ITEM NO.	APPENDIX

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

M.E., PROCESS CONTROL AND INSTRUMENTATION ENGINEERING

REVISED REGULATIONS & SYLLABI

(Students Admitted From the Academic Year 2019-2020)

VISION

To nurture higher echelons of technology through participative education, innovative and collaborative research with a view to bring out employable graduates of International standard.

MISSION

To establish state of the art facilities related to diverse dimension in the field of Instrumentation Engineering, Control Engineering, Process Control & Automation.

To foster higher quality of education with equivocal focus in theory and practical areas of Electronics, Control and Instrumentation Engineering.

To ensure that the dissemination of knowledge reaches the stakeholders and forge the opening of a fresh flair of human resources.

To create opportunities for advancements in different facets of this discipline and offer avenues to reach the citadels of one's career.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

The major objectives of the M.E (Process Control & Instrumentation) programme are to equip the students with adequate knowledge and skills in the areas of Process Control and Instrumentation and prepare them for:

1. Imparting practical knowledge in process control, design of instrumentation systems and contribute to technological development.
2. Attaining professional competency to address the technological needs of society and industrial problems.
3. A successful career in Process Control and Automation industries, R&D organizations and Academic Institutions.
4. Showing the society for life-long self-governing and thoughtful learning skills in their career.
5. Exhibiting their potential in project management, collaborative and multidisciplinary task in their profession.

PROGRAMME OUTCOMES (POs)

A student who has undergone the M.E (Process Control & Instrumentation) program would have acquired abilities to

PO1:ENGINEERING KNOWLEDGE

Apply knowledge of mathematics, science and engineering in practice for instrumentation, control and automation with an ability to discriminate, evaluate,

analyze and synthesize existing and new knowledge and integration of the same for enhancement of knowledge.

PO2:DECISIVE THINKING

Identify, analyse, formulate and solve complex engineering problems in instrumentation, control and automation engineering critically, to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context to handle emerging technologies relating to process industries.

PO3: PLAN AND PROGRESS

Solve instrumentation, control and automation problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors.

PO4: RESEARCH SKILLS

Extract the research skill to unfamiliar problems through literature survey and experiments, and apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in instrumentation, control and automation domains.

PO5: USAGE OF MODERN TOOLS

Learn, Develop, Choose, apply appropriate techniques and resources, modern engineering and IT tools, including prediction and modelling, to complex instrumentation and control, automation engineering activities with an understanding of the limitations.

PO6: COLLABORATIVE AND MULTIDISCIPLINARY WORK

Collaborative and Multidisciplinary work and understanding of group dynamics, recognize opportunities and contribute positively to scientific research, demonstrate a capacity for decision-making based on open mindedness, objectivity and rational analysis in order to achieve common goals.

PO7: PROJECT MANAGEMENT

Demonstrate project management knowledge by applying the same to one's own work, as a member and leader in a team, manage projects by considering economical and financial factors efficiently in respective disciplines and multidisciplinary environments.

PO8: SOFT SKILLS

Communicate confidently and effectively with the peers and the society at large regarding complex engineering activities, be able to comprehend and write effective reports, design documentation by adhering to appropriate standards, make effective presentations.

PO9:LIFE-LONG LEARNING

Recognise the need for Life-long Learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously and independently.

PO10: ETHICAL PRACTICES AND SOCIAL RESPONSIBILITY

Ethical practices and social responsibility, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11: INDEPENDENT AND REFLECTIVE LEARNING

Independent and reflective learning, observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

MAPPING OF POs WITH PEOs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
PEO1	✓	✓	✓	✓	✓						
PEO2		✓	✓	✓		✓	✓	✓		✓	✓
PEO3	✓	✓	✓	✓		✓	✓	✓	✓		
PEO4						✓		✓	✓	✓	
PEO5		✓	✓		✓	✓	✓	✓		✓	✓

M.E (PROCESS CONTROL AND INSTRUMENTATION) FULL TIME

SEMESTER I									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
EIPCPC11	PC	Process Dynamics and Control	3	-	-	25	75	100	3
EIPCPC12	PC	Industrial Instrumentation	3	-	-	25	75	100	3
EIPCPE13	PE	Program Elective-I	3	-	-	25	75	100	3
EIPCPE14	PE	Program Elective-II	3	-	-	25	75	100	3
EIPCMC15	MC	Research Methodology and IPR	2	-	-	25	75	100	2
EIPCCP16	CP	Process Control & Instrumentation Lab	-	-	3	40	60	100	2

EIPCCP17	CP	Instrumentation System Design Lab	-	-	3	40	60	100	2
EIPCAC18	AC	Audit Course-I	2	-	-	-	-	-	0
Total						**205**	**495**	**700**	**18**

SEMESTER II

Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
EIPCPC21	PC	Industrial Data Communication and Control	3	-	-	25	75	100	3
EIPCPC22	PC	System Identification and Modeling	3	-	-	25	75	100	3
EIPCPE23	PE	Program Elective-III	3	-	-	25	75	100	3
EIPCPE24	PE	Program Elective-IV	3	-	-	25	75	100	3
EIPCOE25	OE	Open Elective - I (Inter faculty)	3	-	-	25	75	100	3
EIPCCP26	CP	Industrial Automation Lab	-	-	3	40	60	100	2
EIPCTS27	TS	Internship* and Seminar		Tr 2	S 2	40	60	100	2
EIPCAC28	AC	Audit Course-II	2	-	-	-	-	-	0
Total						**205**	**495**	**700**	**19**

SEMESTER III

Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
EIPCPE31	PE	Program Elective-V	3	-	-	25	75	100	3
EIPCOE32	OE	Open Elective - II (Inter faculty)	3	-	-	25	75	100	3
EIPCPV33	PV-I	Project work & Viva-voce Phase-I	-	Pr 16	S 4	40	60	100	10
Total						**90**	**210**	**300**	**16**

SEMESTER IV

Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
EIPCPV41	PV-II	Project work & Viva-voce Phase-II	-	Pr 24	S 6	40	60	100	15
Total						**40**	**60**	**100**	**15**

***Note:* * - Four weeks during the summer vacation at the end of II[nd] Semester.**

L: Lecture ,P: Practical, T: Tutorial,CA: Continuous Assessment, FE: Final Examination,Tr: Training, Pr: Project work, S: Seminar.

PC	Program Core	**CP**	Core Practical	**AC**	Audit Course
PE	Program Elective	**TS**	Industrial Training and Seminar	**PV**	Project work & Viva-voce

OE	Open Elective	**MC**	Mandatory Learning Course	**EI**	Branch code
				RI	M.E Specialization Code

M.E (PROCESS CONTROL AND INSTRUMENTATION) PART-TIME

S E M E S T E R – I											
Sl. No.	**Course Code**	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
1	PEI PCPC11	PC	Process Dynamics and Control	3	-	-	25	75	100	3	EIPC PC11
2	PEIPC PC12	PC	Industrial Instrumentation	3	-	-	25	75	100	3	EIPC PC12
3	PEIPC MC13	MC	Research Methodology and IPR	2	-	-	25	75	100	2	EIPC MC15
4	PEIP CCP14	CP	Process Control & Instrumentation Lab	-	-	3	40	60	100	2	EIPC CP16
	Total						**115**	**285**	**400**	**10**	

S E M E S T E R – II											
Sl. No.	**Course Code**	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
1	PEIPC PC21	PC	Industrial Data Communication and Control	3	-	-	25	75	100	3	EIPC PC21
2	PEIPC PC22	PC	System Identification and Modeling	3	-	-	25	75	100	3	EIPC PC22
3	PEIPC	OE	Open Elective	3	-	-	25	75	100	3	EIPC

	OE23		- I (from the Dept.)								OEXX
4	PEIPC CP24	CP	Industrial Automation Lab	-	-	3	40	60	100	2	EIPC CP17
	Total						**115**	**285**	**400**	**11**	

S E M E S T E R – III											
Sl. No.	**Course Code**	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
1	PEIPC PE31	PE	Program Elective-I	3	-	-	25	75	100	3	EIPC PEXX
2	PEIPC PE32	PE	Program Elective-II	3	-	-	25	75	100	3	EIPC PEXX
3	PEIPC CP33	CP	Instrumentation System Design Lab	-	-	3	40	60	100	2	EIPC CP17
	Total						**90**	**210**	**300**	**8**	

S E M E S T E R – IV											
Sl. No.	**Course Code**	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
1	PEIPC PE41	PE	Program Elective-III	3	-	-	25	75	100	3	EIPC PEXX
2	PEIPC PE42	PE	Program Elective-IV	3	-	-	25	75	100	3	EIPC PEXX
3	PEIPC TS43	TS	Seminar / Mini project		S 2	M 2	40	60	100	2	EIPC TS27
	Total						**90**	**210**	**300**	**8**	

S E M E S T E R –V											
Sl. No.	**Course Code**	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
1	PEIPC	**PE**	Program	3	-	-	25	75	100	3	EIPC

	PE51		Elective-V								PEXX
2	PEIPCOE52	**OE**	Open Elective - II (from the Dept.)	3	-	-	25	75	100	3	EIPCOEXX
	PEIPCPV53	**PV-I**	Project work & Viva-voce Phase-I	-	Pr 16	S 4	40	60	100	10	EIPCPV33
	Total						**90**	**210**	**300**	**16**	

S E M E S T E R –VI											
Sl. No.	**Course Code**	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
	PEIPCPV41	**PV-II**	Project work & Viva-vocePhase-II	-	Pr 24	S 6	40	60	100	15	EIPCPV41
	Total						**40**	**60**	**100**	**15**	

L:Lecture ,**P**:Practical,**T**: Tutorial, **CA**:Continuous Assessment;**FE**:Final Examination, **S**: Seminar, **M**: Mini Project, **Pr**: Main project

S.No	**COURSE CODE**	**LIST OF PROGRAM ELECTIVES**	**Credits**
1.	EIPCPEXX	Instrumentation System Design	3
2.	EIPCPEXX	Advanced Instrumentation System	3
3.	EIPCPEXX	Instrumentation in Petrochemical Industry	3
4.	EIPCPEXX	Thermal Power Plant Instrumentation	3
5.	EIPCPEXX	Virtual Instrumentation	3
6.	EIPCPEXX	Automotive Instrumentation	3
7.	EIPCPEXX	Advanced Process Control	3
8.	EIPCPEXX	Adaptive Control	3
9.	EIPCPEXX	Optimal Control	3
10.	EIPCPEXX	Robust Control	3
11.	EIPCPEXX	Non Linear System Theory	3
12.	EIPCPEXX	Statistical Process Control	3
13.	EIPCPEXX	Advanced Digital Signal Processing	3
14.	EIPCPEXX	Machine Learning Techniques	3
15.	EIPCPEXX	Robotics & Automation	3

16.	EIPCPEXX	Artificial Intelligence for Process Control.	3
17.	EIPCPEXX	Real time Embedded System	3

S.No	COURSE CODE	LIST OF OPEN ELECTIVES	Credits
1.	EIPCOEXX	Industrial Drives and Control	3
2.	EIPCOEXX	Digital Control	3
3.	EIPCOEXX	Wireless Sensor Networks	3
4.	EIPCOEXX	Digital Image Processing	3
5.	EIPCOEXX	Multi Sensor Data Fusion	3

S.No	COURSE CODE	LIST OFAUDIT COURSES
1.	EIPCACXX	English for Research Paper Writing
2.	EIPCACXX	Disaster Management
3.	EIPCACXX	Sanskrit for Technical Knowledge
4.	EIPCACXX	Value Education
5.	EIPCACXX	Constitution of India
6.	EIPCACXX	Pedagogy Studies
7.	EIPCACXX	Stress Management by Yoga
8.	EIPCACXX	Personality Development through Life Enlightment Skills

EIPCPC11	PROCESS DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the dynamics of various processes and modelling of physical processes using first principles.
- To get adequate knowledge about basic control actions and related issues.
- To educate the effect of various control actions and the methods of tuning the controller.
- To introduce the concept of MIMO process and its control schemes.
- To study the control schemes for typical processes and it's P & I Diagram.

Process Control: Design aspects – Hardware elements of process control system. 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.

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 – position and velocity forms of PID controllers – 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. Methods of controller tuning, Ziegler – Nichols continuous cycling, damped oscillations, process reaction curve method – Cohen and Coon method, time – integral criteria.

Advanced Control Systems: Feedback control of systems with large dead time, dead time compensation – cascade control – feed forward and ratio control – adaptive and inferential control systems – internal model control – model predictive control – introduction to MPC schemes.

Design of Control Systems for Multivariable Process: Design equations – degrees of freedom – poles and zeros – 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. Decoupling control.

Control of Typical Processes: Distillation column, control of top and bottom product composition, reflux ratio. CSTR, four – tank system and PH process.Piping and Instrumentation Drawing (P&I D) of control loops.

REFERENCES

1. Ramesh C Panda and T. Thyagarajan, An Introduction to Process modelling,Identification and control for Engineers, Narosa Publishing House, First edition, 2017.
2. B. WaynBequette, Process Control: Modeling, Design and Simulation, Prentice HallInternational series, Third edition, 2003.
3. George Stephanopoulos, Chemical Process Control, An Introduction to the Theory and Practice, Prentice Hall International Inc., First edition, 2008.
4. Donald R. Coughanowr, Process Systems Analysis and Control, Third Edition, McGraw Hill Inc., 2013.
5. Peter Harriott, Process Control, Tata McGraw Hill 26th Reprint, 2005.
6. D. Patranabis, Principles of Process Control, Tata McGraw Hill, Third Edition, 2013.
7. William L. Luyben, Michael L. Luyben, Essentials of Process Control, Tata McGraw Hill, 1997.

COURSE OUTCOMES

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

1. Understand basic principles and importance of process control in industrial process plants.
2. Acquire knowledge of dynamic modelling and system behaviour.
3. Understand the need for mathematical basis for the design of control systems.
4. Design and implementation of advanced controllers.
5. Understand the concept of MIMO process.

MAPPING OF COs WITH Pos											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓										
CO2	✓	✓				✓		✓	✓		
CO3	✓	✓				✓			✓	✓	

CO4		✓	✓	✓		✓				✓	✓
CO5	✓										

EIPCPC12	**INDUSTRIAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart knowledge on the various techniques used for the measurement of primary industrial parameters like flow, level, temperature and pressure.
- To make students understand the important parameters to be monitored and analyzed in Thermal power plant and Nuclear power plant.
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry.
- To learn about the intrinsic safety techniquesadapted in industries.
- To familiarize the students about the safety instrumented system and method to evaluate risk and safety instrumentation levels.

Measurement of Important Process Variables:

Measurement principles of temperature, pressure, level and flow measuring instruments - general considerations for instrument mounting- calibration principles for temperature and pressure transmitters- semiconductor transducers for temperature, pressure, level, and flow.

Instrumentation for Thermal Power Plant:

Measurement of fuel flow, air flow, drum level, steam pressure, steam temperature - selection and installation of instruments for these variables - dissolved oxygen analyzer -flue gas analyzer -ph analyzer - coal /oil analyzer - pollution instruments-dust monitor.

Instrumentation for Nuclear Power Plant:

Nuclear radiation sensors- out of core–neutron sensors-in core – process instrumentation: temperature sensing, pressure sensing and transmitting, flow sensing, level and position sensing, steam properties sensing, water properties sensing, gas properties sensing – special sensor for sodium cooled reactors and gas cooled reactors.

Instrumentation for Petro Chemical Industry/Refinery:

Selection and installation of instruments for the measurement of temperature, level, flow and pressure in refinery – measurements in pyrolysis, catalytic cracking and reforming processes-hydrocarbon analyser-sulphur in oil analyzer.

Instrumentation for Industrial Safety:

Intrinsic safety: Definition - conservation and emergency vents - flame, fire and smoke detectors - leak detectors - metal detectors.safety instrument system (sis): need, features, components, difference between basic processcontrol system and sis.

Safety Integrity Levels (SIL), Determination method : as -low as reasonablypractical (alarp), evaluating risk: risk matrix, risk graph, layers of

protection analysis (lopa) – issuesrelated to system size and complexity –issues related to field device safety.

REFERENCES

1. D.Patranabis, "Principles of Industrial Instrumentation", 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
2. B.G.Liptak, "Instrumentation Engineers Handbook (Measurement)", Fourth Edition, Volume 1, CRC press, 2011.
3. Donald P.Eckman, Industrial Instrumentation, Wiley Eastern Limited, 1991.
4. ZamuelGlasstone and Alexander Sessonske, "Nuclear Reactor Engineering", CBS publishers and Distributors Pvt. Ltd., 2004.
5. Paul Gruhn and Harry L. Cheddie," Safety Instrumented systems: Design, Analysis andJustification", ISA, 2nd Edition, 2006.
6. Eric W. Scharpf, Heidi J. Hartmann, Harlod W. Thomas, "Practical SIL target selection : Riskanalysis as per the IEC 61511 safety Lifecycle", Exida, 2012.
7. Gill, A.B., "Power Plant performance", Butterworth and Co (Publishers) Ltd, 2003.

COURSE OUTCOMES

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

1. Apply knowledge on measurement and calibration principles of basic industrial process variablesto ensure proper functioning of industrial systems.
2. Appropriately select and mount the instruments for a particular process.
3. Execute instrumentation requirements in various process industries such as Thermal power plant and Nuclear power plant and Petro Chemical/ Refinery.
4. Identify hazardous area and ensure safety measures by evaluating risk levels and features.
5. Design and implement a safety instrumentation system.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓					✓			✓
CO2	✓	✓	✓								
CO3			✓	✓	✓	✓					
CO4				✓	✓			✓			
CO5				✓	✓	✓		✓			

EIPCMC15	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

- To understand the research problem formulation and analyze research related information.

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper.Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

REFERENCES

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall , "Industrial Design", McGraw Hill, 1992.
5. Niebel , "Product Design", McGraw Hill, 1974.
6. Asimov , "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

COURSE OUTCOMES

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

1. Understand research problem formulation.
2. Follow research ethics
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**

CO1	✓	✓	✓					✓			✓
CO2	✓	✓	✓								✓
CO3			✓	✓	✓	✓					✓
CO4				✓	✓			✓			✓
CO5				✓	✓	✓		✓			

EIPCCP16	**PROCESS CONTROL & INSTRUMENTATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

COURSE OBJECTIVES

- To impart knowledge on the real time process modelling principle.
- To design and implement tuning techniques of PID controller for a typical process and verify its performance in MATLAB/Simulink environment.
- To understand the calibration procedure for various transmitters.
- To implement closed loop control for processes like air temperature, air flow and level.
- To familiarize students with design and simulation of advanced control strategies for the given process.
- To develop programming skill for a typical PLC.

LIST OF EXPERIMENTS

1. a. Determination of control valve characteristics
   b. Determination of characteristics of capacitive level transmitter
2. a. Controller tuning using continuous cycling method
   b. Controller tuning using Process Reaction Curve method
3. Modeling of an proto typeair temperature process
4. Study of Air flow control system and determination of transfer characteristics of I/P converter, Control Valve and Flow transmitter
5. Modeling and simulation of a Level process using TUTSIM software package
6. Determination of characteristics of a PID controller using MATLAB (Simulink) software
7. Determination of Transfer function (Experimental model) of Level process
8. Design and simulation of Averaging Control

COURSE OUTCOMES

At the end of the practical course the students will be able to:

1. Identify the types of control valve for a particular process number to determine the characteristics of level and flow transmitter and identify the error if any
2. Model and design controllers for different processes.
3. Design and implement advanced control techniques.
4. Develop and program with TUTSIM and MATLAB software for process control applications.

5. Do the modeling of a real time process.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓								
CO2	✓	✓	✓								
CO3				✓				✓			
CO4		✓			✓			✓			
CO5	✓		✓		✓	✓		✓			

EIPCCP17	**INSTRUMENTATION SYSTEM DESIGN LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

COURSE OBJECTIVES

- To impart knowledge about the implementation of Auto/Manual switch in PID controller.
- To study and implement anti-reset windup scheme and various practical forms of PID controller
- To design and implement an electronic PID controller
- To design and implement signal conditioning circuits for various processes.
- To learn the design and development procedure of cold junction compensation scheme for a thermocouple using RTD

LIST OF EXPERIMENTS

1. a. Implementation of Auto/Manual switch in PID controller
   b. Implementation of anti-reset windup scheme
2. Design of an Annunciator circuit using PLC
3. a. Implementation of practical forms of PID controller
   b. Design and simulation of two position controller for a Thermal process using
   Electronic Work Bench (EWB) software
4. Design and implementation of electronic PID controller
5. Realization of first order and second order systems with dead time using electronic circuits
6. a. Design and implementation of cold junction compensation scheme using RTD
   b. Design of Signal conditioning circuit for the given process
7. Design of Alarm circuit using Logic gates.
8. Design of control valve sizing and orifice.

COURSE OUTCOMES

At the end of the practical course the students will be able to

1. Design and implement the electronic PID controller with auto manual switch.
2. Design PLC based annunciator circuit and logic gates based alarm circuits.
3. Design PID controller with anti reset windup schemes and design of practical forms of process processes.

4. Design and implement cold junction compensation schemes.
5. Design orifice for flow process and size A control valve for a particular application.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓			✓						✓
CO2	✓	✓		✓	✓						✓
CO3	✓	✓		✓	✓						✓
CO4	✓	✓	✓		✓	✓					
CO5	✓		✓	✓	✓						✓

EIPCPC21	**INDUSTRIAL DATA COMMUNICATION AND CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide fundamental knowledge about industrial data acquisition system and different industrial networking standards.
- To provide comprehensive knowledge about the methods of internetworking.
- To give basic knowledge in the architecture and local control unit of distributed control system.
- To give adequate information about SCADA, PLC and OPC.
- To give basic knowledge about HART, field bus, and control network technology.

Data Acquisition Systems(DAS): Review of A/D and D/A Converters - Sampling and digitizing - Review of Analog Communication Systems and techniques - multiplexing –TDM & FDM- Data Communication - transmission lines and digital signals - practical line interface circuits - serial asynchronous communication protocol - Intel 8251A - current loop, RS 232 C- RS 485 - GPIB – USB, Bluetooth.

MODEM: Data coding methods - error detection, correction and encryption. Fiber Optic transmission - Optical fiber Cables - light sources and detectors.Architecture of a PLC – Analog and digital types of I/O modules – PLC system memories - Program and data organization inside a PLC - Networking of multiple PLC.

Methods of Computer Control of Processes, their Configuration and Comparison: Direct Digital Control, Supervisory Digital Control, Distributed Control System (DCS).

DCS :- Local Control Unit(LCU) and architecture - LCU languages - LCU - Process interfacing issues. Operator interface - requirements Engineering interface - requirements - displays - alarms and alarm management. Factors to be considered in selecting a DCS. Introduction to SCADA, OLE for Process control(OPC).

Network Models and Protocols: OSI model - Data link Control protocol. Media access protocol: Command/response - Token passing - CSMA/CD, TCP/IP.

Bridges - Routers - Gateways.Standard ETHERNET and Industrial ETHERNET Configuration - Special requirement for networks used for Control, Wireless LAN.Introduction to MODBUS, CANBUS, LON WORKS, FIP.

Common Industrial Protocols:HART: Introduction - Evolution of Signal standard - HART Communication protocol - Communication modes - HART Commands – HART and the OSI model.Field Bus: Introduction - General Field bus architecture - basic requirements of field bus standard - field bus topology - Interoperability - Interchangeability.

REFERENCES

1. Behrouz A. Forouzan, Data communications and Networking, Tata Mcgraw Hill, 2004.
2. Frank Petruzella, Programmable Logic Controllers, 5th Edition, McGraw-Hill, 2017.
3. William L. Schweber, Data Communications, McGraw-Hill, 1988.
4. Yokogawa – CS 3000, Fundamental Training manual, 2009.
5. Romilly Bowden, HART Application Guide, HART Communication Foundation, 1999.
6. BG Liptak, Instrument Engineer Handbook- Process software and Digital Networks, 4th Edition, 2011.

COURSE OUTCOMES

At the end of the course the students will be able to:

1. Understand the basic principle and modes of digital data transmission and communication.
2. Understand the various types of buses and devices used for data communication in industry.
3. Implement the automation concepts in a process industry with DCS and PLC.
4. Understand different networking topologies for data communication in process industries.
5. Use HART and Filedbus protocols for process industries.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓		✓			✓			✓		✓
CO2		✓	✓		✓						
CO3				✓	✓	✓		✓			✓
CO4			✓	✓			✓				
CO5				✓	✓				✓		

EIPCPC22	**SYSTEM IDENTIFICATION AND MODELLING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart knowledge on various non parametricapproach based system identification.
- To make the student understand the principles of state space modelling of linear and nonlinear systems.
- To know non recursive and recursive parametric identification approaches.
- To learn to develop robust parametric identification methods.
- To impart knowledge pertaining to practical aspects of system identification and control.

Process Identification (Non-Parametric methods): Transient response analysis - frequency response analysis - correlation analysis - State space modeling of systems - nonlinear state space model and linearization of nonlinear models ;modeling in state space - state space models – canonical state space forms-mechanical systems –electrical systems – liquid level systems- thermal systems. state estimation using kalman filter-extended kalman filter – unscented kalman filter-ensemble kalman filter for parameter identification.

Discrete Time System Models for Control: ARX models - bilinear parametric models – ARMAX,OE,BJ models - Hammerstein models – Wienner model – prediction error method and instrumental variable method .Selection of pseudo random binary sequence.

Recursive Plant Model Identification in Open-loop: Identification methods - least squares - recursive least squares - extended least squares – generalized least squares –weighted LSE-maximum likelihood method - model validation identified in open-loop – model order selection.

Recursive Plant Model Identification in Closed-loop: Identification methods - closed-loop output error algorithms - filtered closed-loop error algorithms - filtered open-loop identification algorithms - model validation identified in closed-loop - comparative evaluation of various algorithms. Subspace identification method: classical and innovation forms, free and structures parameterizations- relay feedback identification of stable processes and unstable processes.

Nonlinear System Identification: Modeling of non linear system using ANN-NARX, NNSS,NARMAX- generation of training data – training feed-forward and recurrent neural networks- tsk model- adaptive neuro-fuzzy inference system(ANFIS), Practical aspects of System identification and control: Selection of input signals - offline and online identification; notion for persistent excitation, - drifts and de-trending-outliers and missing data-pre-filtering-robustness – comparison of parameter estimation methods – model order testing and verification-case studies.

REFERENCES

1. Ioan D. Landau and GianlucaZito, Digital Control Systems, Design, Identification and Implementation, Springer-Verlag London Limited 2006.
2. Dan Simon, “Optimal State Estimation Kalman,H-infinity and Non-linear Approaches”, John Wiley and Sons, 2006.

3. Arun K. Tangirala, " Principles of System Identification: Theory and Practice", CRC Press. 2014.
4. F.Van der Heijden, R.P.W.DUIN, D.de Ridder and D.M.J. Tax, "Classification, Parameter Estimation and State Estimation , An Engineering Approach Using MATLAB, John Wiley & Sons Ltd. 2004.
5. Principles of System Identification: Theory and Practice, ArunK.Tangirala, CRC Press,Taylor and Francis group, 2015.
6. Karel J. Keesman , "System Identification: An Introduction",Springer publication,2011.

COURSE OUTCOMES

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

1. Identify a suitable continuous time domain identification method for the taken up process.
2. Select a particular state space model based on specific control engineering problem.
3. Understand and implement the various complexity estimation methods, offline and online, open and closed loop estimation methods for modelling and estimating a process.
4. Gain an idea for Robust parameter estimation.
5. Select a specific identification method with an approximately equal complexity for the case studies.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓		✓							
CO2	✓		✓					✓			
CO3		✓			✓						
CO4							✓				✓
CO5	✓			✓				✓			

EIPCCP26	**INDUSTRIAL AUTOMATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

COURSE OBJECTIVES

- To impart knowledge on various digital Controller design.
- To design and implement tuning techniques of PID controller and verify in MATLAB/Simulink environment.
- To design and implement closed loop control for processes like Air temperature, Air flow and Level using LABVIEW software.
- To familiarize students with fundamental programming concepts in PLC and implementation of ladder logic for an automation application.

- To study the applications of SCADA and DCS for a typical process control application.

LIST OF EXPERIMENTS

1. Design and Simulation of Dead-beat controller using TUTSIM
2. a. Design of Dead time compensator using smith predictor algorithm using MATLAB/SIMULINK
   b)Design and Simulation of Inverse response compensator using MATLAB/SIMULINK
3. a. Study of LABVIEW software
   bStudy of Programmable Logic Controller (Keyence PLC)
4. b)Direction Control of DC motor using PLC
5. Study of SCADA software (Intouchwonderware)
6. PC based control of a simulated process
7. Design of Fuzzy &Neurocontroller for a Pressure Process
8. Study of DCS (Centum CS 3000)

COURSE OUTCOMES

At the end of the practical course the students will be able to

1. Model and design digital controllers for different processes.
2. Apply artificial intelligence algorithm for process control.
3. Get hands on experience on PLC interfacing and troubleshooting
4. Demonstrate his/her ability to develop code in LabView and SCADA software for process control applications.
5. Understand the features of DCS with real-time interface.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓				✓				✓	
CO2	✓	✓			✓	✓	✓			✓	✓
CO3		✓	✓	✓	✓					✓	
CO4	✓	✓	✓	✓	✓	✓		✓			
CO5	✓	✓			✓						

EIPCTS27	**INTERNSHIP AND SEMINAR**	**L**	**T**	**P**	**C**
		0	**2**	**2**	**2**

COURSE OBJECTIVES

- To expose the students to occupational environment related to controls and instrumentation.
- To create opportunity for acquiring practical skills in carrying out preventive maintenance of various field instruments.

The students should undergo training program in reputed industries in the field of process control and instrumentation during the summer vacation (at the

end of second semester for full time) for a minimum stipulated period of four weeks. After completion of the training, the students have to submit a detailed report within ten days from the commencement of the third semester for full time on the training they had undertaken. The students will be evaluated bya team of staff members nominated by the head of the department through a viva voce examination.

COURSE OUTCOMES

At the end of the training the students will be able to

1. Face the challenges related to work environment
2. Manage the issues arising during the execution of projects related to process control and instrumentation.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO2	✓	✓	✓	✓	✓			✓			✓

EIPCPV33	**PROJECT WORK & VIVA-VOCE PHASE-I**	**L**	**Pr**	**S**	**C**
		0	**16**	**4**	**10**

COURSE OBJECTIVES

- To develop the ability to solve a scientific problem related to controls and instrumentation all the way from its identification, literature review till the successful solution of the same.
- To train the students in preparing project reports, face reviews and viva voce examination.

COURSE OUTCOMES

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

1. Take up any challenging practical problems and find solution
2. Learn to adapt systematic and step-by-step problem solving methodology.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓			✓	✓			✓		✓
CO2		✓		✓				✓			✓

EIPCPV41	**PROJECT WORK & VIVA-VOCE PHASE-II**	**L**	**Pr**	**S**	**C**
		0	**24**	**6**	**15**

COURSE OBJECTIVES

- To develop the ability to solve a scientific problem related to controls and instrumentation all the way from its identification, literature review till the successful solution of the same.
- To train the students in preparing project reports, face reviews and viva-voce examination.

COURSE OUTCOMES

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

1. Take up any challenging practical problems and find solution
2. Learn to adapt systematic and step-by-step problem solving methodology.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓			✓	✓			✓		✓
CO2		✓		✓				✓			✓

PE - PROGRAM ELECTIVES

EIPCPEXX	**INSTRUMENTATION SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To make students familiarize orifice design and control valve sizing procedure.
- To impart knowledge on the design of signal conditioning circuits for the measurement of level and temperature.
- To develop skills needed to design and test Analog/ Digital PID controller, data acquisition system and alarm annunciator.

Orifice meter - design of orifice for given flow condition - design of rotameter. Control valves - design of actuators and positioners - valve characteristics - sizing of control valves - liquid, gas and steam services.

Design of V-I, I-V ,P-I and I-P converters. Analog and Digital filter design and Adaptive filter design – Design of signal conditioning circuits for level measurement - Design of signal conditioning circuits for temperaturemeasurement-RTD,thermocouple and thermistor.

Design of cold junction compensation circuit for thermocouple using RTD. Transmitters - zero and span adjustment in D/P transmitters - temperature transmitters- design of RTD based temperature transmitter, thermocouple based temperature transmitter, capacitance based level transmitter and smart flow transmitters, design of flapper-nozzle and design of pneumatic amplifiers.

Design of ON / OFF Controller using Linear Integrated Circuits- Electronic P+I+D controllers - design - adjustment of set point, bias and controller settings- Design of microprocessor based P+I+D controller - Design of microprocessor based system for data acquisition.

Design of alarm and annunciation circuits using analog and digital circuits – Design of Programmable Logic Controller - Design of configurable sequential controller using PLDs.

REFERENCES

1. C.D. Johnson, Process Control Instrumentation Technology, Prentice Hall of India, 8th Edition, 2014.
2. J.P.Bentley, Principles of Measurement Systems, Pearson Education,4th edition, 2004
3. N.A.Anderson, Instrumentation for Process Measurement and Control, Chilton Company, 3rd Edition,2005.
4. D.M.Considine, Process Instruments and Controls Handbook, McGraw-Hill., Fourth Ediion, 1994.
5. Bella G Liptak, Instrument Engineers' Handbook, Elsevier, 3rd Edition, 2010
6. Michael D. Whitt, Successful Instrumentation and Control Systems Design,ISA, 2nd Edition, 2012

COURSE OUTCOMES

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

1. Carryout orifice and control valve sizing for liquid/steam services.
2. Design signal conditioning circuits for temperature sensors, V/I , I/V P/I and I/P converters.
3. Design transmitters.
4. Design, fabricate and test PID controllers and alarm circuits.
5. Design microprocessor based data acquisition system

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓										✓
CO2	✓	✓		✓							✓
CO3	✓	✓		✓							✓
CO4			✓	✓	✓						✓
CO5	✓	✓			✓						✓

EIPCPEXX	**ADVANCED INSTRUMENTATION SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To familiarize the students with concepts of fiber optic sensors, modulating techniques and measurement methods.
- To impart knowledge about laser instrumentation and its application in industry.

- To equip the students about the principle and application of ultrasonic instrumentation systems.
- To learn virtual instrumentation system and software.
- To understand about the smart instruments used in transmitters, communication and measurement systems.

Fiber Optic Instrumentation

Principle of light propagation through a fiber- different types of fiber and their properties-fiber optic sensors- fiber optic instrumentation systems- different types of modulators- optical detectors- measurement of length by interferometer method-moiré fringes- Measurement of pressure, temperature, current, voltage, liquid level and strain.

Laser Instrumentation

Fundamental characteristics of laser-three level and four level laser-laser modes- resonator configuration-q switching and mode locking-cavity dumping-types of laser- measurement of length, distance, velocity, acceleration, current, voltage and atmospheric effects using laser- material processing- laser heating, welding, melting and trimming of materials- removal and vaporization.

Ultrasonic Instrumentation

Principle and propagation of ultrasonic waves- characterization of ultrasonic transmission-reflection and transmission coefficients-generation of ultrasonic waves-magnetostrictive and piezoelectric effects- ultrasonic test methods-pulse echo, transit time, resonance, direct contact and immersion type-measurement of thickness, depth, flow using ultrasonic sensors.

Virtual Instrumentation

Block diagram and architecture of virtual instrumentation- VI's and sub VI's-loops and charts-arrays, clusters and graphs-case and sequence structures-formula nodes, local and global variables- string and file i/o- instrument drivers-publishing data in the web.-simulation of system using VI- development of virtual instrument using GUI.

Smart Measuring Instruments

Smart/Intelligent transducer- Comparison with conventional transducers- Self diagnosis and remote calibration features- Smart transmitter with HART communicator protocol -Measurement of temperature, pressure and Flow using HART transmitter.

REFERENCES

1. Govind P. Agrawal, Fiber-Optic Communication Systems, 4th Edition, Wiley publication, 2010.
2. S.Nagabhushana and N.Sathyanarayana, Lasers and Optical Instrumentation, I.K.International publishing, 2010.
3. Jovitha Jerome, Virtual Instrumentation using LabVIEW, , Eastern Economy edition, PHI learning private Ltd., 2010
4. Lisa .K, Wells and Jeffrey Travis, "LABVIEW for Everyone", Prentice Hall, 2009.
5. Paul. W.Chapman, "Smart sensors" ISA Publications, 1996.

6. J.B.Dixit, AmitYadav, “Intelligent Instrumentation for Engineers”, University Science Press 2012.

COURSE OUTCOMES

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

1. Select fiber optic sensors and Design a fiber optic based instrumentation system for the measurement of industrial process variables.
2. Apply the principle of Lasers and develop laser based measuring instrumentation system.
3. Develop ultrasonic instrumentation system for measurement and analysis.
4. Design systems applying virtual instrumentation principles.
5. Handle smart instruments and HART transmitters.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓								
CO2	✓		✓								
CO3			✓								
CO4	✓		✓	✓		✓		✓			
CO5			✓		✓						✓

EIPCPEXX	**INSTRUMENTATION IN PETROCHEMICAL INDUSTRY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

To enable students to acquire knowledge about

- The different methods of crude oil recovery, processing and refining
- Important Unit operations in petroleum refinery and petrochemical industry
- Production routes of important petrochemicals, and Control of selected petrochemicals roduction processes
- Hazards and therefore the necessary safety measure in planning and function of petrochemical Industry.

Oil Extraction and Processing

Techniques used for oil discovery:-seismic survey - methods of oil extraction - oil rig system – Primary, Secondary and Enhanced oil recovery - separation of gas and water from oil - control loops in oil gas separator - scrubber – coalescer.

Petroleum Refining

Petroleum refining process - unit operations in refinery :- thermal cracking - catalytic cracking - catalytic reforming - polymerization - isomerization - alkylation - Production of ethylene, acetylene and propylene from petroleum.

Chemicals from Petroleum

Chemicals from methane, acetylene, ethylene and propylene - production routes of important petrochemicals such as polyethylene, polypropylene, ethylene dioxide, methanol, xylene, benzene, toluene, styrene, VCM and PVC.

Control Loops in Petrochemical Industry

Control of binary and fractional distillation columns - Control of catalytic and thermal crackers - control of catalytic reformer - control of alkylation process - Control of polyethylene production – Control of VCM and PVC production.

Safety in Instrumentation System

Area and material classification as per National Electric Code (NEC) - Classification as per International Electro technical Commission (IEC) - Techniques used to reduce explosion hazards - Pressurization techniques - Type X, Type Y and Type Z - Intrinsic safety - Mechanical and Electrical isolation - Lower and Upper explosion limit.

REFERENCES

1. HavardDevold, “Oil and Gas Production Handbook-An Introduction to Oil and Gas Production” ABB ATPA Oil and Gas, 2006.
2. Bela G. Liptak, “Instrumentation in Process Industries”, Chilton Book Company, 2005.
3. Petroleum Refining: Technology and Economics, J.H. Gary and G.E.Handwerk, 4 th Edition, Marcel Dekkar, Inc., 2001.
4. Ram Prasad, Petroleum Refining Technology, Khanna Publishers, New Delhi, 2000.
5. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elesevier Science & Technology Books, 2007.
6. Petrochemical Process Technology, ID Mall, Macmillan India Ltd., 2007.

COURSE OUTCOMES

After completing this course the student will:

1. Gain basic knowledge about the methodologies applied for recovery and processing of petroleum.
2. Be familiar with different unit operations involved in Petroleum industry.
3. Have a general understanding of the production routes for important petrochemicals.
4. Be able to describe the control of Important processes like FCCU, Catalytic Reformerand Alkylation.
5. Be able to classify the hazardous zones and gain knowledge about the techniques used to reduce the explosion hazards.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓					✓			✓		✓
CO2		✓	✓				✓		✓		✓

CO3	✓	✓	✓	✓	✓			✓	✓		✓
CO4	✓		✓		✓				✓	✓	✓
CO5	✓		✓	✓	✓				✓		✓

EIPCPEXX	**THERMAL POWER PLANT INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

After completion of the course the students will acquire extensive knowledge about:

- Operation & importance of Instrumentation in Thermal power plant
- Development of Mathematical model of different systems in Thermal power plant
- Conventional and advanced control schemes applied to various processes in ThermalPower Plant
- Measurement of important parameters and control techniques applied to steam turbines
- Calculation and optimization of Boiler efficiency by including various losses in thermal power plant

Basics of Thermal Power Plant

Process of power generation in coal – fired and oil-fired thermal power plants- Types of Boilers Combustion process – Super heater – Turbine – Importance of Instrumentation in thermal power plants.

Boiler Modeling

Development of first principle and data driven models:- combustion chamber, boiler drum, superheater and attemperator

Boiler Control

Combustion control: Air-fuel ratio control-furnace draft control –Drum level control –Steam temperature Control– DCS in power plant – Interlocks in Boiler Operation- Model predictive control of super heater – control of drum level using AI techniques.

Turbine & Alternator - Monitoring and Control

Measurement of speed, vibration, shell temperature of steam turbine – Steam pressure Control – Speed control of turbine – Alternator- Monitoring voltage and frequency –Operation of several units in parallel- Synchronization.

Optimization Of Thermal Power Plant Operation

Determination of Boiler efficiency – Heat losses in Boiler – Effect of excess air – Optimizing total air supply- Combustible material in ash- Reduction of turbine losses-Choice of optimal plant parameters- Economics of operation.

REFERENCES

1. A.B.Gill, “Power Plant Performance”, Elsevier India, New Delhi , 2013.
2. S.M.Elonko and A.L.Kohal, “Standard Boiler Operations”, McGraw Hill, New Delhi, 1994.
3. Sam G. Duke Low, “The Control of Boiler”, ISA press, 1991 .
4. R.K.Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, New Delhi, 1995.
5. K. Krishnaswamy and M. PonniBala, “Power Plant Instrumentation”, PHI Learning Pvt. Ltd, Delhi, 2015.

COURSE OUTCOMES

1. The student will be equipped with the basic knowledge of function of different systems in Thermal power plant
2. The student knows the procedural steps to obtain the mathematical model of various units inThermal power plant
3. Will be able to explain conventional and advanced control concepts and implementation in various processes.
4. Will get idea on the parameters to be monitored, measured and controlled in steam turbines calculation and optimization of Boiler efficiency by including various losses in thermal power plant.
5. Understand important control circuits in boiler and interlock in boiler operations.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓									
CO2	✓	✓				✓		✓			✓
CO3	✓	✓	✓		✓						
CO4	✓	✓		✓		✓	✓		✓	✓	✓
CO5	✓		✓	✓	✓					✓	✓

EIPCPEXX	**VIRTUAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide the background for developing a VI
- To make the student become competent in using state-of-the-art VI tools.
- To enable the student to gain experience in data acquisition and instrument control

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.

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.

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 multi channel analog inputs. Concept of universal DAQ card - use of timers/counters

VI Toolsets

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Simulation of level, thermal, reactor processes. On-Off controller PID Controller.

Applications

Distributed I/O modules-Virtual Laboratory, Virtual Oscilloscope, Virtual function generator, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

REFERENCES

1. Robert H.Bishop, " LabVIEW 2009 Student Edition", Pearson College Division, 2009.
2. N.Mathivanan, "PC-based Instrumentation :Concepts and Practice", Eastern Economy Edition, PHI Learning private ltd ,2007.
3. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000.
4. Jovitha Jerome, "Virtual Instrumentation Using LabVIEW", Eastern Economy Edition, PHI Learning private ltd ,2010.
5. Franco Davoli, Norbert Meyer, Remote Instrumentation and Virtual Laboratories: Service Architecture and Networking , Kindle Edition, 2010.
6. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000.

COURSE OUTCOMES

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

1. Develop software program in VI
2. Experiment with plug-in DAQ interfaces for prototypemeasurement systems
3. Implement basis concepts incorporating various VI Toolsets based on the application in Virtual Instruments.
4. Get the knowledge of Smart Sensors.
5. Get knowledge about VI for real time systems, embedded controller, HMI/SCADA software and Active X programming.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓			✓		✓			✓
CO2	✓	✓	✓		✓						✓
CO3	✓	✓	✓	✓		✓					✓
CO4	✓	✓	✓	✓	✓				✓		
CO5	✓			✓	✓	✓	✓		✓		✓

EIPCPEXX	**AUTOMOTIVE INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To make the students to understand the role of electronics and software related to current trends in automobiles.
- To provide fundamental knowledge of sensors and other technologies used in modern automobiles.
- To provide a strong knowledge on control system to improve safety measures and also to increase comforts of users.
- To impart knowledge on Automotive standards and protocols.

Introduction of Automobile System

Current trends in automobiles with emphasis on increasing role of electronics and software, overview of generic automotive control ECU functioning, overview of typical automotive subsystems and components, AUTOSAR.

Engine Management Systems

Basic sensor arrangement, types of sensors such as oxygen sensors, crank angle position sensors, Fuel metering/ vehicle speed sensors, flow sensor, temperature, air mass flow sensors, throttle position sensor, solenoids etc., algorithms for engine control including open loop and closed loop control system, electronic ignition, EGR for exhaust emission control.

Vehicle Power Train and Motion Control

Electronic transmission control, adaptive power Steering, adaptive cruise control, safety and comfort systems, anti-lock braking, traction control and electronic stability, active suspension control.

Active and Passive Safety System

Body electronics including lighting control, remote keyless entry, immobilizers etc., electronic instrument clusters and dashboard electronics, aspects of hardware design for automotive including electro-magnetic interference suppression, electromagnetic compatibility etc., (ABS) antilock braking system, (ESP) electronic stability.

Automotive Standards, Protocolsand Energy Management

Automotive standards like CAN protocol, LIN protocol, flex ray, OBD-II, CAN FD, automotive Ethernet etc. Automotive standards like MISRA, functional safety standards (ISO 26262).

BMS (Battery Management System), FCM (Fuel Control Module),principles of system design, assembly process of automotives and instrumentation systems.

REFERENCES

1. Understanding Automotive Electronics, William B. Ribbens, Butterworth Heinemann Woburn, 6th ed., 2003.
2. Sensors Applications, Sensors for Automotive Technology by Jiri Marek, Hans Peter Trah, Wiley, 1st Edition, 2003.
3. U.Kiencke, and L. Nielson, *Automotive Control Systems*, Springer Verlag Berlin, 2000.
4. Automotive computers and control system by Tom Weather Jr. &Cland C. Hunter, Prentice Hall Inc., New Jersey, 1984.
5. Understanding Automotive Electronic by Bechhold, SAE, 1998.
6. Automotive Hand Book by Robert Boshe, Bentely Publishers, 5th ed. Germany, 2005.

COURSE OUTCOMES

After learning this course, the students should be able to:

1. Evaluate the sensor and measuring system of automobile.
2. Design the basic modeling and control scheme for automotive systems.
3. Acquire knowledge of various automotive standards and Protocols.
4. understand the current trend in the role of electronics and softwares in automobiles.
5. Apply electronics for body dashboard and Anti Lock Braking systems

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓		✓		✓	✓				✓	
CO2	✓			✓			✓	✓			✓
CO3			✓		✓		✓			✓	✓
CO4		✓		✓	✓						
CO5		✓	✓		✓			✓		✓	✓

EIPCPC22	**ADVANCED PROCESS CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To review the processes with special characteristics.
- To study the fundamental design and implementation of MPC.
- To study robust control system philosophy.

- To design and analyse optimal controllers.
- To understand and design controllers for MIMO process.

Introduction to Process Control: Review of first order and higher order systems, self and non-self regulatory processes, inverse response processes, non-minimum phase processes and open-loop unstable processes. Response to step, impulse and sinusoidal disturbances. Review of design and implementation of PID controller.

Model based Predictive Control: MPC strategy – MPC elements – prediction models – objective function – obtaining the control law – review of some MPC algorithms – Introduction to Non-linear predictive control.Implementation of Model Predictive Control for Heat exchanger and Distillation column.

Robust Control: 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 synthesis of robust controllers – small gain theorem – d-k – iteration- robust control of second-order plant- robust control of distillation column.

Optimal Controllers: H_2 and H-infinity control – loop shaping design - Formulation – characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – H-infinity estimation. LQG controller.

Design of Controllers for MIMO Processes: Introduction to Multivariable process control – selection of controlled outputs manipulation and measurements – RGA for square and non-square plants – control configuration elements – centralized and decentralized feedback control – Trade-offs in MIMO feedback design.

REFERENCES

1. Sigurdskogestad Ian postlethwaite, Multivariable Feedback Control, John wiley& sons, 2000.
2. E.F.Camacho and Bordom, Model Predictive Control, Second edition, Springer – Verlog London limited, 2000.
3. U. Mackenroth “Robust Control Systems: Theory and Case Studies”,Springer international Edition, 2010.
4. J. B. Burl, “Linear optimal control H2 and H-infinity methods”, Addison W Wesley, 2011.
5. 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, 2007.
6. I.R. Petersen, V.A. Ugrinovskii and A. V. Savkin, “Robust Control Design using H-infinity Methods”, Springer, 2000.

COURSE OUTCOMES

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

1. Able to analyse system behavior.

2. Able to understand and design MPC for a given process.
3. Ability to design robust control system.
4. Able to understand the concept of H2 and H∞ controller.
5. Able to understand and design a Multi-Input Multi-Output system.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1		✓									
CO2	✓	✓		✓					✓		
CO3		✓	✓		✓	✓					✓
CO4	✓	✓									
CO5				✓		✓			✓		

EIPCPEXX	**ADAPTIVE CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart knowledge on how to recursively estimate the parameters of discrete input – output models (ARX/ARMAX etc) using recursive parameter estimation methods.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To craft the student design simple adaptive controllers for linear systems using above methods.

Introduction

Introduction to System Identification: – Adaptive Control Vs Conventional feedback control - adaptive control schemes.

Gain schedulingand Model Reference Adaptive System

The principle - Design of gain scheduling controllers- Nonlinear transformations - application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback- Introduction to self oscillating adaptive system. Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory – Design of MRAS using Lyapunov theory – Bounded input bounded output stability – output feedback – Relations between MRAS and STR– Non-Linear systems.

Deterministic Self-tuning Regulators

Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics. Direct adaptive control: Introduction – Adaptive tracking and regulation with independent objectives – Basic design – Extensions of the design – Adaptive tracking and regulation with weighted input – Adaptive minimum variance tracking and regulation – The Basic Algorithms – Asymptotic convergence analysis – Martingale convergence analysis – Adaptive generalized minimum variance control.

Stochastic Self-tuning Regulators

Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators. Indirect adaptive control: Introduction – Adaptive

pole placement – The basic algorithm – Analysis of the indirect adaptive pole placement – The "Singularity" problem – Adding external excitation –Adaptive generalized predictive control – Adaptive linear quadratic control – Iterative identification in closed loop and controller redesign.

Robust Self-Tuning Regulators,PracticalAspectsandCase studies

Robust direct adaptive control – The problem – Direct adaptive control with bounded disturbances – Direct adaptive control with unmodeled dynamics – an example.Robust indirect adaptive control - Standard robust adaptive pole placement – Modified robust adaptive pole placement-Practical aspects of Adaptive Control system.

Temperature control in a distillation column, chemical reactor control, pulp dryer control & control of a rolling mill.

REFERENCES

1. I.D.Landau, R.Lozano and M.M'Saad, Adaptive Control, second Edition, Springer – Verlog London limited, 2011.
2. Karl J.Astron Bjorn Wittenmark, Adaptive Control, second edition, Dover Edition, 2008.
3. Shankar Sastry, " Adaptive Control: Stability, Convergence and Robustness, Dover Books on Electrical Engineering, 2011.
4. PetrosIoannou , Jing Sun , "Robust Adaptive Control , First Edition, Dover Publication, 2012.
5. Kumpati S. Narendra (Author), Anuradha M. Annaswam, Stable Adaptive Systems, Dover Books on Electrical Engineering, 2005.
6. Gang Tao, "Adaptive Control Design and Analysis" 1st Edition. Wiley Interscience, 2003.

COURSE OUTCOMES

At the end of the course the student will able to

1. Design gain scheduling and the model reference adaptive systems.
2. Design different types of deterministic self tuning regulator.
3. Design different types of stochastic self tuning regulator.
4. Design robust self tuning regulator.
5. Understand practical aspects of adaptive control schemes for industrial processes.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1		✓	✓		✓	✓	✓		✓	✓	✓
CO2			✓		✓	✓				✓	✓
CO3			✓		✓	✓				✓	✓
CO4	✓			✓		✓			✓	✓	✓
CO5	✓			✓	✓	✓		✓		✓	✓

EIPCPEXX	OPTIMAL CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To study the statement of optimal control problem, formulation of optimal control problem and selection of performance measure.
- To understand the fundamental concepts of calculus of variation and variational approach to optimal control problems.
- To derive the expression for continuous and discrete linear optimal regulator problem.
- To study the concepts of dynamic programming and its application.
- To understand the concept of numerical solution of two point boundary value problem.

Optimal Control Problems and Performance Measures

Statement of optimal control problem - problem formulation and forms of optimal control - selection of performance measures.

Calculus of Variation

Fundamental concepts – extremumfunctionals involving single and several independent functions - final time and final state are fixed - final time is fixed and final state is free - final time is free and final state is fixed - both final time and final state are free. Piecewise smooth extremals - constrained extrema.

Variational Approach to Optimal Problems

Necessary conditions for optimal control - Pontriyagin's minimum principle - state inequality constraints - minimum time problem - minimum control effort problems.

LQ Control Problem

Linear optimal regulator problem - Matrix Riccati equation and solution method - choice of weighting matrices - steady state properties of optimal regulators - linear tracking problem.

Dynamic Programming

Principle of optimality - recurrence relation of dynamic programming for optimal control problem - computational procedure for solving optimal control problems - dynamic programming application to discrete systems - Hamilton Jacobi Bellman equation. Numerical Techniques: Numerical solution of two-point boundary value problem - steepest decent and Fletcher Powell methods.

REFERENCES

1. D.E.Kirk, Optimal Control Theory-An Introduction, Dover Publications, New York, 2012.
2. M.Gopal, Modern Control Systems Theory, Third Edition, New Age International Publishers, 2015.
3. Katruhiko Ogata, Modern Control Engineering, Prentice Hall of India Ltd, Fifth Edition, 2010.

4. Michael Athans and Peter L. Falb, Optimal Control: An Introduction to the Theory and Its Applications, Dover Publications, New York, 2007.
5. D. Subaramnaidu, Optimal Control Systems, CRC Press, Newyork, 2003.
6. Frank L. Lewis, DragunaVrabie, Vassilis L. Symos, Optimal Control, 3rd Edition, Wiley Publication, 2012.

COURSE OUTCOMES

After completion of this paper the student will

1. Understand the optimal control problem formulation and its selection of performance measures.
2. Recognize and recall the fundamentals of calculus of variation.
3. Implement optimal control concept for minimum time and minimum control effort problems.
4. Apply Matrix Ricatti Equation for real world problem.
5. Understand the concepts of dynamic programming and to find numerical solution of two-point boundary value problem.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓			✓	✓		✓	✓	✓
CO2	✓		✓								
CO3			✓			✓		✓		✓	✓
CO4	✓		✓	✓			✓		✓		
CO5			✓		✓	✓	✓	✓			✓

EIPCPEXX	**ROBUST CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the need for robustness in process control
- To study the fundamentals required for robust control of a process
- To study the stability analysis of LTI system
- To design and analyse stabilizing controllers
- To study some of the methods robust optimal problems
- To give complete treatment of optimal and robust controller

Model Uncertainty and Robustness

Norms for signals and systems – I/P O/P relationship – Power analysis-model uncertainty – Small gain theorem - Robust stability – Stability under unstructured uncertainties – Robust performance – Deficiencies of classical control for MIMO systems.

Lyapunov Theory for LTI Systems

Descriptions of linear dynamical systems – Controllability and observability – Kalman canonical decomposition – pole placement and canonical forms – observers and observer based controllers – operations on systems – state space realization for transfer matrices – lyapunov equations – balanced realization – hidden models and pole-zero cancelation – multivariable system poles and zeros.

Stabilizing Controllers

Optimal robust stability – Conformal mapping – Gain margin optimization – Phase margin optimization – Robust performance more generally – Existence of stabilizing controllers- Duality and special problems – Parameterization of all stabilizing controllers – Structure of controller parameterization – Cart pendulum example for stabilizing controller.

LQR and LQG Problems

Algebraic Riccati equations– All solutions of a Riccati equations – Stabilizing solution and Riccati operator – Extreme solutios and matrix inequalities – Spectral factorization – Positive real functions – Inner outer factorization – Normalized co prime factorization - Standard LQR problem- Guaranteed stability margin of LQR – Solution through LMI

H-α Controland μ Synthesis

Problem formulation – Output feedback H-α control – General H-α solutions – Loop shifting – H_2 and H-α integral control – H-α filtering – LMI for robust control.

REFERENCES

1. L. Fortuna, M.Frasca(Eds) ,"Optimal and Robust Control",CRC press, 2012.
2. K.Zhou, J.C. Doyle and Glover, "Robust and Optimal control", Prentice Hall, 1996
3. J.C. Doyle, B.A. Francis and A.R. Tannenbaum, " Feedback Control Theory" Macmillan,1992.
4. U. Mackenroth "Robust Control Systems: Theory and Case Studies",Springer International edition, 2010.
5. J. B. Burl, " Linear optimal control H2 and H-infinity methods", Addison W Wesley, 1998.
6. 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 AppliedMathematics, 2007.

COURSE OUTCOMES

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

1. Understand the fundamentals of robustness.
2. Understand the application of robust control in MIMO system.
3. Analyze the stability of robust system.
4. Design and analyze robust control system.
5. Understand the concepts of H-α control and μ synthesis.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**

CO1	✓			✓	✓						
CO2	✓	✓		✓							
CO3	✓	✓	✓	✓							
CO4	✓	✓	✓	✓				✓			✓
CO5		✓	✓		✓						

EIPCPEXX	**NON LINEAR SYSTEM THEORY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

1. To introduce the nature of nonlinearities found in control systems both in the forward path and in the feedback path
2. To give exposure to analysis methods of nonlinear systems
3. To understand the describing function analysis.
4. To study about stability analysis.
5. To study about nonlinear control system design.

Non Linear Systems

Non-linear Systems - Behavior of non-linear systems, jump resonance, subharmonic oscillation - Nonlinearities in control system, Nonlinear models and nonlinear Phenomena-Examples, second order systems: qualitative behavior of linear systems, Multiple Equilibria, qualitative behavior near equilibrium points

Phase Plane Analysis

Concept of phase plane analysis, Singular points - construction of phase portraits using isoclines, delta method, Lienard's method and Pell's method - limit cycles-existence of limit cycles.

Describing Function Analysis

Describing Function Analysis: Describing Function Fundamentals-Applications of Describing Functions-Basic Assumptions and definitions-Describing Functions for common nonlinearities. Describing Function Analysis of Non-linear Systems.

Stability Analysis

Stability analysis: Stability in the sense of Lyapunov's - second method of Lyapunov's - Lyapunov's stability analysis of linear time invariant systems and nonlinear system- Krasovskii's theorem- variable gradient method of generating Lyapunov's functions.

Nonlinear Control System Design

Models for Nonlinear systems - Hammerstein and Wiener models - Input signal design for Identification –Real-time parameter estimation for nonlinear systems – Nonlinear PID controller - Gain scheduling control – case studies.

Feedback Linearization- feedback linearization and the canonical form, Input-state and Input-output linearization, Input-state linearization of SISO systems and Input-output linearization of SISO systems.

REFERENCES

1. Hassan K. Khalil, Nonlinear systems, third edition,Prentice Hall, 2002.
2. I.J. Nagarath and M.Gopal, Control Systems Engineering, Fourth Edition, New AgeInternational (P) Ltd., Publishers, 2005.
3. HenkNimeijer, Nonlinear Dynamical Control Systems, Springer Verlag,NewYork, 1990.
4. Alberto Isidori, Nonlinear Control Systems (3rd edition), Springer Verlag, 1995.
5. Jean-Jacques Slotine and Weiping Li, Applied Nonlinear Control, Prentice Hall, New jersey, 1991.
6. K.M.Hangos,J.Bokor and G.Szederkrnyi, Analysis and control of Nonlinear Process systems, Springer.

COURSE OUTCOMES

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

1. Understand the basics of nonlinear systems.
2. Construct the phase plane of systems
3. Derive the describing function.
4. Understand the stability analysis of nonlinear systems.
5. Implement modelling of nonlinear systems and feedback linearization design.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓				✓	✓			✓		✓
CO2	✓	✓					✓				
CO3			✓	✓		✓			✓		✓
CO4				✓	✓					✓	
CO5	✓		✓		✓			✓			✓

EIPCPEXX	**STATISTICAL PROCESS CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To make the students understand the purpose and uses of SPC.

- To use the most common types of control charts and carry out process capability studies.
- To import knowledge about various SPC tools, data collection and construct basic control charts.
- To make the students understand concept of control charts for variables and attributes and how to interpret control chart results.
- To impart knowledge of other statistical process monitoring and control techniques.

Quality Improvement in the Modern Business Environment

The meaning of quality and quality improvement, dimensions of quality, quality engineering terminology, a brief history of quality control and improvement, statistical methods for quality control and improvement, univariate process monitoring and control.

Methods and Philosophy of Statistical Process Control

Introduction, chance and assignable causes of quality variation, statistical basis of the control chart basic principles, choice of control limits, sample size and sampling frequency, rational subgroups analysis of patterns on control charts, discussion of sensitizing rules for control charts, control charts application, the rest of the magnificent seven, implementing spc in a quality improvement program, an application of spc, applications of statistical process control and quality improvement tools in transactional and service businesses.

Control Charts for Variables

Control charts for x and r, statistical basis of the charts, development and use of x and r charts, charts based on standard values, interpretation of x and r charts. the effect of non normality on x and r charts, the operating characteristic function, the average run length for the x chart, control charts for –x and s, construction and operation of x and s charts, the x and s control charts with variable sample size, summary of procedures for x and r, and s charts, applications of variables control charts.

Control Charts for Attributes

The control chart for fraction nonconforming, development and operation of the control chart variable sample size, applications in transactional and service business, the operating characteristic function and average run calculations, control charts for nonconformities (defects).

Other Statistical Process Monitoring and Control Technique

The cumulative sum control chart, basic principles: the cusum control chart for monitoring the process mean, the tabular or algorithmic cusum for monitoring the process mean, recommendations for cusum design, Exponential Weighted Moving Average [EWMA], EWMA for monitoring the process mean, design of EWMA, combining EPC(Engineering process control) and SPC, MINITAB software.

REFERENCES

1. Donald J. Wheeler, Understanding Variation: The Key to Managing Chaos 2, SPC Press, Revised Edition, 2000.

2. Paul Keller, Statistical Process Control Demystified, McGraw Hill Education, 1st Edition,2011.
3. Douglas Montgomery, Introduction to Statistical Process Control, Wiley publications, 7th Edition, 2013.
4. Eslie M. Licinski, Statistical process control , Artech House Publication,2000.
5. PeihuaQiu, Introduction to Statistical Process Control CRC Press, second Edition, 2013.
6. John S. Oakland, Statistical process control, Butterworth Heinmann, sixth edition, 2008.

COURSE OUTCOMES

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

1. Analyse quality control in industries.
2. Understand SPC and its design tools.
3. Construct control charts.
4. Understand the concept of variable and attribute charts.
5. Understand process monitoring and control techniques.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓				✓				
CO2	✓			✓							
CO3		✓									
CO4	✓										
CO5	✓		✓		✓			✓			

EIPCPEXX	**ADVANCED DIGITAL SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

- To review the mathematical basis of discrete time signal analysis.
- To discuss the estimation theory and predictors.
- To design and implement adaptive filters.
- To study the techniques of modern signal processing applications using multirate transforms.

Discrete Random Signal Processing: Discrete Random Processes, Expectations, variance, Co-variance, scalar product, energy of discrete signals- Parseval's theorem. Wiener Khintchine relation- power spectral density Periodogram sample autocorrelation-sum decomposition theorem, spectral factorization theorem- discrete random signal processing by linear systems- simulations of white noise-low pass filtering of white noise.

Spectrum Estimation: Non-parametric methods-correlation method- co-variance estimator - performance analysis of estimators-unbiased, consistent estimators Periodogram Estimator-Barlett spectrum estimation-Welch estimation Model based approach- ARMA and ARMA Signal Modeling -Parameter estimation using Yule - Walker method.

Linear Estimation and Prediction: Maximum likelihood criterion- efficiency of estimator - least mean square error criterion-Wiener filter discrete Wiener Hoff equations-Recursive estimators - Kalman filter- linear prediction, prediction error-whitening filter, inverse filter-Levin son recursion, Lattice recursion, Lattice realization.

Adaptive Filters: FIR adaptive filters - Newton's steepest decent method - adaptive filter based on steepest descent method Window-Hoff LMS adaptive algorithm - Adaptive channel equalization- Adaptive echo cancellor- adaptive noise cancellation- RLS adaptive filters-Exponentially weighted RLS- sliding window RLS-simplified IIR LMS adaptive filter.

Multirate and Wavelet Transform: Review of Decimation and Interpolation Process. Sub band filter theory – PR condition – Cosine modulated filters – Para-unitary filters. Application of wavelet transform with Sub band filter theory. Wavelet transform as a correlator. Multiresolution theory – Heisenberg uncertainty principle – Two dimensional wavelet transform.

REFERENCES

1. Manson H.Hayes, Statistical Digital Signal Processing and Modelling, John Wiley and sons, Inc., New York, 1996.
2. John G. Proakis, Dimitris G. Manolakis, Digital Signal processing, prentice Hall of India, 1995.
3. Sopocles J. Orfanidis, Optimum Signal Processing, McGraw Hill, 1990.
4. N. J Fliege ,Multirate Digital Signal Processing, John Wiley & Sons, 1999.
5. Soman K P, Ramachandran K I, Insight into Wavelets: From Theory To Practice, Prentice Hall of India, 2004.

Course OUtComes

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

1. Analysethe functions and characteristics of different op-amps.
2. Familiarize with various estimation techniques.
3. Able to realize systems using different realization algorithms.
4. Able to analyze and implement different types of adaptive filters.
5. Familiarize with multirate wavelet transform and its implementation.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓				✓			✓		✓
CO2	✓	✓					✓				

CO3	✓		✓			✓				✓	
CO4		✓		✓	✓		✓				✓
CO5			✓		✓					✓	✓

EIPCPEXX	**MACHINE LEARNING TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the machine learning theory.
- To train linear and non-linear learning models.
- To build tree and ensemble based models.
- To implement clustering & dimensionality reduction techniques.
- To apply reinforcement learning techniques.

Foundations of Learning

Components of learning – learning models – geometric models – probabilistic models – logicmodels – grouping and grading – learning versus design – types of learning – supervised –unsupervised – reinforcement – theory of learning – feasibility of learning – error and noise –training versus testing – theory of generalization – generalization bound – approximationgeneralizationtradeoff – bias and variance – learning curve - nearest neighbor models.

Linear Models

Univariate linear regression – multivariate linear regression – generalization and overfitting–validation–regularizedregression – going beyond linearity– locally weighted regression - logistic regression – perceptrons – multilayer neural networks – learning neuralnetworks structures – support vector machines – soft margin SVM.

Tree and Ensemble Models

Decision trees – learning decision trees – pruning – ranking and probability estimation trees–regressiontrees– k-d trees–ensemble learning– bagging and random forests – boosting – meta learning.

Unsupervised Learning

K-means – clustering around medoids – silhouttes – hierarchical -clustering– Mixture of Gaussians – EM algorithm - principal component analysis –locality sensitive hashing – partial least squares –chemometrics applications.

Reinforcement Learning

Passive reinforcement learning – direct utility estimation – adaptive dynamic programming –temporal-difference learning – active reinforcement learning – exploration – learning an actionutilityfunction – generalization in reinforcement learning – policy search – applications in gameplaying – applications in robot control.

REFERENCES

1. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
2. T. M. Mitchell, “Machine Learning”, McGraw Hill, 1997.

3. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, “Learning from Data”, AMLBook Publishers, 2012.
4. Stanfod CS229 Course: http://cs229.stanford.edu
5. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
6. K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.

COURSE OUTCOMES

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

1. Demonstrate the underpinning knowledge on machine learning.
2. Apply various linear models for different class of predictions.
3. Formulate machine learning problems using tree and ensemble models
4. Apply unsupervised learning algorithm for a typical problem
5. Develop reinforcement learning model for process control applications.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓			✓			✓	✓	✓
CO2	✓	✓	✓								✓
CO3			✓	✓	✓				✓		✓
CO4				✓	✓						
CO5	✓	✓	✓		✓		✓				✓

EIPCPEXX	**ROBOTICS AND AUTOMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To study the various parts of robots and fields of robotics
- To study the various kinematics and inverse kinematics of robots
- To study the trajectory planning for robot
- To study the control of robots for some specific applications

Basic Concepts and Power Sources and Sensors

Definition and origin of robotics, different types of robotics, Various generations of robots, degrees of freedom, Asimov’s laws of robotics, Static and dynamic performance, dynamic stabilization of robots.Hydraulic, pneumatic and electric drives. Determination of HP of motor and gearing: ratio, variable speed arrangements. Path determination, micro machines in robotics. Tactile, Proximity and Range Sensors, laser, acoustic, magnetic, fiber optic sensors and Machine vision system.

Manipulators, Actuators and Grippers

Construction of manipulators, manipulator dynamics and force control. Electronic and pneumatic manipulator control circuits .

End Effectors: Types-Mechanical grippers-Magnetic grippers, Vacuum cups, Adhesive gripper, Hooks and Scoops- Tools as end effectors - Robot/ End-effectors interface- Consideration in Gripper selection and Design.

Path Planning

Jacobian work envelop, hill climbing techniques. Methods of Programming: Leadthrough Methods, Capabilities and limitations of Leadthrough Methods, Robot program as a path in space- Motion interpolation, Robot Programming- structure, Motion, End effectors and Sensor commands, Program control communication, Monitor mode commands and Robot programming languages.

Application and Automation

Factory Automation: Fixed Automation, Flexible Automation and Programmable Automation. Intelligent Industrial Automation, Industrial Networking, Bus Standards. Automatic Feeders, Automatic Storage and Retrieval Systems (AS/RS), Transfer Lines, Automatic Inspection Systems

Applications of Robots

Manufacturing and non- manufacturing applications, robot cell design, selection of robot. Factors influencing the selection of Robots.Introduction to Mobile Robots, Legged Robots and Remote Controlled Robots, Automated Guided Robots, Micro Robots – Control and Safety Issues.

Robot Control: Linear methods, Non-linear methods- Control of Industrial Robots Using PLCs.

REFERENCES

1. Groover, M.P., Weiss, M., Nagel, R.N., Odrey, N.G., Industrial Robots: Technology, Programming and Applications, McGraw-Hill Book Company, 2012.
2. Mittal R K, Nagrath I J, “Robotics and control”, Tata McGraw Hill, 2010.
3. Groover, M.P., Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice-Hall of India Private Limited, New Delhi, 2007.
4. Saeed B. Niku, An Introduction to Robotics- Analysis, Systems, Applications, Second Edition, John Wiley & Sons Inc., 2010.
5. K. S. Fu , Ralph Gonzalez, C.S.G. Lee.” Robotics”, McGraw Hill, 2017.
6. MikellGroover, “Industrial Robotics - SIE: Technology - Programming and Applications”, Special Indian Edition, 2017.

COURSE OUTCOMES

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

1. Expertise in fundamentals, Classification and issues related to end effectors and sensors of Robotics
2. Program, Propose and synthesize control law for a given application
3. acquire knowledge about different types of automation
4. Have knowledge about different types of robots safety issues and their applications of robots.
5. Have knowledge about various control methods of robots.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓	✓			✓		✓		✓	
CO2	✓	✓	✓	✓		✓	✓		✓		✓
CO3	✓	✓	✓	✓	✓		✓				
CO4		✓	✓		✓			✓		✓	
CO5		✓	✓		✓				✓		✓

EIPCPEXX	**ARTIFICIAL INTELLIGENCE FOR PROCESS CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To expose the students to the concepts of neural networks, fuzzy logic, genetic algorithm and particle swam optimization.
- To provide adequate knowledge of applications of neurocontroller, fuzzy logic controller and hybrid controllers for real time applications.
- To expose the ideas of GA in optimization and control.

Artificial Neural Networks: Biological neural networks – Artificial neural networks – Activation functions – ANN architectures – Learning methods – Back propagation network – KohonenselfOrgansing Maps – Adaptive Resonance Theory.

Neural Networks for Control: Neurocontroller – Functional block diagram – Inverse dynamics – System identification. Case studies: Neurocontroller for temperature, flow and level processes.

Fuzzy Logic System: Introduction to fuzzy logic – Fuzzy sets and Fuzzy relations: operations and properties -Fuzzification – Types of membership functions – Fuzzy rule base – Canonical rule formation – Decomposition methods.

Fuzzy Logic for control:Design of fuzzy logic controller for temperature and level processes.

Genetic Algorithm:Evolutionary programs – Genetic algorithms: genetic programming and evolutionary programming – Genetic algorithm versus conventional optimization techniques – Genetic representations and selection mechanisms: Genetic operators – Different types of crossover and mutation operators – Optimization problems using GA – Discrete and continuous. Singleand multi Objective problems.

Hybrid Control Schemes: Fuzzification and rule base using ANN – Neurofuzzy--systems – Introduction to particle swarm optimization techniques – Optimization of membership function and rule base using Genetic algorithm and particle swarm optimization techniques - Hybrid control schemes for temperature and level control systems.

REFERENCES

1. LaureneFausett, Fundamentals of Neural Networks, Prentice- Hall, New Jersey, 3rd edition, 2008.
2. Timothy J. Ross, Fuzzy logic with Engineering applications, McGraw Hill, New York, 3rd edition, 2010.
3. Valluru.B.Rao, Hayagriva.Rao, Neural Networks & Fuzzy Logic, BPB Publications, New Delhi, 2003.
4. D.Driankov, H. Helleneloorn, M.Reinframe, An Introduction To Fuzzy Control, Narosa Publishing Co., New Delhi, 1996.
5. Jacek M. zurada, Introduction to Artificial Neural Systems,Jaico Publishing House, New Delhi, 1997.
6. Rajasekaran.S, VijayalakshmiPai.G.A, Neural Networks, Fuzzy logic and Genetic Algorithms, Prentice-Hall of India private limited, New Delhi,2003.

COURSE OUTCOMES

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

1. Understand the basics of ANN and derive different algorithms.
2. Understand the concept of neurocontroller and its application to process control.
3. Understand the concept of fuzzy logic control and its application to process control.
4. Understand the concept of GA to optimization problem.
5. Understand the concept of hybrid control schemes and its application to process control.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	✓	✓				✓		✓			✓
CO2	✓	✓	✓		✓					✓	✓
CO3	✓	✓	✓		✓						
CO4	✓	✓	✓		✓	✓			✓		
CO5	✓	✓	✓		✓	✓					✓

EIPCPEXX	**REAL TIME EMBEDDED SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the Building blocks of Real Time Embedded System
- To familiarize the embedded hardware components & its interface
- To impart knowledge on embedded software development process
- To make the students understand the Real Time Operating Systems
- To give exposure to the Case studies in various fields

Introduction to Real Time Systems

Fundamentals of systems and RTS - Definitions, classification, Characteristics-Basic model of Real Time Systems – Timing constraints – Safety and Reliability- Typical applications of RTS.

Embedded System Components and its Interface

Embedded system definition- architecture and standards with examples - Embedded hardwareprocessors-memory devices-Interface and Peripherals- ARM processor based embedded boards - Power and its Management.

Embedded System Software Development

Software embedded in a system – IDE , Assembler, Compiler ,linker, simulator,debugger,In - circuit Emulator(ICE), Target hardware debugging , Program modeling – Program models, Data flow model, State machine programming models, UML models - High level language descriptions in embedded system, Java based embedded system design.

RTOS based Embedded System Design

Introduction to basic concepts of RTOS –Task, Process and Threads, Interrupt routines in RTOS, Multiprocessing & Multitasking, Preemptive and non-Preemptive scheduling, Task communication – shared memory –Inter Process communication – synchronization between processes – semaphores, mail box, pipes, priority Inversion, priority Inheritance, comparison of Real time operating systems: Vxworks, μC/OS II.

CASE STUDIES

Case studies of Embedded System Design and Coding in application areas of digital consumer electronics ,automotives and networking/communication.

REFERENCES

1. T.Noergaard , “Embedded Systems Architecture : A Comprehensive Guide for Engineers and Programmers”, Elsevier Publications, 2012.
2. A.S.Berger, “Embedded System Design : An Introduction to Process, Tools and Techniques”, CMP Books, 2008.
3. D.D.Gajski, F.Vahid, S.Narayan, “Specification and Design of Embedded Systems”, PTR Prentice Hall, 2007.
4. D.E.Simon, “An Embedded Software Primer”, Addison Wesley, 2000.
5. Kai Qian, David Den haring, Li Cao, “Embedded Software Development with C”, Springer, 2009.

COURSE OUTCOMES

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

1. Understand the fundamental of RTS and its application areas.
2. Understand the embedded system concepts for RTS.
3. Understand the software development environment for specific application.
4. Design RTOS with embedded system.
5. Understand the concept behind the applications as case studies.

MAPPING OF COs WITH POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**

CO1	✓		✓				✓				✓
CO2											✓
CO3	✓	✓				✓					
CO4				✓				✓			✓
CO5											✓

OE - OPEN ELECTIVES

EIPCOEXX	INDUSTRIAL DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives

- To learn about electric drives & its types.
- To acquire knowledge about the circuit model of electric motors.
- To implement the power converters for the drives by efficient control algorithms.
- To understand the need for the digital controllers.
- To study about the generation of control pulses for power electronic converters and their applications.

Introduction to Electric Drives: Classification, characteristics and advantages of electric drives – Speed- torque characteristics of various types of loads and drive motors – Joint speed- torque characteristics - Selection of power rating for drive motor based on thermal limits – Overload capacity – Starting, braking and reversing methods for various types of motors.

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.

Control of DC Drives: Analysis of series and separately excited DC motor with single 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 and analysis of controllers for load changes.

Control of AC Drives: Induction motor drives – stator voltage control of induction motor – torque – slip characteristics – operation with different types of loads – operation with unbalanced source voltages and single phasing – analysis of induction motor fed from non – sinusoidal voltage supply – stator frequency control – variable frequency operation – V/F control, controlled current and controlled slip operation.Synchronous motor drives – Principles of Synchronous motor control – adjustable frequency operation of synchronous motors – voltage source inverter drive with open loop control static rotor resistance control and slip power recovery scheme.

Digital Techniques in Speed Control: Advantages and limitations – Microprocessor, microcontroller and PLC based control of drives – Selection of drives and Control schemes for paper mills, cement mills, sugar mills.

REFERENCES

1. VedamSubrahmaniam, Electric drives – Concepts and applications, Tata McGraw Hill Publishing House, Chennai, 1994.
2. G.K. Dubey, Fundamental of electrical drives, Narosa Publishing House, Chennai, 1995.
3. G.K.Dubey, "Power Semiconductor Controlled Drives," Prentice Hall International, New Jersey, 1989.
4. Paul .C.Krause, Oleg wasynczuk and Scott D.Sudhoff, "Analysis of Electric Machinery and Drive Systems", 2ndedition , Wiley-IEEE Press, 2013.
5. Bimal K Bose, "Modern Power electronics and AC Drives", Pearson education Asia, 2002.
6. R .Krishnan, "Electrical Motor Drives- Modeling, Analysis and Control", Prentice Hall of India Pvt Ltd., 2nd Edition, 2003.

COURSE OUTCOMES

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

1. Get a thorough understanding of motor-load system dynamics and stability, modern drive system objectives and fundamentals of DC and AC motors.
2. Model both DC and AC motors in various conventional methods.
3. Design and analyze both converter and chopper driven DC drives.
4. Understand conventional control techniques of AC drives and will have the ability to design and analyze such system.
5. Get a detailed knowledge on advanced high performance control strategies for AC drives and emerging technologies in electric drives.

EIPCPEXX	DIGITAL CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the components of digital control system
- To provide knowledge on pulse transfer functions and their analysis
- To Introduce Stability Concepts In Discrete Domain
- To Educate On Tuning Of PID Controllers In Discrete Domain
- To Introduce State Variable Analysis In Discrete Domain

Introduction

Advantages of Digital control systems - Practical aspects of the choice of sampling rate and multirate sampling - Basic discrete time signals - Quantization – Sampling theorem - Data conversion and Quantization - Sampling process - Mathematical modeling - Data reconstruction and filtering of sampled signals .

Z - Transform and Inverse ZTransform

Relationship between s - plane and z - plane - Difference equation - Solution by recursion and z - transform - pulse transfer functions of the zero - order hold and relationship between G(s) and G(z)– Bilinear transformation .

Digital Control Systems

Pulse transfer function - z transform analysis of open loop, closed loop systems - Modified z Transform . Root loci - Frequency domain analysis - Bode plots - Gain margin and phase margin - Design of Digital control systems based on Root Locus Technique. State equations of discrete data systems, solution of discrete state equations, State transition Matrix: z - transform method. Relation between state equations and transfer functions.

Controllability and Observability

Concepts on Controllability and Observability - Digital state observer: Design of the full order and reduced order state observer - Pole placement design by state feed back.

Stability Analysis

Stability analysis of linear digital control systems - Stability tests, Stability analysis of discrete time systems based on Lyapunov approach.

REFERENCES

1. M.Gopal, 'Digital Control And State Variable Methods', Tata McGraw Hill, 3rd Edition, 2009.
2. B.C.Kuo, Digital Control System, 2nd Edition, Oxford University Press, 2010.
3. V.I.GeorgeAndC.P.Kurien, Digital Control System, Cengage Learning, 2012.
4. M.SamiFadali, Antonio Visioli, Digital Control Engineering Analysis and Design, Academic Press, 2013.
5. C.M. Houpis, G.B.Lamount, ' Digital Control Systems- Theory, Hardware, Software', International Student Edition, McGraw Hill Book Co., 1985.
6. KannanM.Moddgalya, Digital Control, Wiley India, 2007.

COURSE OUTCOMES

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

1. Analyse digital systems in time domain
2. Analyse digital systems in frequency domain
3. Model and analyse digital systems in state space representation
4. Design controllers for digital systems in state space representation
5. Understand the concept of stability in discrete domain.

EIPCOEXX	WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the technologies and applications for the emerging domain of wirelesssensor networks.
- To impart knowledge on the design and development of the various layers in the WSN protocol stack.
- To elaborate the various issues related to WSN implementations.
- To familiarize the students with the hardware and software platforms used in the design of WSN.

Introduction: Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture – Hardware components, energy consumption of sensor nodes, Network architecture – Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, design principles, Development of wireless sensor networks.

Physical Layer: Wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication , packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, energy usage profile, choice of modulation, power management.

Data Link Layer: MAC protocols –fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols – fundamentals task and requirements ,error control ,framing, link management.

Network Layer: Gossiping and agent-based uni-cast forwarding , Energy-efficient unicast, Broadcast and multicast, geographic routing , mobile nodes, Data –centric and content-based networking – Data –centric routing, Data aggregation, Data-centric storage, Higher layer design issue.

Applications of WSN: WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - ZigBee - Target detection and tracking.

REFERENCES

1. Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks : An Information Processing Approach”, Elsevier, 2004.
2. Holger Karl and Andreas Willig, “Protocols And Architectures for Wireless Sensor Networks”, John Wiley, 2007.
3. Ivan Stojmenovic, “Handbook of Sensor Networks: Algorithms and Architectures”, Wiley,2005.
4. KazemSohraby, Daniel Minoli and TaiebZnati, “Wireless Sensor Networks: Technology, Protocols and Applications”, John Wiley, 2007.
5. BhaskarKrishnamachari, “Networking Wireless Sensors”, Cambridge University Press, 2011.

COURSE OUTCOMES

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

1. Understand the challenges in wireless sensor networks and various components involved in it.
2. Analyze WSN with respect to various performance parameters in the protocol stack.
3. Understand MAC algorithms and Network protocols used for specific WSN applications.

4. Understand the concept of network layer design issues related to higher layers
5. Design and develop a WSN for a gven application.

EIPCOEXX	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives

- To study the basics of image processing and its applications.
- To familiarize with image enhancement and image compression techniques.
- To learn about image restoration techniques and implementation of projection algorithms.

Digital Image Processing: Origin– components - examples of fields that use DIP.

Digital Image Fundamentals: Elements of visual perception, light and the EM spectrum, a simple image formation model, image sampling and quantization, some basic relationships between pixels. Image transforms - Two dimensional orthogonal and unitary transforms - properties of unitary transform.

Image Enhancement: Point operations - contrast stretching - clipping and thresholding - digital negative intensity level slicing - bit extraction. Histogram: modelling - eqalization - modification. Spatial operations: smoothing techniques - magnification and interpolation. Transform operations.

Image Compression and Segmentation: Compression models - elements of information theory - error free compression - run length coding - loss less and lossy predictive coding - image compression standards.Image Segmentation - Detection of discontinuities, point, line and edge detections, gradient operators, Laplacian, edge linking and boundary detection, thresholding, region based segmentation.

Image Filtering and Restoration: Inverse and weiner filters – filtering using image transforms. Splines and interpolation.Maximum entropy restoration.Bayesian methods. Image analysis- spatial feature extraction - transform features. Edge detection – boundary extraction, shape features image segmentation**.**

Image Reconstruction from Projections: Radon transform-inverse radon transform back projection operator-convolution back projection- parallel beam geometry-Fan beam geometry. MRI Fourier reconstruction.

REFERENCES

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, 2nd Edition, Pearson Education, 2003.
2. Jain Anil K., Fundamentals of Digital Image Processing, Prentice Hall of India, New Delhi, 1995.
3. RosenfieldAzriel and KakAvinash C, Digital Picture Processing, Academic PressInc., NY,1991.
4. Pratt William K, Digital Image Processing, John Wiley and Sons, 2001.

Course OUtComes

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

1. Analyzethe basics of image processing.
2. Familiarize with image enhancement techniques.
3. Compress an image using various compression techniques.
4. Restore an image from its degraded version.
5. Construct projections using transforms.

EIPCOEXX	MULTI SENSOR DATA FUSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To learn the concepts and techniques used in sensor data fusion.
- To understand the role of Mathematical tools used.
- To elaborate the concept of Kalman filter to data fusion problems.
- To impart knowledgeon advanced filtering techniques .

Multi Sensor Data Fusion: Introduction, sensors and sensor data, Limitations of single sensor, Use of multiple sensors, Fusion applications. The inference hierarchy: output data, Data fusion model, Architectural concepts and issues, Benefits of data fusion.

Mathematical Tools Used: Algorithms, Taxonomy of algorithms for multisensor data fusion co-ordinate transformations, rigid body motion, Dependability and Markov chains, Meta – heuristics, Data association, Identity declaration.

Estimation: Kalman filtering, practical aspects of Kalman filtering, Extended Kalman filters, Partical filter, Decision level identify fusion, Knowledge based approaches.

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

High Performance Data Structures: Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures.Designing optimal sensor systems with in dependability bounds.Implementing data fusion system.Application of multisensor data fusion for mobile robot mapping and Navigation.

REFERENCES

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 2004.
2. R.R. Brooks and S.S.Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998.
3. Mitchell.H.B, Multi-Sensor Data Fusion-An Introduction, Springer-Verlag, 2012.
4. Martin Liggins, II,JamesLlinas, David L.Hall, Handbook of Multisensor Data Fusion, CRC Press, 2008.
5. Arthur Gelb, Applied Optimal Estimation, M.I.T. Press, 1982.

COURSE OUTCOMES

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

1. Understand the importance of using data fusion in multi-sensor systems.
2. Understand simple approaches to data fusion for enhancing sensor reliability.
3. Derive and apply the kalman filter to data fusion problems.
4. Understand the importance of sensor management and data association.
5. Apply advanced filtering schemes for optimal sensor fusion

AUDIT COURSES

EIPCACXX	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission syllabus.

Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, Key skills are needed when writing an Abstract, Key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the conclusion.

Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Model Curriculum of Engineering & Technology PG Courses [Volume-I] [41]
3. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press 3.
4. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.Highman'sbook. Adrian Wallwork, English.

EIPCACXX	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

Students will be able to:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming.

Introduction Disaster Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Repercussions of Disasters and Hazards Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness and Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Disaster Mitigation Meaning Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company.
2. Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi. 3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep&Deep Publication Pvt. Ltd., New Delhi.

EIPCACXX	SANSKRIT FOR TECHNICALKNOWLEDGE	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects
- Enhancing the memory power
- The engineering Scholars equipped with the Sanskrit will be able to explode the huge knowledge from ancient literature.

Alphabets in Sanskrit, past/ present/ future tense, simple sentences.

Order, introduction of roots technical information about Sanskrit literature.

Technical concepts of Engineering – electrical, mechanical, architecture, mathematics

REFERENCES

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

COURSE OUTCOMES

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood.
3. Being a global language, will help to develop logic in students.

EIPCACXX	VALUE EDUCATION	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Values and self-development –Social values and individual attitude and work ethics, Indian vision of humanism.Moral and non- moral valuation.Standards and principles.Value judgements.

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance. Confidence, Concentration.Truthfulness, Cleanliness.

Honesty, Humanity.Power of faith, National Unity.Patriotism.Love for nature,Discipline.

Personality and Behavior Development - Soul and Scientific attitude.Positive Thinking.Integrity and discipline.Punctuality, Love and Kindness. Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, HappinessVs suffering, love for truth. Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature.

Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence,Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively

REFERENCE

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

COURSE OUTCOMES

Students will be able to

1. Get the knowledge of self-development.
2. Learn the importance of Human values
3. Develop the overall personality

EIPCACXX	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik
- Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

History of Making of the Indian Constitution:

History, Drafting Committee, (Composition& Working)

Philosophy of the Indian Constitution:

Preamble, Salient Features

Contours of Constitutional Rights & Duties:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Organs of Governance:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

Local Administration:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative,CEO of Municipal Corporation.

Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments),

Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Election Commission:

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

REFERENCES

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

COURSE OUTCOMES

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before thearrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party
4. [CSP]under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct.
5. Elections through adult suffrage in the Indian Constitution.
6. Discuss the passage of the Hindu Code Bill of 1956.

EIPCACXX	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Introduction and Methodology

Aims and rationale, Policy background, Conceptual framework andterminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions.Overview of methodology and Searching.

Thematic Overview

Pedagogical practices are being used by teachers, in formal and informal classrooms in developing countries.Curriculum, Teacher education.

Evidence on the Effectiveness of Pedagogical Practices

Methodology for the in depth stage: quality assessment of includedstudies. How can teacher education (curriculum and practicum) and the schoolcurriculum and guidance materials best support effective pedagogy? Theory of change.Strength and nature of the body of evidence for effective pedagogicalpractices.Pedagogic theory and pedagogical approaches.eachers' attitudes and beliefs and Pedagogic strategies.

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Research gaps and future directions

Research design, Contexts, Pedagogy Teacher education, Curriculum and assessment, Dissemination and research impact.

REFERENCES

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher Educationresearch project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basicmaths and reading in Africa: Does teacher preparation count? International Journal EducationalDevelopment, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary Education Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE OUTCOMES

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms indeveloping countries.
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners.
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.

EIPCACXX	STRESS MANAGEMENT BY YOGA	L	T	P	C

		2	**0**	**0**	**0**

COURSE OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

Definitions of Eight parts of yog.(Ashtanga)

Yam and Niyam

Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Asan and Pranayam

i) Various yog poses and their benefits for mind & body

ii)Regularization of breathing techniques and its effects-Types of pranayam

REFERENCES

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami YogabhyasiMandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

COURSE OUTCOMES

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also Improve efficiency

EIPCACXX	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSE OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

Approach to day to day work and duties

ShrimadBhagwadGeeta :

- Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35,
- Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge.

ShrimadBhagwadGeeta:

- Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model.ShrimadBhagwadGeeta:

- Chapter2-Verses 17, Chapter 3-Verses 36,37,42
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

REFERENCES

3. 1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication 2. Department), Kolkata
4. 3. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
5. 4. Rashtriya Sanskrit Sansthanam, New Delhi.

COURSE OUTCOMES

Students will be able to:

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.