M.E. (Instrumentation Engineering)

2015 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I	Demonstrate technical, communication skills and team spirit along with leadership qualities to pursue career in broad areas of instrumentation and control engineering.
II	Engage in life-long learning through independent study and research.
III	Undertake responsibilities for societal, environmental and ethical causes.

PROGRAM OUTCOMES (POs)

a. apply the knowledge of mathematics, science, engineering, and technology to solve instrumentation and control engineering problems

b. acquire knowledge of instrumentation and control engineering with ability to evaluate, analyze and synthesize knowledge related to process instrumentation

c. analyze complex problems related to instrumentation and control engineering and synthesize the information for conducting research

d. think laterally to solve problems related to instrumentation and control engineering and provide/suggest a range of solutions considering health, safety, societal, and environmental factors

e. extract knowledge through literature survey, experimentation and appropriate research methodology, techniques and tools

f. learn and use contemporary tools for solving problems related to process control, automation, measurement and control etc

g. understand group dynamics and rational analysis in order to achieve common goals

h. apply written, oral, and graphical communication in both technical and non technical environments

i. plan and execute project work to achieve the expected goals

j. engage in life-long learning

k. understand the impact of research and responsibility in order to contribute to the society

MAPPING OF PEOs and POs

PEO(s)	Programme Outcome (s)										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
I	x	x			x	x	x	x			
II			x						x	x	
III				x				x			x

M. E. Instrumentation Engineering (Full Time)

Minimum Credits to be earned: 79

First Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE11	Random Processes and Linear Algebra	I,II	a,c	3	2	0	4
15IE12	Process Dynamics and Control	I,II	a,b,c	3	2	0	4
15IE13	Virtual Instrumentation	I,II	e,f,j	3	0	2	4
15IE14	Industrial Data Networks	I	f	3	0	0	3
15IE15	Transducers and Smart Instruments	I	a,b	3	0	0	3
	Elective – I			3	0	0	3
15IE17	Modeling and Simulation Laboratory	I,II	a,c,f,j	0	0	4	2
15IE18	Instrumentation and Control Laboratory	I,II	a,c,f,j	0	0	4	2
15GE19	Business English - I[α]	I,II	a,c,h,j	1	0	2	2
			Total	**19**	**4**	**12**	**27**
Second Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE21	Research Methodology	I,III	d,e	3	0	0	3
15IE22	Advanced Process control	I,II	a,b,c	3	2	0	4
15IE23	Linear and Non-Linear Systems Theory	I,II	a,c	3	2	0	4
15IE24	Instrumentation System Design	I,II	a,b,c	3	2	0	4
	Elective – II			3	0	0	3
	Elective – III			3	0	0	3
15IE27	Advanced Process Control Laboratory	I,II	a,c,f,j	0	0	4	2
15IE28	Technical Seminar	I,II,III	e,g,h,j	0	0	2	1
15GE29	Business English - II[α]	I,II	a,c,h,j	1	0	0	1
			Total	**19**	**6**	**6**	**25**
Third Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective – IV			3	0	0	3
	Elective – V			3	0	0	3
	Elective – VI			3	0	0	3
15IE34	Project Work Phase – I	I,II,III	c,d,e,f,i,j,k	-			6
			Total	**9**	**0**	**0**	**15**
Fourth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE41	Project Work Phase – II	I,II,III	c,d,e,f,i,j,k	-			12
			Total	**-**	**-**	**-**	**12**

[α] Common to all M.E. / M.Tech. Programmes

M. E. Instrumentation Engineering (Part Time)

First Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE11	Random Processes and Linear Algebra	I,II	a,c	3	2	0	4
15IE12	Process Dynamics and Control	I,II	a,b,c	3	2	0	4
15IE13	Virtual Instrumentation	I,II	e,f,j	3	0	2	4
15IE17	Modeling and Simulation Laboratory	I,II	a,c,f,j	0	0	4	2
15GE19	Business English - I[α]	I,II	a,c,h,j	1	0	2	2
			Total	**10**	**4**	**8**	**16**
Second Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE21	Research Methodology	I,III	d,e	3	0	0	3
15IE22	Advanced Process control	I,II	a,b,c	3	2	0	4
15IE23	Linear and Non-Linear Systems Theory	I,II	a,c	3	2	0	4
15IE27	Advanced Process Control Laboratory	I,II	a,c,f,j	0	0	4	2
15GE29	Business English - II[α]	I,II	a,c,h,j	1	0	0	1
			Total	**10**	**4**	**4**	**14**
Third Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE14	Industrial Data Networks	I	f	3	0	0	3
15IE15	Transducers and Smart Instruments	I	a,b	3	0	0	3
15IE24	Instrumentation System Design	I,II	a,b,c	3	2	0	4
15IE18	Instrumentation and Control Laboratory	I,II	a,c,f,j	0	0	4	2
			Total	**9**	**2**	**4**	**12**
Fourth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective I			3	0	0	3
	Elective II			3	0	0	3
	Elective III			3	0	0	3
15IE28	Technical Seminar	I,II,III	e,g,h,j	0	0	2	1
			Total	**9**	**0**	**2**	**10**
Fifth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective IV			3	0	0	3
	Elective V			3	0	0	3
	Elective VI			3	0	0	3
15IE34	Project Work - Phase I	I,II,III	c,d,e,f,i,j,k	-	-	-	6
			Total	**9**	**0**	**0**	**15**
Sixth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE41	Project Work - Phase II	I,II,III	c,d,e,f,i,j,k	-			**12**

[α] Common to all M.E. / M.Tech. Programmes

List of Core Electives							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IE51	Control System Design	I,II	a,b,c	3	0	0	3
15IE52	Optimal Control and Filtering	I,II	a,c	3	0	0	3
15IE53	System Identification and Adaptive Control	I,II	a,b,c	3	0	0	3
15IE54	Fault Tolerant Control	I,II	a,b,f	3	0	0	3
15IE55	Micro Electro Mechanical System[‡]	I	b,f	3	0	0	3
15IE56	Biomedical Signal Processing	I	a,b	3	0	0	3
15IE57	Industrial Drives and Control	I	a,b,f	3	0	0	3
15IE58	Robotics and Automation[‡]	I	a,b,f	3	0	0	3
15IE59	Robust Control	I,II	a,b,c	3	0	0	3
15IE60	Reliability and Safety Engineering	I	a,b,f	3	0	0	3
15IE61	Web based measurement and control	I,II	b,f,j	3	0	0	3
15IE62	Mechatronics	I	a,b,f	3	0	0	3
15IE63	Optimal State Estimation	I,II	a,b,c	3	0	0	3
15IE64	Wireless Sensor Networks	I	a,b,f	3	0	0	3
15IE65	VLSI system design	I	a,f	3	0	0	3
15IE66	Real Time Embedded System	I	a,f	3	0	0	3
15IE67	Applied Soft Computing	I,II	a,f,j	3	0	0	3
15IE68	Network Security and Cryptography	I	a,f	3	0	0	3
15IE69	Sensor and Networking	I	a,b,f	3	0	0	3
15IE70	Embedded Networking	I	a,b,f	3	0	0	3
15IE71	Project Management	II	i,j	3	0	0	3
15IE72	Applied Biomedical Instrumentation	I	a,b,f	3	0	0	3
15IE73	Applied Industrial Instrumentation	I	a,b	3	0	0	3
15IE74	Fuzzy System for Industrial Processes	I,II	a,f,j	3	0	0	3
15IE75	Power Plant Instrumentation	I,II	b,c	3	0	0	3
One Credit Courses							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15IEXA	Instrumentation standards	I,II	a,i,j,f	1	0	0	1
15IEXB	Industrial Process Schemes Implementation	I,II	a,b,f	1	0	0	1
15IEXC	Instrumentation Project Management	I,II	a,i,j,f	1	0	0	1
15IEXD	Detail Engineering Activities Using P&ID	I,II	a,i,j,f	1	0	0	1

[‡] Common to Instrumentation Engineering and Applied Electronics

15IE11 RANDOM PROCESSES AND LINEAR ALGEBRA

3 2 0 4

Course Objectives

- To elaborate the concepts in probability theory, linear algebra and vector space
- To make the students to understand the various random process concepts
- To acquire knowledge in advance matrix theory this has wider application in engineering problems

Course Outcomes (COs)

The students will be able to

1. acquire adequate knowledge in basic concept of engineering mathematics
2. improve the problem evaluation skills
3. choose an appropriate method to solve a practical problem

Unit I

Probability

Random variable-sample spaces-Events-Axiomatic approach to probability- conditional probability-additional theorem, Multiplication theorem - Baye's theorem problems- continuous and discrete random variables, Distribution function-Expectation with properties-Moments, mean, Variance problems for continuous and discrete distributions.

9 Hours

Unit II

Two Dimensional Random Variables

Joint distributions - Marginal and conditional distributions – Covariance - Correlation and Regression.

9 Hours

Unit III

Random Processes

Stochastic process – Classification, Auto correlation and Auto co-variance – Cross Correlation – Stationery process.

Markov chain: Definition and example – Higher transition probabilities – Classification of states and chains.

9 Hours

Unit IV

Linear Algebra

Linear system of equations – Consistency – Test for consistency – Linear dependence and independence of vectors – Vector space – Bases and dimension – Subspace – Inner product space – Orthonormal basis – Gram – Schmitt orthogonalisation process

9 Hours

Unit V

Advanced Matrix Theory

Matrix norms – Jordan canonical form –Generalized Eigen vectors – Singular value decomposition – Pseudo inverse – Least square approximations – QR algorithm.

9 Hours

Unit VI $

Poisson Process: Properties- Applications, Normal Process: Properties- Applications.

Total: 45 + 30 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Reference(s)

1. Richard Johnson, Miller and Freund's, Probability and Statistics for Engineers, Eigth Edition, Prentice Hall, New Delhi, 2010
2. Louis A Pipes, Lawrence R. Harvill, Applied Mathematics for Engineers and Physicists, Third Edition , (Dover books on Mathematics) 2014
3. J. Medhi, Stochastic Processes, Third Edition, New Age International, 2014
4. David C Lay, Linear Algebra and its Applications, Pearson Education Asia, New Delhi, 2011
5. Howard Anton, Elementary Linear Algebra, John Wiley & Sons, 2015
6. Gilbert Strang, Linear Algebra and its Applications, Brooks/Cole Ltd, New Delhi, Third Edition, 2014

15IE12 PROCESS DYNAMICS AND CONTROL

3 2 0 4

Course Objectives

- To obtain the mathematical model of first order systems and understand about the controllers and controller tuning methods.
- To get knowledge about various complex control schemes, multivariable systems and multivariable control schemes for various applications.

Course Outcomes (COs)

The students will be able to

1. obtain the mathematical models for first order real-time systems and understand the characteristics of various control modes.
2. design controller tuning parameters using various methods and understand the concept of various complex control schemes
3. study about the multivariable systems and understand the procedure to apply the multivariable control schemes for simple applications

Unit I

Process Dynamics & Control Actions

Mathematical modeling of processes: Fundamental laws and equations - level, thermal, flow, gas and mixing process. Interacting and non-interacting process - self-regulation - inverse response - degrees of freedom - linearization - transfer function representation of process - variable gain, variable time constant

8 Hours

Unit II

PID Controller

Feedback control of processes: Basic control actions - characteristics of ON/OFF, P, P+I, P+D, P+I+D control modes - non-linear PID control – anti-reset windup - bumpless transfer - practical forms of P+I+D control modes. Selection of control modes for different processes - control schemes for flow, level, pressure and temperature.

8 Hours

Unit III

PID Controller Tuning

Methods of controller tuning, Ziegler Nichols continuous cycling, damped oscillations, process reaction curve methods - Cohen & Coon methods, time - integral criteria. Advanced control systems: Feedback control of systems with large dead time, dead time compensation - Cascade control- feed forward and ratio control

9 Hours

Unit IV

Model based Controllers & Multi-Loop Regulatory Control

Adaptive and inferential control systems - internal model control - Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs -The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method - Decoupling Control

10 Hours

Unit V

Multivariable process

Design of control systems for multivariable process: Design equations - degrees of freedom - number of controlled and manipulated variables - generation of alternative loop configurations - extension to systems with interacting units. Interaction of control loops – relative gain array - selection of loops – Design of non-interacting control loops.

10 Hours

Unit VI[$]

Control of typical processes: Distillation column, control of top and bottom product composition, reflux ratio

Total: 45 + 30 Hours

Reference(s)

1. Dale E. Seborg , Duncan A. Mellichamp , Thomas F. Edgar, and Francis J. Doyle, III *Process Dynamics and Control*, John Wiley and Sons, 3rd Edition, 2013
2. Jose A. Romagnoli and Ahmet Palazoglu , *Introduction to Process Control*, CRC Press, Taylor and Francis Group, Second Edition, First Indian Reprint, 2010
3. Coleman Brosilow and Babu Joseph, *Techniques of Model-based Control*, Prentice Hall International Series, PTR, New Jersey, 2010

15IE13 VIRTUAL INSTRUMENTATION

3 0 2 4

Course Objectives

- To provide basic concepts in virtual instruments
- To know about the programming methods in software used in virtual instrumentation
- To familiarize the students with the applications of virtual instrumentation

Course Outcomes (COs)

The students will able to

1. understand the basics concepts and programming in virtual instrumentation
2. control and acquire the data using instruments
3. interface data acquisition for an application

Unit I

Introduction

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

VI Programming techniques

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O

9 Hours

Unit III

Instrument Control

GPIB Communication, Hardware Specifications, Software Architecture, Instrument I/O Assistant. VISA-Instrument Drivers, Serial Port Communication-Data Transfer rate, Serial port standards, using other interfaces.

9 Hours

Unit IV

Data acquisition

Introduction to latest ADCs, DACs. Introduction to PC based data acquisition - typical plug-in data acquisition board - multiplexing of analog inputs - single ended and differential inputs - different strategy for sampling of multichannel analog inputs. Concept of universal DAQ card - use of timers/counters

9 Hours

Unit V

Networked Data acquisition

Network Data Communication, Local Area Networks, HART Communication, Fieldbuses – MODBUS, PROFIBUS, DeviceNet and ControlNet, FOUNDATION field bus, Industrial Ethernet, IEEE1394 for Industrial Automation.

9 Hours

Unit VI[$]

Virtual Laboratory, Virtual Oscilloscope, Virtual function generator, Development of Virtual Instrument using GUI.

Total: 45 + 30 Hours

Laboratory Component

1. Creating Virtual Instrumentation for simple applications.
2. Programming exercises for loops and charts.
3. Programming exercises for clusters and graphs.
4. Programming exercises on case and sequence structures.
5. Programming exercises on file Input / Output.
6. Data acquisition through Virtual Instrumentation.
7. Create a VI to acquire an analog signal using DAQ Assistant.
8. Developing signal generator using DAQ cards.

Reference(s)

1. Jovitha Jerome, *Virtual Instrumentation Using LabVIEW*, PHI Learning Pvt. Ltd, 2012
2. Garry M Johnson, *Labview Graphical Programming*, Tata McGraw Hill book Co, New Delhi, 2010
3. Jeffrey Travis and Jim Kring, *LabVIEW for Everyone: Graphical Programming made Easy and Fun*, Tata McGraw Hill book Co, New Delhi, 2012
4. *LabVIEW: Basics I & II Manual*, National Instruments, Bangalore, 2011

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE14 INDUSTRIAL DATA NETWORKS

3 0 0 3

Course Objectives

- To give an overview of the Industrial data communications systems
- To provide a fundamental understanding of common principles, various standards, protocols
- To provide insight into some of the new principles those are evolving for future networks

Course Outcomes (COs)

The students will be able to

1. develop the most appropriate technologies and standards for a given application
2. design and ensure the best practice, which is followed in installing and commissioning the data communications links to ensure they run fault-free
3. describe the industrial Ethernet and wireless communication

Unit I

Data Network Fundamentals

EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard – Serial interface converters – ISO/OSI Reference(s) model – Data link control protocol – Media access protocol:-Command/response, Token passing and CSMA/CD - TCP/IP – Bridges – Routers – Gateways –Standard ETHERNET Configuration

9 Hours

Unit II

Wireless Communication & SCADA

Radio and wireless communication : Introduction – components of radio link – the radio spectrum and frequency allocation – radio modems – Wireless Communication (IPv4, IPv6) - SCADA: Remote terminal units, Master station, Communication architectures and Open SCADA protocols

9 Hours

Unit III

Distributed Control System & HART

Evolution – Different architectures – Local control unit –Operator Interface – Displays – Engineering interface – Study of any one DCS available in market – Factors to be considered in selecting DCS – Case studies in DCS. Introduction– Evolution of signal standard – HART communication protocol – Communication modes – HART Networks – HART commands – HART applications – MODBUS protocol structure – Function codes – Troubleshooting

9 Hours

Unit IV

Fieldbus and Profibus

Fieldbus: Introduction, General Fieldbus architecture, Basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability ProfiBus:- Introduction, ProfiBus protocol stack, ProfiBus communication model, Communication objects, System operation and Troubleshooting – Foundation field bus versus ProfiBus

9 Hours

Unit V

AS – Interface (AS-I), Device net and Industrial Ethernet

AS interface: Introduction, Physical layer, Data link layer and Operating characteristics. Device net:- Introduction, Physical layer, Data link layer and Application layer. Industrial Ethernet: - Introduction, 10Mbps Ethernet and 100Mbps Ethernet - Introduction to OLE for process control

9 Hours

Unit VI[$]

Optical Fibre Communications, VISA, GPIB

Total: 45 Hours

Reference(s)

1. T.A. Hughes, Programmable Logic Controllers: Resources for Measurements and Control Series, Third edition, ISA Press, 2010
2. R.Bowden, HART Application Guide, HART Communication Foundation, 2011
3. G.K.McMillan, Process/Industrial Instrument and Controls Handbook, Fifth Edition, McGraw-Hill handbook, New York, 2011
4. J.Berge, Field Buses for Process Control: Engineering, Operation, and Maintenance, ISA Press, 2010
5. S.Mackay, E.Wright, D.Reynders, and J.Park, Practical Industrial Data Networks: Design, Installation and Troubleshooting, Newnes Publication, Elsevier, 2010
6. W.Buchanan, Computer Busses: Design and Application, CRC Press, 2011

15IE15 TRANSDUCERS AND SMART INSTRUMENTS

3 0 0 3

Course Objectives

- To provide a detailed knowledge on transducer characteristics, error analysis and uncertainties measurement.
- To impart a comprehensive knowledge on smart sensor design and recent trends in sensor technologies
- To understand the basics of micro fabrication and various micro sensors and actuators.

Course Outcomes (COs)

The students will be able to

1. analyze the characteristics of a conventional transducers , errors and uncertainties in measurement data
2. acquire a comprehensive knowledge of smart sensor design and recent trends in sensor technologies
3. understand the manufacturing techniques and design aspects of micro sensors and actuators

Unit I

Overview of conventional transducers characteristics and Calibration

Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric, Magneto strictive and Hall effect sensors - Static and Dynamic Characteristics and specifications – Calibration standards – Calibration of differential pressure transmitters

8 Hours

Unit II

Measurement error and uncertainty analysis

Importance of error analysis - Uncertainties, precision and accuracy in measurement -Random errors - Distributions, mean, width and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem - Error propagation - single and multi-variable functions - Data visualization and reduction - Least square fitting of complex functions

11 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit III

Smart sensors & Transmitters

Integrated smart sensors – definition – Universal Sensor Interface – front end circuits – DAQ board design - Digital conversion techniques – Microcontrollers and digital signal processors for smart sensors – selection – Timer - ADC and DAC modules - Standards for smart sensor interface – Smart Transmitters

9 Hours

Unit IV

Micro sensors and actuators

Micro system design and fabrication – Micro pressure sensors (Piezo resistive and Capacitive) – Resonant sensors – Acoustic wave sensors – Bio micro sensors – Micro
actuators – Micro mechanical motors and pumps- Introduction to Nano sensors

9 Hours

Unit V

Recent trends in sensor technologies

Thick film and thin film sensors – Electro chemical sensors – RFIDs - Sensor arrays - Sensor network - Multisensor data fusion - Soft sensor

8 Hours

Unit VI[$]

Smart temperature sensor – Case studies of smart sensor applications and micro sensors

Total: 45 Hours

Reference(s)

1. Ernest O Doebelin and Dhanesh N Manik, *Measurement Systems Application and Design*, 5th Edition, Tata Mc-Graw Hill, 2011
2. Ifan G. Hughes and Thomas P.A. Hase, *Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis*, Oxford University Press, 2010
3. Gerord C.M. Meijer, *Smart Sensor Systems*, John Wiley and Sons, 2010
4. Tai Ran Hsu, *MEMS & Micro systems: Design, Manufacture and Nanoscale Engineering*, Tata McGraw Hill, New Delhi, 2011
5. D. Patranabis, *Sensors and Transducers*, Second Edition, PHI, 2010

15IE17 MODELING AND SIMULATION LABORTORY

0 0 4 2

Course Objectives

- To derive expressions that can be used to estimate parameters from different types of data, for different types of model structures
- To simulate complex control algorithm to solve the control system problems
- To analyze the performance of a system using modern engineering tools

Course Outcomes (COs)

The students will be able to

1. develop a mathematical model of a system/process using modern engineering tools
2. Simulate complex control algorithms to solve the control system problems.
3. analyze the performance of a simple system/process using modern engineering tools

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

List of Experiments:

1. Modelling and analysis of linear process
2. Modelling and analysis of nonlinear process
3. Modelling a simple system using the system identification technique
4. Modelling a simple system using the intelligent technique based identification technique.
5. Modelling and analysis of an inverted pendulum.
6. Design of fuzzy logic controller.
7. Design of artificial neural network controller.
8. Design a full order and reduced order observer for specified pole locations.
9. Design a state estimator/ state feedback controller for a simple system.
10. Design and analysis of a robust controller for a simple system.
11. Mini project.

Total: 60 Hours

15IE18 INSTRUMENTATION AND CONTROL LABORATORY

0 0 4 2

Course Objectives

- To design signal conditioning circuit for the given sensor
- To analyze the behavior of the instrumentation devices using simulation software
- To design and tune controllers for the given process

Course Outcomes (COs)

The students will be able to

1. calibration of field instruments
2. interface and configure the field instruments
3. implement various controller designs, and methods for controller tuning

List of Experiments:

1. Calibration of pressure to current transmitter
2. Calibration of level transmitter of differential pressure type
3. Design of temperature transducer using RTD
4. Design of cold junction compensation circuit using simulation
5. Design and simulation of Instrumentation amplifier
6. Closed loop response of level process in spherical tank system
7. Closed loop response of temperature process station
8. Closed loop response of pressure process
9. Simulate the closed loop response of series and parallel type PID for any process
10. Tuning of PID using different techniques

Total: 60 Hours

15GE19 BUSINESS ENGLISH I

1 0 2 2

Course Objectives

- To acquire skills for using English in workplace effectively.
- To communicate for essential business needs.
- To prepare students for taking BEC Vantage level examination which is an International Benchmark for English language proficiency of Cambridge English Language Assessment (CELA).

Course Outcomes (COs)

The students will be able to

1. To enable students to get International recognition for work and study.
2. To use English confidently in the International business environments.
3. To be able to take part in business discussion, read company literature, write formal and informal business correspondences and listen and understand business conversations.

Unit I

Grammar and Vocabulary

Comparison of adjectives – forming questions – asking complex questions – expressing purpose and function – tenses – conditionals – time statements – modal verbs – active and passive voice – articles – direct and indirect speech – cause and effect – relative pronouns – expressions followed by – *ing* forms – countable / uncountable – acronyms – marketing terms / vocabulary – financial terms – collocations – discourse markers.

10 Hours

Unit II

Listening

Purposes of listening – features of listening texts – potential barriers to listening – specific listening skills – strategies to use when listening– distinguishing relevant from irrelevant information – gap filling exercise – multiple-choice options – note completion – matching and multiple choice questions – listening for specific information, gist, topic, context and function.

7 Hours

Unit III

Speaking

Word and sentence stress – clear individual sounds – turn taking – initiating and responding - intonation patterns – pronunciation – mother tongue intrusion– conversation practice – turn-taking and sustaining the interaction by initiating and responding appropriately.

10 Hours

Unit IV

Reading

Purposes of reading – potential barriers to reading – paraphrasing – identifying facts and ideas – skimming and scanning for information – matching statements with texts– spotting reference words – understanding text structure – understanding the ideas in a text – distinguishing between the correct answer and the distractor – understanding cohesion in a text – deciphering contextual meaning of words and phrases – cloze – proof reading - transcoding.

8 Hours

Unit V

Writing

Paragraphing a text – using appropriate connectives – editing practice –Longer Documents: writing a proposal.

10 Hours

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

15IE21 RESEARCH METHODOLOGY

3 0 0 3

Course Objectives

- To understand some basic concepts of engineering research and its methodologies.
- To identify various sources of information for literature review and data collection.
- To families the various procedures to formulate appropriate research problem and design of experiments.

Course Outcomes (COs)

The students will be able to

1. demonstrate the concepts of engineering research and its methodologies.
2. understand the various methods used to collect the data to research.
3. formulate appropriate research problem and conduct the experiments using systematics methods.

Unit I

Introduction

Definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps.

Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data

9 Hours

Unit II

Sampling Methods

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method – convenience sampling, judgment sampling, quota sampling

9 Hours

Unit III

Hypotheses Testing

Testing of hypotheses concerning means -one mean and difference between two means -one tailed and two tailed tests, concerning variance – one tailed Chi-square test

9 Hours

Unit IV

Computational Instrumentation

Computer Aided Design and Simulation: Physical, Mechanical, Optical and Electronic components and devices - Finite Element Analysis and design validation - Process simulation

9 Hours

Unit V

Computer Aided Measurement Techniques

Data acquisition – Calibration - Repeatability and reproducibility - Automatic inspection. Vision based inspection system: Image processing techniques - Shape Analysis and Photogrammetry

9 Hours

Unit VI[$]

Case Study: apply Research Methodology principles into design and manufacturing field.

Total: 45 Hours

References

1. Kothari, C.R., *Research Methodology – Methods and techniques*, New Age Publications, New Delhi, 2009
2. Panneerselvam, R., *Research Methodology*, Prentice-Hall of India, New Delhi, 2004
3. Kye-Si Kwon, Stevan ready *Practical Guide to Machine Vision Software*, Wiley Publications, 2015
4. Brian Roffel, Ben Petlem., *Advanced Practical Process Control*, Springer, 2011

15IE22 ADVANCED PROCESS CONTROL

3 2 0 4

Course Objectives

- To familiarize about the digital control systems and its stability analysis
- To impart knowledge about digital controller modes using various algorithms
- To get adequate knowledge about Programmable Logic Controllers and also various programming languages

Course Outcomes (COs)

The student will be able to

1. enhance knowledge about the digital control systems and to analyze the discrete data systems
2. design and implement digital controller modes using various algorithms
3. enhance the knowledge about the Programmable Logic Controllers and also to develop the program for real time applications

Unit I

Introduction

Introduction to Computer control system: Need for computer in a control system-Building blocks of a computer control system - Sequential control – Direct digital control – supervisory control.

9 Hours

Unit II

Analysis of discrete data system

Representation and analysis of sampled data control systems: Z-transform and properties – inverse Z-transform - pulse transfer function - data holds-sampling theorems, aliasing – sampling frequency considerations - analysis of closed loop sampled data control systems – modified Z-transform and applications - stability analysis - multirate sampling.

9 Hours

Unit III

Design of digital controller

Digital control algorithms: Design of control algorithm using Z-transform - deadbeat algorithm - Dahlin's method - ringing - Kalman's approach - discrete equivalent to an analog PID controller –

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

servo and regulatory mechanism. - position and velocity forms of PID controllers – tuning - selection of sampling time - algorithms incorporating anti-reset windup and bumpless transfer - Dead time compensation and Smith predictor algorithm.

9 Hours

Unit IV

Programmable logic controller

Programmable Logic Controllers (PLCs): Basic components and configuration - discrete, analog and digital types of I/O modules - control loop module - network communication module - AS-interface. Memory types used in PLCs - memory map

9 Hours

Unit V

Communication in PLC and its application

Programming Languages: Ladder diagram - Boolean - function blocks - programming devices: hand-held programmer - development of programs for typical applications - Installation and maintenance of PLCs. Interlocks and alarms: Interlock design principles, fail-safe design - alarms and their types.

9 Hours

Unit VI[$]

Case Study: Computer control of- thermal process-level process- flow process- pressure process- bottle filling system

Total: 45 +30 Hours

Reference(s)

1. M.Paul, *Digital Computer Application to Process Control*, IFAC, 2014
2. Reinhold Güth, *Computer Systems for Process Control*, Springer, 2012
3. M. Chidambaram, *Computer Control of Processes*, Narosa Publications, 2012
4. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, *Process Dynamics and Control*, 3rd Edition, John Wiley &sons, 2011
5. P.B.Deshpande and R.H. Ash, *Computer Process Control*, 3rd Edition, Instrument Society of America, 2011
6. William Boltan, *Programmable Logic Controllers*, 4th Edition, Newnee, 2011

15IE23 LINEAR AND NON-LINEAR SYSTEMS THEORY

3 2 0 4

Course Objectives

- To impart knowledge and skills needed to classify singular points and construct phase trajectory using delta and isocline methods
- To make the students to understand the concepts of stability and introduce techniques to assess the stability of certain class of non-linear system
- To make the students to understand the various non-linear behaviours such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos

Course Outcomes (COs)

The students will be able to

1. represent the time-invariant systems in state space form as well as to analyze, whether the system is stabilizable, controllable, observable and detectable
2. design state feedback controller and state estimator
3. describe non-linear behaviours such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit I

State Space Approach

Review of state model for systems – Non uniqueness of state model – Role of Eigen values and Eigen vectors -State transition matrix and its properties – free and forced responses – State Diagrams - minimal realization –balanced realization

9 Hours

Unit II

State Feedback Control and State Estimator

Controllability and observability – Stabilizability and Detectability – Kalman Decomposition –State Feedback– Pole placement technique – Full order and reduced order observers

9 Hours

Unit III

Non-Linear Systems

Types of Non-Linearity – Typical Examples – Singular Points – Phase plane analysis (analytical and graphical methods) – Limit cycles – Equivalent Linearization – Describing Function – Analysis, Derivation of describing functions for different non-linear elements

9 Hours

Unit IV

Stability of Non-Linear Systems

Stability concepts – Equilibrium points – BIBO and Asymptotic stability – Stability Analysis by DF method –Lyapunov Stability Criteria – Krasovskil'smethod – Variable Gradient Method – Popov's Stability Criterion –Circle Criterion

9 Hours

Unit V

Non-Linear Systems Analysis

Bifurcation behaviour of Single ODE Systems: - Motivation, Illustration of Bifurcation behaviour and types of bifurcations - Bifurcation behaviour of two-state systems: - Dimensional bifurcations in the phase-plane, Limit cycle behaviour and Hoof Bifurcation -Introduction to Chaos: The Lorenz Equations, Stability analysis of the Lorenz Equations, Numerical study of the Lorenz Equations, Chaos in chemical systems and other issues in Chaos

9 Hours

Unit VI[$]

Bifurcation control of nonlinear systems-Global tracking problem of nonlinear systems-Nonlinear regulation of end-effector motion for a flexible robot arm

Total: 45 + 30 Hours

Reference(s)

1. Curtis. D. Johnson, "*Process Control Instrumentation Technology"*, 8th edition, Pearson Education Limited, 2013
2. Philip L.Skousen, "*Control Valve Handbook*," 3rd edition, Fisher Controls International, 2011
3. Bela G. Liptak, *Instrument Engineers Handbook - Process Software and Digital network*, 4th edition, CRC Press, 2011
4. Andrew Williams," *Applied Instrumentation in the process industries*" 2nd edition, Gulf Publishing company, 2010
5. Marc Hellemans," *The Safety relief valve Handbook*", 1st edition, Elsevier Ltd, 2010

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE24 INSTRUMENTATION SYSTEM DESIGN

3 2 0 4

Course Objectives

- To comprehend the design of signal conditioning circuits for the measurement of Level, temperature and pH
- To develop the skills needed to design, fabricate and test Analog/ Digital PID controller, Data Loggers and Alarm Annunciator
- To make the students to familiarize in designing orifice and control valve sizing

Course Outcomes (COs)

The students will be able to

1. interpret signal conditioning circuits for temperature sensors, V/I and I/V converters
2. explain the fabrication and testing of PID controllers, alarm circuits and smart transmitters
3. implement orifice and control valve sizing for Liquid/Steam Services

Unit I

Design of signal conditioning circuits

Design of V/I Converter and I/V Converter- Analog and Digital filter design and Adaptive filter design – Signal conditioning circuit for pH measurement, Air-purge Level Measurement – Signal conditioning circuit for Temperature measurement: Thermocouple, RTD and Thermistor – calibration and installation procedure for Thermocouple and RTD- Cold Junction Compensation and Linearization – software and hardware approaches

9 Hours

Unit II

Design of transmitters

Study of 2 wire and 4 wire transmitters – Design of RTD based temperature transmitter, thermocouple based temperature transmitter - capacitance based level transmitter and Smart flow transmitters

9 Hours

Unit III

Design of data logger and PID controller

Design of ON / OFF Controller using Linear Integrated Circuits - Electronic PID
Controller – Microcontroller based digital two-degree of freedom PID controller - Microcontroller based Data Logger – Design of PC based Data Acquisition Cards

9 Hours

Unit IV

Orifice and control valve sizing

Review of flow equations - Orifice, Venturi and flow nozzle Sizing: - Liquid, Gas and steam services – Control valve sizing – Liquid, Gas and steam services – Rotameter design- Control valve noise-design of safety relief valves.

9 Hours

Unit V

Design of alarm and annunciation circuit

Alarm and Annunciation circuits using Analog and Digital Circuits – Design of Programmable Logic Controller - Design of configurable sequential controller using PLDs

9 Hours

Unit VI[$]

Control room layout – Instrument power requirement and distribution- Control room

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

lighting – Communication system – Electrical classification – Control panel types – Flat faced and break front panel – Consoles – Comparison of panel types – panel lay out, face layout and rear layout – Auxiliary racks and cabinet – Panel piping and tubing.

Total: 45 + 30 Hours

Reference(s)

1. K.Ogata, *Modern Control Engineering*, Prentice Hall, Fifth Edition, 2012
2. M.Gopal, *Digital Control and State Variable Methods: Conventional and Intelligent Control Systems*, Third Edition, Tata Mc-Graw Hill, 2011
3. B.W.Bequette, *Process Control: Modeling, Design and Simulation*, Prentice Hall International series in Physical and Chemical Engineering Sciences, 2010
4. P. G. Drazin, *Nonlinear Systems*, Cambridge bridge press, 2012

15IE27 ADVANCED PROCESS CONTROL LABORATORY

0 0 4 2

Course Objectives

- To obtain the mathematical models and to understand the characteristics of various controllers
- To get adequate knowledge about Programmable Logic Controllers and also various programming languages
- To attain knowledge about various drives
- To familiarize about analog and digital controllers
- To acquire knowledge about different communication protocols

Course Outcomes (COs)

The students will be able to

1. design and implement various controllers
2. develop and implement various programming languages in real time processes
3. calibrate the transmitters for different process
4. design and develop analog and digital controllers
5. implement different communication protocols for industrial applications

List of Experiments:

1. Analysis of control system hierarchy (ON-OFF, single loop PID controller and Hybrid control System)
2. Design of multi loop (cascade, ratio) control using MATLAB
3. Design of digital controller algorithm using MATLAB
4. Design of Fuzzy logic controller for first order process using MATLAB
5. LabVIEW based cascade control design for Four tank system
6. Control of bottle filling system using programmable logic controller
7. PLC based flow and level control process for Non linear tanks
8. Implementation of continuous control using DCS
9. DCS based Air flow Temperature control process
10. Configuration of Human machine interface and SCADA for a given application
11. Mini project

Total: 60 Hours

15GE29 BUSINESS ENGLISH II

1 0 0 1

Course Objectives

- To acquire skills for using English in business environment.
- To communicate appropriately in business contexts.
- To prepare students for taking BEC Vantage level examination conducted by the Cambridge English Language Assessment (CELA).

Course Outcomes (COs)

- To enable students to acquire business terms for communication.
- To use English confidently in the business contexts.
- To be able to take part in business discussion and write formal and informal business correspondences.

UNIT I

Speaking

Non-verbal communication – agreeing / disagreeing, reaching decisions, giving and supporting opinions – making mini presentations – extending on conservations – collaborative task – tongue twisters.

6 Hours

UNIT II

Writing

Business letters – fax – Shorter Documents: e-mail - memo – message - note – report writing – formal / informal styles.

9 Hours

Total: 15 Hours

References

1. Guy Brook-Hart, "BEC VANTAGE:BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

15IE34 PROJECT WORK PHASE – I

0 0 0 6

Course Objectives

- Identify a real time problem and analyze possible solutions.
- Identify the suitable platform/method to find the solution for the problem
- Complete framework and initiate the work in obtaining a solution

Course Outcomes (COs)

The students will be able to

1. analyze real-time problems with industry or faculty and students in formulating a framework.
2. select suitable engineering tool and apply engineering and management principles to solve the problem.
3. get a preliminary or partial output/ solution for the problem.

15IE41 PROJECT WORK PHASE – II

0 0 0 12

Course Objectives

The goal of project phase II work is to

- interlink their theoretical knowledge with the real time applications and problems
- facilitate the society by giving innovative product/concept or solution to an engineering problem
- develop his/her oral communication and presentation skills

Course Outcomes (COs)

The students will be able to

1. provide a solution to real-time engineering problem or innovate a new product/concept using modern engineering tool and/or instrumentation systems
2. publish or present research papers in the international journal / conference based on the obtained solution to engineering problem or innovation
3. create a VI to acquire images using IMAQ snap
4. explain the stepper motor control with a PC-based data acquisition

15IE51 CONTROL SYSTEM DESIGN

3 0 0 3

Course Objectives

- To impart knowledge on design of controllers using time and frequency domain techniques
- To introduce the techniques of extending the theory on continuous systems to discrete time systems and discrete state space systems
- To introduce design in state estimation

Course Outcomes (COs)

The students will be able to

1. design the controllers using root-locus and bode plot techniques
2. study about the discrete time systems and discrete state space systems
3. analyze the state estimation

Unit I

Basics and Root-Locus Design

Design specifications - sensitivity and stability – Limitations - Controller structure – one and two degrees of freedom - PID controllers and Lag-lead compensators - Root locus design - Design examples

9 Hours

Unit II

Frequency Response Based Design

PID controllers and Lag-lead compensators - Design using Bode plots - use of Nyquist plots and Routh-Hurwitz Criterion - Design examples

9 Hours

Unit III

Optimal Control

Formation of optimal control problems-results of Calculus of variations- Hamiltonian formulation-solution of optimal control problems- Evaluation of Riccati's equation State and output Regulator problems-Design examples

9 Hours

Unit IV

State Estimation

State Estimation Problem - State estimation - Luenberger's observer - noise characteristics - Kalman-Bucy filter - Separation Theorem - Controller Design - Wiener filter - Design examples.

9 Hours

UNIT V

LQR and LQG Design

Formulation of LQR problem- Pontryagin's minimum principle and Hamiltonian solutionsRicatti's equation – Optimal estimation- Kalman filter – solution to continuous and discrete systems - Design examples.

9 Hours

Unit VI[$]

Impulse and step invariant transformations - Methods of discretisation - solution to continuous and discrete systems - Design examples.

Total: 45 Hours

Reference(s)

1. M. Gopal "*Modern Control System Theory*" New Age International, Second Edition, First Indian Reprint, *2010*
2. Arthur G. O. Mutambara, "*Design and Analysis of Control Systems*", CRC Press, Indian reprint 2009
3. G. F. Franklin, J. D. Powell and A. E. Naeini "*Feedback Control of Dynamic Systems*", 6th Edition, Pearson Higher Education, NJ, 2010
4. Loan D. Landau, Gianluca Zito," *Digital Control Systems, Design, Identification and Implementation*", Springer, 2010
5. G. F. Franklin, J. D. Powell and M Workman, "*Digital Control of Dynamic Systems*", Pearson Education (Asia)., 2011

15IE52 OPTIMAL CONTROL AND FILTERING

3 0 0 3

Course Objectives

- To realize the concepts of optimality and its control
- To develop a knowledge about dynamic programming and its principles
- To develop technical concise about various regulator problems

Course Outcomes (COs)

The students will be able to

1. understand the principles and mathematical concepts involved in optimal control
2. acquire the skill of selecting appropriate parameter for the chosen optimal control configuration

Unit I

Calculus of Variations and Optimal Control

Introduction – Performance Index- Constraints – Formal statement of optimal control system – Calculus of Variations – Function, Functional, Increment, Differential and variation and optimum of function and functional –The basic variational problem Extrema of functions and functionals with conditions – variational approach to optimal control system- Euler Langrages equations for scalar case and its generalization to vector case

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Linear Quadratic Optimal Control System

Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case-Time-invariant case – Stability issues of Time-invariant regulator – Linear Quadratic Tracking system: Fine timecase and Infinite time case

9 Hours

Unit III

Discrete Time Optimal Control Systems

Variational calculus for Discrete time systems – Discrete time optimal control systems:- Fixed-final state and open loop optimal control and Free-final state and open-loop optimal control - Discrete time linear state regulator system– Steady state regulator system

9 Hours

Unit IV

Pontryagin Minimum Principle

Pontryagin Minimum Principle – Dynamic Programming: Principle of optimality, optimal control using Dynamic Programming- state inequality constraints – Optimal Control of Continuous time and Discrete-time systems – Hamilton-Jacobi-Bellman Equation – LQR system using H-J-B equation

9 Hours

Unit V

Constrained Optimal Control Systems

Time optimal control systems – Fuel Optimal Control Systems- Energy Optimal Control Systems – Optimal Control systems with state constraints

9 Hours

Unit VI[$]

Minimum time problem – Minimum control effort problems: minimum fuel problem, minimum energy problem – singular intervals in optimal control problems

Total: 45 Hours

Reference(s)

1. Donald E. Kirk, *Optimal Control Theory: An Introduction*, Dover Publications, 2012
2. DesineniSubbaram Naidu, *Optimal Control Systems*, CRC Press, 2010
3. Frank L. Lewis, DragunaVrabie, Vassilis L. Syrmos, *Optimal Control*, John Wiley and Sons, 2012
4. M. Gopal, 'Modern Control System Theory', New Age International Ltd., 2011

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE53 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

3 0 0 3

Course objectives

- To impart knowledge on how to estimate the parameters of input –output models (ARX/ARMAX etc) using various estimation methods
- To make the student design simple adaptive controllers for linear systems using above methods
- To provide the background on the practical aspects of conducting experiments for real time system identification

Course Outcomes (COs)

The students will be able to

1. select a suitable model and parameter estimation algorithm for the identification of systems
2. design simple adaptive controllers for linear and non linear systems
3. identify, formulate, analyze the implementation of adaptive controllers t engineering problems

Unit I

Non Parametric System Identification

System Identification-motivation and overview - Non-parametric methods: Impulse response, step response and Frequency response methods, correlation and spectral analysis methods.

7 Hours

Unit II

Parameter Estimation Methods

Parametric model structures-ARX, ARMAX, OE, BJ models - Linear regression - Least square estimates, statistical properties of LS Estimates. Weighted least squares, maximum likelihood estimation, Prediction error methods, Instrumental variable methods, Recursive Least squares method- Exercises using system identification toolbox.

10 Hours

Unit III

Practical Aspects of Identification

Experimental design – input design for open loop experiments, identification in closed loop: Identifiability, Approaches to closed loop identification, optimal experimental design for higher order black box models, choice of sampling interval and pre sampling filters - robustness – Model validation and Model structure determination-case studies.

9 Hours

Unit IV

Adaptive Control Schemes

Introduction – Adaptive Schemes – auto tuning - types of adaptive control - gain scheduling controller - model reference adaptive control schemes – self tuning controller. MRAC and STC: Approaches – The Gradient approach – Lyapunov functions – Passivity theory – Pole placement method - Minimum variance control.

9 Hours

Unit V

Practical Issues and Implementation

Adaptive controller implementation- controller design, estimator implementation, square root algorithms, interaction of estimation and control, prototype algorithms, operational issues- Stability – Convergence – Robustness – Case studies: Adaptive linear/nonlinear system identification - CSTR, Distillation Coloumn, Thermal Cracker, Desalination Plant.

10 Hours

Unit VI[$]

Adaptive signal processing – Extremum control – Expert control system – Learning system

Total: 45 Hours

Reference(s)

1. Lennart Ljung, *System Identification: Theory for the User*, Second Edition, Prentice Hall, 2010
2. K.J. Astrom and B. J. Wittenmark, *Adaptive Control*, Second Edition, Pearson Education Inc., 2011
3. Tao Liu, Furong Gao, *Industrial Process Identification and control design, Step-test and relay-experiment-based methods*, Springer- Verilog London Ltd, 2012
4. Karel J. Keesman, *System Identification an Introduction*, Springer, 2011
5. B.Roffel, B.H.L.Betlem, *Advanced Practical Process Control*, Springer-verlog Berlin Heidelberg, 2011

15IE54 FAULT TOLERANT CONTROL

3 0 0 3

Course Objectives

- To familiarize the students for the fault detection and isolation of industrial processes and Systems, additionally to fault-tolerant control with a special emphasis to model based techniques (analytical redundancy)
- To review the basic concept of fault detection systems
- To understand the concept of fault diagnosis systems

Course Outcomes (COs)

The students will be able to

1. design and implementation of fault tolerant controllers for industrial systems and processes
2. design decision logic description using languages
3. design fault propagation analysis
4. design and implement fault-tolerant control systems

Unit I

Introduction & Analytical Redundancy Concepts

Introduction - Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches-Introduction- Mathematical representation of Faults and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.

9 Hours

Unit II

Design of Structured Residuals & Directional Structured Residuals

Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation - Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation.

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit III

Fault Diagnosis Using State Estimators

Introduction – State Observer – State Estimators – Norms based residual evaluation and threshold computation - Statistical methods based residual evaluation and threshold settings: Generalized Likelihood Ratio Approach – Marginalized Likelihood Ratio Approach.

9 Hours

Unit IV

Fault Tolerant Control

Introduction – Passive Fault-tolerant Control- Active Fault tolerant Control - Actuator and Sensor Fault tolerance Principles: - Compensation for actuator – Sensor Fault-tolerant Control Design – Fault-tolerant Control Architecture - Fault-tolerant Control design against major actuator failures.

9 Hours

Unit V

Case Studies

Fault tolerant Control of Three-tank System – Diagnosis and Fault-tolerant control of chemical process – supervision of steam generator – Different types of faults in Control valves – Automatic detection, quantification and compensation of valve stiction.

9 Hours

Unit VI[$]

Characteristics of high-transmission-probability tunnel junctions for use as particle detectors - Nonlinear Trajectory Following Control for Automatic Steering of a Collision Avoiding Vehicle.

Total: 45 Hours

Reference(s)

1. Rolf Isermann, *Fault-Diagnosis Systems: An Introduction from Fault Detection to Fault Tolerance* Springer Verlag, 2011
2. Steven X. Ding, *Model based Fault Diagnosis Techniques: Schemes, Algorithms, and Tools,* Springer Publication, 2012
3. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, *Fault-Tolerant Control Systems: Design and Practical Applications,* Springer Publication, 2010
4. Mogens Blanke, Michel Kinnaert, Jan Lunze, Marcel Staroswiecki, *Diagnosis and Fault-Tolerant Control,* Springer, 2013
5. Prashant Mhaskar, Jinfeng Liu, Panagiotis D. Christofides , *Fault-Tolerant Process Control: Methods and Applications,* Springer, 2014
6. Ali Ahammad Shoukat Choudhury, Sirish L. Shah, Nina F. Thornhill, *Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches,* Springer Berlin Heidelberg, 2010

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE55/ 15AE64 MICRO ELECTRO MECHANICAL SYSTEM
(Common to Applied Electronics & Instrumentation Engineering)

3 0 0 3

Course Objective

- To acquire knowledge about various fabrication process, electrical and mechanical concepts in MEMS
- To impart a good knowledge about various MEMS sensors and actuators
- To understand applications of polymer and optical MEMS

Course Outcomes (COs)

The students will be able to

1. understand the concepts of fabrication methods and materials used in MEMS
2. identify the application of MEMS in sensing and actuating process
3. apply the polymer and optical MEMS in various measurements

Unit I

Introduction

Intrinsic Characteristics of MEMS - Energy Domains and Transducers - Sensors and Actuators - Introduction to Microfabrication - Silicon based MEMS processes - New Materials - Review of Electrical and Mechanical concepts in MEMS - Stress and strain analysis - Flexural beam bending - Torsional deflection

9Hours

Unit II

Sensors and Actuators-I

Electrostatic sensors - Parallel plate capacitors - Applications - Interdigitated Finger capacitor - Comb drive devices - Thermal Sensing and Actuation - Thermal expansion - Thermal couples - Thermal resistors - Applications - Magnetic Actuators - Micromagnetic components

9 Hours

Unit III

Sensors and Actuators-II

Piezoresistive sensors - Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors. Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials - Applications to Inertia, Acoustic, Tactile and Flow sensors

9 Hours

Unit IV

Micromachining

Silicon anisotropic etching - Anisotrophic wet etching - Dry etching of silicon - Plasma etching – Deep Reaction Ion Etching (DRIE) - Isotropic wet etching - Gas phase etchants - Case studies: Basic surface micromachining processes - Structural and sacrificial materials - Acceleration of sacrificial etch - Striction and antistriction methods

9 Hours

Unit V

Polymer and Optical MEMS

Polymers in MEMS - Polyimide - SU-8 - Liquid Crystal Polymer (LCP) - PDMS - PMMA - Parylene - Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors - Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS

9 Hours

Unit VI[$]

Case studies of MEMS actuators – micropumps - Assembly of 3D MEMS – Foundry process

Total: 45 Hours

Reference(s)

1. Chang Liu, *Foundations of MEMS*, Pearson Education Inc., 2014
2. James J.Allen, *Micro Electro Mechanical System Design*, CRC Press published in 2010
3. Nadim Maluf, *An Introduction to Micro Electro Mechanical System Design*, Artech House, 2011
4. Mohamed Gad-el-Hak, *The MEMS Handbook: Applications*, CRC press Baco Raton, 2010
5. Tai Ran Hsu, *MEMS & Micro systems: Design, Manufacture and Nanoscale Engineering*, Tata McGraw Hill, New Delhi, 2011
6. Julian W. Gardner, Vijay K. Varadan and Osama O.Awadelkarim, *Micro Sensors MEMS and Smart Devices*, John Wiley & son Ltd, 2012

15IE56 BIOMEDICAL SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To understand the application of signal processing methods in biomedical systems
- To demonstrate how to use a computer workstation as part of a measurement/signal-processing system
- To understand how to measure various biochemical and nonelectrical parameters of human system

Course Outcomes (COs)

The students will be able to

1. learn the usage of signal processing methods to analyze signals originating in biomedical systems
2. understand the concept of signal filtering
3. develop substantial computer programs (using MATLAB) to model biomedical systems

Unit I

Introduction to Signals

Sources of biomedical signals, types of signals – Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT, FFT algorithm – Digital filters – Introduction to FIR and IIR filter

9 Hours

Unit II

Classical Spectral Estimation Techniques

Periodogram, blackman – Tukey spectral estimation applications – Analysis of the doppler signal using the periodogram, analysis of Auditory Evoked Potentials (AEP) using periodogram, analysis of heart rate variability using the periodogramcepstrum analysis – Cepstra, power cepstrum, applications of cepstrum analysis – Analysis of the ECG signal using cepstrum technique, analysis of diastolic heart sound using cepstrum technique

9 Hours

Unit III

Adaptive Noise Cancellation

Introduction, principle of adaptive noise canceling, adaptive Noise cancellation with the LMS and

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

RLS adaptation algorithm - applications – adaptive noise canceling method to enhance ECG monitoring.

9 Hours

Unit IV

Parametric Modeling Methods

Autoregressive (AR) methods – Linear Prediction and Autoregressive methods, the autocorrelation (Yule - walker) methods, applications of AR methods AR modeling of seizure EEG, ECG signals and surface EMG. Autoregressive Moving Average (ARMA) method – MLE method, Akaike method, Durbin method, applications – ARMA modeling of somatosensory Evoked Potentials (SEPs), Diastolic Heart sounds and cutaneous Electro gastric signals

9 Hours

Unit V

Non-Linear Biosignal Processing and Wavelet Transform

Clustering methods – hard and fuzzy clustering, applications of Fuzzy clustering to Biomedical signal processing, Neural Networks (NN): Introduction – NN in processing and analysis of Biomedical signals. Wavelet transform – Introduction, Filter bank implementation of discrete wavelet transform, signal de-noising using wavelet transform, wavelet based compression

9 Hours

Unit VI[$]

Adaptive noise canceling method to enhance Fetal ECG monitoring, adaptive noise canceling method to enhance Electro gastric measurements

Total: 45 Hours

Reference(s)

1. M.Akay, *Biomedical Signal Processing*, Academic Press, San Diego, 2010
2. M.Akay, *Nonlinear Biomedical Signal Processing*, Fuzzy Logic, Neural Networks and New Algorithms, vol.1, IEEE Press Series on Biomedical Engineering, New York, 2010
3. Eugene N.Bruce, *Biomedical Signal Processing and Signal Modeling*, John Wiley & Sons, First Edition, 2013
4. Robert Splinter, *Biomedical Signal and Image Processing*, CRC press, 2012

15IE57 INDUSTRIAL DRIVES AND CONTROL

3 0 0 3

Course Objectives

- To introduce the different types of drives and applications in various industries
- To know the characteristics of various motors and loads
- To understand the modes of operation of a drive in various applications

Course Outcomes (COs)

The students will be able to

1. acquire the knowledge of different speed control methods in AC motors
2. identify the use of drives in industries using fuzzy logic and artificial neural network
3. enable the students to identify the need and choice for various drives

Unit I

Introduction to Electric Drives

Motor-Load system–Dynamics, load torque, steady state stability, Multi quadrant operations of drives. DC motors- speed reversal, speed control and breaking techniques, Characteristics of Induction motor and Synchronous motors-Dynamic and regenerative braking ac drives.

8 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Modeling of DC and AC Machines

Circuit model of Electric Machines-Transfer function and State space models of series and separately excited DC motor–AC Machines – Dynamic modeling –linear transformations-equations in stator, rotor and synchronously rotating reference frames-flux linkage equations-Dynamic state space model-modeling of Synchronous motor.

10 Hours

Unit III

Control of DC Drives

Analysis of series and separately excited DC motor with single phase and Three phase converters operating in different modes and configurations- Analysis of series and separately excited DC motor fed from different choppers-two quadrant and four quadrant operation-Closed loop control of dc drives-Design of controllers.

9 Hours

Unit IV

Control of AC Drives

Operation of induction motor with non-sinusoidal supply waveforms, Variable frequency operation of 3-phase inductions motors, constant flux operation, current fed operations, Constant torque operations, Static rotor resistance control and slip power recovery scheme

9 Hours

Unit V

Advanced Control of AC Drives

Principles of vector control –Direct and indirect vector control of induction motor –DTC- sensor less vector control-speed estimation methods-Applications of Fuzzy logic and Artificial Neural Network for the control of AC drives.

9 Hours

Unit VI[$]

Synchronous motor control, control of stepped motors, Parameter sensitivity of ac drives.

Total: 45 Hours

Reference(s)

1. Paul .C.Krause, Oleg wasynczuk and Scott D.Sudhoff, Analysis of Electric Machinery and Drive Systems, 2ndedition, Wiley-IEEE Press, 2013
2. G.K.Dubey, Power Semiconductor Controlled Drives, Prentice Hall International, New Jersey, 2011
3. Bimal K Bose, Power Electronics and Motor Drives, Pearson education Asia, 2010
4. R .Krishnan, Electrical Motor Drives- Modeling, Analysis and Control, Prentice Hall of India Pvt Ltd., 2nd Edition, 2010

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE58 / 15AE68 ROBOTICS AND AUTOMATION
(Common to Applied Electronics & Instrumentation Engineering)

3 0 0 3

Course Objectives

- To compute the transformations and robot kinematics
- To investigate planning and control design of robot manipulators
- To analyze the sensors and applications of robots

Course Outcomes (COs)

The students will be able to

1. compute the transformations and robot kinematics
2. investigate the path planning and control of robot manipulators
3. describe the sensing and applications of robots

Unit I

Transformations

Evolution of robots and robotics – laws of robotics – robotic joints – classification – specifications – Application – robot architecture – pose of a rigid body – coordinate transformation – homogeneous transformation matrix – Denavit and Hartenberg Parameters – a variant of DH parameters – DH Parametrization of Euler angles

9 Hours

Unit II

Robot Kinematics

Forward position analysis– inverse position analysis – forward and inverse velocity analysis – acceleration analysis – end effectors – design – selection

9 Hours

Unit III

Planning and Control of Robotic Manipulators

Considerations on trajectory planning – joint interrelated trajectories – cartesian path trajectories – control of robot – PID control – computed torque technique – near minimum time control – variable structure control – nonlinear decoupled feedback control – motion control – adaptive control

9 Hours

Unit IV

Robotic Sensors and Vision

Sensors in robotics – classification – tactile, proximity and range sensors – sensors based systems – Introduction to machine vision – the sensing and digitizing function in machine vision – image processing and analysis – training the vision system – robotic applications – robot programming – robot languages – artificial intelligence

9 Hours

Unit V

Robot Applications

Multiple robots – Machine interface – Robots in manufacturing and non-manufacturing application – Robot cell design – Selection of a robot

9 Hours

Unit VI[$]

Mobile Robots and Control Issues

Industrial automation - General layout - General configuration of an automated flow line - Conveyor systems - Inspection station with feedback loops to up steam workstations - Shop floor control - 3 Phases - Order scheduling

Total: 45 Hours

Reference(s)

1. Mittal &Nagrath, *Robotics and Control*, Tata McGraw-Hill Education, 2010
2. K S Fu,Ralph Gonzalez,C S G Lee, *Robotics: Control, Sensing, Vision, and Intelligence*, Tata McGraw-Hill Education, 2011
3. MikellP. Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, *Industrial Robotics*, Tata McGraw-Hill Education, 2012
4. S K Saha, *Introduction to Robotics*, Tata McGraw-Hill Education, 2013

15IE59 ROBUST CONTROL

3 0 0 3

Course Objectives

- To understand the concepts and techniques of multivariable robust control
- To acquire knowledge in H2 optimal control and estimation techniques
- To apply knowledge in H-infinity optimal control techniques
- To understand the concepts in LMI approach of H-infinity control

Course Outcomes (COs)

The students will be able to

1. understand the basic aspects of multivariable linear system theory and control, from both an input/output and a state space point of view
2. solve basic problem in multivariable linear system theory and multivariable control design synthesis techniques for robust controllers
3. acquire awareness of the variety of modern control techniques and their applicability

Unit I

Introduction

Norms of vectors and Matrices – Norms of Systems – Calculation of operator Norms – Vector Random spaces - Specification for feedback systems – Co-prime factorization and Inner functions – Structured and unstructured uncertainty – Robustness

9 Hours

Unit II

H2 Optimal Control

Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal estimation – KalmanBucy Filter – LQG Controller

9 Hours

Unit III

H-Infinity Optimal Control-Riccati Approach

Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – H infinity estimation

10 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit IV

H-Infinity Optimal Control- LMI Approach

Formulation – Characterization of H-infinity sub-optimal controllers by means of LMI Approach – Properties of H-infinity sub-optimal controllers – H-infinity synthesis with pole-placement constraints

9 Hours

Unit V

Synthesis of Robust Controllers

Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration-– Robust Control of Second-order Plant- Robust Control of Distillation Column

8 Hours

Unit VI[$]

Control of Inverted Pendulum- Control of CSTR – Control of Aircraft

Total: 45 Hours

Reference(s)

1. U. Mackenroth, Robust Control Systems: Theory and Case Studies, Springer International Edition, 2010
2. J. B. Burl, Linear optimal control H2 and H-infinity methods, Addison W Wesley, 2011
3. D. Xue, Y.Q. Chen, D. P. Atherton, Linear Feedback Control Analysis and Design with MATLAB, Advances In Design and Control, Society for Industrial and Applied Mathematics, 2010
4. R. Petersen, V.A. Ugrinovskii and A. V. Savkin, Robust Control Design using H- infinity Methods, Springer, 2012

15IE60 RELIABILITY AND SAFETY ENGINEERING

3 0 0 3

Course Objectives

- To acquire in depth knowledge about the concept of reliability and various reliability Improvement methods
- To develop knowledge on maintainability and life testing
- To recognize and identify the safe operation of equipment in process industry

Course Outcomes (COs)

The students will be able to

1. understand the concepts of reliability
2. maintain reliability by reducing failure time in Industry to maintain safety and productivity
3. effectively conduct risk assessment study by applying reliability in hazardous industries

Unit I

Reliability

Definition and basic concepts – Failure data – Failure modes– Reliability in terms of hazard rates and failure density function. Hazard models and 'bath-tub' curve. Applicability of Weibull distribution. Reliability calculation for series, parallel series and K-out of M systems

9 Hours

Unit II

Use of Redundancy and System Reliability Improvement Methods

Objectives – Types of maintenance – Preventive – Condition - based and reliability centered maintenance. Tero technology – Total Productive Maintenance (TPM)

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit III

Maintainability

Definition – basic concepts – relationship between reliability – maintainability and availability – corrective maintenance time distributions and maintainability demonstration. Design considerations for maintainability

9 Hours

Unit IV

Introduction to Life-Testing

Destructive and non-destructive tests – estimation of parameters for exponential and Weibull distributions – component reliability and MIL standards

9 Hours

Unit V

Safety

Causes of failure and unreliability – Measurement and prediction of human reliability – Human reliability and operator training – Reliability and safety: Safety margins in critical devices - Origins of consumerism and importance of product knowledge, product safety, product liability and product safety improvement program

9 Hours

Unit VI[$]

Legal aspects of Industrial safety – Safety measures in factories act – Mines act –
pollution control acts for water – air and land – child labour and women employee acts

Total: 45 Hours

Reference(s)

1. Balagurusamy E, " Reliability Engineering" Tata Mc Graw Hill, New Delhi, 2010
2. Patrick O'Connor, Andre Kleyner, "Practical Reliability Engineering", Fifth edition, Wiley Publishers, 2012
3. Ajitkumar verma , Srividya ajit, Durga rao Karangi, " Reliability and safety engineering", Springer, 2010

15IE61 WEB BASED MEASUREMENT AND CONTROL

3 0 0 3

Course Objectives

- To acquire knowledge about internet, various IP layers and protocols
- To study about various network layers and its applications
- To identify and describe various measurements and Internet based controls

Course Outcomes (COs)

The students will be able to

1. understand the Internet protocols ,various network layers and their applications
2. use internet protocols in measurement using internet
3. develop web based measurement control through internet

Unit I

Introduction to Internet

Origin of Internet – Overview of TCP / IP layers – IP addressing – DNS – Packet switching – Routing – SMTP, POP, MIME, NNTP, FTP, Telnet, HTML, HTTP, URL, SNMP, RFCs, FYIs – STDs

10 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Network Layers

Physical Layer Aspects: Backbone network – Trunks, Routers, Bridges – Access network – MODEMs, WILL, ISDN, XDSL, VSAT

9 Hours

Unit III

Protocol

Physical Layer Aspects: Backbone network – Trunks, Routers, Bridges – Access network – MODEMs, WILL, ISDN, XDSL, VSAT

10 Hours

Unit IV

Measurements through Internet

Web based data acquisition – Monitoring of plant parameters through Internet -Calibration of measuring instruments through Internet

9 Hours

Unit V

Internet based Control

Virtual laboratory – Web based Control – Tuning of controllers through Internet.

7 Hours

Unit VI[$]

Measurement and control of temprature based on web – Smartphones for measurement and control – Internet based distributed measurement and control applications

Total: 45 Hours

Reference(s)

1. J.Michael Stewart, *Network Security, Firewalls & VPN*, 2nd Edition, 2014
2. Douglas E. Camer, *Internet working with TCP/IP*, Prentice Hall, 6th Edition, 2013
3. Jan Jantzen, *Foundations of Fuzzy control – A Practical approach*, 2nd Edition, John wiley & sons Ltd, 2013

15IE62 MECHATRONICS

3 0 0 3

Course Objectives

- To understand combination of electronics and mechanical concepts
- To know about real time applications in mechatronics
- To impart a technical knowledge in stages of designing in mechatronics

Course Outcomes (COs)

The students will be able to

1. design static and dynamic boolean logic systems using combinational, synchronous and asynchronous sequential logic
2. understand the operation of the fundamental elements of microprocessor and PLC systems
3. select suitable actuators and sensors for given applications

Unit I

Sensors and Transducers

Introduction to Mechatronics systems – measurement systems – control systems –microprocessor based controllers –sensors and transducers – resistance, capacitance, inductive transducer, and piezo electric sensor-Photo conductive cell, photo voltaic, Photo resistive –Fiber optic sensors

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Control and Drives

Control devices – Electro hydraulic control devices, electro pneumatic proportional controls – Rotational drives – Pneumatic motors: continuous and limited rotation – Hydraulic motor: continuous and limited rotation – Motion convertors, fixed ratio, invariant motion profile, variators.

9 Hours

Unit III

System Models and Controllers

Building blocks of mechanical, electrical, fluid and thermal systems, rotational – Transational systems, electromechanical systems – hydraulic – mechanical systems – continuous and discrete process controllers – control mode – two-step mode –proportional mode – derivative mode – integral mode – PID controllers – digital controllers – velocity control – adaptive control – digital logic control – micro processors control

9 Hours

Unit IV

PIC Microcontroller Programming

Introduction to PIC microcontroller, PIC architecture, interfacing with keyboards, LEDs, 7 segment LEDs, LCDs, Interfacing with ADCs. Interfacing with DACs Serial communication

9 Hours

Unit V

Design of Mechatronics System

Stages in designing Mechatronics systems – Traditional and mechatronic design - Possible design solutions. Case studies of Mechatronics systems - Pick and place robot- Autonomous mobile robot - Wireless surveillance balloon - Engine management system - Automatic car park barrier

9 Hours

Unit VI[$]

Introduction to the S12 and S12X Microcontroller, S12 Assembly Programming, Interrupts, Clock Generation, Resets, and Operation Modes, Parallel Ports, Serial Communication Interface (SCI), Serial Peripheral Interface (SPI), Analog-to- Digital Converter, Hardware and Software Development Tools, C Language Programming.

Total: 45 Hours

Reference(s)

1. W. Bolton, *Mechatronics*, Pearson education, 2011
2. A.Smaili and F. Mrad, *Mechatronics Integrated Technologies for Intelligent Machines*, Oxford university press, 2010
3. R.K. Rajput, *A Textbook of Mechatronics*, S. Chand & Co, 2010
4. Michael B. Histand and David G. Alciatore, *Introduction to Mechatronics and Measurement Systems*, McGraw-Hill International edition, 2011
5. Munir Bannoura, Rudan Bettelheim and Richard Soja, *Cold Fire Microprocessors & Microcontrollers*, , AMT Publishing, 2010
6. John B Peatman, *Design with PIC Microcontrollers*, Perason Education Asia, Low price edition, 2012

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE63 OPTIMAL STATE ESTIMATION

3 0 0 3

Course Objectives

- To design and implement a discrete Kalman filter ,extended Kalman filter, Iterated extended Kalman filter and second - order extended filter
- To design and implement derivative free Kalman filter such as unscented Kalman filter and its variants and ensemble Kalman filter
- To design and implement H infinity filter and particle filter

Course Outcomes (COs)

The students will be able to

1. design and implement a kalman filter and extended kalman filter
2. design and implement variants of derivative free kalman filters such as unscented kalman filter and variants of H-infinity filters
3. design and Implement various types of particle filters for non-linear and non-gaussian systems

Unit I

Introduction to state estimation and kalman filter

Review of Matrix Algebra and Matrix Calculus and Probability Theory – Least Square Estimation – Review of state observers for Deterministic System- Derivation of the Discrete – time Kalman filter – Kalman filter properties.

9 Hours

Unit II

Extended Kalman Filter

Linearized Kalman filter – Extended Kalman filter – The iterated Extended Kalman filter – The Second order Extended Kalman filter – Constrained Extended Kalman filter – Simultaneous State and Parameter Estimation using EKF.

10 Hours

Unit III

Unscented Kalman Filter

Means and Covariance of non-linear transformations – Unscented transformation – Unscented Kalman filtering –General Unscented transformation - The simplex unscented transformation – Spherical Unscented transformation - Simultaneous State and Parameter Estimation using UKF Constrained Unscented Kalman filter.

9 Hours

Unit IV

The H-Infinity Filter

The H- infinity filter – Introduction - Kalman filter Limitations - A game theory Approach to H-infinity filtering – Steady state H- infinity Filtering: Mixed Kalman - Robust Kalman - Constrained H- infinity filtering.

9 Hours

Unit V

Ensemble Kalman Filter & Particle Filter

Bayesian state Estimation - Ensemble Kalman filter – Introduction to Particle filtering – SIS – Implémentation issues: - Sample Impoverishment - SIR - Particle filter with EKF as proposal - Unscented Particle filter.

8 Hours

Unit VI[$]

Stabilizing depth measurements using Kalman filter - Multimodel Ensemble Kalman Filter - Adaptive Unscented Kalman Filter for nonlinear control.

Total: 45 Hours

Reference(s)

1. Bruce P. Gibbs, Advanced Kalman Filtering, Least-Squares and Modeling: A Practical Handbook, Wiley, 2011
2. Adrian Pizzinga, "Restricted Kalman Filtering Thoery, Methods and Application", Springer, 2012
3. Xiao-Heng Chang, "Takagi – Sugeno Fuzzy systems Non fragile H infinity filtering", Springer, 2012

15IE64 WIRELESS SENSOR NETWORKS

3 0 0 3

Course Objectives

- To obtain a broad understanding of the technologies and applications for the emerging and exciting domain of wireless sensor networks
- To study the challenges and latest research results related to the design and management of wireless sensor networks
- To focus on network architectures and security

Course Outcomes (COs)

The students will be able to

1. learn the basics of wireless sensor networks and its applications in enabling technologies
2. understand the architecture and elements of wireless sensor networks
3. study the tools and platforms needed to establish sensor networks

Unit I

Overview of wireless sensor networks

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

9 Hours

Unit II

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.

9 Hours

Unit III

Networking of sensors

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, 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.

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit IV

Infrastructure establishment

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

9Hours

Unit V

Sensor network platforms and tools

Operating Systems for Wireless Sensor Networks, Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

9 Hours

Unit VI[$]

Security and privacy protection, Heterogeneous fault detection, Discrepancy based fault detection and correction

Total: 45 Hours

Reference(s)

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, *Wireless Sensor Networks: Technology, Protocols and Applications*, John Wiley, 2010
2. Terrance J. Dishongh and Michael McGrath, *Wireless Sensor Networks for medical Applications*, Artech House, 2010
3. Bhaskar Krishnamachari, *Networking Wireless Sensors*, Cambridge University Press, 2011
4. Robert Faludi, *Wireless Sensor Networks*, O'REILLY, 2011
5. Mohammad S. Obaidat and Sudip Mirsa, *Principles of Wireless Sensor Networks*, Cambridge University Press, 2014

15IE65 VLSI SYSTEM DESIGN

3 0 0 3

Course Objectives

- To acquire knowledge about VLSI Design Process
- To understand the concepts of System Design Using VHDL and Programmable Devices
- To understand the types of faults and fault tolerant systems

Course Outcomes (COs)

The students will be able to

1. understand the basics concepts of VLSI design
2. acquire knowledge in design of VLSI system using different techniques
3. explore fault diagnosis and testable algorithms

Unit I

Overview of VLSI Design Methodology

VLSI design process - Architectural design - Logical Design – Physical design – Layout styles – Full custom, Semicustom approaches.Layout Design Rules: Need for design rules – Mead Conway design rules for silicon gate NMOS process – CMOSn well / p well design rules – simple layout examples – sheet resistance – Area capacitance – wiring capacitance.

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Introduction to VHDL

Design process flow - Software tools – Hardware Description Language - VHDL: Date Objects –Data types –Operators – Entitles and Architectures – Components and Configurations – Concurrent signal assignment -Conditional signal assignment – Selected signal assignment – Concurrent statements - Sequential statements –Transport and Inertial delays – Delta delays – Behavioral, Data flow and structural modeling –Attributes – Generics – Packages and Libraries – Multi valued logic and Signal resolution – IEEE 1164 std logic – Subprograms: Functions and Procedures – Operator overloading – Test Benches – Design Examples

10 Hours

Unit III

System Design Using PLDs

Basic concepts – Programming technologies – Programmable Logic Element (PLE) –Programmable Logic Array PLA) – Programmable Array Logic (PAL) – Programmable Logic Architectures – 16L8 -16R4 - 22V10 - Design of combinational and sequential circuits using PLDs – Complex PLDs (CPLDs) – Design of state machines using Algorithmic State Machine (ASM) chart as a design tool

8 Hours

Unit IV

Field Programmable Gate Arrays

Types of FPGA – Xilinx XC3000 series – Logical Cell Array (LCA) – Configurable Logic Blocks (CLB) –Input/Output Blocks (IOB) – Programmable Interconnection Points (PIP) Xilinx XC4000 series - Introduction to Xilinx SPARTAN, VIRTEX FPGA - Design examples

9 Hours

Unit V

Fault Modelling

Defects, Errors, Faults, Levels of Fault models. Types, Fault Detection and Redundancy in Combinational Logic circuits: Path sensitization method, Boolean difference method. Fault Detection in sequential logic circuit, Design for testability: Scan path Testing, Boundary Scan Test, Built in Self-Test for testing memories.

9 Hours

Unit VI[$]

Fault simulator in a VLSI design process, Fault simulation algorithms

Total: 45 Hours

Reference(s)

1. Kamran Eshraghian, Douglas A. Pucknell, "*Essentials of VLSI Circuits and Systems*" Prentice Hall of India, 2011
2. Neil Weste and Kamran Eshranghian, *Principles of CMOS VLSI Design*, Addison Wiley, 2010
3. Charles H. Roth, *Digital Systems Design Using VHDL*, Thomson Publishers, 2010
4. Michael L. Bushnell and Vishwani D. Agrawal, *Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits*, Kluwer Academic Publications, 2013
5. S. Srinivasan, *Digital Circuits and Systems*, NPTEL Courseware, 2010

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE66 REAL TIME EMBEDDED SYSTEM

3 0 0 3

Course Objectives

- To study the various components within an embedded system and their interactions
- To understand the various functions of RTOS
- To understand the networking in embedded system

Course Outcomes (COs)

The students will be able to

1. understand the concept of embedded system lifecycle with multi-tasking
2. explain the inter process communication in an operating system
3. illustrate the networking concepts in embedded system

Unit I

Introduction to Embedded Computing

Complex systems and microprocessors – Design example: Model train controller – Embedded system design process – Formalism for system design – Instruction sets Preliminaries – ARM Processor – CPU: Programming input and output – Supervisor mode, exception and traps – Coprocessor – Memory system mechanism – CPU performance – CPU power consumption

9 Hours

Unit II

Computing Platform and Design Analysis

CPU buses – Memory devices – I/O devices – Component interfacing – Design with microprocessors – Development and Debugging – Program design – Model of programs – Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing

9 Hours

Unit III

Process and Operating Systems

Multiple tasks and multi processes – Processes – Context Switching – Operating Systems – Scheduling policies - Multiprocessor – Inter Process Communication mechanisms– Evaluating operating system performance – Power optimization strategies for processes

9 Hours

Unit IV

RTOS Concepts

microC/OS II kernel structure - microC/OS II initialization - starting MicroC/OS II RTOS Functions: task management - time management - semaphore management - mutual exclusion - semaphore - event management - message management -memory management - porting microC/OSII.

10 Hours

Unit V

Hardware Accelerates & Networks

Accelerators – Accelerated system design – Distributed Embedded Architecture – Networks for Embedded Systems – Network based design – Internet enabled systems

8 Hours

Unit VI[$]

Home Appliances - Automation – Medical - Robotics - Access Control Systems (Smart Cards, RFIDs, FingerScan)

Total: 45 Hours

Reference(s)

1. Marilyn Wolf, Computers as Components, Third Edition: Principles of Embedded Computing System Design, Morgan Kaufmann Publisher, 2012
2. Qing Li, Real Time Concepts for Embedded Systems, 2010
3. Janez Puhan, Operating Systems, Embedded Systems, and Real-Time Systems, FE Publishing; 2 edition, 2013
4. Elecia White, Making Embedded Systems, O'Reilly, 2011
5. Gul N. Khan, Embedded and Networking Systems: Design, Software, and Implementation (Devices, Circuits, and Systems), Chapman and Hall/CRC, 2013

15IE67 APPLIED SOFT COMPUTING

3 0 0 3

Course Objectives

- To expose the students to the concepts of feed forward neural networks
- To provide adequate knowledge about fuzzy and neuro-fuuzy systems
- To provide adequate knowledge of genetic algorithms and its application to economic dispatch and unit commitment problems

Course Outcomes (COs)

The students will be able to

1. implement machine learning through neural networks
2. write Genetic algorithm to solve optimization problems
3. develop a fuzzy expert system and model neuro fuzzy system for clustering and classification

Unit I

Introduction to Soft Computing

Evolution of Computing – Soft Computing Constituents – From Conventional AI to Computational Intelligence – Machine learning Basics.

9 Hours

Unit II

Neural Networks

Machine Learning using Neural Network, Adaptive Networks – Feed Forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance Architectures – Advances in Neural Networks.

9 Hours

Unit III

Fuzzy Logic

Fuzzy sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions – Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit IV

Neuro – Fuzzy Modeling

Adaptive Neuro- Fuzzy Inference systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Tress – Data Clustering Algorithms – Rule base structure Identification – Neuro-Fuzzy Control.

9 Hours

Unit V

Genetic Algorithms

Introduction – Gradient Search – Non-gradient search – Genetic Algorithms: binary and real representation schemes, selection methods, crossover and mutation operators for binary and real coding.

9 Hours

Unit VI[$]

Classical Optimization Technique – Single variable functions – Multivariable functions with no constraints – Multivariable functions with both equality and inequality constraints – Advanced Optimization Techniques – Hill Climbing – Ant Colony Optimization Technique.

Total: 45 Hours

Reference(s)

1. Timothy J. Ross, Fuzzy Logic with Engineering Applications, 3rd Edition, Wiley India Edition, 2011
2. S.N.Sivanandam and S.N.Deepa, Principles of Soft computing, 2nd Edition, Wiley India Edition, 2013
3. David E. Goldberg, Genetic Algorithms in search, optimization and machine learning, Addison Welsey, 2010
4. Laurance Fausett, Englewood cliffs, N.J., Fundamentals of Neural Networks, Pearson Education, 2010
5. Hagan, Demuth, Beale, Neural Network Design, Cengage Learning, 2012
6. N.P.Padhy, Artificial Intelligence and Intelligent Systems, Oxford, 2013

15IE68 NETWORK SECURITY AND CRYPTOGRAPHY

3 0 0 3

Course Objectives

- To understand OSI security architecture and classical encryption techniques
- To acquire fundamental knowledge on the concepts of finite fields and number theory
- To understand various block cipher and stream cipher models
- To describe the principles of public key cryptosystems, hash functions and digital signature

Course Outcomes (COs)

The students will be able to

1. compare various cryptographic techniques
2. design secure applications
3. inject secure coding in the developed applications

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit I

Symmetric Ciphers

OSI Security Architecture - Classical Encryption techniques - Cipher Principles - Data Encryption Standard - Block Cipher Design Principles and Modes of Operation –Triple DES - Introduction to Finite Fields – Advanced Encryption standard – Contemporary Symmetric Ciphers – Confidentiality using Symmetric Encryption

9 Hours

Unit II

Public-Key Encryption and Hash Functions

Introduction to Number Theory – Public-Key Cryptography and RSA– Key Management – Diffie-Hellman Key Exchange – Arithmetic modulo primes- Elliptic Curve Cryptography – Message Authentication and Hash Functions – Hash Algorithms – Digital Signatures and Authentication Protocols

9 Hours

Unit III

Network Security Practice

Authentication applications – Kerberos – X.509 Authentication Service – Electronic mail Security – Pretty Good Privacy – S/MIME – IP Security architecture – Authentication header – Encapsulating Security Payload – Key Management

9 Hours

Unit IV

System Security

Intruders – Intrusion detection – Password Management – Malicious software – Firewalls – Firewall design principles –Trusted systems- Security Standards

9 Hours

Unit V

Wireless Security

Introduction to Wireless LAN Security Standards – Wireless LAN Security Factors and Issues - Security in Cellular Networks

9 Hours

Unit VI[$]

Steganography - Architectural Analysis of Cryptographic Applications for Network Processors

Total: 45 Hours

Reference(s)

1. William Stallings," *Cryptography and Network Security: Principles and Practice, International Edition: Principles and Practice*", Pearson Education Limited,2014
2. F. Garzia,"*Handbook of Communications Security*", WIT Press,2013
3. Keith Martin, "*Everyday Cryptography Fundamental principles and applications*", Oxford University Press, 2012
4. Christof Paar, Jan Pelzl, "*Understanding Cryptography- A textbook for students and practitioners*", Second edition, Springer, 2011

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE69 SENSOR AND NETWORKING

3 0 0 3

Course Objectives

- To obtain a broad understanding of the technologies and applications for the emerging and exciting domain of networks
- To study the challenges and latest research results related to the design and management of sensor networks
- To focus on architecture of Sensor networks and Wireless Embedded Networking

Course Outcomes (COs)

The students will be able to

1. understand the architecture and elements of sensor networks
2. get an idea on MAC protocols for wireless sensor networks
3. study the tools and platforms needed to establish sensor networks

Unit I

Basics of Networking

Over view of Data communication and networking – Layers of OSI Reference(s) model – Overview of general purpose networks and protocols - Ethernet, TCP/IP - Wireless communication (Ip56, Ip58) – Local Interconnect Network

9 Hours

Unit II

Sensor Network Architecture

Sensor Node's (SNs) Global View and Requirements - Individual Components of SN Nodes – Sensor Network Node - Wireless SNs as Embedded System

9 Hours

Unit III

Overview of Communication Protocols for Sensor Networks

Applications/Application Layer Protocols - Localization Protocols – Time Synchronization Protocols –Transport Layer Protocols - Network Layer Protocols - Data Link Layer Protocols - Sensor Bus Standards

9 Hours

Unit IV

Industrial Sensor Networking

Introduction - Industrial Sensor Fitting Communication Protocols - IEEE 1451 Family of Smart Transducer Interface Standards – Internet - based Sensor Networking - Industrial Network Interconnections – Wireless Sensor Networks in Industry.

9 Hours

Unit V

Case Studies

Wireless Pet Dog Management Systems - Agriculture Monitoring - Medical Care Applications - Fire Emergency Applications - Environmental Monitoring Applications

9 Hours

Unit VI[$]

Distributed Sensor Networks – Aeronautical and space sensor System – Alarm and Security Sensor System

Total: 45 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Reference(s)

1. Nitaigour P. Mahalik, "*Sensor Networks and Configuration : Fundamentals, Standards, Platforms, and Applications*", Springer, 2011
2. Mohammad Ilyas and ImadMahgoub, "*Handbook of Sensor Networks: Compact Wireless and Wired Sensing System*", CRC PRESS, 2010
3. Subhas Chandra Mukhopadhyay, Henry Leung, " *Advances in Wireless Sensors and Sensor Networks*",Springer, 2010
4. KazemSohraby, Daniel Minoli, TaiebZnati, "*Wireless Sensor Networks: Technology, Protocols, and Applications*", I st Edition, John Wiley & Sons, 2010

15IE70 EMBEDDED NETWORKING

3 0 0 3

Course Objectives

- To understand the fundamentals of embedded networking protocols
- To understand the design methodologies in wireless networks

Course Outcomes (COs)

The students will be able to

1. differentiate serial and parallel communication protocols
2. develop applications using USB and CAN bus for PIC microcontrollers
3. analyze wireless sensor network communication protocols.

Unit I

Embedded Communication Protocols

Serial Communication: RS232 standard – RS485 – Synchronous Serial Protocols - Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – Parallel Communication: PC Parallel port programming -ISA/PCI Bus protocols – Firewire

9 Hours

Unit II

USB and CAN Bus

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types – Enumeration –Descriptors –PIC18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN

9 Hours

Unit III

Ethernet Basics

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components – Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol

9 Hours

Unit IV

Embedded Ethernet

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

9 Hours

Unit V

Wireless Embedded Networking

Wireless sensor networks – Introduction – Applications – Network Topology – Localization – Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing.

9 Hours

Unit VI[$]

Home appliances control system, Industry automation system, Entertainment system, Security system, Wireless control system.

Total: 45 Hours

Reference(s)

1. Axelson J, Serial Port Complete, Penram Publisher, 2012
2. Santanu Chattopadhyay, Embedded System Design, Penram publications, 2013
3. Jan Axelson, Embedded Ethernet and Internet Complete, Penram Intl. Publishing, 2010
4. Waltenegus W. Dargie, Fundamentals of Wireless Sensor Networks: Theory and Practice, Wiley, 2010
5. Rob Toulson, Fast and Effective Embedded Systems Design: Applying the ARM mbed, Newtons, 2012

15IE71 PROJECT MANAGEMENT

3 0 0 3

Course Objectives

- To introduce students to Operations terminology and concepts.
- To enable the students to comprehend the important aspects like production layout, production planning and inventory management.
- To enable the students to understand the utility of work measurement techniques.

Course Outcomes (COs)

The students will be able to

1. solve the issues involved and tasks to be performed for production planning
2. design plant layout for ergonomics.
3. plan for inventory requirements and management.

UNIT - I

Introduction

Production and Operations Management: Evolution and Functions of Production Management. Production Systems: Job, Batch, Mass, Continuous Flow, Group technology

9 Hours

UNIT - II

Production Location and Layout

Location Decision: Factors Affecting Location Decision. Facility Layout: Product, Process Layout, Cellular Layout, Fixed Position Layout.

9 Hours

UNIT - III

Process Planning

Process Planning: Characteristics and Functions, Aggregate planning: Definition, Methodology. Master Production Schedule, Material Requirement Planning, Capacity Requirement Planning: Methodology. Manufacture Resource Planning (MRP) II.

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT - IV

Inventory Management

Independent Demand model: Economic Order Quantity (EOQ) Model (problems). Type s of Inventory control - P System, Q System, Techniques of Inventory control: ABC Analysis (problem), Just in Time (JIT), KANBAN.

9 Hours

UNIT - V

Work Measurement Techniques and Lean manufacturing

Work Measurement Techniques: Time Study, Method, Time Measurement (MTM), Work Sampling (problems), Lean Manufacturing: 7 Wastes.

9 Hours

UNIT – VI[$]

Project Risk Management Processes, Risk Quantitative Analysis, Risk Qualitative Analysis, Prioritizing Risk

Total: 45 Hours

Reference(s)

1. Norman Gaither and Greg Frazier., "Operations Management", New Delhi:Thomson Learning Inc, 2010
2. KanishkaBedi, "Production and Operations Management", New Delhi: Oxford University Press, 2011
3. S.N.Chary, "Production and Operations Management", New Delhi: Tata McGraw Hill, 2011
4. Byron J Finch, "Operations Now", New Delhi: Tata McGraw Hill, 2012
5. Chase Jacobs, Aquilano, and Agarwal, "Operations Management for Competitive Advantage", New Delhi: Tata McGraw Hill, 2010

15IE72 APPLIED BIOMEDICAL INSTRUMENATION

3 0 0 3

Course Objectives

- To gain adequate knowledge on human physiology and working of bio potential electrodes
- Understand the role of instrumentation in bio medical engineering field
- To get ample knowledge on Electro-physiological, non-electric parameter measurement and medical imaging

Course Outcomes (COs)

The students will be able to

1. analyze about human physiology and bio potential electrodes.
2. comprehend the electro – physiological, blood flow and non – electrical parameter measurements
3. understand the concepts of medical imaging, assisting and therapeutic devices

Unit I

Human Physiology and Bio Potential Electrodes

Cell and their structures – action and resting potential – nervous system: functional organisation of the nervous system, structure of nervous system, neurons, synapse – transmitters and neural communication – cardiovascular system– Physiology of heart and lungs - Circulation and respiration - Transducers - Different types - Piezo-electric, ultrasonic, resistive, capacitive, inductive transducers - Selection criteria

9 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Electro – Physiological and Blood Flow Measurement

Basic components of a biomedical system - Electrodes - Micro, needle and surface electrodes - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier. ECG - EEG - Lead systems and recording methods - Typical waveforms

9 Hours

Unit III

Non-Electrical parameter Measurement

Measurement of blood pressure – Sphygmomanometer and cardiac catheterization - Heart rate – Heart sound –Body Plethysmography – pH of blood – pulse oximeter

9 Hours

Unit IV

Medical Imaging parameter measurement

X- RAY machine – Computer Tomography – Magnetic Resonance Imaging system – ultra sonography – Endoscopy – bio-telemetry

9 Hours

Unit V

Assisting and Therapeutic devices

Cardiac pacemakers – defibrillators - ventilators– heart lung machine – dialysers – elements of audio and visual aids

9 Hours

Unit VI [$]

Biosensors – glucose and drug detection, biomechanics - limb prosthetics – orthotics

Total: 45 Hours

Reference(s)

1. R.S.Khandpur, *Hand Book of Bio-Medical instrumentation*, Tata McGraw Hill publishing company Ltd., 2014
2. J.G. Webster, *Medical Instrumentation: Application and Design*, John Wiley and Sons, New York, 2010
3. Leslie Cromwell, *Biomedical Instrumentation and measurement*, Tata McGraw Hill, 2012
4. G. Well, *Biomedical Instrumentation and Measurements*, Prentice Hall of India, New Delhi, 2011

15IE73 APPLIED INDUSTRIAL INSTRUMENTATION

3 0 0 3

Course Objectives

- To enable the students to acquire knowledge about the various techniques used for the Measurement of primary industrial parameters like flow, level, temperature and pressure.
- To understand the important parameters to be monitored and analyzed in Thermal power Plant.
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry

Course Outcomes (COs)

The students will be able to

1. get knowledge about the hazardous zone classification and intrinsic safety techniques to the adapted in industries
2. work in special purpose instruments like nuclear radiation detection techniques, fiber optic sensors, Instrumentation for NDT applications etc

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit I

Review of industrial instrumentation

Overview of measurement of flow, level, temperature and pressure

9 Hours

Unit II

Measurement in thermal power plant (Boilers)

Selection and Installation of instruments used for the Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature – Feed water quality measurement- Flue gas Oxygen Analyzers- Coal Analyzer.

9 Hours

Unit III

Measurement in petroleum refinery

Parameters to be measured in petroleum industry:-Flow, Level, Temperature and Pressure measurement in Distillation, Pyrolysis, catalytic cracking and reforming process-Hydrocarbon analyzers-oil in or on water- sulphur in oil Analyzer.

9 Hours

Unit IV

Instrumentation for industrial safety

Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems –Conservation and emergency vents - Flame, fire and smoke detectors - Leak Detectors – Metal Detectors.

9 Hours

Unit V

Special purpose instrumentation

Detection of Nuclear Radiation – Corrosion monitoring – Fiber optic sensors- Instrumentation in weather stations – Instrumentation for NDT applications-Image processing technique for measurements.

9 Hours

Unit VI[$]

Parameters to be measured -Distillation column- Crystallization process-Mixing process – Drying.

Total: 45 Hours

Reference(s)

1. B.G.Liptak, *Instrumentation Engineers Handbook (Process Measurement & Analysis)*, Fourth Edition, Chilton Book Co, 2013
2. K.Krishnaswamy and M.Ponnibala, *Power Plant Instrumentation*, PHI Learning Pvt Ltd, 2011
3. *John G. Webster, Halit Eren, The Measurement, Instrumentation, and Sensors Handbook, CRC and IEEE Press, Second Edition 2014*
4. Håvard Devold, *Oil and Gas Production Handbook - An Introduction to Oil and Gas Production*, ABB ATPA oil and gas, 2013
5. *M. Arumugam*, '*Optical Fibre Communication* and *Sensors*', *Anuradha Agencies*, 2012
6. Paul E. Mix, *Introduction to Nondestructive Testing*, John Wiley and Sons, 2010

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IE74 FUZZY SYSTEM FOR INDUSTRIAL PROCESSES

3 0 0 3

Course Objectives

- To recall the basic fuzzy set operations and membership functions.
- To understand the structure of fuzzy controller and fuzzy logic modeling and control.
- To comprehend the fuzzy control for nonlinear systems

Course Outcomes (COs)

The students will be able to

1. implement the self organizing fuzzy control
2. analyze the stability of fuzzy control system
3. apply fuzzy controllers to various industrial processes

Unit I

Fuzzy System

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning-Member ship function-knowledge base-Decision making logic-Optimization of Membership function.

9 Hours

Unit II

Fuzzy Control

Introduction to fuzzy logic modeling and control -Design of Fuzzy Controllers – Structure of fuzzy controller -Table base controller - Input-output mapping -Takagi – Sugeno type controller - Mamdani's fuzzy controller.

9 Hours

Unit III

Fuzzy Control for Nonlinear Systems

Fuzzy modeling and control scheme for nonlinear system - Self organizing fuzzy logic control-changing a set of control rules-adjusting membership functions-changing the finite set of values describing the universe of discourse- Fuzzy logic control for nonlinear time delay system.

9 Hours

Unit IV

Design of Fuzzy Controller using Matlab

Implementation of fuzzy logic controller using MATLAB Fuzzy logic toolbox- Stability analysis of fuzzy control systems- Lyapunov's direct method.

9 Hours

Unit V

Applications

Case study – Liquid level system-Temperature control – Motor speed control- Separation Processes-Distillation Column.

9 Hours

Unit VI[$]

Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN-Neuro-Fuzzy Systems for Pattern Recognition: Image- Speech and Language Processing - Application -: Speech Recognition.

Total: 45 Hours

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Reference(s)

1. Timothy J. Rose, '*Fuzzy logic with Engineering Applications'*, 3rd edition, Wiley India, 2010
2. D.Driankov, H.Hellendroon, M.Reinfrank,'*Introduction to Fuzzy Control'*, 2nd edition,Springer, 2013
3. Zimmerman H.J. '*Fuzzy set theory and its applications*', 3rd edition, Springer science and Business media, 2011
4. Klir G.J,Mark Wierman. '*Uncertainty based Information'*, 2nd edition, springer-Verlag, 2013
5. Lakhmi C. Jain, Janusz Kacprzyk."*New learning Paradigms in soft computing*" 3rd edition, Springer-Verlag Berlin Heidelberg,2013

15IE75 POWER PLANT INSTRUMENTATION

3 0 0 3

Course Objectives

- To gain knowledge on the operation of various conventional power plants & also on the different types of controls being used in boilers
- To acquire knowledge in solar radiation measurements, Solar Photovoltaic systems and applications of solar energy
- To extend the views in the analysis of Geothermal resources, Ocean Energy and additional alternate energy resources

Course Outcomes (COs)

The students will be able to

1. learn the basics of all power generation plant
2. select the instrumentation system for power plant
3. design control loops for power plant

Unit I

Overview of conventional power generation and Control loops in boiler

Brief survey of methods of power generation – Thermal Power plant, Hydro-Electric Power plant, Nuclear Power plant and Cogeneration – Control system diagramming – P&I diagram of boiler – Control loops in boiler – Combustion control – Measurement of furnace draft – Drum level control – Main steam and reheat steam temperature control – Deaerator –Combustion air flow control.

8 Hours

Unit II

Solar Energy

Solar radiation – Solar radiation measurements, Estimation of average solar radiation, Solar radiation on tilted surfaces – Solar energy collectors –Solar Photovoltaic systems – Solar cell characteristics, Solar cell Classification, Construction of PV module, panel and array, MPPT, Classification of PV systems – Applications of solar energy – Solar water heaters, Solar thermal electric conversion, Solar PV power generation, Solar cooking.

10 Hours

Unit III

Wind and Biomass Energy

Wind Energy – Origin of winds, Nature of winds, Site selection considerations, Wind turbine aerodynamics, Basic components of a Wind Energy Conversion System, Wind turbine types and their construction, Design consideration of horizontal axis type wind turbine, Schemes for electrical energy generation (CSCF, VSCF, VSVF), Environmental aspects. Biomass Energy – Biomass resources, Biomass conversion technologies, Biomass gasification, Constant pressure type and constant volume type biogas plants.

10 Hours

Unit IV

Geothermal and Ocean Energy

Geothermal Energy – Types of Geothermal resources, Analysis of geothermal resources, Environmental consideration. Ocean Energy – Tidal Energy – Conversion scheme, Estimation of power – Wave Energy – Power in waves, Wave energy technology – Ocean Thermal Energy Conversion (OTEC) schemes – Claude cycle, Anderson cycle, Hybrid cycle, Environmental impacts.

8 Hours

Unit V

Additional Alternate Energy Resources

Magneto Hydro Dynamic (MHD) power generation – Principles, MHD systems, Voltage and Power output of MHD generator, Materials for MHD generator. Thermoelectric power generation – Basic principles, thermoelectric power generator and its performance analysis, Selection of materials. Thermionic power generation – Principle, Thermionic generator and its performance analysis

9 Hours

Unit VI[$]

Instrumentation for safety interlocks protective devices - Emergency measures – alarms and alarm Analysis - monitoring of environmental pollution.

Total: 45 Hours

Reference(s)

1. G.D.Rai, *Non-Conventional Energy Resources*, 5th Edition, Khanna Publishers, 2011
2. B.H. Khan, *Non-Conventional Energy Resources*, 11th Edition, Tata McGraw Hill, New Delhi, 2012
3. G.F. Gilman, *Boiler Control Systems Engineering*, 2nd Edition , ISA Publication, 2010
4. Larry Drbal, *Power Plant Engineering*, Kluwer academic publications, 2011

$ Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15IEXA INSTRUMENTATION STANDARDS

- - - 1

Course Objective(s)

- To understand Industrial Standard requirements
- To understand International Councils Involved in Standards

What is Standard –Standard Council – Basics of standards – Oil Industries safety Directorate – International society for Automation – American Petroleum Institute – International Electro - Technical Commission - American National Standards Institute – Indian Standard Organization – EIL and other EPCC standards

Total: 15 Hours

Reference(s)

1. Nicholas P. Cheremisinoff, Practical Guide To Industrial Safety, Marcel Dekker, Inc, 2012
2. Walt Boyes, Instrumentation Reference Book, Butterworth-Heinemann, 2011

15IEXB INDUSTRIAL PROCESS SCHEMES IMPLEMENTATION

- - - 1

Course Objective(s)

- To understand the concepts of various process schemes
- To acquire basic knowledge about preparation of offer for PLC based on P&ID
- To gain ample knowledge on function block programming using ABB Software

Explaining Process Schemes of STP/ETP/WTP – Explaining Process Scheme of Diesel Generator – Explaining the procedure to develop Data Logger using Totalizer Block – Procedure to develop IO List based on Process Scheme – ABB AC 500 PLC Overview-Explaining ABB AC 500 Control Builder Software – Procedure to develop System Configuration based on IO List- Overview about FBD- Explaining to prepare Logic Diagram using ABB PLC Software.
Total: 20 Hours

Reference(s)

1. Ghodrat Kalani, *Industrial Process Control: Advances and Applications: Advances and Applications*, Elsevier science, 2013
2. By B.R. Mehta, *Industrial Process Automation Systems: Design and Implementation*, Elsevier science, 2012

15IEXC INSTRUMENTATION PROJECT MANAGEMENT

- - - 1

Course Objective(s)

- To understand the methodology in executing projects
- To understand the importance of project scheduling

Proposal Engineering – Costing sheet preparation – Project Macro Scheduling – Project Micro Scheduling – Project Tracking and Documenting – Manpower allocation – Procurement Long lead Scheduling – Project Completion and Handover Procedures.

Total: 20 Hours

Reference(s)

1. Bela G. Liptak, *Instrument Engineers' Handbook, Third Edition, Volume Three: Process software and digital networks*, CRC press, 2011
2. Walt Boyes, Instrumentation Reference Book, Butterworth-Heinemann, 2012

15IEXD DETAIL ENGINEERING ACTIVITIES USING P&ID

- - - 1

Course Objective(s)

- To understand P&ID symbols and abbreviations
- To acquire basic knowledge about preparation of Instrument Index and IO List
- To gain adequate knowledge on detail engineering activities

Definition & Purpose – P&ID: Symbols, Abbreviations and Typicals for Valves & Motors Overview about ISA S 5.1 – Preparation of Instrument Index – Preparation of IO List- Preparation of Data Sheets – Preparation of Specifications – Preparation of Location Layouts – Preparation of Cable Routing Layout – Preparation of Control Room Layout - Preparation of Cable Schedule – Preparation of PLC Specification – Preparation of Junction Box Wiring Diagram - Preparation of Loop Drawing.

Total: 20 Hours

Reference(s)

1. Instrumentation symbols and identification - ISA 5.1, International Society of Automation
2. Process Measurement Instrumentation - API RP 551, International Society of Automation