intensity factors, fracture toughness and interfacial fracture mechanics-Thin film Mechanics-Overview of Finite Element Stress Analysis.

UNIT – IV **9**

Fabrication Process and Micromachining: Photolithography - Ion implantation - Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition by epitaxy - Etching process- Bulk Micro manufacturing - Surface micro machining – LIGA –SLIGA.

UNIT – V **9**

Micro System Design, Packaging and Applications: Design considerations - Process design - Mechanical design – Mechanical Design using Finite Element Method-Micro system packaging – Die level - Device level - System level – Packaging techniques - Die preparation - Surface bonding - Wire bonding – Sealing – CAD tools to design a MEMS device- Applications of micro system in Automotive industry, Bio medical, Aerospace and Telecommunications.

TOTAL : 45

REFERENCE BOOKS:

1. Mohamed Gad-el-Hak, “The MEMS Hand book”, CRC press, 2009.
2. Tai-Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata McGraw-Hill, New Delhi, 2008.
3. M.-H. Bao, “Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes”, Elsevier, New York, 2000.
4. Julian W. Gardner, Vijay K. Varadan, Osama and Awadel Karim, O., “Microsensors MEMS and Smart Devices”, John Wiley & sons Ltd., New York, 2001.
5. Tai---Ran Hsu, “MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering”, 2^{nd} Edition, Wiley & Sons ISBN: 978---0---470---08301---7, March 2008.
6. Chang Liu, “Foundations of MEMS”, Prentice Hall, 2006.
7. IEEE/ASME: Journal on Microelectromechanical Systems.

Course Outcomes:
On completion of the course students will be able to

- understand the basic concepts of microsensors, microactuators and micromechanics
- know the microfabrication and micromanufacturing techniques
- apply the knowledge to design a microsystem for various applications

14CIE11 ADVANCED DIGITAL IMAGE PROCESSING

3 0 0 3

UNIT – I **9**

Introduction: Elements of Digital Image Processing - Applications of Digital Image Processing-Elements of visual perception: luminance, brightness, contrast, hue, saturation, Mach band effect-Simultaneous contrast, Theory of 2D sampling.

Image Transforms: Need for image transforms-2D: DFT, DCT, Haar, KL, SVD and Wavelet transforms and problems.

UNIT – II **9**

Image Enhancement: Introduction – Enhancement by point processing – Spatial filtering: smoothing and sharpening filters – Enhancement in frequency domain: lowpass, highpass and homomorphic filtering.

Image Restoration: Degradation model, Algebraic approach to Restoration: Unconstrained and Constrained restoration, Inverse filtering: Formulation, Removal of blur caused by Uniform Linear Motion, Wiener filter.

UNIT – III **9**

Image Segmentation: Classification of image-segmentation techniques – Region approach to image segmentation – Clustering techniques – Image segmentation based on thersholding - Active contour - Watershed transformation – Texture based segmentation –– Atlas based segmentation - Wavelet based segmentation.

Mathematical Morphology: Structuring elements – Standard binary morphological operations: Erosion, dilation, opening and closing - Hit (or) miss transforms.

UNIT – IV **9**

Image Compression: Need for image compression – Run-length coding - Huffman coding - Arithmetic coding – Transform-based compression -Vector quantization - Block Truncation Coding – Wavelet based image compression.

Compressed Sensing: Introduction- Image and its processing – problems - Energy Based methods of image processing.

UNIT – V **9**

Image Registration: Registration: Preprocessing, Feature selection: points, lines, regions and templates. Feature correspondence: Point pattern matching, Line matching, Region matching, and Template matching. Transformation functions: Similarity transformation and Affine transformation.

Image Fusion: Introduction - Pixel Fusion, Multiresolution based fusion: Wavelet fusion.

Applications: IMAQ Vision: Pattern matching, Instrument readers.

TOTAL : 45

REFERENCE BOOKS:

1. Jayaraman.S, Esakkirajan.S, and Veerakumar.T, “Digital Image Processing”, Tata McGraw-Hill, New Delhi, First Edition, 2009.
2. Gonzalez, Rafel C. and Woods, Richard E, “Digital Image Processing”, Second Edition, Prentice Hall, New York, 2006.
3. K.P.Soman and R.Ramanathan, “Digital Signal and Image Processing – The Sparse Way”, ISA publishers, Amrita University, Coimbatore, 2012.
4. Ardeshir Goshtasby, “2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications”, John Wiley and Sons, 2005.
5. Jovitha Jerome, “Virtual Instrumentation using LabVIEW”, PHI publishers, PSG College of Technology, Coimbatore, 2010.

6. Tamal Bose, “Signal and Image Processing”, Wiley, 2011.
7. Jain, Anil K., “Fundamentals of Digital Image Processing”, Prentice Hall of India, New Delhi, 2003.
8. S.Sridhar, “Digital Image Processing”, Oxford University Press, New Delhi, 2011.
9. H.B.Mitchell, “Image Fusion: Theories, Techniques and Applications”, Springer, 2010.

Course Outcomes:

On completion of the course the students will be able to

- understand the image formation and the role of human visual system in perception of gray and color images
- apply image processing techniques in both the spatial and frequency domains using various transform techniques
- gain knowledge in Image segmentation, registration, fusion and compression

14CIE12 ADVANCED DIGITAL SYSTEM DESIGN

3 0 0 3

Pre-requisites: Digital Logic Circuits, VLSI Design

UNIT – I **9**

Sequential Circuit Design: Analysis of clocked synchronous sequential circuits and modeling- State diagram, state table, state table assignment and reduction-Design of synchronous sequential circuits, design of iterative circuits-ASM chart and realization using ASM.

UNIT – II **9**

Asynchronous Sequential Circuit Design: Analysis of asynchronous sequential circuit – Flow table reduction – Races – State assignment-Transition table and problems in transition table- Design of asynchronous sequential circuit-Static, dynamic and essential hazards – Designing vending machine controller.

UNIT – III **9**

Fault Diagnosis and Testability Algorithms: Fault table method-Path sensitization method – Boolean difference method - D algorithm -Tolerance techniques – Test generation – DFT schemes – Built In Self Test(architecture).

UNIT – IV **9**

Synchronous Design using Programmable Devices: Programming logic device families: FPGA –- Configurable Logic Blocks- Logic Cell Array- Inputs/Outputs Blocks– Programmable Interconnect point- Switching Matrix – Xilinx XC 4000 series, Introduction to Xilinx Spartan, and Virtex FPGA.

UNIT – V **9**

System Design using VHDL: VHDL operators – Arrays – Concurrent and sequential statements – Packages- Data flow– Behavioral – Structural modeling – Compilation and simulation of VHDL code – Realization of combinational and sequential circuits using HDL – Design of simple microprocessor.

TOTAL: 45

REFERENCE BOOKS:

1. Donald D. Givone, “Digital Principles and Design”, First edition, Tata McGraw-Hill, 2003
2. Charles H.Roth Jr “Digital Systems Design Using VHDL” Thomson Learning, 2004
3. Nripendra N Biswas “Logic Design Theory”, Prentice Hall of India, 2001
4. John M.Yarbrough , “Digital Logic: Applications and Design”, Cengage Learning, First Edition September 11, 1996.
5. Lala, P.K., “Digital Circuit Testing and Testability”, Academic Press, 2002.

Course Outcomes:

On completion of the course the students will be able to

- design synchronous and asynchronous systems
- understand the programming with VHDL
- learn to implement in FPGA

14CIE13 EMBEDDED FPGA BASED CONTROL DESIGN

3 0 0 3

Pre-requisites: Embedded Control, VLSI Design

UNIT – I **9**

Introduction to Embedded System: Definition of Embedded systems; Embedded vs General Computing Systems; Classification of Embedded System; Purpose of Embedded System; Typical Embedded System-Core, Memory, Sensors & Actuators, Communication Interface, Embedded Firmware, Other System Components, PCB and Passive Components; Characteristics and Quality attributes of Embedded Systems.

UNIT – II **9**

Hardware Software Co-Design and Program Modeling: Fundamental issues in Hardware Software Co-Design, Computer system, Computer software- machine, Assembly, High Level C Language, Instruction set architecture- SMPL CPU design- CPU specification-Single cycle and multiple cycle implementations, SAYEH Design and test: processor-data path. FPGAs: ALTERA's cyclone.

UNIT – III **9**

Firmware Design and Development: Firmware design approaches; Library management, Basic I/O device handling- frequency dividers-SSD-LCD Display- Keyboard interface logic- VGA interface logic-HDL simulation and synthesis- Design prototype-Mixed level design with QUARTUS II.

UNIT – IV **9**

Embedded – FPGA System Development Environment: Embedded design steps: Processor selection-interfacing-developing software- Nios II Processor- Configurability features of Nios II, Processor architecture, Instruction set- Alternative cores- System on a Programmable Chip (SOPC) builder overview- Architecture- Functions of SOPC builder, Integrated Development Environment (IDE).

UNIT – V **9**

Embedded FPGA – Control design: Filter design: Filter concepts, FIR filter hardware implementation, FIR embedded implementation-Building the FIR filter. Microcontroller- System platform, Microcontroller architecture.Case Studies: Automated Meter Reading System; Digital Camera

TOTAL: 45

REFERENCE BOOKS:

1. Shibu K V, "Introduction to Embedded Systems", First edition, Tata McGraw Hill, 2011
2. Zainalabedin Navabi, **"**Embedded core design with FPGAs**",** First edition, Tata Mc Graw Hill, 2008.
3. Jonathan W. Valvano, "Embedded Microcomputer Systems: Real Time Interfacing", Thomson, 2000
4. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons; 2002.
5. Ronald Sass and Andrew G. Schmidt, **"**Embedded Systems Design with Platform FPGAs: Principles and Practices**",** Morgan Kuafmann –Elsevier Publisher,2010.

Course Outcomes:

On completion of the course the students will be able to

- understand the fundamentals of embedded-FPGA systems from both hardware and software perspectives
- capable to design an embedded system with FPGA
- use modern EDA tools

14CIE14 NANO ELECTRONICS AND ITS APPLICATIONS

3 0 0 3

Pre-requisites: Materials Science, Digital Electronics

UNIT – I **9**

Quantum Devices: Charge and spin in single quantum dots- Coulomb blockade– Electrons in mesoscopic structures - Single Electron Transfer devices (SETs) – Electron spin transistor – Resonant tunnel diodes, Tunnel FETs - Quantum Interference Transistors (QUITs) - Quantum dot Cellular Automata (QCAs) - Quantum bits (qubits)

UNIT – II **9**

Nanoelectronic Devices: Electronic transport in 1, 2 and 3 dimensions - Electron transport in PN junctions - Short channel NanoTransistor –MOSFETs - Advanced MOSFETs - Trigate FETs, FinFETs – CMOS- Carbon Nanotubes: Carbon materials – Allotropes of carbon – Structure of carbon nanotubes – Types of CNTs – Electronic properties of CNTs – Band structure of Graphene

UNIT – III **9**

Molecular Nanoelectronics: Electronic and optoelectronic properties of molecular materials - Electrodes & contacts – Functions – Molecular electronic devices - Elementary circuits using organic molecules- Organic materials based rectifying diode switches – TFTs- OLEDs- OTFTs

UNIT – IV **9**

Spintronics and Nano photonics: Spintronics and Foundations of nano-photonics- Spin tunneling devices - Magnetic tunnel junctions- Tunneling spin polarization - Giant tunneling using MgO tunnel barriers - Tunnel-based spin injectors - Spin injection and spin transport in hybrid nanostructures - Spin filters -Spin diodes - Magnetic tunnel transistor - Memory devices and sensors : Ferroelectric random access memory- MRAMS

UNIT – V **9**

Nanotechnology in Electronics industry: Advantages of nano electronic devices – Lasers - Micro and Nano-Electromechanical systems – Sensors, Actuators, Optical switches, Bio-MEMS –Data memory –Lighting and Displays – Filters (IR blocking) – Quantum optical devices – Batteries - Fuel cells and Photo-voltaic cells – Electric double layer capacitors – Lead-free solder – Nanoparticle coatings for electrical products

TOTAL : 45

REFERENCE BOOKS:

1. V. Mitin, V. Kochelap, M. Stroscio, "Introduction to Nanoelectronics", Cambridge University Press, 2008.
2. Karl Goser, Peter Glosekotter, Jan Dienstuhl, "Nanoelectronics and Nanosystems", Springer, 2004.
3. Sadamichi Maekawa, "Concepts in Spin Electronics", Oxford University Press, 2006.
4. L. Banyai and S.W.Koch, "Semiconductor Quantum Dots", World Scientific, 1993.
5. Edward L. Wolf, "Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience", Wiley-VCH, 2006.
6. Ali Javey and Jing Kong, "Carbon Nanotube Electronics" Springer Science Media, 2009.
7. Mark A. Ratner and Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Pearson, 2003.

Course Outcomes:

On completion of the course the students will be able to

- know the concepts of Quantum Devices
- analyze the concepts of electron transport and structure of carbon nanotubes
- expose the various organic material devices
- understand the basics of memory devices and applications

14CNE02 WIRELESS SENSOR NETWORKS

(Common to Computer and Communication Engineering, Communication Systems & Control and Instrumentation Engineering)

3 0 0 3

Pre-requisites: Wireless Networks

UNIT – I **9**

Overview of Wireless Networks: Challenges for Wireless Sensor Networks - Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks -case study, Enabling Technologies for Wireless Sensor Networks.

UNIT – II **9**

Architectures : Single-Node Architecture -Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Physical Layer and Transceiver Design Consideration

UNIT – III **9**

MAC and Routing: MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols And Wakeup Concepts -S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols -Energy-Efficient Routing, Geographic Routing.

UNIT – IV **9**

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT – V **9**

Data Management and Security : Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

TOTAL : 45

REFERENCE BOOKS:

1. Ian F. Akyildiz, Mehmet Can Vuran, " Wireless Sensor Networks" John Wiley, 2010
2. Yingshu Li, My T. Thai,Weili Wu, " Wireless Sensor Networks and Applications", Springer, 2008
3. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.
4. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks-An Information Processing Approach", Elsevier, 2007.
5. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks Technology, Protocols and applications", John Wiley, 2007.
6. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
7. Bhaskar Krishnamachari, "Networking Wireless Sensors", Cambridge Press, 2005.
8. Mohammad Ilyas and Imad Mahgaob, "Handbook of Sensor Networks : Compact Wireless And Wired Sensing Systems", CRC Press, 2005.
9. Wayne Tomasi, "Introduction to Data Communication and Networking", Pearson Education, 2007

Course Outcomes:

On completion of the course the students will be able to

- appreciate the need for designing energy efficient sensor nodes and protocols for prolonging network lifetime
- demonstrate an understanding of the different implementation challenges and the solutions approaches