GOVERNMENT COLLEGE OF TECHNOLOGY, Coimbatore – 641 013

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING (FULL TIME)

2018A REGULATIONS : VERTICALS CURRICULA AND SYLLABI

VERTICAL I	VERTICAL II	VERTICAL III	VERTICAL IV
ADVANCED CONTROL	**APPLIED INSTRUMENTATION**	**HEALTH CARE INSTRUMENTATION**	**INDUSTRIAL AUTOMATION**
18NPE$32 - Process Modeling and Simulation	18NPE$17 – Fiber Optics and Laser Instrumentation	18NPE$21 - Biomedical Instrumentation (Common To EEE & EIE)	18NPE$45 – PLC Programming
18NPE$03 – Computer Control of Processes	18NPE$20 – Power Plant Instrumentation (Common To EEE & EIE)	18NPE$39 – Bio Signal Processing	18NPE$24 - Robotics and its Applications
18NPE$33 - System Identification	18NPE$22 – Instrumentation and Control in Petro Chemical Industries	18NPE$40 – Medical Imaging	18NPE$15 - Industrial Internet of Things (Common To ECE & EIE)
18NPE$34 - Non - Linear Control	18NPE$18 – Aircraft Instrumentation	18NPE$41 – Medical Image Processing	18NPE$46 – Data Analytics for IoT
18NPE$35 - Adaptive Control	18NPE$26 - Automotive Instrumentation	18NPE$42 – Medical Robotics	18NPE$47 – IoT for Smart Cities
18NPE$36 - Model Based Control	18NPE$11 - Safety Instrument Systems	18NPE$43 – Diagnosis and Therapeutic Equipment	18NPE$48 – Building Automation
18NPE$37 - Machine Monitoring System	18NPE$38 – Electrical Vehicle Technology	18NPE$44 – Physiological Control Systems	18NPE$49 – Smart Farming

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I – ADVANCED CONTROL

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NPE$32	Process Modeling and Simulation	PE	40	60	100	3	0	0	3
2	18NPE$03	Computer Control of Processes	PE	40	60	100	3	0	0	3
3	18NPE$33	System Identification	PE	40	60	100	3	0	0	3
4	18NPE$34	Non -Linear Control	PE	40	60	100	3	0	0	3
5	18NPE$35	Adaptive Control	PE	40	60	100	3	0	0	3
6	18NPE$36	Model Based Control	PE	40	60	100	3	0	0	3
7	18NPE$37	Machine Monitoring System	PE	40	60	100	3	0	0	3

VERTICAL II - APPLIED INSTRUMENTATION

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NPE$17	Fiber Optics and Laser Instrumentation	PE	40	60	100	3	0	0	3
2	18NPE$20	Power Plant Instrumentation (Common To EEE & EIE)	PE	40	60	100	3	0	0	3
3	18NPE$22	Instrumentation and Control in Petro Chemical Industries	PE	40	60	100	3	0	0	3
4	18NPE$18	Aircraft Instrumentation	PE	40	60	100	3	0	0	3
5	18NPE$26	Automotive Instrumentation	PE	40	60	100	3	0	0	3
6	18NPE$11	Safety Instrument Systems	PE	40	60	100	3	0	0	3
7	18NPE$38	Electrical Vehicle Technology	PE	40	60	100	3	0	0	3

VERTICAL III - HEALTH CARE INSTRUMENTATION

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NPE$21	Biomedical Instrumentation (Common To EEE & EIE)	PE	40	60	100	3	0	0	3
2	18NPE$39	Bio Signal Processing	PE	40	60	100	3	0	0	3
3	18NPE$40	Medical Imaging	PE	40	60	100	3	0	0	3
4	18NPE$41	Medical Image Processing	PE	40	60	100	3	0	0	3
5	18NPE$42	Medical Robotics	PE	40	60	100	3	0	0	3
6	18NPE$43	Diagnosis and Therapeutic Equipment	PE	40	60	100	3	0	0	3
7	18NPE$44	Physiological Control Systems	PE	40	60	100	3	0	0	3

VERTICAL IV - INDUSTRIAL AUTOMATION

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NPE$45	PLC Programming	PE	40	60	100	3	0	0	3
2	18NPE$24	Robotics and its Applications	PE	40	60	100	3	0	0	3
3	18NPE$15	Industrial Internet of Things (Common To ECE & EIE)	PE	40	60	100	3	0	0	3
4	18NPE$46	Data Analytics for IoT	PE	40	60	100	3	0	0	3
5	18NPE$47	IoT for Smart Cities	PE	40	60	100	3	0	0	3
6	18NPE$48	Building Automation	PE	40	60	100	3	0	0	3
7	18NPE$49	Smart Farming	PE	40	60	100	3	0	0	3

VERTICAL I

ADVANCED CONTROL

18NPE$32	PROCESS MODELING AND SIMULATION

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES : NIL

COURSE OBJECTIVES:

- To gain the knowledge about the modeling& simulation techniques of chemical processes.

UNIT – I FUNDAMENTALS OF PROCESS MODELING	**(9 Periods)**
Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Black-Box model, White Box model, Gray model, classification of mathematical methods.Modeling difficulties, Degree-of-Freedom analysis, Selection of design variables.	
UNIT – II MODELING OF DISTRIBUTED PROCESSES	**(9 Periods)**
Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based Approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries.	
UNIT – III INTRODUCTION TO PROCESS MODELLING	**(9 Periods)**
Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g. Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.	
UNIT – IV MODELING OF INDUSTRIAL PROCESS	**(9 Periods)**
Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non ideal multi-component distillation column, Batch distillation with holdup.	
UNIT – V SIMULATION	**(9 Periods)**
Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Kinetic Monte Carlo Simulation Introduction and use of process simulation software (Aspen Plus/ Aspen Hysys) for flow sheet simulation.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOK :

1 *Luyben W.L., "**Process Modeling, Simulation, and Control for Chemical Engineering**",McGraw-Hill (2015)*

2 *Holland, C. D., "**Fundamentals and Modeling of Separation Processes: Absorption,Distillation**", , Englewood Cliffs, Prentice-Hall, 2013*

REFERENCES :

1 *A. K. Jana "**Chemical Process Modelling and Computer Simulation**", Prentice Hall India 3rd Edition, 2018,*

2 *JumaHaydary "**Chemical Process Design and Simulation - Aspen Plus and Aspen HYSYS Applications"**, Wiley, 2019*

3 *SimantRanjanUpreti, "**Process Modeling and simulation for Chemical Engineers**"John Wiley & Sons Ltd,2017*

4 *BabatundeOgunnaike and W. Harmon Ray, "**Process Dynamics, Modeling, and Control**",1st Edition, Oxford University Press, 1994.*

COURSE OUTCOMES:

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

CO1 Understand the first principle's, grey box and empirical model for a given system
CO2 Derive the mathematical models by applying relevant mathematics
CO3 Perform analysis and subsequent conclusion for the developed mathematical models.
CO4 Comprehend the different methods of developing models for industrial processes
CO5 Simulate the mathematical models using relevant software

COURSE ARTICULATION MATRIX :

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PSO 3**
CO1	M		H	L		L							M		L
CO2	M		H	L		L							M		L
CO3	M		H	L		L							M		L
CO4	M		H	L		L							M		L
CO5	M		H	L		L							M		L
18NPE$32	**M**		**H**	**L**		**L**							**M**		**L**

L-Low, M-Moderate(medium), H-High

18NPE$03	COMPUTER CONTROL OF PROCESS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. Control System Design

COURSE OBJECTIVE

* To embed the necessity of computer controlled process and its variants and to design the process via digital control algorithms, and to explore the branches of adaptive multivariable control.

UNIT I – SAMPLED DATA CONTROL SYSTEM	**(9 Periods)**
Introduction – Review of Z transform – modified Z transform – need of computer in a control system – functional block diagram of a computer control system – direct digital control(DDC) – supervisory control – data logger –SCADA .	
UNIT II – SYSTEM MODELLING AND IDENTIFICATION	**(9 Periods)**
Introduction to pulse transfer function – open loop and closed loop response of SDS – pulse testing for process identification – linear least square algorithm – implementation of digital controllers – digital temperature control system – digital position control system – stepping motors and their control.	
UNIT III – DESIGN OF DIGITAL CONTROL ALGORITHM	**(9 Periods)**
Design and implementation of different digital control algorithm – Dead beat – Dahlin – Kalmans algorithm – pole placement controller – position and velocity form algorithm – selection of sampling time – Smith predictor algorithm – Jury's stability test – Schur Cohn stability criterion.	
UNIT IV – ADAPTIVE CONTROL	**(9 Periods)**
Self tuning – gain scheduling – Model Reference Adaptive Control – self tuning regulator – auto tuning and gain scheduling adaptive control design with examples .	
UNIT V – MULTI VARIABLE CONTROL SYSTEM	**(9 Periods)**
Multi variable Control- Transfer matrix representation- poles and zeros of MIMO system- Multi loop control- Process Interaction-Pairing of inputs and outputs- Relative Gain array (RGA)- Multivariable PID control.	
Contact Periods:	
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods	

TEXT BOOKS

1. *Dale Seborg. E, Thomas. F, Edgar, Duncan. A, Mellichamp,* ***"Process Dynamics and Control"*** *Willey India, 2006.*
2. *Astrom .K. J, Bjorn Wittenmark,* ***"Adaptive Control",*** *Second Edition, Prentice Hall of India,2004.*
3. *Deshpande. Pm,and Ash,* ***"Elements of Computer Control System"*** *ISA Press, USA, 1998*

REFERENCE BOOKS

1. *Bequette, B.W.,* ***"Process Control Modeling, Design and Simulation",*** *Prentice Hall of India, 2008.*
2. *Thomas E. Marlin,* ***"Process Control – Designing Processes and Control systems for Dynamic Performance",*** *Mc-Graw-Hill, 2000.*
3. *Stephanopoulos, G.,* ***"Chemical Process Control -An Introduction to Theory and Practice",*** *Prentice Hall of India, 2005*
4. *Sigurd Skogestad, Ian Postlethwaite,* ***"Multivariable Feedback Control: Analysis and Design",*** *John Wiley and Sons, 2005*
5. *P. Albertos and A. Sala,* ***"Multivariable Control Systems An Engineering Approach",*** *Springer Verlag, 2006.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Recognize the basics of Z-transform and model the process.
CO 2: Acquire knowledge on identification.
CO 3: Realize the digital control algorithm.
CO 4: Realize the concepts of adaptive control.
CO 5: perceive the essentials of multivariable control

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	H	M	L	L	M	M	M	L	M	M	H	M	L
CO2	H	H	L	M	M	L	L	L	H	M	H	L	M	M	L
CO3	H	M	H	L	L	L	M	M	M	M	H	M	M	L	M
CO4	H	H	H	M	M	L	H	L	L	L	H	L	L	M	L
CO5	H	H	L	M	M	L	M	L	M	L	M	M	L	M	M
18NPE$03	H	H	M	M	M	L	M	L	M	L	M	M	M	M	L

L-Low, M-Moderate(medium), H-High

18NPE$33	SYSTEM IDENTIFICATION

Category: PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To equip the students in parametric and nonparametric statistical models and estimation techniques.

UNIT – I	INTRODUCTION TO ESTIMATION	(9 Periods)
Introduction, Development of parameter estimators, Least-Squares estimation: Linear least-squares, generalized least-squares, nonlinear least-squares. Sufficient statistics, Analysis of estimation errors, MMSE, MAP, and ML estimators, sequential least-squares, asymptotic properties, General convergence results.		
UNIT – II	**SYSTEM IDENTIFICATION**	**(9 Periods)**
Introduction to system identification: identification based on differential equations, Laplace transforms, frequency responses, difference equations. Stationarity-auto-correlation, cross-correlation, power spectra. Random and deterministic signals for system identification: pulse, step, pseudo-random binary sequence (PRBS), signal spectral properties, persistent excitation.		
UNIT – III	**INPUT SIGNALS**	**(9 Periods)**
Estimates of the plant impulse, step, and frequency responses from identification data, Correlation, spectral analysis for non-parametric model identification, parametric Models-Equation error, output error models, and determination of model order.		
UNIT – IV	**PREDICTION ERROR METHODS**	**(9 Periods)**
Parametric estimation using one-step Ahead prediction error model structures. Estimation techniques for ARX, ARMAX, Box-Jenkins, FIR, and Output Error models. Residual analysis for determining the adequacy of the estimated models.		
UNIT – V	**RECURSIVE IDENTIFICATION**	**(9 Periods)**
Recursive system identification. Kalman filtering, Nonlinear filters -H-infinity Filters		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS

1. *L.Ljung, "**System Identification: Theory for the User"**, 2nd Edition, Prentice-Hall, 1999.*
2. *O.Nelles, "**Nonlinear System Identification"**, Springer-Verlag, Berlin, 2001.*

REFERENCE BOOKS

1. *T. Söderström and P. Stoica, "**System Identification"**, Prentice Hall International, Hemel Hempstead, Paperback Edition, 1994 .*
2. *Arun K. Tangirala**, "Principles of System Identification: Theory and Practice"**, First Edition, CRC Press, 2014*
3. *Karel J. Keesman, "**System Identification: An Introduction"**, Springer-Verlag London, 2011*
4. *Y.Zhu, "**Multivariable System Identification for Process Control"**, Pergamon, 2001.*

COURSE OUTCOMES:

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

CO1 Design suitable inputs, and generate data for system identification.
CO2 Identify the model structure & order determination for an unknown process from empirical data.
CO3 Solve the estimation techniques for parametric & nonparametric models.
CO4 Diagnose and validate the model for practical process applications.
CO5 Explore the non-linear filters.

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	M	M		L	M	L	M	L		M	L	M	L
CO2	H	M	M	M								M	L	M	L
CO3	H	M	M	M			M		M		M	M	L	M	L
CO4	H	M	M	M								M	L	M	L
CO5	H	M	M	M	L	M	M		M		M	M	L	M	L
18NPE$33	**H**	**M**	**M**	**M**	**L**	**M**	**M**	**L**	**M**	**L**	**M**	**M**	**L**	**M**	**L**

18NPE$34	NON-LINEAR CONTROL

Category: PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. Control System Design

COURSE OBJECTIVE:

To gain an understanding and elaborate on the characteristics of nonlinear systems and to introduce the notion of complex systems theory and large-scale real-world problems.

UNIT – I PHASE PLANE ANALYSIS	**(9 Periods)**
Concepts of phase plane analysis: Phase portraits, Singular points, Symmetry in phase plane portraits-Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems.	
UNIT – II DESCRIBING FUNCTION	**(9 Periods)**
Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions-Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles.	
UNIT – III LYAPUNOV THEORY	**(9 Periods)**
Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunov's Direct Method-Positive definite Functions and Lyapunov Functions-Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunov's Direct Method-Krasovski's Method-Variable Gradient Method-Physically – Control Design based on Lyapunov's Direct Method	
UNIT – IV FEEDBACK LINEARIZATION	**(9 Periods)**
Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- Input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation-Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non-Minimum-Phase Systems-Feedback Linearization -Zero-Dynamics and Control Design.	
UNIT – V SLIDING MODE CONTROL	**(9 Periods)**
Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- SISO Systems	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Jitendra R Rao, RamakalyanAyyagari, "**Control Systems: Classical, Modern, and AI-Based Approaches**", CRC Press (Taylor & Francis), 2019*
2. *Jean-Jacques E. Slotine, "**Applied Nonlinear Control**", Prentice Hall Englewood Cliffs, New Jersey, 1991.*

REFERENCE BOOKS

1. *Strogatz, S. H., "**Nonlinear Dynamics & Chaos, with Applications to Physics, Biology, Chemistry and Engineering**", 2nd Edition, Westview Press, 2014.*
2. *Vidyasagar.M, "**Nonlinear System Analysis**",2nd edition, SIAM, 2002.*
3. *Sontag, "**Mathematical Control Theory**", 2nd edition, Springer Verlag, 1998.*
4. *Khalil, H.K., "**Nonlinear Systems**", Prentice Hall Englewood Cliffs, New Jersey, 3rd Edition, 2002.*
5. *Meiss, J.D., "**Differential Dynamical Systems**", SIAM, 2007*

COURSE OUTCOMES:

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

CO1 Distinguish between linear and nonlinear systems and their behavior.
CO2 Apply various tools to describe and examine nonlinear systems.
CO3 Elaborate Lyapunov's theory.
CO4 Investigate a range of controller design techniques suitable for nonlinear control systems.
CO5 Design preliminaries of a Sliding Mode Controller

COURSE ARTICULATION MATRIX :

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO 3**
CO1	H	M	H	M				H				M	L	M	H
CO2	H	M	M	M								M	M	M	L
CO3	H	M	M	H					H	H	M	H	L	M	M
CO4	H	M	M	M								M	M	M	L
CO5	H	M	M	M							M	M	L	M	L
18NPE$34	**H**	**M**	**M**	**M**				**L**	**L**	**L**	**M**	**H**	**M**	**M**	**M**

L-Low, M-Moderate(medium), H-High

18NPE$35	ADAPTIVE CONTROL

Category: PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. CONTROL SYSTEM DESIGN

COURSE OBJECTIVE:

- To learn the definition of adaptive control and methods of adaptation and parameter identification of systems, inspect the self-tuning of PID controllers based on parameter identification and to design the model reference adaptive control.

UNIT – IINTRODUCTION TO ADAPTIVE CONTROL	**(9 Periods)**
Introduction to adaptive control – Effects of process variations –Adaptive control schemes – Adaptive control problem – Non-parametric identification – Step response method – Impulse response method – Frequency response method.	
UNIT – IIPREDICTION ERROR METHODS	**(9 Periods)**
Parametric Identification- Linear in parameter models-ARX-ARMAX-ARIMAX-Least square estimation - Recursive least square estimation -Extended least square estimation -Maximum likelihood estimation – Introduction to non-linear systems identification – Pseudo random binary sequence.	
UNIT – IIISELF TUNING REGULATORS	**(9 Periods)**
Self-Tuning Regulator-Deterministic in-direct self-tuning regulators-Deterministic direct self-tuning regulators -Introduction to stochastic self-tuning regulators – Stochastic indirect self-tuning regulator.	
UNIT – IVLYAPUNOV THEORY	**(9 Periods)**
The MIT rule – Lyapunov theory – Design of model reference adaptive controller using MIT rule and Lyapunov theory – Relation between model reference adaptive controller and self-tuning regulator.	
UNIT – VGAIN SCHEDULING AND ADAPTIVE CONTROLLERS	**(9 Periods)**
Tuning of Controllers and Case Studies- Design of gain scheduling controller – Auto-tuning of PID regulator – Stability analysis of adaptive controllers – Application of adaptive control in chemical reactor, distillation column and variable area tank system.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Karl J. Astrom and Bjorn Wittenmark, "**Adaptive Control**", Pearson Education (Singapore), Second Edition, 2003.*
2. *Shankar Sastry and Marc Bodson, "**Adaptive Control: Stability, Convergence, and Robustness**", Prentice-Hall, 1994.*
3. *I. D. Landau, R. Lozano, and M. MSaad, "**Adaptive Control**", NY: Springer-Verlag, 1998.*

Reference Books

1. *Chalam, "**Adaptive Control Systems: Techniques and Applications**", CRC Press, 1987.*
2. *Landau, I.D., Lozano, R., MSaad, M., Karimi, A, "**Adaptive Control Algorithms, Analysis and Applications**", 2nd edition, Springer, 2011*
3. *T. C.H.A. Hsia**, "System Identification"**, Lexington books, 1974.*
4. *Stephanopoulis G. "**Chemical Process Control"**, Prentice Hall of India, New Delhi, 1990.*
5. *Gang Tao, "**Adaptive Control Design and Analysis"**, Wiley-IEEE Press, 2003,*
6. *Kumpati S. Narendra,Anuradha M. Annaswamy, "**Stable Adaptive Control Systems"**, Prentice Hall, 1989.*

COURSE OUTCOMES:

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

CO1 Interpret the effect of parameter variation and the principle of adaptive control schemes.
CO2 Categorize different parametric identification methods.
CO3 Comprehend Deterministic and Stochastic Self Tuning Regulators.
CO4 Draft a model reference adaptive controller
CO5 Devise a gain scheduling controller to analyze adaptive control schemes for industrial processes.

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	M	M			L	L	L	L		M	L	M	L
CO2	H	M	M	M	L							M	L	M	L
CO3	H	M	M	M		L						M	L	M	L
CO4	H	M	M	M							M	M	L	M	L
CO5	H	M	M	M	M		M			M		M	L	M	L
18NPE$35	**H**	**M**	**M**	**M**	**M**	**L**	**M**	**L**	**L**	**M**	**M**	**M**	**L**	**M**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$36	MODEL BASED CONTROL

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVES

To make the student understand the concept of model predictive control and adaptive control schemes.

UNIT – I MODEL PREDICTIVE CONTROL SCHEMES	**(9 Periods)**
Introduction to Model Predictive Control - Model Predictive Control Elements - Generalized Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme	
UNIT – II MULTIVARIABLECONTROL	**(9 Periods)**
Introduction to MIMO Systems-Multivariable control- Transfer matrix representation- poles and zeros of MIMO system -Multiloop Control- RelativeGainarray(RGA)-MultivariablePID Control- Multivariable IMC-IMCPID	
UNIT – III STATE SPACE MODEL PREDICTIVE CONTROL	**(9 Periods)**
State-space MPC - deterministic formulation - state feedback control - Separation principle - Implementation of output feedback MPC - Review of Kalman filters – State Observer Based Model Predictive Control Schemes	
UNIT – IV CONSTRAINED MODEL PREDICTIVE CONTROL	**(9 Periods)**
Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization – Constrained LQ Control Theory - Constrained Model Predictive Control Scheme	
UNIT – V ADAPTIVE CONTROL	**(9 Periods)**
Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–Lyapunov Theory - ModelReferenceAdaptiveControl – Adaptive Command Tracking – Robust Model Reference Adaptive Control Scheme	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Coleman Brosilow, Babu Joseph, "**Techniques of Model-Based Control**", Prentice Hall PTR Pub 2002*

2 *E. F. Camacho, C. Bordons ,"**Model Predictive Control**",Springer, 2007.*

REFERENCES :

1 *Paul SerbanAgachi, Zoltan K. Nagy, MirceaVasileCristea, and Arpad Imre-Lucaci , "**Model Based Control Case Studies in Process Engineering"** ,WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim 2006*

2 *Ridong Zhang, AnkeXueFurongGao,"**Model Predictive Control Approaches Based on the Extended State Space Model and Extended Non-minimal State Space Model**",Springer Nature Singapore Pte Ltd. 2019*

3 *J.A. Rossiter "**Model-Based Predictive Control A Practical Approach**"Taylor& Francis e-Library, 2005.*

4 *K.J. Astrom and B. J. Wittenmark, "**Adaptive Control**", Second Edition, Pearson Education Inc., second Edition 2008.*

COURSE OUTCOMES:

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

CO1 Develop Model Predictive Control for industrial processes.
CO2 Explain various MIMO controllers used in industries.
CO3 Implement state space based MPC for the given problem.
CO4 Analyze constrained model predictive control scheme.
CO5 Design adaptive control for the given application.

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	M	M					L			L	H	H	L
CO2	H	H	M	M					L			L	H	H	L
CO3	H	H	M	L					L			L	H	H	L
CO4	H	H	M	L					L			L	H	H	L
CO5	H	H	M	L					L			L	H	H	L
18NPE$36	**H**	**H**	**M**	**L**					**L**			**L**	**H**	**H**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$37	MACHINE MONITORING SYSTEM	Category:

PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVE:

To make the students familiarize with the concept of condition-based maintenance for effective utilization of machines.

UNIT – I INTRODUCTION TO MACHINE CONDITION MONITORING	**(9 Periods)**
Introduction – Maintenance principles – Failure Modes Effects and Criticality Analysis (FMECA)-Fault Diagnostics and Prognostics –Future of condition based monitoring – Introduction of Machine Learning in Machine Monitoring System.	
UNIT – II INSTRUMENTATION IN MACHINE MONITORING	**(9 Periods)**
Introduction to Sensing elements and Measurement Techniques, Errors in Measurements – Calibration - Overview of Transducers in Machine Monitoring –Thermography - Radiography	
UNIT – III VIBRATION AND NOISE MONITORING	**(9 Periods)**
Accelerometers : Basics, Mounting methods – Vibration Monitoring : Basics of Vibration ,Characteristics of Vibration systems – Mode shapes & Operational deflection shapes – Experimental Modal Analysis Industrial issues, Laser based Vibration Monitoring –– Machinery faults diagnosed by vibration analysis -Noise Monitoring : Basics of noise, Sound Field, Concept of Db And Audio Frequency Range, Noise Standards.	
UNIT – IV SIGNAL PROCESSING IN MACHINERY MONITORING	**(9 Periods)**
FFT analysis – Time domain analysis -Frequency domain analysis – Signal filtering – Cepstrum analysis –Hilbert Transform in condition monitoring	
UNIT – V MACHINERY MAINTENANCE	**(9 Periods)**
Maintenance strategies – Reactive, Preventive, and Predictive – Benefits of planned maintenance – Bath tub curve–Trends in Machine monitoring - Case study: paper mill Condition Monitoring in Paper mill	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *A. R. Mohanty, "**Machinery Condition Monitoring: Principles and Practices"** , CRC Press, Taylor & Francis, 2015*

2 *Cornelius Scheffer and PareshGirdhar, "**Practical Machinery Vibration Analysis and Predictive Maintenance**", Elsevier, 2004.*

REFERENCES :

1 *Collacot, "**Mechanical Fault Diagnosis and Condition Monitoring**", Chapman- Hall, 1987.*

2 *Davies, "**Handbook of Condition Monitoring – Techniques and Methodology**", Springer, 1998.*

3 *Stephen Marsland, "**Machine Learning: An Algorithmic Perspective ",** 2nd edition, CRC Press, 2014*

4 *BKN Rao, "**Handbook of Condition Monitoring**", 1st edition, Elsevier Advanced Technology,1996*

COURSE OUTCOMES:

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

CO1 Explain the basic concepts related to machine monitoring system and machine learning
CO2 Summarize the application of transducer and its measurement techniques in condition monitoring.
CO3 Identify the faulty component in a machine by analyzing the acquired vibration and noise signals
CO4 Apply signal processing in machinery monitoring
CO5 Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine

COURSE ARTICULATION MATRIX :

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO 3**
CO1	H	L		L					L			L	H	H	L
CO2	H	L		L					L			L	H	H	L
CO3	H	H	M	L		M			L			L	H	H	L
CO4	H	H	M	L		M			L			L	H	H	L
CO5	H	M		L		H			L			L	H	H	L
18NPE$37	**H**	**M**	**L**	**L**		**L**			**L**			**L**	**H**	**H**	**L**

L-Low, M-Moderate(medium), H-High

VERTICAL II

APPLIED INSTRUMENTATION

18NPE$17	FIBER OPTICS AND LASER INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To elaborate the fundamentals of optic fiber and laser, types, properties and its applications

UNIT I – FUNDAMENTALS OF OPTICAL FIBRE	**(9 Periods)**
Principles of light propagation through a fiber - Different types of fibers and their properties, fiber characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicer – Fiber termination – Optical sources – Optical detectors.	
UNIT II – MEASUREMENT USING OPTICAL FIBRES	**(9 Periods)**
Fiber optic sensors – Fiber optic instrumentation system - Measurement of pressure, temperature, current, voltage, liquid level and strain.	
UNIT III – FUNDAMENTALS OF LASER	**(9 Periods)**
Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.	
UNIT IV – MEASUREMENT USING LASERS	**(9 Periods)**
Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.	
UNIT V – HOLOGRAPHY AND MEDICAL APPLICATIONS	**(9 Periods)**
Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing. Medical applications of lasers - Laser instruments for surgery and removal of tumors.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *John M. Senior* ***"Optical Fiber Communications: Principles And Practice"*** *Pearson Education, 3rd Edition, 2009.*
2. *Eric Udd, William B.,and Spillman, Jr.,* ***"Fiber Optic Sensors: An Introduction for Engineers and Scientists ",*** *John Wiley & Sons, 2011.*

REFERENCE BOOKS

1. *R.P.Khare* ***"Fibre Optics and Optoelectronics"*** *Oxford Press, 2004.*
2. *John F. Read* ***"Industrial Applications of Lasers"*** *Academic Press, 2nd Edition, 2008*
3. *M. Arumugam* ***"Optical Fibre Communication and Sensors"*** *Anuradha Agencies, 2010*
4. *P Bhattacharya* ***"Semiconductor optoelectronics"*** *Prentice Hall, 2nd Edition, 2003.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the basic concepts, different types of fiber and also the losses involved in the fibers.

CO2: Analyze the application of the fiber optic sensors used in the measurement of various parameters.

CO3: Describe the fundamental characteristics and properties of laser and its configuration

CO4: Illustrate the application of laser for the measurement of different parameters.

CO5: Discuss the basic principle of holography and medical applications of Laser.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L											H	L	
CO2	H	L											H	H	
CO3	H	L											H	L	
CO4	H	L											H	H	
CO5	H	L											H	L	
18NPE$17	**H**	**L**											**H**	**M**	

L-Low, M-Moderate (medium), H-High

18NPE$20	POWER PLANT INSTRUMENTATION *(Common to EEE & EIE Branches)*

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To understand the important process variables and their measurements and thereby develop control
  loops for optimal performance of power plant.

UNIT - I: METHODS OF POWER GENERATION	**(9 Periods)**
Methods of power generation – hydro, thermal, nuclear, solar and wind power –Importance of instrumentation in power generation – basic building block for all types of power generation plants - details of boiler processes – P and I diagram of boiler - cogeneration.	
UNIT - II: MEASUREMENTS IN POWER PLANTS	**(9 Periods)**
Measurement of feed water flow, air flow, steam flow and coal flow – Drum level measurement– Steam pressure and temperature measurement – Turbine speed and vibration measurement – Flue gas analyzer – Fuel composition analyzer.	
UNIT - III: ANALYZERS IN POWER PLANTS	**(9 Periods)**
Analysis of impurities in feed water and steam- Flue gas oxygen analyzer - dissolved oxygen analyzer - chromatography - pH Meter - Fuel analyzer -pollution monitoring instruments.	
UNIT - IV: CONTROL LOOPS IN BOILER	**(9 Periods)**
Combustion Control-air/fuel ratio control - furnace draft control - drum level control - main steam and reheat steam temp control - super heater control - attemperator – de-aerator control - distributed control system in power plants - interlocks in boiler operation.	
UNIT – V: TURBINE AND CONTROL	**(9 Periods)**
Types of steam turbines – impulse and reaction turbines – compounding – Turbine governing system– Speed and Load control – Transient response rise – Free governor mode operation – Automatic Load Frequency Control – Turbine oil system – Oil pressure drop relay – Oil cooling system– Turbine run up system.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1. *Sam Dukelow **"Control of Boilers"** Instrument Society of America, 1991*
2. *Gill.A.B **"Power Plant performance"** Butterworth and Co (Publishers) Ltd, 2003.*

REFERENCE BOOKS:

1. *Liptak B.G **"Instrumentation in Process Industries"** Chilton Book Company, 2005.*
2. *Jain R.K **"Mechanical and Industrial Measurements"** Khanna Publishers, New Delhi, 1999.*
3. *Krishnaswamy, K. and Ponnibala.M **"Power Plant Instrumentation"** PHI Learning Pvt. Ltd., New Delhi, 2011.*

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO 1: Explain the different methods of generating power

CO 2: Select instruments for both online and off line measurements in power plants

CO 3: Differentiate between conventional and nonconventional power generation techniques

CO 4: Analyze the control strategies implemented in different stages of power plant

CO 5: Understand the operation of hydro, thermal, nuclear, wind and solar power plants.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO2	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO3	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO4	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO5	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
18NPE$20	**H**	**M**	**M**	**M**	**L**	**M**	**M**	**H**	**H**	**H**	**M**	**M**	**H**	**L**	**M**

L-Low, M-Moderate (medium), H-High

18NPE$22	INSTRUMENTATION AND CONTROL IN PETROCHEMICAL INDUSTRIES

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To familiarize on unit - operations in petroleum refinery and petrochemical industry.

UNIT - I : DISTILLATION COLUMNS & REACTORS.	**(9 Periods)**
Introduction to petroleum exploring, processing and refining constituents of crude oil - Piping and Instrument diagram of petroleum refinery. Instrumentation and control in distillation columns: distillation equipment- variable and degrees of freedom - measurement and control of column pressure - liquid distillate - Vapor distillate and inerts - control of feed, re-boiler and reflux - use of gas chromatograph-cascade and feed forward controls. Temperature control and pressure control in batch reactors.	
UNIT - II : DRYERS AND HEAT EXCHANGERS.	**(9 Periods)**
Control of batch dryers and continuous dryers.- Instrumentation and control in heat exchangers: variables and degree of freedom - liquid to liquid heat exchangers - steam heaters - condensers – re-boilers and vaporizers -use of cascade and feed forward control.	
UNIT - III : CONTROL OF PUMPS.	**(9 Periods)**
Centrifugal pumps- ON-OFF control-pressure control-flow control- throttling control Rotary pump - Reciprocating pumps- throttling.	
UNIT - IV : EFFLUENT AND WATER/ WASTE WATER TREATMENT.	**(9 Periods)**
Chemical oxidation -chemical reduction -neutralization -precipitation -biological control- waste water management process.	
UNIT - V : EVAPORATORS AND INTRINSIC SAFETY.	**(9 Periods)**
Types Of Evaporators - Measurement and Control of Absolute Pressure, Density, Conductivity, Differential Pressure And Flow In Evaporators- Intrinsic Safety Of Instruments.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Bela. G. LIPTAK* ***"Instrumentation in Processing Industries"*** *Chilton Book Company, 2012.*
2. *Considine D.M* ***"Handbook Of Applied Instrumentation"*** *Mcgraw Hill, 1964.*

REFERENCE BOOKS

1. *Goldstien R.F, Waddams A.L* ***"Petroleum Chemicals Industry"*** *Spon-Publisher, 3rd Edition,1967.*
2. *George.T. Austin* ***"Shreve's Chemical Process Industries"*** *5th Edition, McGraw Hill, 1998.*
3. *Balchan J.G and Mumme K.I* ***"Process Control Structures and Applications"*** *Van Nostrand Reinhold Company, New York, 1988.*
4. *Curtis D. Johnson* ***"Process Control Instrumentation Technology"*** *17th Edition, Pearson Education, New Delhi, 2002.*

COURSEOUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain petroleum production process and important unit operations in a refinery.

CO2: Discuss the control of dryers and heat exchangers.

CO3: Select appropriate control strategy for pumps.

CO4: Recognize the steps involved in various waste water treatment processes.

CO5: Describe about the measurement of various parameters in evaporators and safety measures followed in process industries.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H		L										H	M	
CO2	H		L										H	M	
CO3	H		L										H	M	
CO4	H												H	M	
CO5	H		H			H							H	M	
18NPE$22	**H**		**L**			**L**							**H**	**M**	

L-Low, M-Moderate(medium), H-High

18NPE$18	AIRCRAFT INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. Control System Design

COURSE OBJECTIVE

- To preface or open the concepts and equations of motion of aircraft systems and its modeling and to familiarize the stability design and state space form of Aircraft systems.

UNIT I – BASIC CONCEPTS	**(9 Periods)**
Air craft and aerospace vehicle instrumentation: Air data instruments: altimeter, air speed rate of climb –gyroscopic instruments – turn and back indicator – artificial horizon – directional Gyro Schuler Tuning, Stable Platform – Automatic pilots – integrated flight instruments – Capacitance type fuel level indicating system – altitude compensation – magnetic compass. Aircraft Instrument Elements and mechanisms- Pitot- static instruments –Primary Flight Instruments- Heading Indicating Instruments-Remote Indicating compasses.	
UNIT II – AIRCRAFT EQUATIONS OF MOTION	**(9 Periods)**
Conservation of linear, angular momentum equations with rotor effects-Euler angles-flight path equations-kinematic equations-gravity equations-equations at steady-state and perturbed conditions.	
UNIT III AIRCRAFT PERFORMANCE AND MODELING	**(9 Periods)**
Different Aircraft Propulsion systems-Propeller-Turboprop Aircraft Engine-Turbojet –Turbofan-Modelling of Thrust forces and moments during steady state and perturbation.	
UNIT IV – AIRCRAFT STABILITY AND DESIGN	**(9 Periods)**
Aircraft Static Stability-Longitudinal analysis-Lateral Directional analysis-Lift chart –Trim diagram-Application of Laplace Transforms to Longitudinal Perturbation Equations and Lateral Directional analysis - Routh-Hurwitz analysis of Longitudinal Stability- Dynamic modes-Solution of Longitudinal Equations-Rolling, Spiral and Dutch roll.	
UNIT V – STATE VARIABLE MODELLING OF AIRCRAFT DYNAMICS	**(9 Periods)**
State variable modeling of Longitudinal Dynamics-Lateral Directional Dynamics-Modeling of Altitude, Flight path angle, Engine Dynamics, Actuator Dynamics, Atmospheric Turbulence.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Pallett E.G.H.* ***"Aircraft Instrumentation and Integrated Systems"*** *Longman Scientific and Technical,1992.*
2. *Nagaraja N.S.* ***"Elements of Electronic Navigation"*** *Tata McGraw Hill Publishing Ltd., New Delhi, 1975.*

REFERENCE BOOKS

1. *Mekinley, J.L. and Bent, R.D.* ***"Aircraft Power Plants"*** *McGraw-Hill, 1993*
2. *Pallet, E.H.J* ***"Aircraft Instruments & Principles"*** *Pitman & Co., 1993*
3. *McKinley, J.L., and Bent, R.D.* ***"Aircraft Maintenance & Repair"*** *McGraw-Hill, 1993.*
4. *Marcello R. Napolitano* ***"Aircraft Dynamics -From Modeling to Simulation"*** *John Wiley & Sons, Inc., 2012.*
5. *Jan R. Wright, Jonathan E. Cooper* ***"Introduction to Aircraft Aero elasticity and Loads"*** *John Wiley & Sons, Inc., 2007.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Describe the terminologies of aircraft systems.
CO 2: Formulate the essential angles in the aircraft design.
CO 3: Identify the forces and moments of aircraft.
CO 4: Perform stability analysis using various techniques for aircraft systems.
CO 5: Model the aircraft dynamics.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	H	M	M	L	M	L	M	L	M	M	M	L	M
CO2	H	L	H	M	H	H	L	H	L	M	H	M	M	L	M
CO3	L	M	M	H	M	M	M	L	M	L	M	L	H	L	L
CO4	H	H	H	L	M	L	H	L	M	M	H	M	H	M	L
CO5	H	L	H	M	L	L	M	M	L	L	M	M	H	H	L
18NPE$18	**H**	**M**	**M**	**M**	**M**	**M**	**M**	**L**	**M**	**L**	**M**	**M**	**M**	**L**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$26	AUTOMOTIVE INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To illustrate the application of sensors and actuators used in automotive field.

UNIT - I : AUTOMOTIVE SYSTEM	**(9 Periods)**
Evolution of electronics in automobiles, emission laws, introduction to Euro standards, equivalent Bharat standards. Basics of combustion, engine fuelling and exhaust emission, electronic control of carburetion, petrol fuel injection, diesel fuel injection. Ignition systems: Ignition fundamentals, Electronic Ignition system, programmed ignition, distribution less ignition, direct ignition, spark plugs.	
UNIT - II : SENSORS AND ACTUATORS	**(9 Periods)**
Working principle and characteristics of airflow rate, engine crank shaft angular position, hall effect, throttle angle, temperature, exhaust gas oxygen sensors. Fuel injector, exhaust gas recirculation actuators, stepper motor actuator and vacuum operated actuator.	
UNIT - III : MEASUREMENT AND DIAGNOSTICS	**(9 Periods)**
Measurements – fuel quality, coolant temperature, oil pressure vehicles speed, Display devices – LED, LCD, VFD, CRT and types, CAN network, the glass cockpit and information system. Onboard diagnostics – fault code displays. Off board diagnostics – engine data display, expert system occupant protection system – Airbag deployment system security and warning system	
UNIT - IV : ENGINE CONTROL SYSTEM	**(9 Periods)**
Control modes for fuel control, engine control subsystems and ignition control methodologies. Electronic transmission control-Shift point control, Lockup control/torque converter clutch, Engine torque control during shifting Different Engine Control Units used in engine management.	
UNIT - V : CHASSIS AND SAFETY SYSTEMS	**(9 Periods)**
Traction control system, antilock braking system, electronic suspension system, Steering system basics, Fundamentals of electronically controlled power steering, centralized door locking system, climate control of cars.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Tom Denton* ***"Automobile Electrical and Electronic Systems"*** *Arnold Publishers, Fourth Edition 2012.*
2. *Robert Bosch* ***"Automotive Electrics and Automotive Electronics"*** *Springer, Fifth Edition, 2014.*

REFERENCE BOOKS

1. *V A W Hillier* ***"Fundamentals of Automotive Electronics"*** *OUP Oxford, Second Edition 2001.*
2. *Ronald K Jurgen* ***"Automotive Electronic Handbook"*** *McGraw Hill, Second Edition,*

1999.

3. *William B Ribbens* ***"Understanding Automotive Electronics"*** *Sixth Edition, Newnes Pubilishers, 2003*
4. *Bogdan M. Wilamowski, J. David Irwin* ***"The Industrial Electronics Handbook"*** *CRC Press, Second Edition, 2011.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Perceive the electronics involved in automotive systems
CO2: Choose appropriate sensors for automobiles based on applications
CO3: Describe the diagnostic procedures and communication protocols.
CO4: Select the Control schemes for Engine Management systems.
CO5: Apply instrumentation techniques to safety in modern automobile.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	L									M	M	
CO2	H	M	M	L									H	M	
CO3	H	M	M	L									H	M	
CO4	H	M	M	L									H	M	
CO5	H	M	M	L									H	M	
18NPE$26	**H**	**M**	**M**	**L**									**H**	**M**	

L-Low, M-Moderate(medium), H-High

18NPE$11	SAFETY INSTRUMENT SYSTEMS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To make aware of basic concepts of instrument safety and risk analysis techniques.

UNIT I – CONCEPTS	**(9 Periods)**
History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -line and staff functions for safety- budgeting for safety- safety policy.	
UNIT II – TECHNIQUES	**(9 Periods)**
Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Safety Audit.	
UNIT III – ACCIDENT INVESTIGATION AND REPORTING	**(9 Periods)**
Concept of an accident, reportable and non reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee –cost of accident.	
UNIT IV – SAFETY PERFORMANCE MONITORING	**(9 Periods)**
ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.	
UNIT V – SAFETY EDUCATION AND TRAINING	**(9 Periods)**
Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Krishnan N.V. **"Safety Management in Industry"** Jaico Publishing House, Bombay, 2016*
2. ***"Accident Prevention Manual for Industrial Operations",** N.S.C.Chicago, 2011*

REFERENCE BOOKS

1. *Heinrich H.W. **"Industrial Accident Prevention"** McGraw-Hill Company, New York, 2010.*
2. *John Ridley, **"Safety at Work",** Butterworth & Co., London, 2013*
3. *Blake R.B., **"Industrial Safety"** Prentice Hall, Inc., New Jersey, 2014*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Understand the roles of safety instruments in industry.

CO 2: Identify the hazards to take preventive actions.

CO 3: Identify the techniques for safety of instrument.

CO 4: Recommend the practices for compiling and measuring work injury experience

CO 5: Know the importance of safety education and rules followed in industry.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO2	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO3	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO4	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO5	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
18NPE$11	**M**	**M**	**L**	**L**	**M**	**M**	**L**	**M**	**M**	**M**	**M**	**H**	**M**	**M**	**H**

L-Low, M-Moderate(medium), H-High

18NPE$38	ELECTRICAL VEHICLE TECHNOLOGY

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVES:

* To familiarize the technology of Electric and Hybrid Electric Vehicles and their business perspective

UNIT – I INTRODUCTION	**(9 Periods)**
Conventional Vehicles: Basics of vehicle performance - Introduction to Hybrid Electric Vehicles: History of hybrid and Electric Vehicles (EV), social and environmental importance of hybrid and electric vehicles – EV classification and Scenario in India.	
UNIT – II ELECTRIC TRAINS	**(9 Periods)**
Electric Drive-trains: Concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives- drive system efficiency.	
UNIT – III ANALYSIS OF ENERGY STORAGE	**(9 Periods)**
Energy Storage: Li- ion Battery, Fuel Cell, Super Capacitor and Fly wheel based energy storage and its analysis. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor and power electronics, selecting the energy storage technology, Communications, supporting subsystems.	
UNIT – IV ENERGY MANAGEMENT STRATEGIES	**(9 Periods)**
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies	
UNIT – V BUSINESS PERSPECTIVE OF ELECTRIC VEHICLE	**(9 Periods)**
Design of a Hybrid Electric Vehicle (HEV) - Design of a Battery Electric Vehicle (BEV) Fuel Cell Heavy Duty Vehicles. Business: E-mobility business, electrification challenges, Connected mobility and Autonomous mobility- EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKs

1 *MehrdadEhsani, YiminGao, Sebatien Gay and Ali Emadi,* ***"Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design"****, CRC press, 2016.*

2 *C. Mi, M. A. Masrur and D. W. Gao,* ***"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives",*** *John Wiley & Sons, 2018.*

REFERENCES

1 *S. Onori, L. Serrao and G. Rizzoni,* ***"Hybrid Electric Vehicles: Energy Management Strategies"****, Springer, 2015.*

2 *James Larminie and John Loury,* ***"Electric Vehicle Technology – Explained",*** *John Wiley & Sons Ltd, 2016.*

3 *Sandeep Dhameja,* ***"Electric Vehicle Battery Systems",*** *Butterworth – Heinemann, 2018*

4 *Ronald K Jurgen,* ***"Electric and Hybrid – Electric Vehicles",*** *SAE, 2017*

5 *T. Denton,* ***"Electric and Hybrid Vehicles",****Routledge, 2016*

COURSE OUTCOMES:

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

CO1 Interpret and compare the operation and principle behind conventional and different combination of EV

CO2 Analyze suitable drive scheme for developing an electric vehicle

CO3 Analyze the battery or fuel source performance and operation

CO4 Suggest an apt energy management system.

CO5 Explicate the infrastructure for Electric Vehicles and business potential.

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	H	M	L									H	M	L
CO2	H	H	M	L									H	M	L
CO3	H	H	M	L									H	M	L
CO4	H	H	M	L									H	M	L
CO5	H	H	M	L									H	M	L
18NPE$38	**H**	**H**	**M**	**L**									**H**	**M**	**L**

L-Low, M-Moderate(medium), H-High

VERTICAL III

HEALTH CARE INSTRUMENTATION

18NPE$21	**BIOMEDICAL INSTRUMENTATION** *(Common to EEE & EIE Branches)*

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. Biology for Engineers

COURSE OBJECTIVE

- To give a knowledge about the various electro physiological measurements in human body and to present terminologies of the measurement of non-electrical parameter in the human body.

UNIT - I : PHYSIOLOGY	**(9 Periods)**
Cell and its structure – Resting and action potential – Propagation of action potentials – The heart and cardiovascular system - Electrophysiology of cardiovascular system – Physiology of the respiratory system – Nervous system - Central nervous system and Peripheral nervous system – Electrode theory – Bio-potential electrodes - Transducers for biomedical applications.	
UNIT - II : ELECTRO PHYSIOLOGICAL MEASUREMENT	**(9 Periods)**
ECG – Vector cardiographs – EEG – EMG – ERG – EOG – Lead system and recording methods – Typical waveforms. Electrical safety in medical environment, shock hazards– leakage current- Instruments to protect against electrical hazards.	
UNIT - III : NON- ELECTRICAL PARAMETER MEASUREMENTS	**(9 Periods)**
Measurement of blood pressure, blood flow and cardiac output – Plethysmography – Measurement of heart sounds – Gas analysers – Blood gas analysers – Oximeters.	
UNIT - IV : MEDICAL IMAGING AND TELEMETRY	**(9 Periods)**
X-ray machine – Echocardiography – Computer tomography – MRI – Diagnostic ultrasound – PET – SPECT – Electrical impedance tomography – Thermograph – Biotelemetry.	
UNIT - V : ASSISTING AND THERAPEUTIC DEVICE	**(9 Periods)**
Pacemakers – Defibrillators – Ventilator – Anaesthesia machine – Nerve and muscle stimulator – Heart lung machine – Kidney machine – Audiometers – Diathermy –Endoscopes – Lasers in biomedicine.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Leslie Cromwell **"Biomedical Instrumentation and Measurement"** PHI, New Delhi, 2007.*
2. *Khandpur. R.S **"Handbook of Biomedical Instrumentation"** 2nd edition, Tata McGraw Hill,2011.*

REFERENCE BOOKS

1. *Joseph J Carr and John M.Brown, **"Introduction to Biomedical Equipment Technology'',** John Wiley and sons, New York, 4th edition, 2012*
2. *John G. Webster, **"Medical Instrumentation Application and Design",** John Wiley and sons, New York, 2009.*
3. *Ed. Joseph D. Bronzino **"The Biomedical Engineering Handbook"** Third Edition, BocaRaton, CRC Press LLC, 2014.*
4. *M.Arumugam, **"Bio-Medical Instrumentation",** Anuradha Agencies, 2018.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1 Explain the physical foundations of biological systems and the various electrodes used in medical field.

CO 2 Discuss about the various electro physiological measurements in the human body.

CO 3 Choose the instrument for the measurement of non-electrical parameter in the human body.

CO 4 Compare the various medical imaging techniques and their applications.

CO 5 Explain the working of medical assisting and therapy equipments.

COURSE ARTICULATION MATRIX:

CO/ PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	M	M	L	L	L	L	M	H	L	L	L	M	H	M	L
CO2	M	M	L	M	L	M	M	H	L	M	M	L	H	L	L
CO3	L	L	L	M	L	M	M	H	M	L	H	M	H	L	M
CO4	L	M	L	M	L	M	M	H	M	M	M	H	H	M	M
CO5	L	L	L	M	L	L	M	H	L	M	H	L	H	M	H
18NPE$21	**L**	**M**	**L**	**M**	**L**	**M**	**M**	**H**	**L**	**M**	**M**	**M**	**H**	**M**	**L**

L-Low, M-Moderate (medium), H-High

18NPE$39	BIO SIGNAL PROCESSING

Category: PE

L	T	P	C
3	0	0	3

PRE REQUISITES: NIL

COURSE OBJECTIVE:

* To impart knowledge on biosignals, linear and non-linear filtering techniques to extract desired information from biosignals.

UNIT – I BIOSIGNAL AND SPECTRAL CHARACTERISTICS	**(9 Periods)**
Introduction to Biosignals: Nature of Biomedical Signals - ENG, EMG, ECG, EEG, ERP, EGG and PCG -Noise: Random, Structured, Physiological Noise – Filters: IIR, FIR and Integer Filters for ECG Analysis.	
UNIT – II SPECTRAL ESTIMATION OF BIO SIGNALS	**(9 Periods)**
Time Series Analysis - Application in EEG, PCG Signals - Time Varying Analysis of Heart-Rate Variability - Model based ECG Simulator - Spectral Estimation: Blackman Tukey Method, Periodogram and Model based Estimation - Application in Heart Rate Variability - PCG Signals.	
UNIT – III ADAPTIVE FILTERING AND WAVELET DETECTION	**(9 Periods)**
Adaptive Filtering: Noise canceller, LMS Adaptive Filter, RLS Adaptive Filter - Removal of Artifacts in ECG - Wavelet Detection in ECG: Structural Features, Matched Filtering, Adaptive Wavelet Detection - Detection of Overlapping Wavelets.	
UNIT – IV BIOSIGNAL CLASSIFICATION AND RECOGNITION	**(9 Periods)**
Signal Classification and Recognition – Statistical Signal Classification - Linear Discriminant Function - Direct Feature Selection and Ordering - Back Propagation Neural Network based Classification - Application in Normal versus Ectopic ECG Beats.	
UNIT – V TIME FREQUENCY AND MULTIVARIATE ANALYSIS	**(9 Periods)**
Time Frequency Representation: Spectrogram, Wigner Distribution - Time-scale Representation: Scalogram, Wavelet Analysis – Data Reduction Techniques: ECG Data Compression, ECG Characterization - Feature Extraction - Wavelet Packets - Multivariate Component Analysis: PCA and ICA.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Rangaraj M. Rangayyan, **"Biomedical Signal Analysis-A Case Study Approach"**, Second Edition, Wiley IEEE Press, 2016.*

2 *Willis J. Tompkins, **"Biomedical Digital Signal Processing"**, Prentice Hall of India, New Delhi, 2003.*

REFERENCES:

1 *Arnon Cohen, **"Bio-Medical Signal Processing Vol I and Vol II",** CRC Press Inc., Florida, 1999.*

2 *Emmanuel C. Ifeachor, Barrie W.Jervis, "Digital Signal processing- A Practical Approach", Pearson Education Ltd., 2004.*

3 *Raghuveer M. Rao and AjithS.Bopardikar, **"Wavelet Transform – Introduction to Theory and its Applications"**, Pearson Education, India, 2000.*

4 *K.P.Soman and K.Ramachandran, "**Insight into Wavelet from Theory to Practice"**, PHI, New Delhi, 3rd Edition, 2010.*

COURSE OUTCOMES:

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

CO1 Explain the characteristics of biosignals
CO2 Describe biosignals in time domain and estimate the spectrum
CO3 Apply wavelet detection techniques for biosignal processing
CO4 Classify biosignals using neural networks
CO5 Analyze the features using multivariate component analysis

COURSE ARTICULATION MATRIX :

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO 3**
CO1	H	M	L										H	M	L
CO2	H	H	M	M	M								M	H	L
CO3	H	M			M								M	H	L
CO4	H	H	L	L									M	H	L
CO5	H	H	L	H	L								M	H	L
18NPE$39	**H**	**H**	**L**	**M**	**L**								**M**	**H**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$40	MEDICAL IMAGING

Category: PE

L	T	P	C
3	0	0	3

PRE REQUISITES: NIL

COURSE OBJECTIVES:

* To impart knowledge on different types of medical imaging equipment and their significance in medical diagnostics.

UNIT – I MEDICAL X-RAY EQUIPMENT	**(9 Periods)**
Nature of X-rays: X-Ray Absorption, Tissue Contrast - X-Ray Equipment: X-ray Tube, Collimator, Bucky Grid, Power Supply - Digital Radiography - Discrete Digital Detectors: Storage Phosphor, Film Scanning Types – Fluoroscopy: X-Ray Image Intensifier Tubes, Digital Fluoroscopy – Angiography: Cine Angiography, Digital Subtraction Angiography - Mammography.	
UNIT – II COMPUTED TOMOGRAPHY	**(9 Periods)**
Principles of Tomography - CT Generations - X-Ray: Sources, Collimation, Detectors, Viewing Systems - Spiral CT Scanning - Ultra Fast CT Scanners - Image Reconstruction Techniques: Back Projection and Iterative Method.	
UNIT – III MAGNETIC RESONANCE IMAGING	**(9 Periods)**
Fundamentals of Magnetic Resonance - Interaction of Nuclei: Static Magnetic Field, Radiofrequency Wave, Rotation and Precession - Induction of Magnetic Resonance Signals – Bulk Magnetization, Relaxation Processes T1 and T2 - Block Diagram Approach of MRI System - System Magnets: Permanent, Electromagnet - Super Conductors - Gradient Magnetic Fields - Radio Frequency Coils - Shim Coils - Electronic Components - fMRI.	
UNIT – IV NUCLEAR IMAGING SYSTEM	**(9 Periods)**
Radio Isotopes: Alpha, Beta, and Gamma Radiations – Radiopharmaceuticals - Radiation Detectors: Proportional Counter, GM Counter and Scintillation Detectors - Gamma Camera: Principle of Operation, Collimator, Photo Multiplier Tube, X-Y Positioning Circuit - Pulse Height Analyzer - Principles of SPECT and PET.	
UNIT – V RADIATION THERAPHY AND RADIATION SAFETY	**(9 Periods)**
Effects of Radiation: Direct and Indirect - Radiation Therapy: Linear Accelerator, Tele Gamma Machine - Recent Techniques in Radiation Therapy - Stereotaxic Radiotherapy and Radiosurgery, 3D CRT, IMRT, IGRT and Cyber Knife - Radiation Measuring Instruments: Dosimeter, Film Badges, Thermo Luminescent Dosimeters and Electronic Dosimeter - Radiation Protection in Medicine: Radiation Protection Principles, ICRP and AERB.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Anthony B. Wolbarst, PatrizioCapasso and Andrew R. Wyant, "**Medical Imaging: Essentials for Physicians**", JohnWiley& Sons, Inc, 2013.*

2 *Barton F. Branstetter, "**Practical Imaging Informatics: Foundations and Applications for Medical Imaging**", Second Edition, Springer, 2021.*

REFERENCES:

1 *Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt and John M.Boone, "**The Essential Physics of Medical Imaging"**, Lippincott Williams and Wilkins, Third Edition, 2012.*

2 *R. Hendee and Russell Ritenour, "**Medical Imaging Physics**", William Wiley- Liss, Fourth Edition, 2002.*

3 *Gopal B. Saha, "**Physics and Radiobiology of Nuclear Medicine**", Springer, Third Edition, 2006.*
4 *P. Ragunathan, "**Magnetic Resonance Imaging and Spectroscopy in Medicine concepts and Techniques**", Orient Longman, 2007.*

COURSE OUTCOMES:

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

CO1 Explain the components and working principle of X-ray machine.
CO2 Analyze the techniques involved in CT imaging system
CO3 Describe about MRI and its significance over X-ray and CT
CO4 Identify the applications of nuclear imaging system in the field of medicine
CO5 Summarize the effects of radiation and its safety methods.

COURSE ARTICULATION MATRIX :

COs/POs	PO 1	PO 2	PO 3	PO 4	P O5	PO 6	P O7	PO 8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO1	H	M	L										H	M	L
CO2	H	H	M	M	M								M	H	L
CO3	H	M			M								M	H	L
CO4	H	H	L	L									M	H	L
CO5	H	H	L	H	L								M	H	L
18NPE$40	**H**	**H**	**L**	**M**	**L**								**M**	**H**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$41	MEDICAL IMAGE PROCESSING

Category: PE

L	T	P	C
3	0	0	3

PRE REQUISITES: NIL

COURSE OBJECTIVE:

- To teach the concepts and techniques for processing medical images

UNIT – I FUNDAMENTALS OF IMAGE PROCESSING	**(9 Periods)**
Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationship between Pixels - Color Image Fundamentals – 2D Mathematical Preliminaries - 2D Transforms.	
UNIT – II MEDICAL IMAGE ENHANCEMENT	**(9 Periods)**
Image Enhancement Operations – Image Noise and Modeling - Image Restoration – Image Degradation Model - Medical Image Enhancement: Spatial Domain Filters, Frequency Domain Filters.	
UNIT – III MEDICAL IMAGE RECONSTRUCTION	**(9 Periods)**
Mathematical Preliminaries - Basic Reconstruction Methods - Image Reconstruction in CT Scanners, MRI, fMRI - Ultrasound Imaging - 3D Ultrasound Imaging - Nuclear Medical Imaging Modalities: SPECT, PET, Molecular Imaging.	
UNIT – IV IMAGE SEGMENTATION AND ANALYSIS	**(9 Periods)**
Image Segmentation: Pixel, Edge and Region based Segmentation - Active Contour Models - Level sets for Medical Image Segmentation - Image Representation and Analysis.	
UNIT – V IMAGE CLASSIFICATION AND REGISTRATION	**(9 Periods)**
Feature Extraction and Representation - Statistical, Shape, Texture Features - Statistical and Neural Network based Image Classification - Image Registration: Rigid Body Transformation – Affine Transformation - Principal Axes Registration -Feature based Registration - Elastic Deformation based Registration - Registration of Images from Different Modalities - Evaluation of Registration Methods.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Geoff Dougherty, "**Digital Image Processing for Medical Applications**", First Edition, Cambridge University Press, 2010.*

2 *KavyanNajarian and Robert Splerstor, "**Biomedical Signals and Image processing**", Second Edition, CRC Press, 2012.*

REFERENCES:

1 *Rafael C. Gonzalez, Richard E. Woods, "**Digital Image Processing**", Fourth Edition, Pearson Education India Ltd., 2018.*

2 *AtamP.Dhawan, "**Medical Image Analysis**", Second Edition, John Wiley & Sons, Inc., 2011.*

3 *RavikanthMalladi, "Geometric **Methods in Bio-Medical Image Processing (Mathematics and Visualization)"**, First Edition, Springer-Verlag Berlin Heidelberg, 2002.*

4 *A. ArdeshirGoshtasby, "**Image Registration Principles, Tools and Methods (Advances in Computer Vision and Pattern Recognition**", Springer 2014.*

COURSE OUTCOMES:

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

CO1 Explain the concepts of digital image processing.
CO2 Illustrate image pre-processing techniques for medical image processing.
CO3 Summarize medical imaging and reconstruction methods for high dimensionality visualization
CO4 Analyze image segmentation in medical images
CO5 Apply image processing algorithms to classify and register medical images

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	L	H	M									M	H	L
CO2	L	L	H										M	L	L
CO3	H	M	L	H									M	H	L
CO4	M	H	L	L									M	H	L
CO5	H	H	L	H									M	H	L
18NPE$41	**M**	**M**	**M**	**M**									**M**	**H**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$42	MEDICAL ROBOTICS

Category: PE

L	T	P	C
3	0	0	3

PRE REQUISITES: NIL

COURSE OBJECTIVES :

* To impart knowledge on different types of robots and their applications in the field of medicine.

UNIT – I INTRODUCTION TO ROBOTICS	**(9 Periods)**
Introduction to Robotics - Overview of Robot Subsystems - Degrees of Freedom – Configurations and Concept of Workspace - Dynamic Stabilization – Sensors: Sensors and Controllers, Internal and External Sensors, Position, Velocity and Acceleration Sensors, Proximity Sensors, Force sensors - Actuators: Pneumatic and Hydraulic Actuators, Stepper Motor Control Circuits, End Effectors, Various Types of Grippers, PD and PID Feedback Actuator Models.	
UNIT – II MANIPULATORS & BASIC KINEMATICS	**(9 Periods)**
Construction of Manipulators - Manipulator Dynamic and Force Control - Electronic and Pneumatic Manipulator - Machinery Vision – Ranging: Laser, Acoustic, Magnetic, Fiber Optic and Tactile Sensor.	
UNIT – III SURGICAL ROBOTS	**(9 Periods)**
Da Vinci Surgical System - Image guided Robotic Systems - Focal Ultrasound based Surgical Applications - Robotic Tele-surgical System: CABG, Urologic, Cardiac, Neuro, Pediatric, and Gynecologic Surgery - anorobotics.	
UNIT – IV REHABILITATION AND ASSISTIVE ROBOTS	**(9 Periods)**
Pediatric Rehabilitation - Robotic Therapy for the Upper Extremity and Walking - Clinical-Based Gait Rehabilitation Robots - Motion Correlation and Tracking - Motion Prediction - Motion Replication - Portable Robot for Tele Rehabilitation - Robotic Exoskeletons: Design considerations, Hybrid Assistive Limb.	
UNIT – V WEARABLE ROBOTS	**(9 Periods)**
Kinematics and Dynamics for Wearable Robots - Wearable Robot Technology: Sensors, Actuators, Portable Energy Storage - Human–Robot Cognitive Interaction (cHRI) - Human–Robot Physical Interaction (pHRI) - Wearable Robotic Communication.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Jocelyne Troccaz, "**Medical Robotics**", JohnWiley& Sons, Inc, 2013.*
2 *AchimSchweikard and Floris Ernst, "**Medical Robotics**", Second Edition, Springer, 2015.*

REFERENCES:

1 *Spong and Vidhyasagar, "**Robot Dynamics and Control**", John Wiley and Sons, First Edition, 2008.*
2 *Shane Xie, "**Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances**", Springer, 2016.*
3 *Jacob Rosen, Blake Hannaford and Richard M Satava, "**Surgical Robotics: System Applications & Visions**", Springer, 2011.*
4 *Fu.K.S, Gonzalez. R.C. and Lee, C.S.G, "**Robotics: Control, Sensing, Vision and Intelligence**", Tata McGraw Hill International, First edition, 2008.*

COURSE OUTCOMES:

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

CO1 Describe the concepts of sensors and actuators for robot configuration
CO2 Explain the functions of manipulators and basic kinematics
CO3 Illustrate the application of robots for various surgeries
CO4 Analyze the robotic systems for rehabilitation
CO5 Summarize the concept of wearable robots

COURSE ARTICULATION MATRIX :

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO 3**
CO1	H	M	L										H	M	L
CO2	H	H	M	M	M								M	H	L
CO3	H	M			M								M	H	L
CO4	H	H	L	L									M	H	L
CO5	H	H	L	H	L								M	H	L
18NPE$42	**H**	**H**	**L**	**M**	**L**								**M**	**H**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$43	DIAGNOSIS AND THERAPEUTIC EQUIPMENT

Category: PE

L	T	P	C
3	0	0	3

PRE REQUISITES: NIL

COURSE OBJECTIVE:

* To impart knowledge on medical equipment used in the measurement of parameters related to cardiology and neurology.

UNIT – I CARDIAC EQUIPMENT	**(9 Periods)**
Electrocardiograph - Normal and Abnormal Waveform, Heart Rate Monitor, Heart Rate Variability, Holter Monitor - Cardiac Pacemaker: Internal and External Pacemaker, Types, Batteries - AC and DC Defibrillator: Internal and External, Types - Precautions.	
UNIT – II NEUROLOGICAL EQUIPMENT	**(9 Periods)**
Multi Channel EEG Recording System - Clinical Significance of EEG - Sleep Patterns: Epilepsy, Evoked Potential – Visual, Auditory and Somatosensory, EEG Bio Feedback Instrumentation, Psychophysiological Measurements for Testing Sensory Responses – Magneto Encephalo Graph (MEG): Sensing, Principle and Instrumentation.	
UNIT – III MUSCULAR EQUIPMENT	**(9 Periods)**
EMG: Recording and Analysis of EMG Waveforms, Fatigue Characteristics, Muscle Stimulators - Nerve Stimulators - Nerve Conduction Velocity Measurement - EMG Bio Feedback Instrumentation - Electro Gastro Graph (EGG) - Magneto Myo Graph (MMG).	
UNIT – IV PATIENT MONITORING AND BIOTELEMETRY	**(9 Periods)**
Patient Monitoring Systems: ICU/CCU Equipment, Infusion Pumps, Bed Side Monitors, Central Monitoring Console - Architecture of Biotelemetry System – Single and Multi-Channel Biotelemetry - Inductively Coupled Biotelemetry - Optical Biotelemetry - Readout Formats - Concept of m-Health 2.0 - Point of Care Devices – Disposable Hematology Sensors.	
UNIT – V SPECIAL DIAGNOSTIC TECHNIQUES	**(9 Periods)**
Need for Heart Lung Machine - Functioning of Bubble, Disc Type and Membrane Type Oxygenators - Dialyser : Hemodialyser and Peritoneal Dialyser Unit - Wearable Artificial Kidney – Lithotripsy -Cryogenic technique – Thermography: Recording Principle and Clinical Application – Tonometer - Auto Refractometer - Audiometer: Beksey's Type, Pure Tone, Speech - Galvanic Skin Resistance (GSR) - Polygraph.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Joseph J. Carr and John M. Brown, **"Introduction to Biomedical Equipment Technology"**, Pearson Education, Fourth Edition, 2014.*

2 *John G.Webster, "**Medical Instrumentation Application and Design"**, John Wiley and Sons, New York, Fourth Edition, 2009.*

REFERENCES:

1 *Myer Kutz, **"Biomedical Engineering & Design Handbook: Volume 2"**, McGraw-Hill Publisher, Second Edition, 2009.*

2 *L.A Geddes and L.E.Baker, **"Principles of Applied Biomedical Instrumentation"**, John Wiley and Sons, Third Edition, 2008.*

3 *Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer,* ***"Biomedical Instrumentation and Measurements"****, Pearson Education India, Second Edition, 2015*
4 *Antony Y.K.Chan,* ***"Biomedical Device Technology, Principles and Design",*** *Charles Thomas Publisher Ltd, 2008.*

COURSE OUTCOMES:

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

CO1 Explain different medical devices in the measurement of parameters related to cardiology
CO2 Elaborate different types of neurological equipment
CO3 Analyze signals generated by muscles
CO4 Identify suitable monitoring and transmission equipment for patient diagnosis system.
CO5 Interpret the features using multivariate component analysis.

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	L	L	H	M									M	H	L
CO2	L	L	H										M	L	L
CO3	H	M	L	H									M	H	L
CO4	M	H	L	L									M	H	L
CO5	H	H	L	H									M	H	L
18NPE$43	**M**	**M**	**M**	**M**									**M**	**H**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$44	PHYSIOLOGICAL CONTROL SYSTEMS

Category: PE

L	T	P	C
3	0	0	3

PRE REQUISITES: NIL

COURSE OBJECTIVE:

* To teach the concept of physiological control system and its significance on biological signals.

UNIT – I PHYSIOLOGICAL SYSTEMS WITH FEEDBACK	**(9 Periods)**
Introduction to Biosignals: Nature of Biomedical Signals - ENG, EMG, ECG, EEG, ERP, EGG and PCG -Noise: Random, Structured, Physiological Noise – Filters: IIR, FIR and Integer Filters for ECG Analysis.	
UNIT – II STATIC ANALYSIS OF PHYSIOLOGICAL SYSTEM	**(9 Periods)**
Determination of Steady State Operating Point - Steady State Analysis - Regulation of Cardiac Output - Chemical Regulation of Ventilation - Time Domain Analysis of Linear Control Systems - Transient Response Analysis - Dynamics of Neuromuscular Reflex Motion - Frequency Domain Analysis of Linear Control Systems - Frequency Response of Circulatory Control - Glucose Insulin Regulation.	
UNIT – III STABILITY ANALYSIS OF PHYSIOLOGICAL CONTROL SYSTEM	**(9 Periods)**
Relative Stability: Stability Analysis of Pupilary Light Reflex - Model of Cheyne-Stokes Breathing - Identification of Physiological Control Systems: Parametric Estimation, Identification of Closed Loop System.	
UNIT – IV MODELING OF NERVE ACTION	**(9 Periods)**
Modeling the Nerve Action Potential: Voltage Clamp Experiment and its Interpretation, Model for the Strength Duration Curve, Modeling Skeletal Muscle Contraction, Linear Model of Muscle Contraction, Modeling Myoelectric Activity.	
UNIT – V SYSTEM IDENTIFICATION	**(9 Periods)**
System Identification in Physiology: Modeling of Sensory Receptors - Pupil Control System - Modeling Cardiovascular System - Modeling Blood Flow - Systemic Blood Flow - Coronary Circulation - Behavior of the Immune System - Linearized Model of Immune Response to Disease.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1 *Michael C.K. Khoo, "**Physiological Control Systems-Analysis Simulation and Estimation**", IEEE Press Series in Biomedical Engineering, 2000.*

2 *Suresh R. Devasahayam, "**Signals and Systems in Biomedical Engineering-Signal Processing and Physiological Systems Modeling**", Kluwer Academic/Plenum Publishers, 2000.*

REFERENCES:

1 *I.J.Nagrath and M.Gopal, "**Control System Engineering**", New Age International Publishers, Sixth Edition, 2008.*

2 *FaridGolnaraghi, Benjamin C. Kuo, "**Automatic Control Systems**", Wiley, NinethEdition, 2014.*

3 *Richard C.Dorf& Robert H. Bishop, "**Modern Control Systems**", Prentice Hall, TwelfthEdition, 2010.*

4 *Joseph J.DiStefano, Allen R.Stubberud, Schaum's, "**Outline of Feedback and Control Systems**", McGraw-Hill Education, Second Edition, 2013.*

COURSE OUTCOMES:

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

CO1 Compare and contrast conventional signal and physiological signals.
CO2 Describe statistical analysis of a physiological control system
CO3 Obtain stability analysis of physiological control systems
CO4 Analyze muscular and nuerological control system
CO5 Relate a physiological control system with system identification

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L										H	M	L
CO2	H	H	M	M	M								M	H	L
CO3	H	M			M								M	H	L
CO4	H	H	L	L									M	H	L
CO5	H	H	L	H	L								M	H	L
18NPE$44	**H**	**H**	**L**	**M**	**L**								**M**	**H**	**L**

L-Low, M-Moderate(medium), H-High

VERTICAL IV

INDUSTRIAL AUTOMATION

18NPE$45	PLC PROGRAMMING

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES:

1. Digital Electronics

COURSE OBJECTIVE:

* To introduce concept of programming in PLC and enhance students' skills in programming PLCs for various use cases.

UNIT – I IEC 61131-2 STANDARD: PLC BASICS AND HARDWARE	**(9 Periods)**
Programmable Logic Controller (PLC): IEC 61131 Standard- Hardware components of PLC – Power supply and I/O module types - HMIs - Networking of PLC- Overview of safety of PLC with case studies- Process SafetyAutomation: Levels of process safety through use of PLCs	
UNIT – II IEC 61131- 3 - BASIC FUNCTIONS	**(9 Periods)**
Ladder Diagram(LD) Programming Basics: Processor Memory Organization, Program Scan, Relay-Type Instructions – Programming on-off outputs- Creating ladder diagrams from process control narrative descriptions	
UNIT – III IEC 61131-3 - TIMER AND COUNTER FUNCTIONS	**(9 Periods)**
Register basics – Timer functions: Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer and Cascading Timers - Counter Instructions : Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder and Counter applications, Combining Counter and Timer Functions- Creating ladder diagrams from process control narrative descriptions	
UNIT – IV INTERMEDIATE AND ADVANCED FUNCTIONS	**(9 Periods)**
Arithmetic functions – Number comparison functions – Skip and MCR functions – Data move systems – PLC advanced functions: Utilising digital bits, Sequencer functions, Matrix functions and Analog PLC operation - PID control of continuous processes - FBD equivalent to LD programming- Introduction to FBD Programming, IL, SFC and ST	
UNIT – V PLC PROGRAMMING FOR USECASES	**(9 Periods)**
Development PLC programe: Traffic Light Control: Two way ANDFour way – Water Level Control - Automatic Material Sorting System- Automatic Bottle Filling System- ISA–18.1Annunciator Sequences and Specifications	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1 *Frank D. Petruzella,* ***"Programmable Logic Controllers",*** *5th Edition, McGraw- Hill, New York, 2017.*

2 *John. W. Webb and Ronald A. Reis* ***"Programmable Logic Controllers – Principles and Applications"*** *4th Ed., Printice Hall Inc., New Jersy, 5th Ed. 2002*

REFERENCES

1 *Bolton. W,* ***"Programmble Logic Controllers"*** *Fifth Edition, Elsevier Newnes, 2009.*

2 *Stuart Boyer A,* ***"SCADA: Supervisory control and data Acquisition",*** *Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society,2010*

3 *Curtis D.Johnson,* ***"Process control Instrumentation Technology****", 8th Ed. Pearson Education, 2006*

COURSE OUTCOMES:

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

CO1 Comprehend the the necessity of PLC programming standard and hardware system
CO2 Demonstrate the understanding of basic functions in IEC 61131-3
CO3 Familiarize themselves with IEC 61131-3 timer and counter functions
CO4 Acquaint the knowledge of using IEC 61131-3 Intermediate and Advanced functions
CO5 Design and develop PLC programming for certain use cases

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L	M	H	M	L					H	H	H	H
CO2	H	M	L	M	H	M	L					H	H	H	H
CO3	H	M	L	M	H	M	L					H	H	H	H
CO4	H	M	L	M	H	M	L					H	H	H	H
CO5	H	M	L	M	H	M	L					H	H	H	H
18NPE$45	**H**	**M**	**L**	**M**	**H**	**M**	**L**					**H**	**H**	**H**	**H**

18NPE$24	ROBOTICS AND ITS APPLICATIONS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To impart knowledge on structure, kinematics, dynamics and control of robotics

UNIT I – INTRODUCTION TO ROBOTICS	**(9 Periods)**
History of Robots – Classifications – Various fields of Robotics – Actuators – Sensors – Manipulators – End effectors – Application areas – Robot programming languages	
UNIT II – ROBOT KINEMATICS	**(9 Periods)**
Mathematical representation – Homogeneous transformation – DH representation of standard robots – Inverse kinematics	
UNIT III – ROBOT DYNAMICS	**(9 Periods)**
Velocity kinematics – Jacobian and Inverse Jacobian – Lagrangian formulation – Eulers-Lagrangian formulation – Robot equation of motion.	
UNIT IV – TRAJECTORY PLANNING	**(9 Periods)**
Introduction – Path Vs Trajectory – Joint space Vs Cartesian – Space descriptions – Basics of trajectory planning – Joint space trajectory planning – Cartesian space trajectories.	
UNIT V – CONTROL AND APPLICATIONS OF ROBOTS	**(9 Periods)**
Linear control of robot manipulation – Second order systems – Trajectory following control – Modeling and control of single joint - Architecture of Industrial robotic controllers – Robots in manufacturing and non-manufacturing applications	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *R.K.Mittal and I.J.Nagrath,* ***"Robotics and Control",*** *Tata McGraw Hill, Fourth Edition, 2005.*
2. *Sayed B. Niku,* ***"Introduction to Robotics, Analysis, Systems and Applications",*** *Pearson Education, Second Edition, 2011.*

REFERENCE BOOKS

1. *R.D.Klafter, T.A.Chimielewski, M.Negin,* ***"Robotic Engineering – An Integrated Approach",*** *Prentice Hall of India, 2010.*
2. *Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey,* ***"Industrial Robotics Technology Programming and Applications",*** *Tata McGraw Hill, Second Edition 2012.*
3. *John J. Craig,* ***"Introduction to Robotics Mechanics and Control",*** *Pearson Education, Third Edition, 2018.*
4. *Ashitava Ghoshal,* ***"Robotics – Fundamental Concepts and Analysis",*** *Oxford University Press, Sixth Edition, 2010.*
5. *B.K.Ghosh,* ***"Control in Robotics and Automation: Sensor Based Integration",*** *Allied Publishers, 1999.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the various parts and its functions in a robot

CO 2: Mathematically represent the kinematics and dynamics using various formulations and transformations.

CO 3: Choose proper sensor, actuator and end effector for specific applications

CO 4: Outline the overall approach in design of a robot.

CO 5: Apply the different control techniques for robot manipulators.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H							H				M	H
CO2	H	H	H			L	M			H				M	H
CO3	H	H	H			L	M			H				M	H
CO4	H	H	H	M		M	M			H				M	H
CO5	H	H	H	M		M				H				M	H
18NPE$24	**H**	**H**	**H**	**M**		**M**	**M**			**H**				**M**	**H**

L-Low, M-Moderate(medium), H-High

18NPE$15	INDUSTRIAL INTERNET OF THINGS (Common to ECE & EIE Branches)

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To explain in concise manner how IoT is used in industry.

UNIT - I : INTERNET OF THINGS	**(9 Periods)**
Internet in general and Internet of Things: layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia.	
UNIT - II : LAYERS IN IoT	**(9 Periods)**
Transport services: TCP, UDP, socket programming. Network layer: forwarding and routing algorithms (Link, DV), IP-addresses, DNS, NAT and routers.	
UNIT - III : LOCAL AREA NETWORKS	**(9 Periods)**
Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular Internet access, and Machine-to-machine and IoT Analytics.	
UNIT - IV : INDUSTRIAL AUTOMATION	**(9 Periods)**
Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things.	
UNIT - V : IoT APPLICATIONS FOR INDUSTRY	**(9 Periods)**
Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Dr. Ovidiu Vermesan, Dr. Peter Friess* ***"Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems"*** *River Publishers, 2013*
2. *Vijay Madisetti and Arshdeep Bahga,* ***"Internet of Things (A Hands-on-Approach)"*** *1st Edition, VPT, 2015*
3. *Adrian McEwen* ***"Designing the Internet of Things"*** *Wiley Publishers, 2013*

REFERENCE BOOKS

1. *Manoel Carlos Ramon* ***"Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers"*** *Apress, 2014.*
2. *Mark Harrison, Florian Michahelles* ***"Architecting the Internet of Things"*** *Springer – 2011*
3. *Olivier Hersent, David Boswarthick, Omar Elloumi* ***"The Internet of Things – Key applications and Protocols"*** *Wiley, 2012*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Comprehend the functions of layered tasks and protocols employed in packet network to build IoT

CO2: Explain purposes of transport Services, forwarding and routing algorithms and IP addressing mechanism

CO3: Assimilate various protocols in pertinent to Local Area Networks for IoT

CO4: Gain knowledge on different industrial standards involved in the development of IIoT solution for Industrial automation

CO5: Identify IoT use cases in various industries and demonstrate the IoT project implementation modalities

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	L								M	L	L
CO2	M	M	L	L	L								M	L	L
CO3	M	M	L	L	L								M	L	L
CO4	M	M	L	L	L								M	L	L
CO5	M	M	L	L	L								M	L	L
18NPE$15	**M**	**M**	**L**	**L**	**L**								**M**	**L**	**L**

L-Low, M-Moderate(medium), H-High

18NPE$46	DATA ANALYTICS FOR IOT

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVES:

* To introduce the concept of Big Data Analytics and its relevance to IoT

UNIT – I INTRODUCTION TO TECHNOLOGICAL DEVELOPMENTS IN IoT	**(9 Periods)**
Defining IoT Analytics and Challenges- Business value concerns, - IoT Devices and Networking Protocols basics - Analyzing data - IoT Analytics for the Cloud- Building elastic analytics - Designing for scale, Cloud security and analytics, Overview of AWS, Microsoft Azure, and ThingWorx.	
UNIT – II CLOUD ANALYTICS ENVIRONMENT	**(9 Periods)**
The AWS Cloud Formation - The AWS Virtual Private Cloud (VPC) - terminate and clean up the Environment- data processing for analytics -big data technology to storage - Apache Spark for data processing, handling change, Exploring and visualizing data -Techniques to understand data quality - R and R Studio.	
UNIT – III GENERAL STRATEGIES ON EXTRACTING VALUE FROM DATASETS	**(9 Periods)**
Decorating Data - Communicating with Others Visualization and Dashboarding - Applying Geospatial Analytics to IoT Data - Data Science for IoT Analytics: Introduction to Machine learning (ML), and Deep learning.	
UNIT – IV SOCIETAL IMPACT OF MULTIMEDIA BIG DATA	**(9 Periods)**
Multimedia Social Big Data Mining - Process Model - SWOT Analysis - Techniques for Social Big Data Analytics - Advertisement Prediction - MMBD Sharing on Data Analytics Platform - Legal/Regulatory Issues	
UNIT – V APPLICATION ENVIRONMENTS	**(9 Periods)**
Big Data Computing for IoT Applications: Precision Agriculture, Machine Learning in Improving Learning Environment, Network-Based Applications of Multimedia Big Data Computing, Recent Trends in IoT-Based Analytics and Big Data, Future Directions and Challenges of Internet of Things.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1 *Andrew Minteer,* ***"Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices"****, Packt Publishing, first edition, July 2017.*

2 *SudeepTanwar, SudhanshuTyagi, Neeraj Kumar,* ***"Multimedia Big Data Computing for IoTApplications:Concepts, Paradigms and Solutions"****, Springer, 2020.*

REFERENCES

1 *John Soldatos,* ***"Building Blocks for IoT Analytics",*** *River Publishers Series In Signal, Image and Speech Processing, 2017.*

2 *NilanjanDey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy,* ***"Internet of Things and Big Data Analytics Toward Next-Generation Intelligence",*** *Springer International Publishing, 2018.*

3 *Stackowiak, R., Licht, A., Mantha, V., Nagode, L.,"* ***Big Data and The Internet of Things Enterprise Information Architecture for A New Age****", Apress, 2015.*

COURSE OUTCOMES:

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

CO1 Discuss the Technological developments in IoT
CO2 Investigate cloud based IoT analytic environment
CO3 Apply various Big data strategies
CO4 Explore social impact of multimedia big data
CO5 Develop solution to smart IoT systems with big data

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L	M	H	M	L					H	H	H	H
CO2	H	M	L	M	H	M	L					H	H	H	H
CO3	H	M	L	M	H	M	L					H	H	H	H
CO4	H	M	L	M	H	M	L					H	H	H	H
CO5	H	M	L	M	H	M	L					H	H	H	H
18NPE$46	**H**	**M**	**L**	**M**	**H**	**M**	**L**					**H**	**H**	**H**	**H**

L-Low, M-Moderate(medium), H-High

18NPE$47	IOT FOR SMART CITIES

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVES:

- To introduce students the important principles, components and practices in the IoT for smart cities

UNIT – I INTRODUCTION TO IOT FOR SMART CITIES	**(9 Periods)**
Introduction-Characteristics of Smart Cities - IoT-Based Solutions for Smart Cities - Smart Home - Transport and Traffic Management - Challenges, Smart City Planning and Management - The Fundamentals of Smart Infrastructure - Role of Machine Learning and Deep Learning in Internet of Things enabled Smart Cities	
UNIT – II TECHNOLOGIES FOR INTERNET OF THINGS	**(9 Periods)**
Introduction, Communication Technologies for IoT Networks: Protocols for IoT - Overview of Secure IoT Architectures - IoT-Based Services for Smart Cities - Cellular Mobile Networks -Cloud Internet of Things - Study of Communication Technologies - Intelligent Traffic System, -Disaster Management - Implementation and Comparison of MQTT, WebSocket, and HTTP Protocols for Smart Room IoT Application in Node-RED	
UNIT – III AI FOR SMART CITIES	**(9 Periods)**
Overview of Artificial Intelligence, Machine Learning and deep learning algorithms for smart cities - case study: smart street lighting, Smart building, Smart parking, smart irrigation, smart waste and smart water management, and Vehicle Payload Monitoring System	
UNIT – IV TRANSPORTATION SYSTEM IN SMART CITY	**(9 Periods)**
Traffic Management for Smart Cities - Electric Vehicles in Smart Cities - EV Charging Techniques - Renewable Energy - Smart Distribution Systems - Smart Grid -Traffic Control System for Smart City using Image Processing - Interactive Analysis Platform for Bus Movement: A Case Study of One of the World's Largest Annual Gathering	
UNIT – V SECURITY AND PRIVACY IN SMART CITY	**(9 Periods)**
Privacy and Social Values in Smart Cities - Information Security in the Smart City - IoT Security Challenges - Blockchain Technology for IoT - Case Studies: Smart Homes, Food Supply Chain Traceability System, smart street lighting, Smart building, Smart parking, smart irrigation, Security and Privacy Threats in IoT-Enabled Smart Cities	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1 *WaleedEjaz, AlaganAnpalagan*, ***Internet of Things for Smart Cities: Technologies, Big Data and Security***, *1st ed. Springer International Publishing, 2019.*

2 *Stimmel, Carol L,* ***Building smart cities: analytics, ICT, and design thinking****, Taylor & Francis, 2016.*

REFERENCES

1 *Vincenzo Piuri, RabindraNath Shaw, Ankush Ghosh, Rabiul Islam,* ***AI and IoT for Smart City Applications, Springer****, 2022.*
2 *Al-Turjman, Fadi,* ***Intelligence in IoT-enabled smart cities****, CRC Press, 2019.*
3 *Oswald Campesato* ***, Artificial Intelligence, Machine Learning, and Deep Learning****, , Mercury Learning and Information, 2020.*
4 *Arpan Kumar Kar, M P Gupta, P. VigneswaraIlavarasan, Yogesh K. Dwivedi,* ***Advances in smart cities : smarter people, governance and solutions,*** *CRC Press, 2017.*
5 *Hammi, B., Khatoun, R., Zeadally, S., Fayad, A., &Khoukhi, L.* ***IoT technologies for smart cities,*** *2018.*
6 *Joel J. P. C. Rodrigues, Parul Agarwal, KavitaKhann,* ***IoT for Sustainable Smart Cities andSociety****, 2022.*

COURSE OUTCOMES:

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

CO1 Comprehend concepts and challenges in IoT for smart cities
CO2 Discuss key technology enablers for IoT
CO3 Investigate the application areas of Artificial Intelligence with in smart cities
CO4 Analyze transportation system and its implementation challenge in smart cities
CO5 Examine Security and privacy concerns in smart cities

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L	M	H	M	L					H	H	H	H
CO2	H	M	L	M	H	M	L					H	H	H	H
CO3	H	M	L	M	H	M	L					H	H	H	H
CO4	H	M	L	M	H	M	L					H	H	H	H
CO5	H	M	L	M	H	M	L					H	H	H	H
18NPE$47	**H**	**M**	**L**	**M**	**H**	**M**	**L**					**H**	**H**	**H**	**H**

L-Low, M-Moderate(medium), H-High

18NPE$48	BUILDING AUTOMATION

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVES:

* To introduce students the important principles, components and practices in the Building Automation System

UNIT – I INTELLIGENT BUILDINGS AND BUILDING AUTOMATION SYSTEM	**(9 Periods)**
Intelligent Buildings: Definitions of intelligent building, Intelligent architecture and structure - Facilities management Vs. Intelligent buildings - Technology systems and evolution of intelligent buildings: Features, and Characteristics - Building Automation System (BAS) - Various Systems of Building Automation: Building Management System, Energy Management System, Security and Safety System, Video Management System.	
UNIT – II HVAC AND CONTROL OF AIR- CONDITIONING SYSTEMS	**(9 Periods)**
Introduction to HVAC – Review of Sensors, Transducers, and their Selection for HVAC: Temperature, Pressure, Level, Flow, RH, Valves, and Actuators, - Overview of Controllers for HVAC: Concept of Controller IOs, Standard Signals, Signal Compatibility between Controller and Field Devices. Air Handling Unit: Concept, Components, Working Principle. Typical control loops of the air- conditioning process: Cascade control of variable air volume (VAV) systems, Sequential split- range control, Two- position control and on/off control - Temperature controls in AHU - Humidity controls in AHU - Static pressure control - Control of Constant Air Volume (CAV) System.	
UNIT – III ENERGY MANAGEMENT SYSTEM	**(9 Periods)**
Concept - Energy Meters: Types, Meter Networking, and Monitoring Energy Parameters - Analysis of Power Quality: Instantaneous Power, Active Power, Reactive Power, and Power Factor - Voltage, Current effect of Power Quality on Energy Consumption - Energy Reports - Energy Conservation - Importance of Energy Saving.	
UNIT – IV SAFETY SYSTEM	**(9 Periods)**
Introduction – Fire: Meaning, Fire Development Stages, Fire Sensors & Detectors, Detector Placement, Detectors Required for Various Applications - Fire Extinguishing Principles, Fire Extinguishers and its Classification - Fire Alarm System: Controllers, Components, Features, Concept of Fire Loop and Fire Devices, 2-Wire & 4-Wire Loops, Working Principle, System Description, Pre-alarm and Alarm, Troubles and Fault - Cable Selection and Installation Guidelines - Best Installation Practices - NFPA and IS2189 Standards - System Programming.	
UNIT – V BAS COMMUNICATION STANDARDS AND INTEGRATED SYSTEMS	**(9 Periods)**
BAS communication standards: Features of BACnet, LonWorks, Modbus, PROFIBUS, EIB - Compatibility of different open protocol standards - Integration at management level - overview of applications of Internet technologies in BAS: Automation level, and Management level. Integration of Building Management System, Energy Management System, Safety System, Security Systems & Video Management - Benefits of Integrated Systems, Challenges, Future Prospects of Integrated Systems	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1 *Shengwei Wang,* ***Intelligent Buildings and Building Automation****, 2009*

2 *Reinhold A. Carlson Robert A. Di Giandomenico,* ***Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building****,1st edition (R.S. Means Company Ltd), (1991).*

REFERENCES

1 *Roger W. Haines,* ***"HVAC system Design Handbook",*** *fifth edition*

2 *National Joint Apprenticeship & Training Committee, Building Automation System Integration With Open Protocols: System Integration With Open Protocols*

3 *John I. Levenhagen and Donald H. Spethmann,* ***HVAC Controls and Systems (Mechanical Engineering)*** *, 1992.*

4 *James E.Brumbaugh,* ***"HVAC fundamentals"****, vol: 1 to 3.*

COURSE OUTCOMES:

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

CO1 Demonstrate the understanding of concept of intelligent building and Building Automation System

CO2 Choose suitable hardware and design of HVAC in building automation system

CO3 Discuss the concept of energy management system.

CO4 Analyze the safety system for building

CO5 Comprehend various communication standards in BAS and develop Integrated system building automation

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L	M	H	M	L					H	H	H	H
CO2	H	M	L	M	H	M	L					H	H	H	H
CO3	H	M	L	M	H	M	L					H	H	H	H
CO4	H	M	L	M	H	M	L					H	H	H	H
CO5	H	M	L	M	H	M	L					H	H	H	H
18NPE$48	**H**	**M**	**L**	**M**	**H**	**M**	**L**					**H**	**H**	**H**	**H**

L-Low, M-Moderate(medium), H-High

18NPE$49	SMART FARMING

Category: PE

L	T	P	C
3	0	0	3

PREREQUISITES: NIL

COURSE OBJECTIVES:

* To introduce students the important principles, components and practices in the smart farming technology

UNIT – I INTRODUCTION	**(9 Periods)**
History of Precision farming- Sensing Technology- Control Algorithm- Yield Monitoring- Soil Property Sensing- Acquisition through Remote Sensing- Crop Information- Farmland Data- Spatial Sensing- Temporal Sensing- Feedback Control.	
UNIT – II MACHINE LEARNING IN AGRICULTURE	**(9 Periods)**
Machine Learning in Agriculture- Deep Learning in Agriculture- Yield prediction- Weed Detection- Irrigation Management - Discrimination between Weed and Crop- Forecasting stages.	
UNIT – III IoT IN AGRICULTURE	**(9 Periods)**
Need of IoT in Agriculture - Case study: Protection of Agricultural land from wild animals - Irrigation and Water Quality Management – Monitoring Farm Soil- Aquaponics- Agricultural Machinery- Disease and Pest Control- Challenges and Issues.	
UNIT – IV DRONES IN AGRICULTURE	**(9 Periods)**
Agricultural Drones: Types of Drones and Classifications – Definitions and Terminologies- Study of Natural Resources and Vegetation- Mapping and Monitoring.	
UNIT – V AGRICULTURE 5.0	**(9 Periods)**
Introduction to Agriculture 5.0- Remote Sensing- Application of Nanotechnology in Agriculture- Role of Big data- Hurdles faced by Farmers in Adopting- Current Policy Trends and Regulation.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1 *Latief Ahmad, FirasathNabi,* ***"Agriculture 5.0 – Artificial Intelligence, IoT and Machine learning",*** *CRC Press, 2021.*

2 *Qin Zhang,* ***"Precision Agriculture Technology for Crop Farming",*** *CRC Press, 2016.*

REFERENCES

1 *Govind Singh Patel,* ***"Smart Agriculture",*** *CRC Press, 2021.*

2 *Ajith Abraham, Sujata Dash, Joel J.P.C.Rodrigues,* ***"AI Edge and IoT based smart agriculture",*** *2021, Elsevier*

3 *Amitava Choudhury, Arindam Biswas, T.P.Singh, Santanu Kumar Ghosh,* ***"Smart Agriculture Automation using Advanced Technologies"****, 2021, Springer*

COURSE OUTCOMES:

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

CO1 Apprehend the fundamentals of precision farming and associated parameter monitoring methods.

CO2 Investigate the Machine learning approaches for agriculture

CO3 Demonstrate the understanding of implementation of IoT in various stages of agriculture.

CO4 Analyze the use of drones in agriculture

CO5 Comprehend the underpinning knowledge on Agriculture 5.0

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	M	L	M	H	M	L					H	H	H	H
CO2	H	M	L	M	H	M	L					H	H	H	H
CO3	H	M	L	M	H	M	L					H	H	H	H
CO4	H	M	L	M	H	M	L					H	H	H	H
CO5	H	M	L	M	H	M	L					H	H	H	H
18NPE$49	**H**	**M**	**L**	**M**	**H**	**M**	**L**					**H**	**H**	**H**	**H**

L-Low, M-Moderate(medium), H-Hig