SRM VALLIAMMAIENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION)

SRM Nagar, Kattankulathur, Chengalpattu Dt- 603 203, Tamil Nadu, India

(Approved by AICTE, Affiliated to Anna University, 'A' Grade Accredited by NAAC, NBA Accredited, ISO 9001: 2015 Certified)

DEPARTMENT OF
ELECTRONICS AND INSTRUMENTATION ENGINEERING

M.E – CONTROL AND INSTRUMENTATION ENGINEERING

POST GRADUATE

CURRICULA AND SYLLABI

(REGULATIONS 2023)

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University, Chennai,
'A' grade accredited by NAAC, NBA accredited ISO 9001:2015 certified)

M.E. CONTROL AND INSTRUMENTATION ENGINEERING
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULA & SYLLABI (I - IV SEMESTER)

1. PROGRAMME EDUCATIONAL OBJECTIVE (PEOs)

1. Graduates of this program will excel through the core competency skills inculcated with a strong foundation in Instrumentation and Process Control.
2. Graduates of this program will have the capability to be successful in the chosen profession through commitment, effective communication, ethics and team work.
3. Graduates of this program will exhibit self-learning capability and demonstrate a pursuit in lifelong learning through higher studies and research.
4. Graduates of this program will show involvement and willingness in assuming responsibility in societal and environmental causes.

2. PROGRAMME OUTCOMES (PO's)

1. Acquire state of art knowledge in instrumentation, control and automation, with an ability to discriminate, evaluate, analyze and synthesize the already existing knowledge and integrate the contemporary knowledge to enhance cognizance.
2. Ability to carry out a detailed analysis of various engineering problems in the field of Instrumentation and Control Systems leading to suitable solutions for the same or elevate the prosecution of research in a wider prospective.
3. Evaluate a wide range of potential solutions for instrumentation, control and automation problems and consider public health and safety, cultural, societal and environmental factors to arrive at feasible and superlative solutions.
4. Ability to design, develop and propose theoretical and practical methodologies for carrying out detailed investigation to complex engineering problems in the field of Instrumentation and Control Systems.
5. Ability to develop and utilize modern IT tools for modelling, analyzing and solving various engineering problems in this field.
6. Willingness and ability to get involved in a team of engineers/researchers to take up sophisticated multidisciplinary challenges in the field of Instrumentation and Control Systems by sharing the comprehension and collaboration.
7. Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team by managing projects efficiently in respective discipline and multidisciplinary environments after consideration of economical and financial factors.

8. Ability to express ideas clearly and communicate orally as well as in writing with others in an effective manner, adhering to various national and international standards and practices for the documentation and presentation of the content.

9. Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

10. Acquire professional and intellectual integrity, 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.

11. Ability to have ownership of self-actions and develop self-evaluation techniques.

12. Apply ethical principles and commit to professional ethics and responsibilities and name of the engineering practices.

3. PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Imparting practical knowledge in process control, design of instrumentation systems and contribute to technological development and Exhibiting their potential in project management, collaborative and multidisciplinary task in their profession.
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 and Showing the society for life-long self- governing and thoughtful learning skills in their career.

PEO / PO Mapping:

ROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I	2	3	2		2				3	1			1	2	
II	1		1	2	2	2	2	2		2		3		3	2
III	2		2		2				2	2	2	2	1		2
IV	2	2	3	2	3	3		1			2	2	1	2	

Contributions: 1. Reasonable 2.Significant 3.Strong

SEMESTER	NAME OF THE SUBJECT	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
SEM-I	**THEORY**															
	Advanced Mathematics for Electrical and Instrumentation Engineering	1	1	1	2	-	-	-	-	-	-	-	1	2	1	-
	Transducers and Smart Instruments	1	1	1	2	2	-	-	1	1	-	1	2	2	1	1
	System Theory	1	2	2	2	1	-	1	1	1	1	1	2	1	2	2
	Control System Design	1	2	2	2	2	-	-	1	1	-	3	1	1	1	3
	Industrial Automation	1	2	2	2	2	-	-	1	1	1	3	1	1	1	3
	Design of Embedded Systems	1	-	1	2	2	1	1	-	1	-	3	2	1	2	3
	PRACTICALS															
	Modeling and Simulation Laboratory	1	2	2	2	3	-	3	-	3	-	3	3	1	2	1
	Automation Laboratory	1	2	2	2	3	-	3	-	3	-	3	3	1	2	1
SEM-II	**THEORY**															
	Advanced Process Control	1	2	2	3	2	-	-	-	1	-	1	2	1	2	3
	Advanced Control Systems	1	2	2	2	2	-	1		1	-	1	1	1	2	3
	Professional Elective - I															
	Professional Elective - II															
	Professional Elective - III															
	Professional Elective - IV															
	PRACTICALS															
	Digital Control and Instrumentation Laboratory	1	2	2	2	3	2	3	2	3	2	3	3	1	2	2
	Mini Project	1	2	2	2	3	2	3	2	3	2	3	3	1	2	2
SEM-III	Research Methodology and IPR	-	-	-	-	-	-	3	2	3	2	3	3	1	2	2
	Professional Elective - V															
	Professional Elective - VI															
	Project Work Phase - I	1	2	2	2	3	2	3	2	3	2	3	3	1	2	2
SEM-IV	Project Work Phase - II	1	2	2	2	3	2	3	2	3	2	3	3	1	2	2

PROFESSIONAL ELECTIVES

SEMESTER - II

S. No	NAME OF THE SUBJECT	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ELECTIVE - I	Control System Design for Power Electronics	1	2	2	1	1	-	1	1	1	-	1	1	1	2	1
	Soft Computing Techniques	1	2	3	3	2	-	1	1	2	-	1	2	1	2	2
	Control of Electric Drives	1	2	2	2	2	-	1	-	2	1	1	1	1	2	2
	Multi Sensor Data Fusion	1	2	2	2	2	1	1	1	-	-	-	1	-	2	3
ELECTIVE - II	Advanced Digital Signal Processing	1	1	2	2	-	-	1	-	-	-	-	1	1	2	1
	Applied Industrial Instrumentation	1	-	3	3	-	1	1	2	2	1	1	1	1	2	3
	Digital Image Processing	1	1	2	2	2	1	1	-	1	1	-	1	1	2	1
	Nano Electronics	1	2	2	2	2	1	1	1	-	-	-	1	-	2	3
ELECTIVE - III	Modeling and Simulation	1	1	3	3	2	1	1	1	1	2	-	1	1	2	1
	Bio Medical Signal Processing	1	2	-	2	2	1	-	1	1	-	-	1	1	2	3
	Industrial Data Networks	1	2	3	2	2	1	1	-	2	2	2	2	1	2	3
	Advanced Machine Learning Techniques	1	2	2	2	2	1	1	1	-	-	-	1	-	2	3

SEMESTER – III

SI. No	NAME OF THE SUBJECT	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
ELECTIVE - IV	Robust Control	1	2	3	2	2	-	1	1	1	-	1	1	1	2	2
	Optimal Control	1	2	3	2	2	-	1	1	1	-	1	1	1	2	2
	System Identification and Adaptive Control	1	2	3	2	2	-	1	1	1	1	1	1	-	2	2
	Fault Tolerant Control	1	2	3	2	2	1	1	-	1	1	-	2	-	2	2
ELECTIVE - V	Smart Grid	1	2	2	3	-	-	2	-	-	-	-	2	-	2	3
	Renewable Energy Systems	1	-	2	2	-	2	2	2	2	2	2	2	-	2	3
	Robotics and Automation	1	2	3	2	2	2	2	-	2	2	-	2	1	2	2
	Robotics and Control	1	2	3	2	2	2	2	2	2	-	-	2	1	2	2
	Digital Instrumentation	1	2	3	2	2	2	2	2	2	2	2	1	1	2	2
ELECTIVE - VI	Internet of Things and Applications	1	2	2	2	2	2	2	2	2	2	-	1	1	2	1
	Wireless Sensor Networks	1	2	-	2	2	2	-	2	2	-	-	1	1	2	1
	MEMS Technology	1	3	2	2	2	2	2	-	2	2	2	1	1	2	2
	Advanced Artificial Intelligence	1	2	2	2		2	2	2	2	2	-	1	1	2	1
	Waste Management and Energy Recovery Techniques	1	2	2	2	2	2	2	2	2	2	-	1	1	2	1

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M.E. CONTROL AND INSTRUMENTATION ENGINEERING

REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABUS

SEMESTER I

S.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	MA3123	Advanced Mathematics for Electrical and Instrumentation Engineering	BSC	4	4	0	0	4
2.	CI3162	Transducers and Smart Instruments	PCC	3	3	0	0	3
3.	PP3164	System Theory	PCC	3	3	0	0	3
4.	CI3164	Control System Design	PCC	3	3	0	0	3
5.	CI3165	Industrial Automation	PCC	3	3	0	0	3
6.	CI3166	Design of Embedded Systems	PCC	3	3	0	0	3
PRACTICALS								
7.	CI3167	Modeling and Simulation Laboratory	PCC	3	0	0	3	1.5
8.	CI3168	Automation Laboratory	PCC	3	0	0	3	1.5
			TOTAL	**25**	**19**	**1**	**6**	**22**

SEMESTER II

S.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	CI3261	Advanced Process Control	PCC	3	3	0	0	3
2.	CI3262	Advanced Control Systems	PCC	3	3	0	0	3
3.	PCI31X	Professional Elective - I	PEC	3	3	0	0	3
4.	PCI32X	Professional Elective - II	PEC	3	3	0	0	3
5.	PCI33X	Professional Elective - III	PEC	3	3	0	0	3
6.	PCI34X	Professional Elective- IV	PEC	3	3	0	0	3
PRACTICALS								
7.	CI3267	Digital Control and Instrumentation Laboratory	PCC	4	0	0	4	2
8.	CI3248	Mini Project	EEC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER III

S.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	BA3371	Research Methodology and IPR	RMC	3	3	0	0	3
2.	PCI35X	Professional Elective- V	PEC	3	3	0	0	3
3.	PCI36X	Professional Elective- VI	PEC	3	3	0	0	3
PRACTICALS								
5.	CI3345	Project Work Phase - I	EEC	12	0	0	12	6
6.	CI3346	Technical Seminar	EEC	2	0	0	2	1
7.	CI3347	Internship (4 Weeks)	EEC	0	0	0	0	2
			TOTAL	**23**	**9**	**0**	**14**	**18**

SEMESTER IV

S.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
PRACTICALS								
1.	CI3441	Project Work Phase - II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 74

BASIC SCIENCE COURSES (BSC)

S.No	Course Code	Course Title	Contact Periods	L	T	P	C	Semester
1.	MA3163	Advanced Mathematics for Electrical and Instrumentation Engineering	4	4	0	0	4	I
TOTAL CREDITS							4	

PROFESSIONAL CORE COURSES (PCC)

S.No	Course Code	Course Title	Contact Periods	L	T	P	C	Semester
1.	CI3162	Transducers and Smart Instruments	3	3	0	0	3	I
2.	PP3164	System Theory	3	3	0	0	3	I
3.	CI3164	Control System Design	3	3	0	0	3	I
4.	CI3165	Industrial Automation	3	3	0	0	3	I
5.	CI3166	Design of Embedded Systems	3	3	0	0	3	I
6.	CI3167	Modeling and Simulation Laboratory	3	0	0	3	1.5	I
7.	CI3168	Automation Laboratory	3	0	0	3	1.5	I
8.	CI3261	Advanced Process Control	3	3	0	0	3	II
9.	CI3262	Advanced Control Systems	3	3	0	0	3	II
10.	CI3267	Digital Control and Instrumentation Laboratory	3	0	0	3	2	II
TOTAL CREDITS							26	

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S.No	Course Code	Course Title	Contact Periods	L	T	P	C	Semester
1.	BA3371	Research Methodology and IPR	3	3	0	0	3	III
TOTAL CREDITS							3	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	Course Code	Course Title	Contact Periods	L	T	P	C	Semester
1.	CI3248	Mini Project	4	0	0	4	2	II
2.	CI3345	Project Work Phase - I	12	0	0	12	6	III
3.	CI3346	Technical Seminar	2	0	0	2	1	III
4.	CI3347	Internship (4 Weeks)	0	0	0	0	2	III
5.	CI3441	Project Work Phase - II	24	0	0	24	12	IV
TOTAL CREDITS							23	

PROFESSIONAL ELECTIVES

SEMESTER II
ELECTIVE – I

S.No	Course Code	Course Title	Contact Periods	L	T	P	C
1.	PCI311	Control System Design for Power Electronics	3	3	0	0	3
2.	PCI312	Soft Computing Techniques	3	3	0	0	3
3.	PCI313	Control of Electric Drives	3	3	0	0	3
4.	PCI314	Multi Sensor Data Fusion	3	3	0	0	3

SEMESTER II
ELECTIVE – II

S.No	Course Code	Course Title	Contact Periods	L	T	P	C
1.	PCI321	Advanced Digital Signal Processing	3	3	0	0	3
2.	PCI322	Applied Industrial Instrumentation	3	3	0	0	3
3.	PCI323	Digital Image Processing	3	3	0	0	3
4.	PCI324	Nano Electronics	3	3	0	0	3

SEMESTER II
ELECTIVE – III

S.No	Course Code	Course Title	Contact Periods	L	T	P	C
1.	PCI331	Modeling and Simulation	3	3	0	0	3
2.	PCI332	Bio Medical Signal Processing	3	3	0	0	3
3.	PCI333	Industrial Data Networks	3	3	0	0	3
4.	PCP3201	Advanced Machine Learning	3	3	0	0	3

SEMESTER II
ELECTIVE – IV

S.No	Course Code	Course Title	Contact Periods	L	T	P	C
1.	PCI341	Robust Control	3	3	0	0	3
2.	PCI342	Optimal Control	3	3	0	0	3
3.	PCI343	System Identification and Adaptive Control	3	3	0	0	3
4.	PCI344	Fault Tolerant Control	3	3	0	0	3

SEMESTER III

ELECTIVE – V

S.No	Course Code	Course Title	Contact Periods	L	T	P	C
1.	PPS504	Smart Grid	3	3	0	0	3
2.	PPS505	Renewable Energy Systems	3	3	0	0	3
3.	PCI351	Robotics and Automation	3	3	0	0	3
4.	PCI352	Robotics and Control	3	3	0	0	3
5.	PCI353	Digital Instrumentation	3	3	0	0	3

SEMESTER III

ELECTIVE – VI

S.No	Course Code	Course Title	Contact Periods	L	T	P	C
1.	PCI361	Internet of Things and Applications	3	3	0	0	3
2.	PCI362	Wireless Sensor Networks	3	3	0	0	3
3.	PCI363	MEMS Technology	3	3	0	0	3
4.	CP3166	Artificial Intelligence	3	3	0	0	3
5.	PCI364	Waste Management and Energy Recovery Techniques	3	3	0	0	3

SUMMARY

	Name of the Programme: M.E. CONTROL AND INSTRUMENTATION ENGINEERING						
S.NO	SUBJECT AREA	CREDIT PER SEMESTER				CREDITS TOTAL	%
		I	II	III	IV		
1.	**FC**	4	-	-		**4**	5.40
2.	**PCC**	18	8	-		**26**	35.13
3.	**PEC**	-	12	6	-	**18**	24.32
4.	**EEC**	-	2	9	12	**23**	31.08
5.	**RMC**	-	-	3	-	3	4.05
	TOTAL	22	22	17	12	**74**	**100**

TOTAL NO. OF CREDITS: 74

MA3163 **ADVANCED MATHEMATICS FOR ELECTRICAL AND INSTRUMENTATION ENGINEERING**

L	T	P	C
4	0	0	4

OBJECTIVES:

- This course also will help study the decomposition of matrices and Matrix Theory.
- The students to identify, formulate, abstract, and solve problems in Calculus of Variations
- This course covers Laplace Transform Techniques for Partial Differential Equations
- The extensive experience with the tactics of linear programming problem solving and logical thinking applicable in Electrical engineering.
- The primary objective of this course is to demonstrate various analytical skills in applied mathematics

UNIT-I: MATRIX THEORY **12**

Cholesky decomposition Generalized Eigenvectors - QR Factorization-Least squares method-Singular value decomposition.

UNIT-II: CALCULUS OF VARIATIONS **12**

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

UNIT-III: LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS **12**

Laplace transform: Definitions – Properties – Transform error function – Bessel's function – Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace Transform: – Solutions to partial differential equations: Heat equation – Wave equation.

UNIT-IV: LINEAR PROGRAMMING **12**

Formulation–Graphical solution–Simplex method -Transportation and Assignment models.

UNIT-V: FOURIER SERIES **12**

Fourier trigonometric series: Periodic function as power signals–Convergence of series–Even and odd function: Cosine and sine series– Non periodic function: Extension to other intervals-Power signals : Exponential Fourier series–Parseval's theorem and power spectrum–Eigenvalue problems and orthogonal functions– Generalized Fourier series.

TOTAL: 60 PERIODS

OUTCOMES :

- Apply various methods in matrix theory to solve system of linear equations.
- Maximizing and minimizing the functional that occur in electrical engineering discipline.
- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

- Could develop a fundamental understanding of linear programming models, able to apply the Simplex method for solving linear programming problems.
- Solving Fourier series analysis both periodic and Non Periodic functions and its uses in representing the power signal.

REFERENCE BOOKS:

1.Andrews L.C. and Phillips R.L., "Mathematical Techniques for Engineers and Scientists",Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

2.Bronson, R. “Matrix Operation”, Schaum’s outline series,2nd Edition, McGraw Hill, 2011.

3.Elsgolc, L. D. "Calculus of Variations", Dover Publications, New York, 2007.

4.Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

5.O'Neil, P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.

6.Taha, H.A., “Operations Research, An Introduction”,9th Edition,Pearson education, New Delhi, 2016

Course Outcomes	PROGRAM OUTCOMES											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	2	1	-	-	-	-	-	-	-	1
CO2	3	2	2	1	-	-	-		-	-	-	1
CO3	3	2	2	1	-	-	-		-	-	-	1
CO4	3	2	2	1	-	-	-		-	-	-	1
CO5	3	2	2	1	-	-	-		-	-	-	1
Average	3	2	2	1								1

CI3162 TRANSDUCERS AND SMART INSTRUMENTS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give an overview of the working and characteristics of conventional transducers
- To provide a detailed knowledge on error and determination of uncertainties in measurement.
- To give a comprehensive knowledge on smart sensor design, development and interface details.
- To give exposure to manufacturing techniques and different types of Micro sensors and actuators
- To give an exposure of latest trends in sensor technologies including multisensory data fusion.

UNITI OVERVIEW OF CONVENTIONAL TRANSDUCERSANDTHEIR CHARACTERISTICS 9

Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric, Magnetostrictive and Hall effect sensors - Static and Dynamic Characteristics and specifications.

UNITII MEASUREMENT ERROR AND UNCERTAINTY ANALYSIS 9

Importance of error analysis - Uncertainties, precision and accuracy in measurement – limiting error and probable error - Random errors - Distributions, mean, width and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem - Error propagation - single and multi- variable functions, propagating error in functions

UNITIII SMART SENSORS 9

Definition – Integrated smart sensors –sensing elements –design of Interface electronics - parasitic effects – sensor linearization - Dynamic range - Universal Sensor Interface - front end circuits - DAQ– Design – Digital conversion - Microcontrollers and digital signal processors for smart sensors – selection criteria - Timer, Analog comparator, ADC and DAC modules - Standards for smart sensor interface.

UNITIV MICRO SENSORS AND ACTUATORS 9

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

UNITV RECENT TRENDS IN SENSOR TECHNOLOGIES 9

Thick film and thin film sensors- Electro chemical sensors – RFIDs - Sensor arrays - Sensor network- Multisensor data fusion - Soft sensor, Micro Actuators and Microstructures.

TOTAL:45 PERIODS

OUTCOMES:

- Compare conventional transducers and select the suitable one for the given application
- Analyze and quantify the uncertainties in measuremen tdata.
- Design and develop customized smart sensors for different applications
- Acquire a comprehensive knowledge of manufacturing techniques and design aspects of micro sensors and actuators
- Get exposure to latest sensor technology and advanced measurement methodologies.

REFERENCES

1. Ernest O Doebelin and Dhanesh N Manik, “Measurement Systems Application and Design”, 5th Edition, Tata Mc-GrawHill,2011.
2. Ifan G. Hughes and Thomas P.A. Hase, “Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis”, Oxford UniversityPress,2010.
3. Gerord C.M. Meijer, “Smart Sensor Systems, John Wiley andSons,2008.
4. Tai-Ran Hsu, “Mems and Micro Systems: Design and Manufacture, Tata McGrawHill, 2002.
5. D. Patranabis, “Sensors and Transducers”, Second Edition,PHI,2004.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	1	-	1	-	-	-	3	-	-	1	1	-	-
CO2	3	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO3	2	-	-	2	-	-	-	-	-	-	-	1	2	-	1
CO4	1	-	-	-	2	-	-	-	-	-	1	-	2	-	-
CO5	-	2	-	-	-	-	-	1	-	-	-	1	1	-	1
AVERAGE	1.4	0.4	0.2	0.4	0.6			0.2	0.6		0.4	0.6	1.2	0.4	0.4

PS3164 **SYSTEM THEORY**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the modeling and representing systems in state variable form.
- To provide train on solving linear and non-linear state equations.
- To understand illustrate the properties of control system.
- To understand classify non–linearities and examine stability of systems in the sense of Lyapunov's theory.
- To provide educate on modal concepts, design of state, output feedback controllers and estimators.

UNIT-I: STATE VARIABLE REPRESENTATION **9**

Introduction-Concept of State-Space equations for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment - free and forced responses- State Diagrams.

UNIT -II: SOLUTION OF STATE EQUATIONS **9**

Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- Cayley Hamilton's Theorem System modes-Role of Eigen values and Eigen vectors.

UNIT -III: PROPERTIES OF THE CONTROL SYSTEM **9**

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT -IV: NON-LINEARITIES AND STABILITY ANALYSIS **9**

Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions. Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems- Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

UNIT -V: MODAL ANALYSIS **9**

Controllable and Observable Companion Forms - SISO and MIMO Systems – Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the concept of State-State representation for Dynamic Systems.
- Describe the solution techniques of state equations.
- Realize the properties of control systems in state space form.

- Identify non-linearities and evaluate the stability of the system using Lyapnov notion .
- Perform Modal analysis and design controller and observer in state space form.

TEXT BOOKS:

T1. M. Gopal, “Modern Control System Theory”, New Age International, 2005.

T2. K. Ogatta, “Modern Control Engineering”, PHI, 2002.

REFERENCES:

R1. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-, 1999.

R2. John J. D’Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2003.

R3. M. Vidyasagar, “Nonlinear Systems Analysis’, 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey, 2002.

R4. D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005.

PS3164	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	3	2	1	1	2	2				2	3			
CO2	2	3	2	2	2	1		2				2		1	2	
CO3	3	2	1	3	2	2		1				2	2			
CO4	2	3	2	2	1	2		1				2	2			
CO5	3	1	2	2	3	1		2				2	3		2	
AVERAGE	2.6	2.2	2	2.2	1.8	1.4	0.4	1.6				2	2	0.2	0.8	

CI3164 CONTROL SYSTEM DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on continuous system and discrete system and effect of sampling
- To impart knowledge on design of controllers using root-locus and frequency domain techniques.
- To educate on concept of state space and design of controllers and observers.
- To introduce the techniques of extending the theory on continuous systems to discrete time systems.
- To introduce the linear quadratic regulator and estimation in the presence of Noise.

UNIT I CONTINUOUS AND DISCRETE SYSTEMS 9

Review of continuous systems- Need for discretization-comparison between discrete and analog system. Sample and Hold devices - Effect of sampling on transfer function and state models- Analysis.

UNIT II ROOT LOCUS DESIGN 9

Design specifications-In Continuous domain - Limitations- Controller structure- Multiple degrees of freedom- PID controllers and Lag-lead compensators- Root locus design-Discretization & Direct discrete design.

UNIT III DESIGN IN FREQUENCY RESPONSE BASED DESIGN 9

Lag-lead compensators – Design using Bode plots- use of Nichole's chart and Routh-hurwitz Criterion-Jury's stability test-Schur-Cohn Stability Criterion - Digital design.

UNIT IV STATE VARIABLE DESIGN 9

Pole Assignment Design- state and output feedback-observers - Estimated state feedback - Design examples (continuous & Discrete).

UNIT V LQR AND LQG DESIGN 9

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

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to understand the specification, limitation and structure of controllers.
- Ability to design a controller using Root-locus and Frequency Domain technique.
- Acquire knowledge on state space and ability to design a controller and observer.
- Ability to design LQR for a system,
- . Ability to design LQG for a system.

REFERENCES

1. G.F.Franklin,J.D.Powell and MWorkman,“Digital Control ofDynamic Systems”,PHI,2002.
2. Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado “Control system Design”, PHI, 2003.
3. M.Gopal, “Digital Control and State variable methods” Mcgraw hill 4thdition,2012.
4. Benjamin C. Kuo “Digital control systems”, Oxford UniversityPress,2004
5. M. Gopal,“Modern control system Theory” New AgeInternational,2005.
6. J.J. D’Azzo, C.H. Houpis and S.N Sheldon, “Linear Control system analysis and design with MATLAB”, TaylorandFrancis,2009.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	1	-	1	-	-	-	3	-	-	-	1	-	-
CO2	3	-	-	-	-	-	-	-	-	-	1	1	-	2	-
CO3	2	-	-	2	-	-	-	-	-	-	-	-	2	-	1
CO4	1	-	-	-	2	-	-	-	-	-	1	-	2	-	-
CO5	-	2	-	-	-	-	-	1	-	-	-	-	1	-	1
AVERAGE	1.4	0.4	0.2	0.4	0.6			0.2	0.6		0.4	0.2	1.2	0.4	0.4

CI3165	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To educate on design of signal conditioning circuits for various applications
- To Introduce signal transmission techniques and their design
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses used in automation industries.

UNIT I INTRODUCTION 9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

UNIT II AUTOMATION COMPONENTS 9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROLSYSTEMS 9

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT V DISTRIBUTED CONTROL SYSTEM 9

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS, Commercial DCS.

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to design a signal conditioning circuits for various application
- Ability to acquire a detail knowledge on data acquisition system interface
- Ability to acquire a detail knowledge on Distributed Control System.

- Ability to acquire a detail knowledge on PLC.
- Students will be able to understand the basics and Importance of communication buses in applied automation Engineering.

REFERENCES

1. S.K.Singh, "Industrial Instrumentation", Tata Mc graw Hill, 2nd editioncompanies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition,2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition,2000.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", Ceneage Learning, 3rd Edition,2005.

CO-PO and PSO Mapping:

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	1	2	3								11	1	2	3
CO2	1		1		1				3			1		
CO3	3						2				1		2	
CO4	2			2								2		1
CO5	1				2						1	2	3	3
AVERAGE	1.6	0.4	0.8	0.4	0.6		0.4		0.6		2.6	1.2	1.4	1.4

CI3166	DESIGN OF EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide a clear understanding on the basic concepts, Building Blocks of Embedded System
- To teach the fundamentals of Embedded processor Modeling , Bus Communication in processors, Input/output interfacing
- To introduce on processor scheduling algorithms , Basics of Real time operating system
- To discuss on aspects required in developing a new embedded processor, different Phases & Modeling of embedded system
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNITI INTRODUCTION TO EMBEDDED SYSTEMS 9

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA, Memory management methods- memory mapping, cache replacement concept, Timer and Counting devices, Watchdog Timer, Real Time Clock

UNITII EMBEDDED NETWORKING AND INTERRUPTS SERVICE MECHANISM 9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols - RS232 standard – RS485 –USB – Inter Integrated Circuits (I^2C) – interrupt sources , Programmed-I/O busy- wait approach without interrupt service mechanism- ISR concept-– multiple interrupts – context and periods for context switching, interrupt latency and deadline - Introduction to Basic Concept Device Drivers.

UNIT III RTOS BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication- shared memory, message passing-, Interposes Communication – synchronization between processes- semaphores, Mailbox, pipes, priority inversion, priority inheritance-comparison of commercial RTOS features
-RTOS Lite, Full RTOS, Vx Works, µC/OS-II, RT Linux,

UNIT IV SOFTWARE DEVELOPMENT TOOLS 9

Software Development environment-IDE, assembler, compiler, linker, simulator, debugger, In circuit emulator, Target Hardware Debugging, need for Hardware-Software Partitioning and Co-Design. Overview of UML, Scope of UML modeling, Conceptual model of UML, Architectural, UML basic elements- Diagram- Modeling techniques - structural, Behavioral, Activity Diagrams.

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 9

Objectives, different Phases & Modeling of the Embedded product Development Life Cycle

(EDLC), Case studies on Smart card- Adaptive Cruise control in a Car -Mobile Phone software for key inputs.

Note: Class Room Discussions and Tutorials can include the following Guidelines for improved Teaching
/Learning Process: Practice through any of Case studies through Exercise/Discussions on Design , Development of embedded Products like : Smart card -Adaptive Cruise control in a Car - Mobile Phone - Automated Robonoid

TOTAL: 45 PERIODS

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

- Anabilitytodesignasystem,component,orprocesstomeetdesiredneedswithinrealistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- Describe the differences between the general computing system and the embedded system.
- Design real time embedded systems using the concepts of RTOS.
- Foster ability to understand the role of embedded systems in industry
- Recognize the classification of embedded systems

REFERENCES

1. Rajkamal, 'Embedded system-Architecture, Programming, Design',TMH,2011.
2. Peckol, "EmbeddedsystemDesign",JohnWiley&Sons,2010
3. Shibu.K.V, "Introduction to Embedded Systems",TataMcgrawHill,2009
4. Lyla B Das," Embedded Systems-AnIntegratedApproach",Pearson2013
5. EliciaWhite,"Making EmbeddedSystems",O'ReillySeries,SPD,2011
6. Bruce Powel Douglass, "Real-Time UML Workshop forEmbeddedSystems,Elsevier,2011
7. Simon Monk, "Make: Action, Movement, Light and Sound with Arduino and Raspberry Pi", O'Reilly Series,SPD, 2016.
8. Tammy Noergaard, "Embedded System Architecture, A comprehensive Guide for Engineers and Programmers",Elsevier,2006
9. JonathanW.Valvano,"Embedded Microcomputer Systems ,Real Time Interfacing",Cengage Learning,3rdedition,2012
10. Michael Margolis,"Arduino Cookbook, O'ReillySeries,SPD,2013.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	1	-	1	-	2	-	3	-	-	-	1	-	-
CO2	2	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO3	2	-	-	2	-	-	-	-	-	-	-	-	3	-	1
CO4	1	-	-	-	2	-	-	-	-	-	1	1	2	-	-
CO5	1	-	3	-	-	2	-	-	-	-	-	1	2	-	-
AVERAGE	1.4		0.8	0.4	0.6	0.4	0.4		0.6		0.4	0.4	1.6	0.4	0.2

CI3167 MODELING AND SIMULATION LABORATORY

	L	T	P	C
	0	0	4	1.5

COURSE OBJECTIVES:

- To get knowledge about software packages required for solving algebraic equations.
- To design different controllers.
- To simulate system application involving nonlinear models.
- To Use standard routines in Matlab / Simulink
- To get knowledge on Scilab / Scicos packages.

LIST OF EXPERIMENTS:

1. Solving nonlinear single and simultaneous nonlinear algebraic equations;
2. To find the eigen values, eigen vectors of a given matrix. Solution of Ax=b
3. To setup simulation diagram of a simple feedback block diagram (First order plus time delay system with a proportional controller) and find out the ultimate controller gain and frequency of oscillation.
4. For the FOPTD system considered in problem (4), Calculate the PI and PID settings by Ziegler- Nichols continuous cycling method. Compare the servo and regulatory performances.
5. Given a transfer function model design PI controller by ZN method & IMC method. Calculate the gain margin, phase margin and Maximum sensitivity function for these two methods.
6. Given nonlinear model equations of a bioreactor, linearise the model equations to get the transfer function model. Design a PI controller. Simulate the performance of the controller on the nonlinear system
7. Set up a block diagram simulation of a 2x2 transfer function matrix (each subsystem as a FOPTD model) with decentralized PI control system. Using the closed loop system, with different values of the detuning factor compare the closed loop servo responses.
8. Given the input (x_1 and x_2) and output (y) data of a system and the model equation y =k_1 Cx_1 x^m, g$_2$et the model parameters by the nonlinear least square routine.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- Ability to get familiarize with matlab / Simulink

- Ability for solving mathematical equations.
- Ability to analyze the performance of nonlinear systems.
- Ability to design different controllers for industrial applications
- Ability to tune the different controllers parameters.

REFERENCES:

1. S.L. Campbell, J.P.Chancelier and R.Nikoukhah, "Modeling and Simulation in Scilab / Scicos", Springer, 2006.
2. D.Xue, Y.Chen & E. Atherton, "Linear Feedback Control, analysis and design.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	2	-	-	-	3	-	3	-	1	-	-	2	-
CO2	2	-	-	2	-	-	-	-	-	-	-	-	3	1	1
CO3	1	2	-	-	2	-	-	-	-	-	1	-	2	1	1
CO4	2	-	-	-	-	-	-	-	-	-	-	1	1	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	-	3	-
AVERAGE	1.4	1	0.4	0.4	0.4		0.6		0.6		0.4	0.2	1.2	1.4	0.4

CI3168	AUTOMATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

To teach the importance of monitoring, control and to impart theoretical and practical skills in

- Interpretation of Piping & Instrumentation Diagrams
- Interfacing pilot plants with Industrial Type Distributed Control System Programming of Industrial Type Programmable Logic Controller (Ladder Logic and Function Block Programming)
- Design and implementation of advanced control schemes.
- Design of Data acquisition systems.

LIST OF EXPERIMENTS:

1. Interpretation of P & ID (ISA5.1)
2. Control of a typical process using multi-loop PID controller.
3. Interfacing data acquisition card with personal computer.
4. Control of thermal process using embedded controller.
5. PC based control of level process.

6. Configure Function Blocks and develop Feedback and Cascade Control Strategies using Function Blocks in industrial type Distributed Control system.
7. On-line monitoring and control of a pilot plant using an industrial type distributed control system.
8. Simple exercises using the Instruction Set of Industrial Type Programmable Logic Controller.
9. Programmable logic controller exercises for Filling / Draining control operation.
10. Programmable logic controller exercises for Reversal of dc motor direction.
11. Control of level and flow measurement system using industrial type programmable logic controller.
12. Design and implementation of advanced control scheme on the skid mounted pilot plant.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

- Ability to experimentally measure Industrial process parameters/variables such as flow, level, temperature and pressure.
- Ability to configure an Industrial Type Single / Multi-loop PID Controller
- Gain hands on experience in working with Industrial Type Distributed Control System
- Ability to monitor and Control a pilot plant using Industrial Type DCS (Centralized Monitoring & Decentralized Control).
- Ability to realize the Discrete Control Sequence in Industrial Type PLC using Ladder.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	-	-	-	3	-	1	-	-	1	-	1	2	3
CO2	3	-	1	-	1	-	-	-	3	-	-	-	1	-	2
CO3	3	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO4	2	1	-	2	-	-	2	-	-	3	-	2	2	3	1
CO5	2	2	-	-	-	3	-	-	-	-	-	1	-	2	-
AVERAGE	2.6	0.8	0.2	0.4	0.2	1.2	0.4	0.2	0.6	0.6	0.4	0.6	0.8	1.8	1.2

CI3261	ADVANCED PROCESS CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the process control loop and obtain the mathematical model of different processes.
- To educate on the conventional PID controller and it associated features and design the PID controller using different tuning techniques.
- To elaborate different types of controls schemes such as cascade control, feed forward control etc.
- To educate on multivariable systems and multi-loop control.
- To educate on various industrial processes.

UNIT - I: PROCESS DYNAMICS 9

Need for process control – The process control loop – Continuous and batch processes – P & I diagram - Self-regulation - Interacting and non-interacting systems - Mathematical models of level, Pressure, flow and thermal processes–Linearization of nonlinear systems–Final Control Element.

UNIT - II: PID CONTROLLER AND TUNING 9

Characteristic of ON - OFF, P, P+I, P+D and P+I +D control modes – Digital PID algorithm – Auto/manual transfer – Reset windup – Practical forms of PID controller – Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio – Tuning – Process reaction curve method and Z - N and Cohen - Coon techniques – Continuous cycling and damped oscillation methods–Auto-tuning.

UNIT - III: ENHANCEMENT OF SINGLE-LOOP CONTROL & MODEL BASED CONTROL SCHEMES 9

Cascade control – Split-range control – Feed-forward control – Ratio control – Inferential control – override control – Smith predictor control scheme – Internal model control (IMC) – IMC PID controller Dynamic matrix control – Generalized predictive control.

UNIT - IV: MULTIVARIABLE SYSTEMS & MULTI-LOOP CONTROL 9

Multivariable systems – Transfer matrix representation – Poles and zeros of MIMO system – Introduction to multi-loop control – Process Interaction – Pairing of inputs and outputs – The relative gain array(RGA) – Properties and applications of RGA – Multi - loop PID controller–Decoupling control Multivariable PID controller.

UNIT - V: CASE-STUDIES 12

Model predictive control – Control schemes for distillation column, CSTR, four - tank system and pH.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Ability to apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes.
- Ability to design, tune and implement P/PI/PID controllers to achieve desired performance for SISO processes.
- Ability to understand and use different single-loop control and model based control schemes.
- Ability to analyze and design multivariable and multi-loop control systems.
- Ability to understand the various processes namely four-tank system, pH process, bioreactor, distillation column.

REFERENCES:

1. Stephanopoulos G, "Chemical Process Control", Pearson, 2015.
2. Bequette WB, "Process Control: Modeling, Design and Simulation", Prentice Hall India, 2003.
3. Seborg DE, Mellichamp DA, & Edgar TF, "Process Dynamics and Control", Wiley, 2013.
4. Chidambaram M, "Computer Control of Processes", Narosa, 2006.
5. Luyben WL, "Process Modeling, Simulation and Control for Chemical Engineers", 2013.
6. Johnson CD, "Process Control Instrumentation Technology", Pearson, 2015.
7. Coughanowr DR & LeBlanc SE, "Process Systems Analysis and Control", McGraw Hill, 2013.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	-	3	-	-	-	-	-	-	2	1	1	2	3
CO2	1	-	1	-	1	-	-	-	3	-	-	-	1	-	-
CO3	3	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO4	2	-	-	2	-	-	-	-	-	-	-	-	2	-	1
CO5	1	-	-	-	2	-	-	-	-	-	1	-	2	3	3
AVERAGE	1.6	0.2	0.2	1	0.6				0.6		0.8	0.2	1.2	1.4	1.4

CI3262 ADVANCED CONTROL SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To provide the knowledge on phase plane analysis.
- To provide the knowledge on describing function analysis.
- To introduce the optimal controller and optimal estimator including Kalman filter.
- To introduce the system identification and adaptive control techniques.
- To introduce the robust control techniques.

UNIT - I: PHASE PLANE ANALYSIS 9

Features of linear and non-linear systems – Common physical nonlinearities – Methods of linearization – Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT - II: DESCRIBING FUNCTION ANALYSIS 9

Basic concepts – Derivation of describing functions for common nonlinearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations, Relay Feedback.

UNIT - III: INTRODUCTION TO OPTIMAL CONTROL AND ESTIMATION 9

Introduction – Performance measures for optimal control problem – LQR tracking – LQR regulator – Optimal estimation – Discrete Kalman Filter.

UNIT - IV: INTRODUCTION TO SYSTEM IDENTIFICATION ADAPTIVE CONTROL 9

Introduction to system identification – The least squares estimation – The recursive least squares estimation - Correlation by frequency Analysis– Introduction to adaptive control – Gain scheduling controller – Model reference adaptive controller – Self-tuning controller.

UNIT - V: INTRODUCTION TO ROBUST CONTROL 9

Introduction – Norms of vectors and matrices – Norms of systems – H2 optimal controller – H2 optimal estimation – H-infinity controller – H-infinity estimation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the physical nonlinearities, linearize and analyze nonlinear systems using phase plane technique.
- Ability to analyze nonlinear systems with the describing function technique.
- Ability to know the performance measures and use LQR controllers and Kalman filter for optimal control problems.
- Ability to identify a system using least squares and recursive least techniques and understand the need and techniques of adaptive control.
- Ability to understand the need for robust control and use them for control and estimation.

REFERENCES:

1. Gopal M, "Modern Control System Theory", New Age International, 2015.
2. Mohandas KP, "Modern Control Engineering", Sanguine Technical Publishers, 2016.
3. Sinha A, "Linear Systems: Optimal and Robust Control", CRC Press, 2007.
4. Cheng D, Sun Y, Shen T and Ohmori H, "Advanced Robust and Adaptive Control Theory And Applications", New Age International, 2010.
5. Astrom KJ & Wittenmark B, "Adaptive Control", Dover Publications, 2013.
6. Kirk DE, "Optimal Control Theory: An Introduction", Dover Publications, 2012.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	-	-	3	-	-	-	-	1	1	1	1	2	3
CO2	1	-	1	-	1	-	-	-	3	-	-	-	1	-	-
CO3	3	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO4	2	-	-	2	-	-	-	-	-	-	-	-	2	-	1
CO5	1	-	-	-	2	-	-	-	-	-	1	2	2	3	3
AVERAGE	1.6	0.2	0.2	0.4	1.2				0.6	0.2	0.6	0.6	1.2	1.4	1.4

CI3267	**DIGITAL CONTROL AND INSTRUMENTATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES:

To impart the theoretical and practical knowledge on

- Implementation of different types of converters.
- Design and Simulate types of power system.
- Design of input – output interfaces.
- Design of controllers for linear and nonlinear systems.
- Implementation of closed loop system using hardware simulation.

LIST OF EXPERIMENTS:

1. Simulation of Converters
2. Simulation of Machines
3. Simulation of Power System
4. Simulation of Process Loop
5. Design of analog and digital interfaces
   (i) Digital input,
   (ii) Analog input,
   (iii) Digital output,
   (iv) Analog output,
6. Design of analog and digital interfaces, interrupts, timer handling.

7. Design of controllers for linear systems
8. Design of controllers for nonlinear systems
9. Hardware in loop simulation of system.
10. Microcontroller
11. PC based Data acquisition and control
12. Hardware simulation of closed loop control system.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

- Ability to simulate different types of machines, converters.
- Ability to design analog and digital interfaces for both input and output of the system
- Ability to design controllers for both linear and nonlinear system.
- Ability to perform both hardware and software simulation.
- Ability to design process loops in a system.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	-	-	-	-	-	1	-	-	1	-	1	2	3
CO2	3	-	1	-	1	-	-	-	3	-	-	1	1	-	-
CO3	3	-	-	-	-	-	-	-	-	-	1	1	-	2	-
CO4	2	-	-	2	-	-	2	-	-	-	-	-	2	-	1
CO5	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
AVERAGE	2.2	0.2	0.2	0.4	0.2		0.4	0.2	0.6		0.4	0.6	0.8	0.8	0.8

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CI3248 MINI PROJECT

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- Make students able to demonstrate the ability to collaborate with others as they work on intellectual projects.
- Provide a platform to the students to implement their technical skills on a given/selected task.
- To get the Knowledge for the assembling of electronics circuit with components on PCB (Printed Circuit Board) of circuit design.
- Design and development of project based on hardware and software for electronics, control and instrumentation systems.
- Design solutions for real life problems using engineering knowledge.

The student works on a topic approved by the head of the department and prepare a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

OUTCOMES:

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

1. Identify the problem by applying acquired knowledge.
2. Analyze and categorize executable project modules after considering risks.
3. Choose efficient tools for designing project modules.
4. Combine all the modules through effective team work after efficient testing

Elaborate the completed task and compile the project report

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	-	-	-	-	-	1	-	-	1	-	1	2	3
CO2	3	-	1	-	1	-	-	-	3	-	-	1	1	-	-
CO3	3	-	-	-	-	-	-	-	-	-	1	1	-	2	-
CO4	2	-	-	2	-	-	2	-	-	-	-	-	2	-	1
CO5	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

BA3371	Research Methodology and IPR	L	T	P	C
		3	0	0	3

OBJECTIVES:

- o familiarise the students with the scientific methodology involved in research process.
- To help students to understand various concepts related to Research design and measurement.
- To learn to design and validate data collection tools.
- To give an idea about IPR, registration and its enforcement.
- To acquaint the students with basics of intellectual property rights

UNIT I INTRODUCTION TO RESEARCH 9

The hallmarks of scientific research – the building blocks of science in research – the research process for applied and basic research – the need for theoretical frame work – hypothesis development – hypothesis testing with quantitative data. The research designs. The purpose of the study: Exploratory, Descriptive, Hypothesis testing (Analytical and Predictive) – cross sectional and longitudinal studies.

UNIT II EXPERIMENTAL DESIGN 9

The laboratory and the field experiment – internal and external validity – factors affecting internal validity. Measurement of variables – scales and measurement of variables – development scales - rating scale and concept in scales being developed. Stability measures.

UNIT III DATA COLLECTION METHOD 9

Interviewing, questionnaires etc. Secondary sources of data collection. Guidelines for questionnaire design – electronic questionnaire design and surveys. Special data source: Focus groups, Static and dynamic data-collection methods and when to use each. Sampling techniques and confidence in determining sample size. Hypothesis testing determination of optimal sample size.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY 9

Introduction - Invention and Creativity - An Overview of Intellectual Property (IP) - Importance -Protection of IPR - Basic types of property. Forms of Industrial Properties: Patents, Industrial Designs, Plant Varieties, copyrights, Trademarks, Geographical Indications.

UNIT IV PATENTS, COPYRIGHTS, TRADEMARKS, OTHER INTELLECTUAL PROPERTY RIGHTS 9

Introduction to Patents, Procedure for Filing of patents. Acquisition of patent rights. Copyrights and related rights - Trade Marks and rights arising from Trademark registration - Definitions - Industrial Designs and Integrated circuits - Protection of Geographical Indications at national and International levels, Plant Varieties - Application Procedures, Trade Secrets.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will get a thorough understanding of how research is conducted in Business Organisation.
- The students will understand the concept of scaling and measurement in management research particularly relating to qualitative data.
- The students will be familiarized with the data collection methods and procedures and make their research studies scientific.
- Skill to understand the concept of intellectual property rights.
- Develops procedural knowledge to Legal System and solving the problem relating to intellectual property rights.

REFERENCES:

1. Ranjit Kumar, Research Methodology, Pearson India, 2005.
2. C.R. Kothari, Gaurav Garg, Research Methodology, New Age International Publishers, 2019.
3. Uma Sekaran and Roger Bougie, Research methods for Business, 5th Edition, Wiley India, New Delhi, 2015.
4. Pandey, Neeraj, Dharni, Khushdeep, Intellectual Property Rights, PHI, 2020.
5. Sople, Vinod V. Managing Intellectual Property: The Strategic Imperative, PHI, 2020.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2						1						1	2	3
CO2		2		1									1	-	-
CO3	1	1											-	2	-
CO4	1			1									2	-	1
CO5				2									-	-	-
AVERAGE	0.8	0.6		0.8			0.2						0.8	0.8	0.8

CI3345	PROJECT WORK PHASE - I	L	T	P	C
		0	0	12	6

The project work for M.E. / M.Tech. Programme consists of Phase–Phase–II and I. The Phase–I is to be undertaken during III semester and Phase–II, which is a continuation of Phase–I is to be undertaken during IV semester.

COURSE OBJECTIVES:

1. To enable students to use all concepts for creating a solution for a problem
2. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
3. To develop their own innovative prototype of ideas
4. To improve the team building, communication and management skills of the students.
5. To improve project management ability of the students.
6. To train the students in preparing project reports and to face reviews and viva voce examination

TOTAL: 180 PERIODS

COURSE OUTCOME:

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

5. Identify the problem by applying acquired knowledge.
6. Analyze and categorize executable project modules after considering risks.
7. Choose efficient tools for designing project modules.
8. Combine all the modules through effective team work after efficient testing
9. Elaborate the completed task and compile the project report.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	-	-	-	2	-	-	1	1	2	-
CO2	1	-	-	2	-	-	2	-	-	2	-	-	2	-	2
CO3	1	-	2	-	-	-	-	2	-	-	2	-	-	2	-
CO4	2	-	-	-	1	-	-	-	-	-	-	2	1	-	-
CO5	1	2	-	1	-	-	1	-	-	2	-	1	-	1	-

CI3346 **TECHNICAL SEMINAR** **L T P C**

0 0 2 1

OBJECTIVES:
• To encourage the students to study advanced engineering developments
• To prepare and present technical reports.
• To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

METHOD OF EVALUATION:
During the seminar session, each student is expected to prepare and present a topic on engineering/ technology, for a duration of about 8 to 10 minutes. In a session of two periods per week, students are expected to present the seminar. Each student is expected to present atleast twice during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance. Evaluation is 100% internal.

TOTAL: 30 PERIODS

OUTCOMES:
- Ability to review, prepare and present technological developments
- Ability to face the placement interviews
- Acquire knowledge of the industry
- Develop a greater understanding about career options
- Identify areas for future knowledge and skill development

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	-	-	-	2	-	-	1	1	2	-
CO2	1	-	-	2	-	-	2	-	-	2	-	-	2	-	2
CO3	1	-	2	-	-	-	-	2	-	-	2	-	-	2	-
CO4	2	-	-	-	1	-	-	-	-	-	-	2	1	-	-
CO5	1	2	-	1	-	-	1	-	-	2	-	1	-	1	-

CI3347 **INTERNSHIP (4 WEEKS)**

L	T	P	C
0	0	0	2

COURSE OBJECTIVES:

- To explore career interests while applying knowledge and skills learned in the classroom in a work setting.
- To learn and provides an opportunity to build professional networks.

The students should undergo Industrial training for a period as specified in the Curriculum during summer / winter vacation. In this case the training has to be undergone for 4 weeks period.
The students may undergo Internship at Research organization / University (after due approval from the Head of the Institution) for a period prescribed in the curriculum during summer / winter vacation, in lieu of Industrial training.

- **COURSE OUTCOMES:**
- The internship will provide students with the opportunity to
- Gain practical experience within the business environment.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned in the classroom in a work setting.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of business professionals.
- Identify areas for future knowledge and skill development

The project work for M.E. / M.Tech. Programme consists of Phase–I and Phase–II. The Phase–I is to be undertaken during III semester and Phase–II, which is a continuation of Phase–I is to be undertaken during IV semester.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	-	-	-	2	-	-	1	1	2	-
CO2	1	-	-	2	-	-	2	-	-	2	-	-	2	-	2
CO3	1	-	2	-	-	-	-	2	-	-	2	-	-	2	-
CO4	2	-	-	-	1	-	-	-	-	-	-	2	1	-	-
CO5	1	2	-	1	-	-	1	-	-	2	-	1	-	1	-
AVERAGE	1.4	0.4	0.4	0.6	0.2		0.6	0.4	0.4	0.8	0.4	0.8	0.8	1	0.4

CI3441	PROJECT WORK PHASE - II	L	T	P	C
		0	0	24	12

COURSE OBJECTIVES:

7. To enable students to use all concepts for creating a solution for a problem
8. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
9. To develop their own innovative prototype of ideas
10. To improve the team building, communication and management skills of the students.
11. To improve project management ability of the students.
12. To train the students in preparing project reports and to face reviews and viva voce examination

TOTAL: 180 PERIODS

COURSE OUTCOME:

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

10. Identify the problem by applying acquired knowledge.
11. Analyze and categorize executable project modules after considering risks.
12. Choose efficient tools for designing project modules.
13. Combine all the modules through effective team work after efficient testing
14. Elaborate the completed task and compile the project report.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	-	-	-	2	-	-	1	1	2	-
CO2	1	-	-	2	-	-	2	-	-	2	-	-	2	-	2
CO3	1	-	2	-	-	-	-	2	-	-	2	-	-	2	-
CO4	2	-	-	-	1	-	-	-	-	-	-	2	1	-	-
CO5	1	2	-	1	-	-	1	-	-	2	-	1	-	1	-
AVERAGE	1.4	0.4	0.4	0.6	0.2		0.6	0.4	0.4	0.8	0.4	0.8	0.8	1	0.4

PCI311	CONTROL SYSTEM DESIGN FOR POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore conceptual bridges between the fields of Control Systems and Power Electronics
- To Study Control theories relevant to the design of feedback controllers in Power Electronics
- To Study relevant controlling techniques in power Electronics.
- To obtain the mathematical model of power converters
- To explore in the nonlinear control system.

UNIT - I: MODELLING OF DC-TO-DCPOWER CONVERTERS 9

Modelling of Buck Converter , Boost Converter ,Buck-Boost Converter, Cuk Converter, Sepic Converter, Zeta Converter, Quadratic Buck Converter, Double Buck-Boost Converter, Boost- Boost Converter General Mathematical Model for Power Electronics Devices

UNIT - II: SLIDING MODE CONTROLLER DESIGN 9

Variable Structure Systems. Single Switch Regulated Systems Sliding Surfaces, Accessibility of the Sliding Surface Sliding Mode Control Implementation of Boost Converter ,Buck-Boost Converter, Cuk Converter, Sepic Converter, Zeta Converter, Quadratic Buck Converter, Double Buck-Boost Converter, Boost-Boost Converter

UNIT - III: APPROXIMATE LINEARIZATION CONTROLLER DESIGN 9

Linear Feedback Control, Pole Placement by Full State Feedback , Pole Placement Based on Observer Design ,Reduced Order Observers, Generalized Proportional Integral Controllers, Passivity Based Control, Sliding Mode Control Implementation of Buck Converter , Boost Converter ,Buck-Boost Converter.

UNIT - IV: NONLINEAR CONTROLLER DESIGN 9

Feedback Linearization Isidori’s Canonical Form, Input-Output Feedback Linearization, State Feedback Linearization, Passivity Based Control, Full Order Observers, Reduced Order Observers.

UNIT - V: PREDICTIVE CONTROL OF POWER CONVERTERS 9

Basic Concepts, Theory, and Methods, Application of Predictive Control in Power Electronics, AC-DC-AC Converter System, Faults and Diagnosis Systems in Power Converters.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand an overview on modern linear for power electronics devices.
- Ability to understand nonlinear control strategies.
- Ability to model modern power electronic converters for industrial applications.
- Ability to design appropriate controllers for modern power electronics devices.
- Ability to understand linearization in controller design.

REFERENCES:

1. Hebertt Sira - Ramírez, Ramón Silva - Ortigoza, “Control Design Techniques in Power Electronics Devices”,Springer2012
2. Mahesh Patil, Pankaj Rodey, “Control Systems for Power Electronics: A Practical Guide”, Springer India, 2015.
3. Blaabjerg José Rodríguez, “Advanced and Intelligent Control in Power Electronics and Drives”,

Springer,2014

4. Enrique Acha, Vassilios Agelidis, Olimpo Anaya, TJE Miller, “Power Electronic Control in Electrical Systems”, Newnes,2002
5. Marija D. Aranya Chakrabortty, Marija , “Control and Optimization Methods for Electric Smart Grids”, Springer, 2012.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	-	1	-	-	-	-	1	-	-	-	-	-	1	-
CO2	-	-	-	-	2	-	-	-	-	2	3	-	-	-	1
CO3	1	-	-	-	-	-	2	-	-	-	-	-	-	2	-
CO4	2	-	-	-	-	-	-	-	-	-	-	1	-	-	2
CO5	1	-	3	-	-	-	-	1	-	1	1	-	2	-	-
AVERAGE	1.2		0.8		0.4		0.4	0.4		0.6	0.8	0.2	0.4	0.6	0.6

PCI312 SOFT COMPUTING TECHNIQUES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To expose the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback neural networks.
- To teach about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm.
- To provide adequate knowledge about of FLC tool box.
- To provide knowledge about NN toolbox.

UNIT - I: INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems -Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCulloch Pitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propagation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training-applications.

UNIT - II: ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY 9

Counter propagation network- architecture- functioning & characteristics of counter Propagation network- Hopfield/ Recurrent network configuration - stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications- Implementation and training - Associative Memory.

UNIT - III: FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification inferencing and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT - IV: GENETIC ALGORITHM 9

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 - Single objective and multi-objective problems - Procedures in evolutionary programming.

UNIT - V: HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine- Evolutionary Programming-Particle Swarm Optimization - Case study – Familiarization of NN, FLC and ANFIS ToolBox.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The students will be able to know the basic ANN architectures, algorithms and their limitations.
- Also will be able to know the different operations on the fuzzy sets.
- Will be capable of developing ANN based models and control schemes for non - linear system.
- Will get expertise in the use of different ANN structures and online training algorithm.
- Will be knowledgeable to use Fuzzy logic for modeling and control of non-linear systems.
- Will be competent to use hybrid control schemes and P.S.O and support vector Regressive.

REFERENCES:

1. Laurene V.Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson Education.
2. Timothy J.Ross, “Fuzzy Logic with Engineering Applications” Wiley India, 2008.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
5. W.T. Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control” MIT Press”, 1996.
6. T.Ross, “Fuzzy Logic with Engineering Applications”, Tata McGraw Hill, NewDelhi, 1995.
7. Ethem Alpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, MIT Press, 2004.
8. Corinna Cortes and V.Vapnik, " Support - Vector Networks, Machine Learning” 1995.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	1	-	-	-	-	3	2	-	1	1	-	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-
CO3	2	-	-	-	-	-	-	-	-	-	2	-	-	2	-
CO4	-	-	2	-	-	-	3	-	-	-	-	-	1	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO6	1	-	-	2	-	-	2	-	-	2	-	-	2	-	2
AVERAGE	1.2		0.4	0.6	0.4		1		0.6	0.8	0.4	0.2	1	1	0.4

PCI313	**CONTROL OF ELECTRIC DRIVES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the PWM converters and modeling of current controller.
- To understand on modeling of dc motor, drives and control techniques.
- To analyze dynamic modeling of Induction motor drive.
- To educate on the V/f and vector control of Induction motor.
- To educate on generation of firing pulses and control algorithms in embedded platforms.

UNIT - I: POWER ELECTRONIC CONVERTERS FOR DRIVES 9

Power electronic switches and its characteristics-state space representation of switching converters-Fixed frequency PWM-Variable frequency PWM- space vector PWM- Hysteresis current control - dynamic analysis of switching converters-PWM modulator model-– modeling of current controller – design of current controller.

UNIT - II: ANALYSIS AND CONTROL OF DC DRIVES 9

Modelling of DC machines-block diagram/transfer function- Steady state analysis of single phase and three phase converter control DC motor drive – Two quadrant, Three phase converter controlled DC motor drive steady state analysis of chopper controlled DC motor drives - four quadrant chopper circuit - closed loop control - speed control -current control - cascade control – constant torque/power operation - comparison of chopper / converter fed drives - techniques - merits / demits

UNIT - III: ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE 9

Basics of induction motor drive-classification – equivalent circuit- torque Vs slip characteristics - steady state performance - real time model of a two - phase IM, Reference frame theory, Three - phase to Two - phase transformation, power equivalence, generalized model in arbitrary reference frames, electromagnetic torque, Equation in flux Linkages, small - signal equation of the IM, evaluation of control characteristics of IM

UNIT- IV: CONTROL OF INDUCTION MOTOR DRIVE 9

VSI fed induction motor drives- waveforms for 1-phase, 3-phase Non - PWM and PWM VSI fed induction motor drives - principles of V/F control - Vector control of Induction Motor Drives- Principles of Vector control – Vector control methods – Direct methods of vector control – Indirect methods of vector control – Adaptive control principles – Self tuning regulator Model referencing control.

UNIT - V: EMBEDDED CONTROL OF DRIVES 9

Generation of firing pulses - generation of PWM pulses using embedded processors-IC control of DC drives- fixed frequency / variable frequency / current control - V/F control using PIC microcontroller - vector control using embedded processors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Able to model and analyze electrical motor drives and their subsystems.
- Able to choose a suitable rotating machine for an electrical motor drive.
- Able to choose a suitable power electronic converter structure for an electrical motor drive.
- Able to choose a suitable control structure and calculate control parameters for an electrical motor drive.
- Able to design control using suitable processors.

REFERENCES:

1. R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” Prentice Hall of India, 2002.
2. Vedam Subrahmanyam, “Thyristor control of Electric drives”, Tata McGraw Hill,1988
3. Ion Boldea & S.A.Nasar “Electric Drives”, CRC Press, 2006
4. P.C. Kraus, “Analysis of Electrical Machines”, Tata McGraw Hill Book Company
5. Buxbaum, A.Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer - Verlag, Berlin, 1990.
6. Simon Ang, Alejandro Oliva “Power Switching Converters”, CRC Press, 2005
7. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education, 2nd Edition, 2003.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	-	-	-	-	-	2	3	-	-	1	2	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	-	-	1	-	-	-	2	-	-	-	2	-	1	-	-
CO4	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	-	-	-	2	-	-	-	-	2	-	1	-	-	3
AVERAGE	1.2	0.4	0.2		0.4		0.4	0.4	0.6	0.4	0.4	0.4	0.6	0.4	1.2

PCI314	**MULTI SENSOR DATA FUSION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

- **COURSE OBJECTIVES**
- To educate on sensor data inference hierarchy and fusion models.
- To educate on the algorithms used for data fusion.
- To educate on Kalman filter and its application to decision identity fusion.
- To educate on advanced filtering and sensor fusion concepts.

UNIT I MULTISENSOR DATA FUSION INTRODUCTION 9
sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

UNIT II ALGORITHMS FOR DATA FUSION 9
Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.

UNIT III ESTIMATION: 9
Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters. Decision level identify fusion. Knowledge based approaches.

UNIT IV ADVANCED FILTERING 9
Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.

UNIT V HIGH PERFORMANCE DATA STRUCTURES: 9
Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems within dependability bounds. Implementing data fusion system.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- Ability to explain and use multiple sensor data in data fusion model.
- Capable to use algorithms for data fusion.
- :Ability to estimate using kalman filter.
- Ability to estimate using advance filtering such as data, extended information filtering.
- Ability to handle various high performance data structures

REFERENCES:
1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 1992.
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998.
3. Arthur Gelb, Applied Optimal Estimation, The M.I.T. Press, 1982.
4. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company, 1987.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	-	-	-	-	-	2	3	-	-	1	2	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	-	-	1	-	-	-	2	-	-	-	2	-	1	-	-
CO4	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	-	-	-	2	-	-	-	-	2	-	1	-	-	3
AVERAGE	1.2	0.4	0.2		0.4		0.4	0.4	0.6	0.4	0.4	0.4	0.6	0.4	1.2

PCI321 ADVANCED DIGITAL SIGNAL PROCESSING L T P C

3 0 0 3

COURSE OBJECTIVES

- To expose the students to the fundamentals of digital signal processing in frequency domain & its application
- To teach the fundamentals of digital signal processing in time-frequency domain & its application
- To compare Architectures & features of Programmable DSP processors& develop logical functions of DSP Processors
- To discuss on Application development with commercial family of DSP Processors
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT - I: FUNDAMENTALS OF DSP 9

Frequency interpretation, sampling theorem, aliasing, discrete - time systems, constant - coefficient difference equation. Digital filters: FIR filter design – rectangular, Hamming, Hanning windowing technique. IIR filter design – Butterworth filter, bilinear transformation method, frequency transformation. Fundamentals of multirate processing – decimation and interpolation.

UNIT - II: TRANSFORMS AND PROPERTIES 9

Discrete Fourier transform (DFT): - properties, Fast Fourier transform (FFT), DIT-FFT, and DIF-FFT. Wavelet transforms: Introduction, wavelet coefficients – orthonormal wavelets and their relationship to filter banks, multi-resolution analysis, and Haar and Daubechies wavelet.

UNIT - III: ADAPTIVE FILTERS 9

Wiener filters – an introduction. Adaptive filters: Fundamentals of adaptive filters, FIR adaptive filter teepest descent algorithm, LMS algorithm, NLMS, applications – channel equalization. Adaptive recursive filters – exponentially weighted RLS algorithm.

UNIT - IV: ARCHITECTURE OF COMMERCIAL DIGITAL SIGNAL PROCESSORS 9

Introduction to commercial digital signal processors, Categorization of DSP processor – Fixed point and floating point, Architecture and instruction set of the TI TMS 320 C54xx and TMS 320 C6xxx DSP processors, On-chip and On-board peripherals – memory (Cache, Flash, SDRAM),codec, multichannel buffered I/O serial ports (McBSPs), interrupts, direct memory access (DMA), timers and general purpose / Os.

UNIT - V: INTERFACING I/O PERIPHERALS FOR DSP BASED APPLICATIONS 9

Introduction, External Bus Interfacing Signals, Memory Interface, I/O Interface, Programmed I/O, Interrupts, Design of Filter, FFT Algorithm, Application for Serial Interfacing, DSP based Power Meter, Position control, CODEC Interface.

TOTAL: 45 PERIODS

Note: Discussions / Exercise / practice on signal analysis, transforms, filter design concepts with simulation tools such as Matlab / Labview / CC studio will help the student understand signal processing concepts and DSP processors. Overview of TMS320C54xx and TMS320C67xx / other DSP Starter Kits, Introduction to code composer studio (CCS), Board support library, Chip support library and Runtime support library, Generating basic signals, Digital filter design, Spectrum analysis, Adaptive filters, Speech and Audio processing applications.

COURSE OUTCOMES:

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

- Students will learn the essential advanced topics in DSP that are necessary for successful Postgraduate level research.
- Students will have the ability to solve various types of practical problems in DSP
- Comprehend the DFTs and FFTs, design and analyze the digital filters, comprehend the Finite word length effects in Fixed point DSP Systems.
- The conceptual aspects of Signal processing Transforms are introduced.
- The comparison on commercial available DSP Processors helps to understand system design through processor interface.
- Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

REFERENCES:

1. John. G.Proakis, Dimitris G.Manolakis, “Digital signal processing”, Pearson Edu, 2002
2. Sen M.Kuo, Woon - Seng S.Gan, “Digital Signal Processors- Pearson Edu, 2012
3. Ifeachor E. C., Jervis B. W ,”Digital Signal Processing: A practical approach, Pearson-

Education, PHI / 2002
4. Shaila D.Apte, “Digital Signal Processing”, Second Edition, Wiley, 2016.
5. Robert J. Schilling, Sandra L. Harris, ”Introduction To Digital Signal Processing with Matlab”, Cengage,2014.
6. Steven A. Tretter, “Communication System Design Using DSP Algorithms with Laboratory Experiments for the TMS320C6713™ DSK”, Springer, 2008.
7. Rulph Chassaing and Donald Reay, “Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK”, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
8. K.P. Somanand K.L. Ramchandran, Insight into WAVELETS from theory to practice, Eastern Economy Edition, 2008.
9. B Venkataramani and M Bhaskar **“**Digital Signal Processors**”**, TMH, 2nd, 2010.
10. Vinay K.Ingle, John G.Proakis,”DSP-A Matlab Based Approach”, Cengage Learning,2010
11. Taan S.Elali,”Discrete Systems and Digital Signal Processing with Matlab”, CRC Press2009.
12. Monson H. Hayes,“ Statistical Digital signal processing and modelling”, John Wiley & Sons,2008.
13. Avatar Sing, S. Srinivasan, “Digital Signal Processing - Implementation using DSP Microprocessors with Examples from TMS320C54xx”, Thomson India, 2004.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	1	-	-	-	2	-	2	-	1	2	-	2
CO2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO3	3	-	-	-	-	2	-	-	-	-	-	-	1	-	-
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
CO6	2	-	-	-	1	-	-	2	-	-	-	2	2	-	-
AVERAGE	1.4			0.6	0.2	0.4		0.8		0.6	0.2	0.6	1	0.2	0.6

PCI322	APPLIED INDUSTRIAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

- The measurement techniques for flow, level, pressure and temperature.
- The selection and installation of instruments for power plant and petrochemical industries.
- The need and function of important industrial analyzers.
- Advanced instrumentation used for providing safety.
- Terminologies related to safety instrumented system and Hazard analysis.

UNIT - I: REVIEW OF INDUSTRIAL INSTRUMENTATION 9

Overview of Measurement of Flow, level, Temperature and Pressure.

UNIT - II: MEASUREMENT IN THERMAL POWER PLANT AND PETROCHEMICAL INDUSTRY 9

Selection and Installation of instruments used for the Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature – Feed water quality measurement - Flow, Level, Temperature and Pressure measurement in Distillation, Pyrolysis, catalytic cracking and reforming process.

UNIT - III: INDUSTRIAL ANALYSER 9

Flue gas Oxygen Analyzers - Gas chromatography - dissolved oxygen analyzers - CO, CO_2 and NO_2 monitors - dust monitors - coal Analyzer - Hydrocarbon analyzers - oil in or on water- sulphur in oil Analyzer.

UNIT - IV: INSTRUMENTATION FOR INDUSTRIAL SAFETY 9

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

UNIT - V: SAFETY INSTRUMENTATION 9

Introduction to Safety Instrumented Systems – Hazards and Risk – Process Hazards Analysis(PHA)- Safety Life Cycle – Control and Safety Systems - Safety Instrumented Function -Safety Integrity Level (SIL) – Selection, Verification and Validation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- The student will gain knowledge on instrumentation for flow, level, pressure and temperature.
- Would gain knowledge on measuring devices involved with power plant and petrochemical industries.
- Will be able to explain the principle behind the important industrial analyzers.
- Will get idea on measuring devices associated with critical industrial applications.
- Would gain knowledge on analysis of hazardous events and safety instrumented system.

REFERENCES:

1. B.G. Liptak, "Instrumentation Engineers Handbook (Process Measurement & Analysis)", Fourth Edition, Chilton Book Co, 2003.
2. K. Krishnaswamy and M. Ponnibala, "Power Plant Instrumentation", PHI Learning Pvt Ltd, 2011.
3. John G Webster, "The Measurement, Instrumentation, and Sensors Handbook", CRC and IEEE Press, 1999.
4. Håvard Devold, "Oil and Gas Production Handbook - An Introduction to Oil and Gas Production", ABB ATPA oil and gas, 2006.
5. Paul Gruhn, P.E., CFSE and Harry Cheddie, P.E., "Safety Instrumented Systems: Design, Analysis, and Justification", 2nd Edition, ISA, 2006.
6. Al.Sutko, Jerry. D. Faulk, "Industrial Instrumentation", Delmar publishers, 1996.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	-	-	2	-	1	-	-	1	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	1	-	2	-
CO3	2	-	2	-	-	-	-	-	-	2	-	-	-	-	-
CO4	2	-	-	-	-	-	-	1	-	-	-	-	-	2	-
CO5	-	1	-	-	1	-	-	-	-	-	1	1	-	-	1
AVERAGE	1.2	0.2	0.8		0.4			0.6		0.6	0.2	0.4	0.2	0.8	0.2

PCI323 DIGITAL IMAGE PROCESSING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The objectives of this course to impart knowledge in

- the fundamentals of image processing
- the techniques involved in image enhancement
- the low and high-level features for image analysis
- the fundamentals and significance of image compression
- the hardware for image processing applications

UNIT - I: FUNDAMENTALS OF IMAGE PROCESSING 9

Introduction to image processing systems, sampling and quantization, color fundamentals and models, image operations – arithmetic, geometric and morphological. Multi-resolution analysis – image pyramids

UNIT - II: IMAGE ENHANCEMENT 9

Spatial domain; Gray-level transformations – histogram processing – spatial filtering, smoothing and sharpening. Frequency domain: filtering in frequency domain – DFT, FFT, DCT – smoothing and sharpening filters – Homomorphic filtering. Image enhancement for remote sensing images and medical images.

UNIT - III: IMAGE SEGMENTATION AND FEATURE ANALYSIS 9

Detection of discontinuities – edge operators – edge linking and boundary detection, thresholding – feature analysis and extraction – region based segmentation – morphological watersheds – shape skeletonization, phase congruency. Number plate detection using segmentation algorithm.

UNIT - IV: IMAGE COMPRESSION 9

Image compression: fundamentals – models – elements of information theory – error free compression – lossy compression – compression standards. Applications of image compression techniques in video and image transmission.

UNIT - V: EMBEDDED IMAGE PROCESSING 9

Introduction to embedded image processing. ASIC vs FPGA - memory requirement, power consumption, parallelism. Design issues in VLSI implementation of Image processing algorithms - interfacing. Hardware implementation of image processing algorithms: Segmentation and compression

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course students will comprehend

- Fundamentals of image processing.
- Techniques involved in image enhancement, segmentation and compression and their real - time applications.
- The Simulation of image processing applications using software
- The implementation of image processing using hardware.
- Familiar with various tools like Matlab Raspberry pi, python programming.

NOTE: Discussions / Exercise / practice on Image enhancement, segmentation and compression with simulation tools such as Matlab / Raspberry pi (python programming) will help the student understand image processing concepts and hardware implementation using relevant processors.

REFERENCES:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image processing", 2nd edition, Pearson education, 2003
2. Anil K. Jain, "Fundamentals of digital image processing", Pearson education, 2003.
3. Milan Sonka, Valclav Halavac and Roger Boyle, "Image processing, analysis and machine vision", 2nd Edition, Thomson learning, 2001.
4. Mark Nixon and Alberto Aguado, "Feature extraction & Image processing for computer vision", 3rd Edition, Academic press, 2012.
5. Donald G. Bailey, "Design for Embedded Image processing on FPGAs" John Wiley and Sons, 2011.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	1	-	-	-	-	2	-	-	2	-	2	-	-
CO2	1	-	-	2	-	-	-	-	2	-	-	-	-	2	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	2	-	-	-	-	1	-	-
CO5	1	-	-	-	-	-	-	-	2	-	-	1	-	-	1
AVERAGE	1	0.6	0.2	0.4				0.8	0.8		0.4	0.2	0.6	0.4	0.2

PCI324	NANO ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the properties of electron and its implication for electronics
- To teach the importance and the issues of Nanoscale CMOS technology.
- To introduce the characteristics and applications of Nano electronic devices, methods and techniques.
- To teach the circuits and architectural features of nano memory devices.
- To introduce the various fabrication techniques for nano electronic devices.

UNIT I INTRODUCTION **9**

Overview of nanotechnology – Implication on science, engineering and technology- Particles-, waves, Wave mechanics, schrodinger equation- Electron transport in semiconductors and nanostructures, Nano materials and its properties- Electrical and Electronics Applications of Nanotechnology.

UNIT II NANOSCALE CMOS **9**

Survey of modern electronics and trends towards nano electronics CMOS scaling, challenges and limits, static power, device variability, interconnect - CNT-FET, FinFET, Ferro FET - Surround gate FET nanoscale CMOS circuit design and analysis

UNIT III NANOELECTRONIC DEVICES **9**

Resonant-tunneling diodes- Resonant Tunneling Transistor-Single-electron transfer devices-Potential effect transistors- Nano Photonic Devices-Molecular electronic devices -Nano-electromechanical system devices-Recent development.

UNIT IV NANOELECTRONIC COMPUTATION AND MEMORIES **9**

Quantum-dot cellular automata –Spintronics- Memristor- Nano tube for memories- Nano RAM NanoscaleDRAM, SRAM, Tunnel magneto resistance-Giant magneto resistance- design and applications.

UNIT V FABRICATION TECHNIQUES **9**

Clean room standards-Microfabrication –Synthesis of nano materials-nanofabrication- E-beam lithography- X-ray and ion-beam lithography- nano imprint lithography- Scanning probe lithography- Nano-characterization techniques.

NOTE: Class room discussions and tutorials can include the following guidelines for improved teaching /learning process :Discussions/Practice on Workbench : on modelling of nano/micro analog &digital devices.

TOTAL : 45 PERIODS

COURSE OUTCOMES: After the completion of this course the student will be able to:

- Understand the properties of electron and the significance of of nanotechnology.
- Concept of nanoscale CMOS devices and its various issues.
- Apply the concept of nanotechnology and understand the significance of nano electronic
- devices.

- Understand the nano configurations of computational processors and memories with improve design strategies.
- Learn and understand the nano fabrication techniques

REFERENCES :

1. Hagelstein, Peter L., Stephen D. Senturia, and Terry P. Orlando, “Introduction to Applied Quantum and Statistical Physics.”, New York, NY: Wiley, 2004.
2. Rainer Waser, “Nanoelectronics and Information Technology”, Wiley 2005
3. Michael A. Nielsen and Isaac L. Chuang, “Quantum Computation and Quantum Information”, Cambridge University Press, 2000.
4. Adrian Ionesu and Kaustav Banerjee eds. “ Emerging Nanoelectronics: Life with and after CMOS” , Vol I, II, and III, Kluwer Academic, 2005.
5. Kiyoo Itoh Masashi Horiguchi ,Hitoshi Tanaka, Ultra Low voltage nano scale memories. Spl Indian Edition, Springer.
6. George W. Hanson, Fundamental of nanoelectronics, Pearson education

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1	-	-	-	-	2	-	-	2	-	2	-	-
CO2	1	-	-	2	-	-	-	-	2	-	-	-	-	2	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	2	-	-	-	-	1	-	-
CO5	1	-	-	-	-	-	-	-	2	-	-	1	-	-	1
AVERAGE	1	0.6	0.2	0.4				0.8	0.8		0.4	0.2	0.6	0.4	0.2

PCI331 MODELING AND SIMULATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To Teach how to mathematically model engineering systems
- To educate on how to use computer tools
- To teach to solve the resulting mathematical models.
- To understand the computer tool used is MATLAB and the focus will be on developing
- solving models of problems encountered in aerospace engineering and mechanics.

UNITI OVERVIEW OF MATHEMATICAL MODELING 9

Mathematical Model, classification of model equations, Development of mathematical model, Simulation, Nonlinear Differential Equations, Conservation of Mass/Energy/Momentum, Black Box Models.

UNITII MODEL DEVELOPMENTS FOR SIMPLE SYSTEMS 9

Settling velocity of spherical particle, Vaporization from a single droplet in quiescent air, Modeling of a surge tank, Modeling of the pH process, Modeling of a long chain polymerization reaction, PDE model for tubular reactor with axial dispersion.

UNITIII MODEL DEVELOPMENTS FOR COMPLEX SYSTEMS 9

Isothermal CSTR, Lineraisation of a nonlinear equation, Bioreactor Modeling, Magnetic levitation (unstable systems), Choletts model with input multiplicities, Model for predators and Prey populations, Non-Isothermal continuous stirred tank reactor.

UNITIV NUMERICAL SOLUTIONS O FMODEL EQUATIONS 9

Newton – Raphson's method for a system of nonlinear algebraic equations; Runge-Kutta Methods of solving numerically IVP ODEs, Numerical solution of nonlinear BVP ODEs**,** Numerical solution of nonlinear PDE, Least square Curve Fitting ,Variable transformation to get a linear equation.

UNITV SIMULATION USING STANDAR DROUTINES 9

MATLAB and SCILAB programs for solving nonlinear algebraic equations, nonlinear IVP ODEs, BVP ODEs, parameter estimation problems with examples.

TOTAL : 45 PERIODS

OUTCOMES:

- An ability to apply knowledge of math, science, and engineering. This will be accomplishedbyapplyingthesedisciplinestovariousproblemsinModeling.
- An ability to identify and solves engineering problems. This will be accomplished by using MATLAB to simulate the solution to various problems in design.
- An ability to use the techniques and skills of modern engineering tools necessary for the engineering practice. This objective will be accomplished by using Matlab.
- An ability to Analyse the engineering problems.
- An ability to formulates solutions for engineering problems

REFERENCES:

1. Bequette, B.W., "Process Dynamics: Modeling, Analysis and Simulation, Prentice-Hall International", Singapore,1998.
2. Jana, A.K. "Chemical Process Modeling and Computer simulation", Prentice-Hall-India, New Delhi,2011,
3. Finlayson, B.A., "Introduction to Chemical Engineering Computing", Wiley Student Edition, Singapore,2006.
4. M.Chidambaram, "Mathematical Modeling and Simulation for Engineers", Cambridge University Press, New Delhi-2017.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	1	-	1	-	-	1	-	2	-	2	-	2
CO2	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	1	-	-	3	-	3	-	-	3	-	2	-	3	-
CO4	-	2	-	-	2	-	-	-	2	-	-	-	1	-	-
CO5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
AVERAGE	1.2	0.6		0.2	1	0.2	0.6		0.6	0.6	0.4	0.4	0.6	1	0.8

PCI332 BIO MEDICAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce fundamental principles of biosignal processing
- To introduce theoretical and methodological procedures of biosignal processing .
- To be familiar with the noise cancellation procedures.
- To analysis various techniques involved in biosignal processing.
- To estimate parametric models of the measured biosignals for prediction, simulation and diagnostic purposes.

UNITI INTRODUCTIONTOSIGNALS 9

Sources of Biomedical signals, types of signals – Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT, FFT algorithm – Digital filters – Introduction to FIR andIIRfilter.

UNITII CLASSICAL SPECTRAL ESTIMATION TECHNIQUES 9

Periodogram, Blackman – Tukey spectral Estimation applications – Analysis of the biosignal using Periodogram,–Cepstra, power cepstrum, applications of cepstrum analysis – analysis of the biosignal usingcepstrumtechnique.

UNITIII ADAPTIVE NOISE CANCELLATION 9

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

LMS and RLS adaptation algorithm - applications – adaptive noise canceling method to enhance ECG monitoring, adaptive noise canceling method to enhance Fetal ECG monitoring, adaptive noise canceling method to enhance Electro gastric measurements.

UNITIV PARAMETRIC MODELING METHODS 9

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

UNITV NON LINEAR BIOSIGNAL PROCESSING AND WAVELET TRANSFORM 9

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

TOTAL PERIOD:45

OUTCOMES:

- Ability to estimate suitable models of the measured biosignals.
- Ability to use mathematical/computational tools for biomedical image and signal analysis.
- Ability to do the parametric modeling
- Ability to use various simulation tools
- Abilty to analyse the Noise cancellation procedures.

.REFERENCES

1. M.Akay, “Biomedical Signal Processing”, Academic Press, SanDiego,1994.
2. M.Akay, “Nonlinear Biomedical Signal Processing”, Fuzzy Logic, Neural Networks and New Algorithms, vol.1, IEEE Press Series on Biomedical Engineering,NewYork,2000.
3. Eugene N.Bruce, “Biomedical Signal Processing and Signal Modeling”, John Wiley &Sons, FirstEdition,2000.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO2	1	-	-	2	-	-	2	-	-	2	-	1	2	-	2
CO3	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	1	-	-	1	-	-	1	-	-	2	-	-	-	1	-
AVERAGE	1.4			0.6			0.6			0.8		0.2	0.8	1	0.4

PCI333 INDUSTRIAL DATA NETWORKS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To give an overview of the Industrial data communications systems.
- To provide a fundamental understanding of common principles, various standards, and protocols.
- To provide insight into some of the new principles those are evolving for future networks.
- To provide a fundamental concepts of DCS Communications
- To provide PLC programming knowledge

UNIT - I: DATA NETWORK FUNDAMENTALS 9

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

UNIT - II: PLC, PLC PROGRAMMING & SCADA 9

Evolutions of PLCs – Programmable Controllers – Architecture – Comparative study of Industrial PLCs. – PLC Programming: - Ladder logic, Functional block programming, Sequential function chart, Instruction list and Structured text programming – SCADA: - Remote terminal units, Master station, Communication architectures and Open SCADA protocols.

UNIT - III: DISTRIBUTED CONTROL SYSTEM & HART 9

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

UNIT - IV: PROFIBUS AND FF 9

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

UNIT - V: AS – INTERFACE (AS - i), DEVICE NET AND INDUSTRIAL ETHERNET 9

AS interface – Device net - Industrial Ethernet - Introduction to OLE for process control - WSN technology - IOT - IIOT

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Ability to develop an understanding of and be able to select and use most appropriate technologies and standards for a given application.
- Ability to design and ensure the best practice in industry.
- Ability to familiar with the DCS communication standards
- Ability to program PLCs.
- Understand various communication buses pertaining to process industries.

REFERENCES:

1. G.K. McMillan, "Process / Industrial Instrument and Controls Handbook", Fifth Edition, McGraw Hill handbook, NewYork, 1999.
2. T.A.Hughes, "Programmable Logic Controllers: Resources for Measurements and Control Series", Fourth edition, ISA Press, 2005.
3. J. Berge, "Field Buses for Process Control: Engineering, Operation, and Maintenance", ISA Press, 2004.
4. S. Mackay, E. Wright, D.Reynders, and J. Park, "Practical Industrial Data Networks: Design, Installation and Troubleshooting", Newnes Publication, Elsevier, 2004. Alasdair Gilchrist," Industry 4.0: The Industrial Internet of Things, Apress, 2016.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	2	-	-	-	2	-	-	1	1	2	-
CO2	1	2	-	2	-	-	2	-	-	2	-	-	2	1	2
CO3	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO4	1	-	-	-	-	-	2	-	-	-	-	-	2	-	-
CO5	1	-	-	1	-	-	-	-	-	2	-	2	-	1	-
AVERAGE	1.4	0.4		0.6	0.4		0.8		0.4	0.8		0.6	1.2	0.8	0.4

PCP3201 ADVANCED MACHINE LEARNING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basic concepts and techniques of Machine Learning.
- To appreciate supervised and unsupervised learning and their applications
- To understand the theoretical and practical aspects of Probablistic Models
- To appreciate the concepts and algorithms of reinforcement learning
- To learn aspects of computational learning theory

TECHNIQUES:

- To study the various probability based learning techniques.
- To understand graphical models of machine learning algorithms.

UNIT – I **9**

Learning – Machine Learning Foundations –Overview – Design of a Learning system - Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version

Spaces and the Candidate Elimination Algorithm – Linear Discriminants –Linear Separability – Linear Regression.

UNIT – II **9**

Linear model for classification - Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT - III **9**

Decision trees – learning decision trees – Constructing Decision Trees -ranking and probability estimation trees – Regression trees – clustering trees – learning ordered rule lists – learning unordered rule lists – descriptive rule learning – association rule mining – first -order rule learning- Gaussian Mixture Models- Nearest Neighbor Methods –K means Algorithms- Vector Quantization – Self Organizing Feature Map.

UNIT - IV **9**

Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms –Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Directed graphical models- Undirected graphical models- Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

UNIT - V **9**

Sampling –Basic sampling methods- Monte Carlo- Reinforcement Learning- Model-Based Learning- Temporal Difference Learning Exploration Strategies- Deterministic and Non-deterministic Rewards Actions Computational Learning Theory - Mistake bound analysis, sample complexity analysis, VC dimension. Occam learning, applications in game playing – applications in robot control.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the appropriate machine learning strategy for any given problem
- Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
- Design systems that uses the appropriate graph models of machine learning
- Modify existing machine learning algorithms to improve classification efficiency
- Identify applications suitable for different types of machine learning with suitable justification

REFERENCE BOOKS:

1. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.
2. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
3. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.

4. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
5. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
6. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2011.
7. Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Chapman and Hall/CRC Press, Second Edition, 2014.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	3	3	3	2								3	3		2
2	3	3	3	3	2								2	2		2
3	3	3	3	3	2								2	2		2
4	3	3	3	3	2								2	2		2
5	3	3	3	3	2								2	2		2
Average	3	3	3	3	2								2.2	2.2		2

PCI341 ROBUST CONTROL **L T P C**

3 0 0 3

OBJECTIVES:

- To introduce norms, random spaces and robustness measures.
- To educate the students on H2 optimal control and estimation techniques.
- To educate the students on H-infinity optimal control techniques.
- To educate the students on the LMI approach of H-infinity control.
- To educate the students on synthesis techniques for robust controllers and illustrate through case studies.

UNIT-I TRODUCTION 9

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.

UNIT-II H_2OPTIMAL CONTROL 9

Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal estimation – Kalman Bucy Filter – LQG Controller.

UNIT-III H-INFINITY OPTIMAL CONTROL –RICCATIAPPROACH 9

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

UNIT-IV H-INFINITY OPTIMAL CONTROL –LMIAPPROACH 9

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

UNIT-V SYNTHESIS OF ROBUST CONTROLLERS &CASESTUDIES 9

Synthesis of robust controllers – Small gain theorem – D-K iteration – Control of inverted pendulum – Control of CSTR – Control of aircraft – Robust control of distillation column.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach.
- Ability to detect faults in sensor and actuators using GLR and MLR based approaches.
- Ability to design sensor and actuators using GLR and MLR based approaches.
- Ability to explain various types of fault tolerant control schemes such as Passive and active approaches.
- Ability to Design fault-tolerant control scheme in the presence of actuator failures.

REFERENCE BOOKS:

1. Sinha A, "Linear Systems: Optimal and Robust Control", CRC Press,2007.
2. Da-Wei G, Petkov PH &Konstantinov MM "Robust Control Design with MATLAB®", New Age International,2006.
3. Cheng D, Sun Y, Shen T &Ohmori H, "Advanced Robust And Adaptive Control Theory And Applications", New Age International,2010.
4. Green M &Limebeer DJN, "Linear Robust Control, Dover Publications Inc.,2012.
5. Xue D, Chen YQ & Atherton, DP, "Linear Feedback Control: Analysis and Design with MATLAB", Society for Industrial and Applied Mathematics (SIAM),2007.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	2	-	1	-	-	3	-	2	1	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO4	1	-	-	2	-	-	-	-	-	-	1	-	-	3	1
CO5	2	-	-	1	-	2	-	-	2	1	1	-	-	-	-
AVERAGE	0.8	0.4		1		0.6			1	0.6	0.8	0.2	0.2	1	0.2

PCI342 **OPTIMAL CONTROL** **L T P C**

3 0 0 3

OBJECTIVES:

- To highlight the significance of optimal control in process industries and the different methods of optimization.
- Tointroducetheconceptofvariationalapproachforthedesignofoptimalcontrolsystem.
- To formulate linear quadratic optimal control strategy with specified degree of stability.
- To impart knowledge about discrete time linear state regulator system and discrete time linear quadratic tracking system.
- To illustrate the application of dynamic programming and HJB equation for the design of constrained and time optimal control systems.

UNIT-I INTRODUCTION TO OPTIMAL CONTROL 9

Statement of optimal Control problem - problem formulation and forms of optimal control - performance measures - various methods of optimization - Linear programming - nonlinear programming.

UNIT-II CALCULUS OFVARIATIONS 9

Basic concepts – variational problem - Extreme functions with conditions - variational approach to optimal control systems.

UNIT-III LINEAR QUADRATIC OPTIMALCONTROLSYSTEM 9

Problem formulation - finite time LQR - infinite time LQR - Linear Quadratic tracking system – LQR with a specified degree of stability.

UNIT-IV DISCRETE TIME OPTIMALCONTROL SYSTEM 9

Variational calculus for DT system – DT optimal control system - DT linear state regulator system -- DT linear quadratic tracking system .

UNIT-V PONTRYAGINMINIMUM PRINCIPLE 9

Pontryagin minimum principle-Dynamic programming – Hamilton - Jacobi – Bellmanequation- LQR system using HJB equation – Time optimal control – fuel optimal control system - optimal control system with constraints.

TOTAL: 45 PERIODS

OUTCOMES:

- Formulate the optimization problem based on the requirements and evaluate the performance of optimal controller.
- Apply the variational approach for optimal control systems with conditions.
- Differentiate finite time LQR and infinite time LQR and design linear quadratic tracking system.
- Analyze discrete time optimal control systems used in different applications.
- Design constrained optimal control system and time optimal control system.

REFERENCE BOOKS:

1. Naidu D.S, Optimal Control System, CRC Press,2003.
2. Kirk D.E, Optimal Control Theory, Dover publication,2004.
3. Lewis F.L. DragunaVrabia, Syrmos V.L, Optimal control, John Wiley & sons,2012.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	2	-	1	-	-	3	-	2	1	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO4	1	-	-	2	-	-	-	-	-	-	1	-	-	3	1
CO5	1	2	-	2	-	-	-	-	2	2	-	-	1	-	-
AVERAGE	0.6	0.8		1.2		0.2			1	0.8	0.6	0.2	0.4	1	0.2

PCI343	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To give an overview on the different data driven identification methods.
- To make the student understand the principles of relay based identification.
- To enable the student to select a suitable model for identification.
- To elaborate the concept of estimating the parameters of the selected models using parameter estimation algorithm.
- To enable the student to identify Relay Feedback Identification and Closed-Loop Identification.
- To provide the background on the practical aspects of conducting experiments for real time system identification.

UNIT - I: INTRODUCTION **9**

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

UNIT - II: PARAMETER ESTIMATION METHODS **9**

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

UNIT - III: RELAY FEEDBACK IDENTIFICATION **9**

A generalized relay feedback identification method – model; structure selection - relay feedback identification of stable processes: FOPDT and SOPDT model. Illustrative examples.

UNIT - IV: CLOSED-LOOP IDENTIFICATION **9**

Identification of systems operating in closed loop: Identifiability considerations– direct identification indirect identification -Subspace Identification methods: classical and innovation forms, Joint input–output identification.

UNIT - V: PRACTICAL ASPECTS OF IDENTIFICATION **9**

Practical aspects: experimental design –input design for identification, notion for persistent excitation, drifts and de-trending–outliers and missing data –pre-filtering –Model validation and Model structure determination-case studies: identification of simple FOPDT and SOPDT systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Ability to develop various models from the experimental data.
- Will be able to select a suitable model and parameter estimation algorithm for the identification of systems.
- Will be able to carry out the verification and validation of identified model.
- Will gain the Relay Feedback Identification and Closed-Loop Identification.
- Will gain expertise on using the model for prediction and simulation purposes and for developing suitable control schemes.

REFERENCE BOOKS:

1. Karel J.Keesman,” System Identification an Introduction”, Springer, 2011.
2. Lennart Ljung, “System Identification: Theory for the user”, Second edition, Prentice Hall,1999.
3. Tao Liu, Furong Gao, “Industrial Process Identification and control design, Step-test and relay - experiment - based methods”, Springer - Verilog London Ltd, 2012.
4. T.S.Soderstrom, Petre G.Stoica, “System Identification”, Prentice Hall, 1989.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	-	2	-	2	-	-	2	2	1	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	3	-	-	-	-	-	-	2	-	-	-	-	-
CO4	3	-	-	-	-	-	2	-	-	-	1			3	1
CO5	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-
AVERAGE	0.8		0.6	0.2	0.4		0.8			0.8	0.6	0.2	0.6	1	0.2

PCI344	FAULT TOLERANT CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To give an overview of different Fault Detection and Diagnosis methods.
- To impart knowledge and skills needed design and detect faults in sensor and actuators using GLR.
- To impart knowledge on MLR based Approaches.
- To present an overview of various types of fault tolerant control schemes.
- To impart knowledge on Passive and active approaches.

UNIT - I: INTRODUCTION TO MODEL – BASED FAULT DIAGNOSIS 9

Introduction to Fault tolerant control - Types of faults and different tasks of Fault Diagnosis and Implementation -Mathematical representation of Faults and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties.

UNIT - II: DESIGN OF STRUCTURED RESIDUALS & DIRECTIONAL STRUCTURED RESIDUALS 9

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

UNIT - III: FAULT DIAGNOSIS USING STATE ESTIMATORS 9

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

UNIT - IV: ACTUATOR AND SENSOR FAULT-TOLERANT CONTROL DESIGN 9

Introduction - Plant Models - Nonlinear Model - Linear Model. Sensor Faults - Model -based Fault Diagnosis Actuator / Sensor Fault Representation - Actuator and Sensor Faults Estimation. Fault Estimation Based on -Unknown Input Observer - Decoupled Filter - Singular Value Decomposition .Sensor Fault - tolerant Control Design - Fault-tolerant Control Architecture - General Fault-tolerant Control Scheme.

UNIT - V: CASE STUDIES 9

Fault tolerant Control of Three-tank System –Diagnosis and Fault-tolerant control of Chemical process – Different types of faults in Control valves – Automatic detection, Application to a Winding Machine - Sensor Fault-tolerant Control Method for Active Suspension System.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach.
- Ability to design and detect faults in sensor and actuators using MLR based approaches.
- Ability to design and detect faults in sensor and actuators using GLR based approaches.

Ability to explain various types of fault tolerant control schemes such as Passive and active approaches.

- Ability to Design fault-tolerant control scheme in the presence of actuator failures.

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REFERENCE BOOKS:

1. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, Fault-Tolerant Control Systems: Design and Practical Applications, Springer Publication, 2009
2. Janos J. Gertler, “Fault Detection and Diagnosis in Engineering systems” – 2nd Edition, Marcel Dekker,1998
3. Rolf Isermann, Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.
4. Ali Ahammad Shoukat Choudhury, Sirish L. Shah, Nina F. Thornhill, Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches, Springer, 2008
5. Mogens Blanke, Diagnosis and Fault-Tolerant Control, Springer, 2003.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	-	-	-	1	-	-	2	2	-	1	-	2
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	3	-	-	-	-	-	3	1
CO5	-	2	-	2	-	-	-	-	-	-	2	-	1	-	-
AVERAGE	0.8	1	0.2	0.4	0.4		0.2	0.6		0.4	0.8		0.4	1	0.6

PPS504	SMART GRID	L	T	P	C
		3	0	0	3

OBJECTIVES:
1. To Study about Smart Grid and its present developments.
2. To familiarize about Smart Grid technologies.
3. To familiarize the different smart meters and advanced metering infrastructure.
4. To illustrate the basic concepts of the power quality management issues in Smart Grid.
5. To impart knowledge on the fundamental concepts of the high performance computing for Smart Grid applications.

UNIT-I: INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid.

UNIT-II: SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT-III:SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, Standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT-IV: POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT-V:HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Networking Fundamentals - Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

OUTCOMES:

- Learners will develop more understanding on the concepts of Smart Grid and its present developments.
- Learners will study about different Smart Grid technologies.

- Learners will acquire knowledge about different smart meters and advanced metering infrastructure.
- Learners will have knowledge on power quality management in Smart Grids
- Learners will develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

.

REFERENCE BOOKS:

1 Stuart Borlase "Smart Grid Infrastructure, Technology and Solutions", CRC Press2012.

2 JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley2012.

3 Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecatiand Gerhard P. Hancke, "Smart Grid Technologies: Communication Technologies and Standards" IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November2011.

4 Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey" , IEEE Transaction on Smart Grids, vol. 14,2012.

CO-PO and PSO Mapping:

1905404	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1	1			1	1	2						1		
CO2	1	1	1			1	1	2						2		
CO3	1	1	2			1	1	2						2		
CO4	1	1	1			1	1	2						2		
CO5	1	1	1			1	1	2						1		
AVERAGE	1	1	1.			1	1	2						1.		

PPS505	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Awareness about renewable Energy Sources and technologies.
- Adequate inputs on a variety of issues in harnessing renewable Energy.
- Recognize current and possible future role of renewable energy sources.
- To get adequate knowledge of PV systems and Wind Energy systems.
- To understand the biomass energy system and other energy sources.

UNIT-I: RENEWABLE ENERGY (RE) SOURCES 9

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

UNIT -II: WIND ENERGY 9

Power in the Wind – Types of Wind Power Plants (WPPs)–Components of WPPs Working of WPPs-

Siting of WPPs-Grid integration issues of WPPs.

UNIT -III: SOLAR PV AND THERMAL SYSTEMS 9

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with PCM- Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, **Applications of Solar PV in Electric Vehicle.**

UNIT -IV: BIOMASS ENERGY 9

Battery Basics- Introduction-Biomass resources –Energy from Biomass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

UNIT -V: OTHER ENERGY SOURCES 9

Tidal Energy: Energy from the tides, Barrage and Non-Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)-Hydrogen Production and Storage- Fuel cell: Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems, Need for Hybrid Systems-Range and type of systems.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to create awareness about renewable Energy Sources and technologies.
- Ability to get adequate inputs on a variety of issues in harnessing renewable Energy.
- Ability to recognize current and possible future role of renewable energy sources.
- Ability to explain the various renewable energy resources and technologies and their applications.
- Ability to understand basics about biomass energy.

TEXT BOOKS:

T1. Joshua Earnest, Tore Wizeliu, Wind Power Plants and Project Development, PHI Learning Pvt.Ltd, New Delhi, 2011.

T2. D.P.Kothari, K.C Singal, Rakesh Ranjan “Renewable Energy Sources and Emerging Technologies”, PHI Learning Pvt.Ltd, New Delhi,2013.

T3. Scott Grinnell, “Renewable Energy & Sustainable Design”, CENGAGE Learning, USA, 2016.

REFERENCES:

R1. A.K.Mukerjee and Nivedita Thakur,” Photovoltaic Systems: Analysis and Design”, PHI Learning Private Limited, New Delhi, 2011..

R2. Richard A. Dunlap,” Sustainable Energy” Cengage Learning India Private Limited, Delhi,2015.

R3. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, New Delhi,2011.

R4. Bradley A. Striebig, Adebayo A.Ogundipe and Maria Papadakis,”Engineering Applications in Sustainable Design and Development”, Cengage Learning India Private Limited, Delhi, 2016.

R5. Godfrey Boyle, “Renewable energy”, Open University, Oxford University Press in association with the Open University, 2004.
R6. Shobh Nath Singh, ˆNon-conventional Energy resources, Pearson Education, 2015.

CO-PO and PSO Mapping:

1905404	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	3	2	1	3	2	2				2	3		2	
CO2	3	2	2	2	2	3		2				2		1	2	
CO3	3	2	1	3	2	3		2				2	2		2	
CO4	3	2	2	2	1	3		2				2	2		2	
CO5	3	2	2	2	3	3		2				2	3		2	
AVERAGE	3	2	2	2.2	1.8	3	0.4	2				2	2	0.2	2	

PCI343 ROBOTICS AND AUTOMATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basic elements used in robot.
- To analyse the kinematics of robots.
- To derive the path for the robot arm.
- To provide the dynamic modelling of the robot.
- To understand the various robot control mechanism.

UNIT-I ELEMENTS OF ROBOTS 9

Introduction - brief history, types, classification and usage, Science and Technology of robots, Elements of robots – links, joints, actuators, and sensors, Position and orientation of a rigid body, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

UNIT-II KINEMATICS 9

Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators Inverse kinematics solution for the general 6R serial manipulator.

UNIT-III VELOCITY ANALYSIS AND PATH PLANNING 9

Linear and angular velocity of links, Velocity propagation, Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-singularity analysis Robot Path planning.

UNIT-IV DYANAMIC MODELING OF ROBOT 9

Lagrangian formulation for equations of motion, Generation of symbolic equations of motion Two-DOF manipulator- Lagrange-Euler formulation – Newton-Euler formulation – Inverse dynamics.

UNIT-V ROBOTCONTROL MECHANISM **9**

Motion planning and control and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Nonlinear model based control schemes.

TOTAL: 45PERIODS

OUTCOMES:

- Comprehends the knowledge of basic elements of a robot .
- Concepts of Robot mathematical modeling.
- Ability to analyse for kinematics, Dynamics and path planning.
- To know about the differential motion and statics in robotics.
- Learn about various linear and nonlinear control techniques of the robot.

REFERENCE BOOKS:

1. R.K. Mittal and I J Nagrath, "Robotics and Control", Tata Mac Graw Hill, Fourth Reprint 2007.
2. Ghosal A., "Robotics: Fundamental Concepts and Analysis", Oxford University Press,2nd reprint, 2008.
3. Fu.K, Gonzalez, R. and Lee, C. S. G., "Robotics: Control, Sensing, Visionand Intelligence¸ McGraw - Hill, 1987.
4. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering, A Integrated approach", Prentice Hall of India, 2003.
5. Saeed B. Niku ,''Introduction to Robotics '', Pearson Education,2010.
6. Reza N.Jazar, "Theory of Applied Robotics Kinematics, Dynamics and Control", Springer, Fist Indian Reprint 2010.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	2	-	-	-	3	-	-	3	1	1	-	2
CO2	1	-	-	-	2	-	-	-	-	-	-	-	-	2	-
CO3	-	1	-	-	-	-	-	2	-	-	2	-	-	3	1
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	1	2	-	1	-	-	-	1	-	-	1	-	-	-	-
AVERAGE	0.8	0.6		0.6	0.4			1.2			1.2	0.2	0.2	1	0.6

PCI344 **ROBOTICS AND CONTROL**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce robot terminologies and robotic sensors.
- To educate direct and inverse kinematic relations.
- To educate on formulation of manipulator Jacobians and introduce path planning techniques.
- To educate on robot dynamics.
- To introduce robot control techniques.
- To study various applications of robot.

UNIT-I INTRODUCTION AND TERMINOLOGIES 9

Definition-Classification-History- Robots components-Degrees of freedom-Robot joints-coordinates- Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors-proximity and range sensors-vision system-social issues.

UNIT-II KINEMATICS 9

Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics solution and programming-degeneracy and dexterity.

UNIT-III DIFFERENTIAL MOTION AND PATH PLANNING 9

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Robot Path planning.

UNIT-IV DYNAMIC MODELLING 9

Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton- Euler formulation – Inverse dynamics.

UNIT-V ROBOT CONTROL SYSTEM 9

Linear control schemes-joint actuators-decentralized PID control computed Torque Control–force control- hybrid position force control- Impedance/ Torque control.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to understand the components and basic terminology of Robotics.
- Ability to model the motion of Robots
- Ability to analyze the workspace and trajectory panning of robots.
- Ability to develop application based Robots.
- Ability to formulate models for the control of mobile robots

REFERENCES:

1. R.K. Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, Fourth edition.
2. Saeed B. Niku ,’’Introduction to Robotics ’’, Pearson Education,2002.
3. Fu, Gonzalez and Lee McGraw Hill,’’Robotics ", international edition.
4. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering, An Integrated approach", Prentice Hall of India, 2003.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	-	-	2	-	-	-	3	-	-	3	-	2	-	-
CO2	1	-	-	-	2	-	-	-	-	-	-	-	-	2	-
CO3	-	1	-	-	-	-	-	2	-	-	2	-	-	-	3
CO4	-	-	-	-	-	3	-	-	-	-	-	1	-	1	-
CO5	2	1	-	-	2	-	-	1	-	-	1	-	-	-	-
AVERAGE	1	0.4		0.4	0.8	0.6		1.2			1.2	0.2	0.4	0.6	0.6

PCI345 DIGITAL INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVES

- To discuss to the students on the fundamentals building blocks of a digital instrument.
- To teach the digital data communication techniques.
- To study on bus communication standards and working principles.
- To teach Graphical programming using GUI for instrument building.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT-I DATA ACQUISITION SYSTEMS 9

Overview of A/D converter, types and characteristics – Sampling, Errors. Objective – Building blocks of Automation systems -Calibration, Resolution, Data acquisition interface requirements.– Counters – Modes of operation- Frequency, Period, Time interval measurements, Prescaler, Heterodyne converter for frequency measurement, Single and Multi-channel Data Acquisition systems-Digital storage Oscilloscope-digital display interface.

UNIT-II INSTRUMENT COMMUNICATION 9

Introduction, Modem standards, Data transmission systems- Time Division Multiplexing (TDM) – Digital Modulation Basic requirements of Instrument Bus Communications standards, interrupt and data handshaking , serial bus- basics, Message transfer, - RS-232, USB, RS-422, Ethernet Bus- CAN standards interfaces .General considerations -advantages and disadvantages- Instrumentation network design ,advantages and limitations ,general considerations, architecture, model, and system configuration of : HART network, Mod Bus,Fieldbus.

UNIT-III VIRTUAL INSTRUMENTATION BASICS 9

Block diagram, role and Architecture for VI–– tool bar,Graphical system design &programming usingGUI –Virtual Instrumentation for test, control design-modular programming-conceptual and program approaches for creation of panels,icons-Loops-Arrays-clusters-plotting data-structures-strings and File I/O- Instrument Drivers

UNIT-IV CONFIGURINGPROGRAMMABLE INSTRUMENTATION 9

Microprocessor based system design –Peripheral Interfaces systems and instrument communication standards –Data acquisition with processor and with VI – Virtual Instrumentation Software and hardware simulation of I/O communication blocks-peripheral interface – ADC/DAC – Digital I/O – Counter , Timer-servo motor control-PID control.

UNIT-V CASE STUDIES 9

Processor based DAS, Data loggers, VI based process measurements like temperature, pressure and level development system- DSO interface -digital controller for colour video display.

Note: Class room discussions and tutorials can include the following guidelines for improved teaching /learning process: Discussions/Exercise/Practice on Workbench for Digital Control of Relays/Solenoids, Digital I/O – Counter, Timer-servo motor control-PID control / LCD graphics Interface/storage interface.

TOTAL: 45 PERIODS

OUTCOMES:

- Use digital integrated circuit logic family chips.
- Perform computational and measurement activities using digital techniques, build sequential and combinational logic circuits.
- Analyse working of A/D and D/A converters, use display devices for digital circuits, use digital meters for measurements.
- Graduates will understand the fundamental principles of electrical and electronics circuit and instrumentation, enabling them to understand current technology and to adapt to new devices and technologies.
- Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

REFERENCE BOOKS:

1. Mathivanan, “PC based Instrumentation Concepts and practice”, Prentice-Hall India,2009.
2. JovithaJerome,”Virtual Instrumentation usingLabview”PHI,2010.
3. Gregory J. Pottie / William J. Kaiser, Principles of Embedded Networked Systems Design, CAMBRIDGE UNIVERSITY PRESS (CUP), 2016.
4. Jonathan W Valvano, “Embedded Microcomputer systems”, Brooks/Cole, Thomson,2010.
5. Cory L.Clark,”Labview Digital Signal Processing & Digital Communication,TMcH, 2005.
6. Lisa K. wells & Jeffrey Travis, Lab VIEW for everyone, Prentice Hall, NewJersey,1997.
7. H S Kalsi, “Electronic Instrumentation” Second Edition, TataMcGraw-Hill,2006.
8. K.Padmanabhan, S.Ananthi A Treatise on Instrumentation Engineering, IKPublish,2011.
9. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGHill,Newyork,1997.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	2	-	-	-	-	3	-	2	-	1	-	-
CO2	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	-	-	2	-	-	-	2	-	-	-	-	-	-	2
CO4	-	-	-	1	-	-	-	-	-	-	-	1	2	-	-
CO5	1	-	-	-	-	-	1	-	2	-	-	1	-	3	-
AVERAGE	0.8	0.2		1			0.2	0.4	1		0.4	0.4	0.6	1	0.4

PCI351	**INTERNET OF THINGS AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To give an overview of the Interconnection and Integration of the Physical World with Cyber Space.
- To provide an insight into Design of IOT application.
- To impart knowledge on trends of future networking.
- To provide an insight into Development of IOT application.
- To understand the concepts of data analytics.

UNIT - I: INTERNET PRINCIPLES 9

Definition and Characteristics - IoT enabling technologies – Levels of deployment – Domain specific IoTs - SDN and NFV for IoT – ISO/OSI model – MAC address and IP address - Overview of TCP/IP and UDP - Basics of DNS - Classes of IP addresses - Static and dynamic addressing – Salient features of IPV4 – Specifications of IPV6 and 6LoPAN.

UNIT - II: PHYSICAL AND LOGICAL DESIGN METHODOLOGIES 9

Requirements and Specifications – Device and Component Integration —Physical design using prototyping boards - Sensors and actuators, choice of processor, interfacing and networking - Logical Design – Open source platforms - Techniques for writing embedded code - Case studies and examples using Python programming and Arduino/Raspberry Pi prototyping boards – IoT application development using Wireless Sensor Networks - Single Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes.

UNIT - III: PROTOCOLS AND CLOUDS FORIOT 9

Application layer protocols for IoT – MQTT and – Introduction to cloud storage models and communication APIs – Web application framework – Designing a web API – Web services - IoT device management.

UNIT - IV: INDUSTRIAL IOT AND SECURITY 9

Introduction to the Industrial Internet - Networked Control Systems – Network delay modeling- Architecture and design methodologies for developing IoT application for Networked Control Systems – Example using SCADA system - Software Design Concepts - Middleware IIOT platforms- securing the Industrial Internet- Introduction of Industry 4.0.

UNIT - V: PROCESS DATA ANALYTICS 9

Process analytics - Dimensions for Characterizing process- process Implementation technology Tools and Use Cases - open source and commercial tools for Process analytics - Big data Analytics for process data - Analyzing Big process data problem – Crowd sourcing and Social BPM - Process data management in the cloud.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Gain knowledge about the principles of Internet.
- Ability to realize an IoT application using physical devices, operating systems and programming tools.
- Ability to Cloud-based computing & storage for IoT.
- Realize the need for security.
- Ability to understand the concept of process data analytics.

REFERENCES BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things A Hands-on Approach", Universities Press (India), 2015.
2. Alasdair Gilchrist," Industry 4.0: The Industrial Internet of Things", A press,2016.
   Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley & Sons, 2014.
3. Francis Dacosta, "Rethinking the Internet of Things", A press Open, 2014.
4. Beheshti, S.-M.-R., Benatallah, B., Sakr, S., Grigori, D., Motahari - Nezhad, H.R., Barukh, M.C., Gater, A., Ryu, S.H." Process Analytics Concepts and Techniques for Querying and Analyzing Process Data" Springer International Publishing Switzerland, 2016.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	-	-	-	-	-	-	1	1	-	1	-	2
CO2	-	1	-	-	-	-	-	-	-	-	-	1	-	2	-
CO3	-	-	-	-	-	1	-	-	2	-	-	-	2	-	-
CO4	-	1	-	3	-	-	-	-	-	-	2	-	-	3	-
CO5	1	2	-	-	-	2	-	-	1	2	-	-	-	1	-
AVERAGE	0.6	0.8	0.2	0.6		0.6			0.6	0.6	0.6	0.2	0.6	1.2	0.4

PCI352 **WIRELESS SENSOR NETWORKS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce the technologies and applications for the emerging domain of wireless sensor 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 used in the design of WSN.
- To familiarize the students with software platforms used in the design of WSN.

UNIT - I: INTRODUCTION 9

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 – Introduction to LRWPAN – Design procedure for WSN development.

UNIT - II: PHYSICAL INTRODUCTION LAYER 9

Wireless 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.

UNIT - III: DATA LINK LAYER 9

MAC protocols – fundamentals of wireless MAC protocols – MAC standards for WSN: IEEE 802.15.4 STD, ISA 100, low duty cycle protocols and Sleep - wake up concepts, contention - based protocols, Schedule-based protocols, Link Layer protocols – fundamentals task and requirements, error control, framing, link management.

UNIT - IV: NETWORK LAYER 9

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**,** Wireless HART, PROFIBUS and MODBUS protocols.

UNIT - V: WSN DESIGN METHODOLOGY 9

Network Simulators and Programming tools for WSN– Programming Challenges – Security Challenges – Implementation Issues – case study on networked control system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Ability to analyze WSN with respect to various performance parameters in the protocol stack.
- Ability to understand MAC algorithms
- Ability to work with Network protocols used for specific WSN applications.
- Design and develop a WSN for a given application.
- Ability to familiar various network standards.

REFERENCE BOOKS:

1. Ivan Stojmenovic, “Handbook of Sensor Networks: Algorithms and Architectures”, Wiley, 2005.
2. Kazem Sohraby, Daniel Minoli and Taieb Znati, “Wireless Sensor Networks Technology, Protocols and Applications”, John Wiley, 2007.
3. Bhaskar Krishnamachari, “Networking Wireless Sensors”, Cambridge University Press, 2011.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	2	-	-	-	-	2	-	-	-	1	-	1
CO2	-	2	-	-	1	-	1	-	-	-	-	-	-	1	-
CO3	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-
CO4	1	-	-	-	-	-	1	-	-	1	-	1	2	-	-
CO5	1	1	-	1	2	-	1	-	-	-	1	-	-	2	-
AVERAGE	0.8	0.6		0.6	0.6		0.6		0.4	0.2	0.6	0.2	0.6	1.2	0.2

PCI353 **MEMS TECHNOLOGY**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES.

- To teach the students properties of materials, microstructure and fabrication methods.
- To teach the design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling.
- To teach the fundamentals of piezoelectric sensors and actuators through exposure to different MEMS and NEMS devices.
- To involve Discussions/Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT - I: MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS 9

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors - Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress - resonant frequency and quality factor.

UNIT - II: ELECTROSTATIC SENSORS AND ACTUATION 9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators - Applications.

UNIT - III: THERMAL SENSING AND ACTUATION 9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT - IV: PIEZO ELECTRIC SENSING AND ACTUATION 9

Piezoelectric effect - cantilever piezoelectric actuator model - properties of piezoelectric materials - Applications.

UNIT - V: CASE STUDIES 9

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS - NEMS Devices.

Note: Class room discussions and tutorials can include the following guidelines for improved teaching / learning process: Discussions / Exercise / Practice on Workbench: on the basics / device model design aspects of thermal / peizo / resistive sensors etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Understand basics of micro fabrication, develop models and simulate electrostatic and electromagnetic sensors and actuators.
- Understand material properties important for MEMS system performance, analyze dynamics of resonant micro mechanical structures.
- The learning process delivers insight onto design of micro sensors, embedded sensors & actuators in power aware systems like grid.
- Understand the design process and validation for MEMS devices and systems, and learn the state of the art in optical micro systems.

- Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

REFERENCE BOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2. Marc Madou , “Fundamentals of micro fabrication ”, CRC Press,1997.
3. Boston, “Micromachined Transducers Source book”, WCB McGraw Hill, 1998.
4. M.H. Bao “Micromechanical transducers Pressure sensors, accelerometers and gyroscopes”, Elsevier, NewYork, 2000.

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	2	-	-	-	-	3	-	-	1	1	-	2
CO2	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	1	-	-	3	-	-	-	-	-	-	2	-	3
CO4	2	-	-	-	-	-	-	-	-	-	-	1	-	3	-
CO5	-	3	-	-	-	2	-	-	-	-	2	-	-	1	-
AVERAGE	0.8	0.8	0.2	0.4		1			0.6		0.4	0.4	0.6	1.2	1

CP3166 ADVANCED ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the various characteristics of Intelligent agents.
- To learn the different search strategies in AI.
- To learn to represent knowledge in solving AI problems.
- To understand the different ways of designing software agents.
- To know about the various applications of AI.

UNIT I -INTRODUCTION 9

Introduction - Foundation and history of AI. AI Problems and techniques - AI programming languages – Introduction to LISP and PROLOG – Problem spaces and searches -Blind search strategies; Breadth first - Depth first –Heuristic search techniques Hill climbing - Best first – A* algorithm AO* algorithm – game trees Minimax algorithm – Game playing – Alpha beta pruning.

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UNIT-II PROBLEM SOLVING METHODS 9

Knowledge representation issues – Predicate logic – logic programming – Sematic nets -Frames and inheritance - constraint propagation –Representing Knowledge using rules – Rules based deduction system.

UNIT - III: REASONING UNDER UNCERTAINTY 9

Introduction to uncertain knowledge review of probability – Baye’s Probabilistic inferences and Dempster Shafer theory –Heuristic methods – Symbolic reasoning under uncertainty- Statistical reasoning – Fuzzy reasoning – Temporal reasoning- Non monotonic reasoning.

UNIT - IV: PLANNING AND LEARNING **9**

Planning - Introduction, Planning in situational calculus - Representation for planning – Partial order planning algorithm- Learning from examples- Discovery as learning – Learning by analogy – Explanation based learning –Introduction to Neural nets – Genetic Algorithms

UNIT - V: APPLICATIONS **9**

Principles of Natural Language Processing Rule Based Systems Architecture - Expert systems Knowledge Acquisition concepts – AI application to robotics – Current trends in Intelligent Systems.

TOTAL :45 PERIODS

OUTCOMES:

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

- Use appropriate search algorithms for any AI problem.
- Represent a problem using first order and predicate logic.
- Provide the apt agent strategy to solve a given problem.
- Design software agents to solve a problem.
- Design applications for NLP that use Artificial Intelligence.

TEXT BOOKS:

1. Patrick Henry Winston," Artificial Intelligence", Addison Wesley, Books Third edition, 2000.

REFERENCE BOOKS:

1. George F Luger, Artificial Intelligence, Pearson Education, 6th edition, 2009.
2. Engene Charniak and Drew Mc Dermott," Introduction to Artificial intelligence, Addison Wesley 2000.
3. Nils J. Nilsson,"Principles of Artificial Intelligence", Narosa Publishing House, 2000

CO	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1		1				3						2		
CO2			2										3	
CO3	3			2								1		
CO4		2			3								2	
CO5	2		2									3		
AVERAGE	1	0.6	0.8	0.4	0.6	0.6						1.2	1	

PCI334	WASTE MANAGEMENT AND ENERGY RECOVERY TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide information on various methods of waste management.
- To Impart Knowledge about separation techniques & Transformation Technologies.
- To detail on the recent technologies of waste disposal
- To familiarize students with recent energy generation techniques.
- To make student realize on the importance of healthy environment.

UNIT I CHARACTERISTICS AND PERSPECTIVES 9

Sources – Types – Composition – Generation – Estimation Techniques – Characterization –Types of Collection System – Transfer Stations – Transfer Operations – Material Recycle/ Recovery Facilities.

UNIT II UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES 9

Separation & Processing: Size Reduction – Separation through Density Variation, Magnetic / Electric Field: Densification - Physical, Chemical and Biological Properties and Transformation Technologies – Selection of Proper Mix of Technologies.

UNIT III WASTE DISPOSAL 9

Disposal Option & Selection Criteria - Landfill Classification – Types – Siting Considerations – Landfill Gas (Generation, Extraction, Gas Usage Techniques) – Leachates Formation, Movement, Control Techniques – Environmental Quality Monitoring – Layout, Closure & Post Closure Operation – Reclamation - Waste Disposal: A Case Study of Bangalore

UNIT IV TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION 9

Physical Transformation: Component Separation & Volume Reduction: Chemical Transformation– Combustion/Gasification/ Pyrolysis: Energy Recovery - Biological Transformation – Aerobic Composting – Anaerobic Digestion.

UNIT V HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING 9

Definition – Sources – Classification – Incineration Technology - Incineration vs Combustion Technology – RDF / Mass Firing – Material Recycling Paper / Glass / Plastics etc., - Disposal of White Goods & E-Wastes. Hazardous Waste Management: Generation, Storage & Collection, Transfer & Transport, Processing, Disposal-Hazardous Waste Treatment: Physical & Chemical Treatment, Thermal Treatment, Biological Treatment - Pollution Prevention and Waste Minimization-Hazardous Wastes Management in India.

TOTAL: 45 PERIODS

REFERENCES

1. George Polimveros, 'Energy Cogeneration Hand book', Industrial Press Inc, New York 1982.
2. Howard S. Peavy etal, 'Environmental Engineering', McGraw Hill International Edition, 1985.
3. LaGrega, M., et al., 'Hazardous Waste Management', McGraw-Hill, c. 1200 pp., 2nd edition.,2001.
4. Manoj Datta, 'Waste Disposal in Engineered Landfills', Narosa Publishing House, 1997.
5. Parker Colin and Roberts, 'Energy from Waste – An Evaluation of Conversion Technologies',Elsevier Applied Science, London, 1985.
6. Stanley E. Manahan, 'Hazardous Waste Chemistry, Toxicology and Treatment', Lewis

Publishers, Chelsea, Michigan, 1990.
7. Tchobanoglous, Theisen and Vigil, ‘Integrated Solid Waste Management’, 2d Ed. Mc-GrawHill, New York, 1993.
8. Freeman, M. H.1988. ‘Standard Handbook of Hazardous Waste Treatment and Disposal’, Mc-Graw-Hill Book Company, New York.
9. Tchobanoglous, G., Theisen, H. and Eliassan, R. ‘Solid Wastes Engineering Principles and Management Issues’, McGraw-Hill Book Company, New York, 1977.

COURSE OUTCOMES:

- Acquired basic knowledge about the Methods of Waste Management.
- Understand the concept of Segregation & Transformation Techniques.
- Learned the technologies that are available for effective waste disposal along with pros/ cons.
- Ability to develop various Energy generation Techniques.
- Able to predict the waste related problems (Hazardous Waste, Pharma Waste, Biomedical Waste etc).

CO-PO and PSO Mapping:

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	-	-	-	2	-	-	-	2	-	-	1	1	2	-
CO2	1	2	-	2	-	-	2	-	-	2	-	-	2	1	2
CO3	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO4	1	-	-	-	-	-	2	-	-	-	-	-	2	-	-
CO5	1	-	-	1	-	-	-	-	-	2	-	2	-	1	-
AVERAGE	1.4	0.4		0.6	0.4		0.8		0.4	0.8		0.6	1.2	0.8	0.4