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 – 2019
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**															
	Applied Mathematics for Electrical Engineers	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
	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
SEM-II	**THEORY**															
	Advanced Process Control	1	2	2	3	2	-	-	-	1	-	1	2	1	2	3
	Industrial Automation	1	2	2	2	2	-	1		1	-	1	1	1	2	3
	Advanced Control Systems	1	2	1	2	1	1	2	1	1	1	1	2	1	2	3
	Professional Elective - I															
	Professional Elective -II															
	Professional Elective -III															
	PRACTICALS															
	Digital Control and Instrumentation Laboratory	1	2	2	2	3	2	3	2	3	2	3	3	1	2	2
	Automation Laboratory	1	2	2	2	3	2	3	2	3	2	3	3	1	2	2
SEM-III	Professional Elective - IV															
	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	1	3	3	2	1	1	1	1	2	-	1	1	2	1
	Control of Electric Drives	1	2	2	2	2	-	1	-	2	1	1	1	1	2	2
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
ELECTIVE - III	Modeling and Simulation	1	2	3	3	2	-	1	1	2	-	1	2	1	2	2
	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

SEMESTER – III

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 - 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
	Chemical Process Systems	1	2	2	2	2	1	1	1	-	-	-	1	-	2	3
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
	Artificial Intelligence	1	2	2	2		2	2	2	2	2	-	1	1	2	1
	Machine Learning	1	2	2	2	2	2	2	2	2	2	-	1	1	2	1

REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
M.E. CONTROL AND INSTRUMENTATION ENGINEERING
CURRICULA & SYLLABI I TO IV SEMESTERS

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1918106	Applied Mathematics for Electrical Engineers	FC	4	4	0	0	4
2.	1913101	Transducers and Smart Instruments	PC	3	3	0	0	3
3.	1913102	System Theory	PC	4	3	1	0	4
4.	1913103	Control System Design	PC	4	4	0	0	4
5.	1913104	Design of Embedded Systems	PC	3	3	0	0	3
PRACTICALS								
6.	1913105	Modeling and Simulation Laboratory	PC	4	0	0	4	2
			TOTAL	**22**	**17**	**1**	**4**	**20**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1913201	Advanced Process Control	PC	4	4	0	0	4
2.	1913202	Industrial Automation	PC	3	3	0	0	3
3.	1913203	Advanced Control Systems	PC	3	3	0	0	3
4.	19XXXXX	Professional Elective - I	PE	3	3	0	0	3
5.	19XXXXX	Professional Elective - II	PE	3	3	0	0	3
6.	19XXXXX	Professional Elective - III	PE	3	3	0	0	3
PRACTICALS								
7.	1913213	Digital Control and Instrumentation Laboratory	PC	4	0	0	4	2
8.	1913214	Automation Laboratory	PC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	19XXXXX	Professional Elective - IV	PE	3	3	0	0	3
2.	19XXXXX	Professional Elective - V	PE	3	3	0	0	3
3.	19XXXXX	Professional Elective - VI	PE	3	3	0	0	3
PRACTICALS								
4.	1913314	Project Work Phase - I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	1913401	Project Work Phase - II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

SUMMARY

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

M.E. Control and Instrumentation Engineering

S.No	SUBJECT AREA	CREDIT PER SEMESTER				CREDITS TOTAL	%
		I	II	III	IV		
1.	**HS**	**-**	**-**	**-**	**-**	**-**	**-**
2.	**FC**	4	-	-	-	**4**	6
3.	**BS**	-	-	-	-	-	-
4.	**ES**	-	-	-	-	-	-
5.	**PC**	16	14	-	-	**30**	43
6.	**PE**	-	9	9	-	**18**	26
7.	**OE**	-	-	-	-	-	-
8.	**EEC**	-	-	6	12	**18**	26
9.	**PCD**	-	-	-	-	-	-
	TOTAL	**20**	**13**	**15**	**12**	**70**	**100**

TOTAL NO. OF CREDITS: 70

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	Course Code	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1913314	Project Work Phase - I	EEC	12	0	0	12	6
2.	1913401	Project Work Phase - II	EEC	24	0	0	24	12

FOUNDATION COURSES (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1918106	Applied Mathematics for Electrical Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1913101	Transducers and Smart Instruments	PC	3	3	0	0	3
2.	1913102	System Theory	PC	4	3	1	0	4
3.	1913103	Control System Design	PC	4	4	0	0	4
4.	1913104	Design of Embedded Systems	PC	3	3	0	0	3
5.	1913105	Modeling and Simulation Laboratory	PC	4	0	0	4	2
6.	1913201	Advanced Process Control	PC	4	4	0	0	4
7.	1913202	Industrial Automation	PC	3	3	0	0	3
8.	1913203	Advanced Control Systems	PC	3	3	0	0	3
9.	1913213	Digital Control and Instrumentation Laboratory	PC	4	0	0	4	2
10.	1913214	Automation Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES I, II & III
SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PROFESSIONAL ELECTIVE - I								
1.	1913204	Control System Design for Power Electronics	PE	3	3	0	0	3
2.	1913210	Soft Computing Techniques	PE	3	3	0	0	3
3.	1913206	Control of Electric Drives	PE	3	3	0	0	3
PROFESSIONAL ELECTIVE - II								
1.	1913207	Advanced Digital Signal Processing	PE	3	3	0	0	3
2.	1913208	Applied Industrial Instrumentation	PE	3	3	0	0	3
3.	1913209	Digital Image Processing	PE	3	3	0	0	3
PROFESSIONAL ELECTIVE - III								
1.	1913205	Modeling and Simulation	PE	3	3	0	0	3
2.	1913211	Bio Medical Signal Processing	PE	3	3	0	0	3
3.	1913212	Industrial Data Networks	PE	3	3	0	0	3

PROFESSIONAL ELECTIVES IV, V & VI
SEMESTER III

PROFESSIONAL ELECTIVE – IV								
S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1913301	Robust Control	PE	3	3	0	0	3
2.	1913302	Optimal Control	PE	3	3	0	0	3
3.	1913303	System Identification and Adaptive Control	PE	3	3	0	0	3
4.	1913304	Fault Tolerant Control	PE	3	3	0	0	3
5.	1913313	Chemical Process Systems	PE	3	3	0	0	3
PROFESSIONAL ELECTIVE - V								
1.	1913309	Smart Grid	PE	3	3	0	0	3
2.	1913310	Renewable Energy Systems	PE	3	3	0	0	3
3.	1913305	Robotics and Automation	PE	3	3	0	0	3
4.	1913312	Robotics and Control	PE	3	3	0	0	3
5.	1913311	Digital Instrumentation	PE	3	3	0	0	3
PROFESSIONAL ELECTIVE - VI								
1.	1913306	Internet of Things and Applications	PE	3	3	0	0	3
2.	1913307	Wireless Sensor Networks	PE	3	3	0	0	3
3.	1913308	MEMS Technology	PE	3	3	0	0	3
4.	1912317	Artificial Intelligence	PE	3	3	0	0	3
5.	1912105	Machine Learning Techniques	PE	3	3	0	0	3

1918106	APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- The primary objective of this course is to demonstrate various analytical skills in applied mathematics
- The students to identify, formulate, abstract, and solve problems in Calculus of Variations
- The extensive experience with the tactics of linear programming problem solving and logical thinking applicable in Electrical engineering.
- This course also will help study the decomposition of matrices and Matrix Theory.
- This gives application of Probability and random variables with its distributions.

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 – Functionals dependent on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz methods.

UNIT - III: PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions – Function of a random variable.

UNIT - IV: LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M 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

COURSE OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

1. Apply various methods in matrix theory to solve system of linear equations.
2. Maximizing and minimizing the functional that occur in electrical engineering discipline.
3. Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variables.
4. Could develop a fundamental understanding of linear programming models, able to apply the Simplex method for solving linear programming problems.
5. Solving Fourier series analysis both periodic and Non Periodic functions and its uses in representing the power signal.

REFERENCES :

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.

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	2	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	1	-	-
CO4	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-

1913101 TRANSDUCERS AND SMART INSTRUMENTS

L	T	P	C
3	0	0	3

COURSE 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.

UNIT - I: OVERVIEW OF CONVENTIONAL TRANSDUCERS AND THEIR CHARACTERISTICS 9

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

UNIT - II: 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

UNIT - III: 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.

UNIT - IV: 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 Nano sensors.

UNIT - V: 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

COURSE OUTCOMES:

- Compare conventional transducers and select the suitable one for the given application.
- Analyze and quantify the uncertainties in measurement data.
- 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 McGraw Hill, 2011.
2. Ifan G.Hughes and Thomas P.A.Hase, "Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis", Oxford University Press, 2010.
3. Gerord C.M.Meijer, "Smart Sensor Systems, John Wiley and Sons, 2008.
4. Tai-Ran Hsu, "Mems and Micro Systems: Design and Manufacture, Tata McGraw Hill, 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

1913102	SYSTEM THEORY	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To understand the fundamentals of physical systems in terms of its linear and nonlinear models.
- To educate on representing systems in state variable form
- To educate on solving linear and non-linear state equations
- To exploit the properties of linear systems such as controllability and observability
- To educate on stability analysis of systems using Lyapunov's theory
- To educate on modal concepts and design of state and output feedback controllers and estimators.

UNIT - I: STATE VARIABLE REPRESENTATION 9

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

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- System modes- Role of Eigen values and Eigen vectors.

UNIT - III: STABILITY ANALYSIS OF LINEAR SYSTEMS 9

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

UNIT - IV: STATE FEEDBACK CONTROL AND STATE ESTIMATOR 9

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems- The 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.

UNIT - V: LYAPUNOV STABILTY ANALYSIS 9

Introduction-Equilibrium Points- BIBO Stability-Stability of LTI Systems- Stability in the sense of Lyapunov - Equilibrium Stability of Nonlinear Continuous-Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous-Time Autonomous Systems – Krasovskil's and Variable-Gradiant Method.

TOTAL : 45+30 = 75 PERIODS

COURSE OUTCOMES:

- Ability to represent the time-invariant systems in state space form as well as analyze, whether the system is stabilizable, controllable, observable and detectable.
- Ability to design state feedback controller and state observers
- Ability to classify singular points and construct phase trajectory using delta and isocline methods.
- Use the techniques such as describing function, Lyapunov Stability, Popov's Stability Criterion and Circle Criterion to assess the stability of certain class of non-linear system.
- Ability to describe non-linear behaviors such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos.

REFERENCES:

1. M.Gopal, "Modern Control System Theory", New Age International, 2005.
2. K.Ogatta, "Modern Control Engineering", PHI, 2002.
3. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.
4. D.Roy Choudhury, "Modern Control Systems", New Age International, 2005.
5. John J.D'Azzo, C.H.Houpis and S.N.Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.
6. Z.Bubnicki, "Modern Control Theory", Springer, 2005.
7. C.T.Chen, "Linear Systems Theory and Design'' Oxford University Press, 3rd Edition, 1999.
8. M.Vidyasagar, "Nonlinear Systems Analysis', 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey.

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	-	-	-	-	-	1	-	-	2	-	1
CO4	1	-	-	-	2	-	-	-	-	-	1	1	2	-	-
CO5	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-

1913103 **CONTROL SYSTEM DESIGN** **L T P C**

4 0 0 4

COURSE 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 12

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 12

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 12

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 12

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

UNIT - V: LQR AND LQG DESIGN 12

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 : 60 PERIODS

COURSE 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.

REFERENCES:

1. G.F.Franklin, J.D.Powell and M.Workman, "Digital Control of Dynamic 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 4^{th} edition, 2012.
4. Benjamin C.Kuo "Digital control systems", Oxford University Press,2004
5. M.Gopal,"Modern control system Theory" New Age International,2005.
6. J.J.D'Azzo, C.H.Houpis and S.N Sheldon, "Linear Control system analysis and design with MATLAB", Taylor and Francis, 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

1913104	**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.

UNIT- I: 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

UNIT - II: 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-, Inter process 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

COURSE OUTCOMES:

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

- An ability to design a system, component, or process to meet desired needs with in realistic 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, “Embedded system Design”, John Wiley & Sons,2010
3. Shibu.K.V, “Introduction to Embedded Systems”, Tata Mcgraw Hill, 2009
4. Lyla B Das,” Embedded Systems - An Integrated Approach”, Pearson 2013
5. Elicia White,” Making Embedded Systems”, O’Reilly Series,SPD,2011
6. Bruce Powel Douglass, ”Real-Time UML Workshop for Embedded Systems, 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. Jonathan W.Valvano,”Embedded Microcomputer Systems ,Real Time Interfacing”,Cengage Learning,3rd edition, 2012
10. Michael Margolis,” Arduino Cookbook, O’ Reilly Series, 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	-	-

1913105	MODELING AND SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

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. Solving IVPO des
3. To find the eigen values, eigen vectors of a given matrix. Solution of Ax=b
4. 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.
5. 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.
6. 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.
7. 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
8. 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.
9. 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	-

1913201 ADVANCED PROCESS CONTROL

L	T	P	C
4	0	0	4

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 12

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 12

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 12

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 12

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: 60 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

1913202	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

COURSE 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 CONTROL SYSTEMS 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

COURSE 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 detail knowledge on Distributed Control System.
- Ability to acquire 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 McGraw Hill, 2nd edition companies, 2003.
2. CD 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	12	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	2	3	3

1913203	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:

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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CO3	3	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO4	2	-	-	2	-	-	-	-	-	-	-	-	2	-	1
CO5	1	-	-	-	2	-	-	-	-	-	1	2	2	3	3

1913213	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	-	-	-

1913214	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:

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CO3	3	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO4	2	1	-	2	-	-	2	-	-	3	-	2	2	3	1
CO5	2	2	-	-	-	3	-	-	-	-	-	1	-	2	-

1913204	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 OFDC-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.
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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	-	-

1913205	MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

COURSE 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.

UNIT - I: 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.

UNIT - II: 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.

UNIT - III: 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.

UNIT - IV: NUMERICAL SOLUTIONS OF MODEL 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.

UNIT - V: SIMULATION USING STANDARD ROUTINES 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- An ability to apply knowledge of math, science, and engineering. This will be accomplished by applying these disciplines to various problems in Modeling.
- 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 analyze the engineering problems.
- An ability to formulates solutions for engineering problems.

REFERENCES:

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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.

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CO3	2	1	-	-	3	-	3	-	-	3	-	2	-	3	-
CO4	-	2	-	-	2	-	-	-	2	-	-	-	1	-	-
CO5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2

1913206	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.

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CO3	-	-	1	-	-	-	2	-	-	-	2	-	1	-	-
CO4	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	-	-	-	2	-	-	-	-	2	-	1	-	-	3

1013207	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 12

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 6

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.
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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:

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CO3	3	-	-	-	-	2	-	-	-	-	-	-	1	-	-
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
CO6	2	-	-	-	1	-	-	2	-	-	-	2	2	-	-

1013208 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.
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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.

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CO2	1	-	-	-	-	-	-	-	-	-	-	1	-	2	-
CO3	2	-	2	-	-	-	-	-	-	2	-	-	-	-	-
CO4	2	-	-	-	-	-	-	1	-	-	-	-	-	2	-
CO5	-	1	-	-	1	-	-	-	-	-	1	1	-	-	1

1013209	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.

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CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	2	-	-	-	-	1	-	-
CO5	1	-	-	-	-	-	-	-	2	-	-	1	-	-	1

1913210 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.
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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.

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CO5	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO6	1	-	-	2	-	-	2	-	-	2	-	-	2	-	2

1913211 BIO MEDICAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

UNIT - I: INTRODUCTION TO SIGNALS 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 and IIR filter.

UNIT - II: CLASSICAL SPECTRAL ESTIMATION TECHNIQUES 9

Periodogram, Blackman – Tukey spectral Estimation applications – Analysis of the bio signal using Periodogram, – Cepstra, power cepstrum, applications of cepstrum analysis – analysis of the bio signal using cepstrum technique.

UNIT - III: 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 Electrogastric measurements.

UNIT - IV: 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 somatosensory Evoked Potentials (SEPs), Diastolic Heart sounds and cutaneous Electrogastric signals.

UNIT - V: 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: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

1. M.Akay, "Biomedical Signal Processing", Academic Press, San Diego, 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, First Edition, 2000.

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CO3	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	1	-	-	1	-	-	1	-	-	2	-	-	-	1	-

1913212	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	-

1913314	PROJECT WORK (PHASE- I)	L	T	P	C
		0	0	12	6

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.

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 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
5. Elaborate the completed task and compile the project report.

CO-PO and PSO Mapping:

CO	PO												PSO		
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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	-

1913301 ROBUST CONTROL

L	T	P	C
3	0	0	3

COURSE 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: INTRODUCTION 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: H2 OPTIMAL CONTROL **9**
Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal estimation – Kalman Bucy Filter – LQG Controller.

UNIT - III: H-INFINITY OPTIMAL CONTROL –RICCATI APPROACH **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 –LMI APPROACH **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 & CASE STUDIES **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

COURSE 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		
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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	-	-	-	-

1913302 OPTIMAL CONTROL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To highlight the significance of optimal control in process industries and the different methods of optimization.
- To introduce the concept of variational approach for the design of optimal control system.
- 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 OF VARIATIONS 9

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

UNIT - III: LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM 9

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

UNIT - IV: DISCRETE TIME OPTIMAL CONTROL SYSTEM 9

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

UNIT - V: PONTRYAGIN MINIMUM PRINCIPLE 9

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

TOTAL: 45 PERIODS

COURSE 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.Draguna Vrabia, Syrmos V.L, Optimal control, John Wiley & sons, 2012.

CO-PO and PSO Mapping:

CO	PO												PSO		
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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	-	-

1913303	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:

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CO1	1	-	-	-	2	-	2	-	-	2	2	1	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	3	-	-	-	-	-	-	2	-	-	-	-	-
CO4	3	-	-	-	-	-	2	-	-	-	1			3	1
CO5	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-

1913304	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		
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CO1	2	-	1	-	-	-	1	-	-	2	2	-	1	-	2
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	3	-	-	-	-	-	3	1
CO5	-	2	-	2	-	-	-	-	-	-	2	-	1	-	-

1913313	CHEMICAL PROCESS SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the various unit operations.
- To derive material and energy balance for various processes.
- To understand the concepts of fluid mechanics and thermodynamics.
- To study about various process equipment's.
- To study about various industrial processes.

UNIT - I: INTRODUCTION 9

Historical overview of Chemical Engineering: Concepts of unit operations and unit processes, and more recent developments, The Chemical Industry-scope, features & characteristics. Flow sheets, and symbols for various operations.

UNIT - II: MATERIAL AND ENERGY BALANCE 9

Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge, and bypass, combustion reactions, Forms of energy, optimum utilization of energy, Energy balance calculations in simple systems. Introduction to Computer aided calculations - steady state material and energy balances, combustion reactions.

UNIT - III: DIMENSIONAL ANALYSIS & PUMPS 9

Basic Fluid Concepts: Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non Newtonian viscosity, Dimensional Analysis (Buckingham PI theorem), Types of flows, Methods of Analysis, Fluid Statics. Pipe flow, Pumps, Agitation and Mixing, Compressors.

UNIT - IV: THERMODYNAMICS & THERMAL EQUIPMENTS 9

Review of conduction, resistance concept, extended surfaces, lumped capacitance; Introduction to Convection, natural and forced convection, correlations; Radiation; Heat exchangers Fundamental principles and classification of heat exchangers, Evaporators

UNIT - V: VARIOUS OPERATIONS 9

Fundamental principles and classification of Distillations, Adsorption, Absorption, Drying, Extraction, Membrane Process. Energy and Mass Conservation in process systems and industries. Introduction to chemical reactors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Ability to understand various types of Unit operations.
- Identify mathematical model of various process.
- Describe the concepts of fluid mechanics.
- Describe the concepts of thermodynamics
- Ability to understand the Energy and Mass Conservation in process systems.

REFERENCE BOOKS:

1. G.T. Austin, R.N. Shreve, Chemical Process Industries, 5th ed., McGraw Hill, 1984.
2. W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, Sixth Edition, McGraw Hill, 2001.
3. R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley, New York, 2004.
4. L.B. Anderson and L.A. Wenzel, Introduction to Chemical Engineering, McGraw Hill,1961.
5. H.S.Fogler, Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2006.

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	-	-	-	3	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO4	3	-	-	-	1	-	-	2	-	-	-	-	-	3	1
CO5	1	-	-	-	-	-	-	-	-	-	-	2	2	-	-

1913309	SMART GRID	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Study about Smart Grid technologies.
- To Study about different smart meters and advanced metering infrastructure.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications.
- To study about the Web Service and CLOUD computing to make Smart Grids smarter.

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, National and International Initiatives 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 SMARTGRID APPLICATIONS 9

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

COURSE 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 Press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley2012.
3. Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, 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, Satyajayant Misra, Guoliang Xue, 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:

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

1913310 RENEWABLE ENERGY SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To explain the concept of various forms of renewable energy.
- To outline division aspects of renewable energy sources for both domestics and industrial applications.
- To outline utilization of renewable energy sources
- To understand the various energy conversion techniques
- To analyze the relative merits and demerits of conversion techniques.

UNIT - I: SOLAR ENERGY 9

Solar energy – The Sun – Production and transfer of solar energy -- Solar radiation at the earth's surface – Sun - Earth angles – Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation – Solar thermal collectors General description and characteristics – Flat plate collectors solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT - II: WIND ENERGY 9

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - Types of wind power conversion systems – wind energy conversion devices - classification, characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept - Wind power plant design.

UNIT - III: BIO ENERGY 9

Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion – Properties of biomass – Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas- alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT - IV: OTHER TYPES OF ENERGY 9

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro - geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications- Introduction to integrated energy systems.

UNIT - V: DIRECT CONVERSION OF THERMAL TO ELECTRICAL ENERGY 9

Conventional energy conversion cycles - Reversible and irreversible cycles – Thermodynamics analysis of Carnot – Stirling – Ericsson – Otto – Diesel – Dual – Lenoir – Atkinson – Brayton - Rankine. Thermoelectric Converters–Thermionic converters–MHD–Ferro electric converter Nernst effect generator.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Knowledge in working principle of various renewable energy systems.
- Capability to do basic design of renewable energy systems.
- Awareness on various energy conversion principles.
- Ability to design the thermoelectric systems
- Ability to analyze the various energy conversion techniques.

REFERENCE BOOKS:

1. Sukhatme, S.P. J.K.Nayak, Solar Energy, Tata McGraw Hill, 4th edition, 2017.
2. Jhon Twidell and Tony Weir, A., Renewable Energy Sources, 3rd edition, 2015.
3. Kishore VVN, Renewable Energy Engineering and Technology: Principles and practice, Teri Press, New Delhi, 2019.
4. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, 1980.
5. G.N. Tiwari, Solar Energy-Fundamentals, Design, Modelling and Applications, Alpha Science International, Limited, 2013.
6. D.Yogi Goswami, Kreith, F and Kreider, J. F., Principles of Solar Engineering, 2nd edition, CRC Press, 2000.
7. Ahmed: Wind energy Theory and Practice, PHI, Eastern Economy Edition, 2012.
8. Kothari, Renewable Energy Sources and Emerging Technologies, PHI, Eastern Economy Edition, 2012.
9. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 2012.
10. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill, 2007.

11. Bridgurater, A.V., Thermochemical processing of Biomass, Academic Press,1981
12. Bent Sorensen, Renewable Energy, Elsevier, Academic 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	1	-	1	-	-	-	1	-	-	-	1	-	1	-	2
CO2	-	-	-	-	-	-	-	3	-	-	-	2	-	2	-
CO3	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-
CO4	3	-	-	-	2	-	-	-	-	-	2	1	-	3	1
CO5	1	-	1	-	2	-	2	1	-	2	2	-	-	1	-

1913305	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic elements used in robot.
- To analyze 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: ROBOT CONTROL 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: 45 PERIODS

COURSE OUTCOMES:

- Comprehends the knowledge of basic elements of a robot.
- Concepts of Robot mathematical modeling.
- Ability to analyze 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 McGraw 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, Vision and Intelligence¸ McGraw - Hill, 1987.
4. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering, An 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		
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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	-	-	-	-

1913312 **ROBOTICS AND CONTROL**

L	T	P	C
3	0	0	3

COURSE 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 controls chimes - joint actuators - decentralized PID control computed Torque Control – force control - hybrid position force control- Impedance / Torque control.

TOTAL: 45 PERIODS

COURSE 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:

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CO2	1	-	-	-	2	-	-	-	-	-	-	-	-	2	-
CO3	-	1	-	-	-	-	-	2	-	-	2	-	-	-	3
CO4	-	-	-	-	-	3	-	-	-	-	-	1	-	1	-
CO5	2	1	-	-	2	-	-	1	-	-	1	-	-	-	-

1913311 DIGITAL INSTRUMENTATION

L	T	P	C
3	0	0	3

COURSE 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 using GUI – 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: CONFIGURING PROGRAMMABLE 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

COURSE OUTCOMES:

- Use digital integrated circuit logic family chips.
- Perform computational and measurement activities using digital techniques, build sequential and combinational logic circuits.
- Analyze 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. Jovitha Jerome, "Virtual Instrumentation using Labview" 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, New Jersey, 1997.
7. H S Kalsi, "Electronic Instrumentation" Second Edition, Tata McGraw Hill, 2006.
8. K.Padmanabhan, S.Ananthi A Treatise on Instrumentation Engineering, IKPublish, 2011.
9. Gary Johnson, LabVIEW Graphical Programming, Second edition, Tata McGraw Hill, Newyork,1997.

CO-PO and PSO Mapping:

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CO3	2	-	-	2	-	-	-	2	-	-	-	-	-	-	2
CO4	-	-	-	1	-	-	-	-	-	-	-	1	2	-	-
CO5	1	-	-	-	-	-	1	-	2	-	-	1	-	3	-

1913306 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 – Crowdsourcing 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:

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CO3	-	-	-	-	-	1	-	-	2	-	-	-	2	-	-
CO4	-	1	-	3	-	-	-	-	-	-	2	-	-	3	-
CO5	1	2	-	-	-	2	-	-	1	2	-	-	-	1	-

1913307 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:

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CO3	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-
CO4	1	-	-	-	-	-	1	-	-	1	-	1	2	-	-
CO5	1	1	-	1	2	-	1	-	-	-	1	-	-	2	-

1913308 **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:

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CO3	-	-	1	-	-	3	-	-	-	-	-	-	2	-	3
CO4	2	-	-	-	-	-	-	-	-	-	-	1	-	3	-
CO5	-	3	-	-	-	2	-	-	-	-	2	-	-	1	-

1912317 **ARTIFICIAL INTELLIGENCE**

L	T	P	C
3	0	0	3

COURSE 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–Definition–Future of Artificial Intelligence–Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT - II: PROBLEM SOLVING METHODS **9**

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems - Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games.

UNIT - III: KNOWLEDGE REPRESENTATION **9**

First Order Predicate Logic–Prolog Programming – Unification – Forward Chaining - Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering – Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.

UNIT - IV: SOFTWARE AGENTS **9**

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi - agent systems.

UNIT - V: APPLICATIONS **9**

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving.

TOTAL : 45 PERIODS

COURSE 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. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach ‖, Prentice Hall, Third Edition, 2009.
2. Bratko, ―Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison- Wesley Educational Publishers Inc., 2011.

REFERENCE BOOKS:

1. M.Tim Jones,― Artificial Intelligence : A Systems Approach (Computer Science) ‖, Jone and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J.Nilsson, ― The Quest for Artificial Intelligence ‖, Cambridge University Press, 2009.

CO-PO and PSO Mapping:

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CO3	3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
CO4	-	2	-	-	3	-	-	-	-	-	-	-	-	2	-
CO5	2	-	2	-	-	-	-	-	-	-	-	-	3	-	-

1912105 MACHINE LEARNING TECHNIQUES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce various types of machine learning and its basics
- To provide an insight to different supervised learning techniques, merits and demerits.
- To enable the students to understand Graphical models and their applicability to real world problems.
- To study the various probability based learning techniques.
- To study and evaluate dimensionality reduction for the given data.

UNIT - I: INTRODUCTION 9

Machine learning: What and why? - Examples of Machine Learning Applications-Types Of Machine Learning Supervised Learning - Machine Learning Process - The Curse of Dimensionality, Over fitting - Training, Testing, and Validation Sets -The Confusion Matrix & Basic Statistics - Bias - Variance Tradeoff.

UNIT - II: NEURONS, NEURAL NETWORKS, AND LINEAR DISCRIMINANTS 9

Hebb's Rule-Neural Networks – The Perceptron - Linear Separability & Linear Regression. The Multi-layer Perceptron: Biases, Algorithm - Local minima and Stochastic gradient Descent Examples Of Using The MLP: Regression Problem & Classification Example – Deriving Back - Propagation.

UNIT - III: DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS 9

Linear Discriminant Analysis (LDA) - PRINCIPAL COMPONENTS ANALYSIS(PCA), Factor Analysis - Independent Components Analysis - PROBABILISTIC MODEL - Gaussian Mixture Models: EM Algorithm - Nearest Neighbor Methods - Support Vector Machines

UNIT - IV: LEARNING 9

Evolutionary Learning - The Genetic Algorithms (GA) - Reinforcement Learning - Decision Trees - CLASSIFICATION AND REGRESSION TREES (CART)-Ensemble Learning: Boosting, Bagging, Random Forests - Unsupervised Learning : K-Means – Algorithm - Vector Quantisation.

UNIT - V: GRAPHICAL MODELS 9

Bayesian Networks - Markov Random Fields - Hidden Markov Models (HMMS) - Markov Chain Monte Carlo (MCMC) Methods - Deep Belief Networks (DBN)

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Distinguish between, supervised, unsupervised and semi-supervised learning.
- 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.

REFERENCE BOOKS:

1. Stephen Marsland,— Machine Learning – An Algorithmic Perspective ‖,Second Edition, Chapman and Hall / CRC Machine Learning and Pattern Recognition Series, 2014
2. Ethem Alpaydin, — Introduction to Machine Learning (Adaptive Computation and Machine Learning Series) ‖, Third Edition, MIT Press, 2014.
3. William F.Clocksin and Christopher S.Mellish,‖ Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003.
4. Gerhard Weiss, — Multi Agent Systems ‖, Second Edition, MIT Press, 2013.

5. David L.Poole and Alan K.Mackworth, — Artificial Intelligence: Foundations of Computational Agents ‖, Cambridge University Press, 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	-	1	-	-	-	3	-	-	-	-	-	-	2	-	-
CO2	-	-	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	2	-	-	-	-	-	-	-	-	1	-	-
CO4	-	2	-	-	3	-	-	-	-	-	-	-	-	2	-
CO5	2	-	2	-	-	-	-	-	-	-	-	1	3	-	-

1913401 PROJECT WORK (PHASE- II) L T P C

0 0 24 12

The project work for M.E. / M.Tech. Programs consist 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. In case of candidates of M.E. / M.Tech. Programmes not completing Phase-I of project work successfully, the candidates can undertake Phase-I again in the subsequent Semester. In such cases the candidates can enrol for Phase-II, only after successful completion of Phase-I.

There shall be three assessments (each 100 marks) during the Semester by a review committee. The Student shall make presentation on the progress made before the Committee. The Head of the Institution shall constitute the review committee for each branch of study. The total marks obtained in the three assessments shall be reduced to 50 marks and rounded to the nearest integer. There will be a vice-voce Examination during End Semester Examinations conducted by a Committee consisting of the supervisor, one internal examiner and one external examiner. The internal examiner and the external examiner shall be appointed by the Controller of Examination.

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: 360 PERIODS

COURSE 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
5. 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	-