VISION:
The vision of the department is to produce analytically proficient and technologically competent Electrical and Electronics Engineers who can serve and take forward the academic, industry and research organizations to newer heights and be effective for building the nation.

MISSION:
- To impart high quality technical education with the state of the art laboratory practice.
- To provide conducive academic ambience to enable best teaching and learning processes.
- To generate resources through research and consultancy projects for pursuing research and developmental activities in emerging areas.
- To associate with academic and industrial organizations for research activities to develop and provide vital and viable solutions for social needs indigenously.
- To develop leadership skills in students with high degree of ethics, morals and values and instill confidence to lead the organization.
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To provide students good foundation from engineering fundamentals, mathematical modeling to hardware-software programming intelligence towards latest trends in measurements and control.

II. To provide students, the ability to develop smart solutions for the purpose of system automation

III. To promote student awareness, for life-long learning and introduce them to professional ethics and code of practice.

IV. To encourage students to work in interdisciplinary and frontier areas.

2. PROGRAMME OUTCOMES (POs)

On successful completion of the programme, the graduate would have

PO1 An ability to independently carry out research/investigation and development work to solve practical problems

PO2 An ability to write and present a substantial technical report/document

PO3 Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4 Design and develop modern control and industrial automation systems using various control techniques, smart sensors and actuators.

PO5 Work on automation platforms such as PLC, SCADA and IIOT for analysis and design of industrial automation.

PO6 Develop innovative control and instrumentation techniques based on AI and Machine Learning algorithms with due concern aligning with latest trends and socio-economic values.

3. MAPPING OF PEOs with POs

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Mapped with 1,2,3 &- scale :1-low ; 2-medium ; 3-high
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YEAR II

SEM III

| Professional Elective III                       |     |     |     |     |     |     |
| Professional Elective IV                        |     |     |     |     |     |     |
| Professional Elective V                        |     |     |     |     |     |     |
| Project Work I                                  | 3   | 3   | 3   | 3   | 3   | 3   |

SEM IV

| Project Work II                                 | 3   | 3   | 3   | 3   | 3   | 3   |
# Curriculum and Syllabus I to IV Semesters

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### Theory

1. **MA3156** Applied Mathematics for Electrical Engineers
   - FC
   - Periods: L: 4, T: 0, P: 0
   - Contact Periods: 4
   - Credits: 4

2. **RM3151** Research Methodology and IPR
   - RMC
   - Periods: L: 2, T: 1, P: 0
   - Contact Periods: 3
   - Credits: 3

3. **CO3101** Instrumentation System Design
   - PCC
   - Periods: L: 3, T: 0, P: 0
   - Contact Periods: 3
   - Credits: 3

4. **CO3151** Control System Design
   - PCC
   - Periods: L: 4, T: 0, P: 0
   - Contact Periods: 4
   - Credits: 4

5. **CO3152** Intelligent Controllers
   - PCC
   - Periods: L: 3, T: 0, P: 0
   - Contact Periods: 3
   - Credits: 3

6. **Professional Elective I**
   - PEC
   - Periods: L: 3, T: 0, P: 0
   - Contact Periods: 3
   - Credits: 3

### Practical

7. **CO3111** Control System Design Laboratory
   - PCC
   - Periods: L: 0, T: 0, P: 4
   - Contact Periods: 4
   - Credits: 2

8. **CO3112** Intelligent Controllers Laboratory
   - PCC
   - Periods: L: 0, T: 0, P: 4
   - Contact Periods: 4
   - Credits: 2

**Total**

- Theory: 19 L, 1 T, 8 P, 28 Contact Periods, 24 Credits

## Semester II

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### Theory

1. **CO3201** Machine Learning for Instrumentation
   - PCC
   - Periods: L: 3, T: 0, P: 0
   - Contact Periods: 3
   - Credits: 3

2. **CO3252** Non Linear Control
   - PCC
   - Periods: L: 3, T: 1, P: 0
   - Contact Periods: 4
   - Credits: 4

3. **CO3251** Modern Automation Systems
   - PCC
   - Periods: L: 3, T: 0, P: 0
   - Contact Periods: 3
   - Credits: 3

4. **Professional Elective II**
   - PEC
   - Periods: L: 3, T: 0, P: 0
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   - Credits: 3

5. **Professional Elective III**
   - PEC
   - Periods: L: 3, T: 0, P: 0
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   - Credits: 3

### Practical

6. **CO3211** Automation Laboratory
   - PCC
   - Periods: L: 0, T: 0, P: 4
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   - Credits: 2

7. **CO3212** Advanced Measurements Laboratory
   - PCC
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**Total**

- Theory: 15 L, 1 T, 8 P, 24 Contact Periods, 20 Credits
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**SUMMARY**

Programme: M.E. Control & Instrumentation Engineering

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### UNIT I: MATRIX THEORY (12)

The Cholesky decomposition - Generalized Eigen vectors, Canonical basis - QR factorization - Least squares method - Singular value decomposition

### UNIT II: CALCULUS OF VARIATIONS (12)

Concept of variation and its properties – Euler’s equation – Functionals dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries - Direct methods: Ritz and Kantorovich methods

### UNIT III: ONE DIMENSIONAL RANDOM VARIABLES (12)

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable

### UNIT IV: LINEAR PROGRAMMING (12)

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

### UNIT V: FOURIER SERIES (12)

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals - Power signals: Exponential Fourier series – Parseval’s theorem and power spectrum

**TOTAL: 60 PERIODS**

**OUTCOMES:**

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

- **CO1** Apply the concepts of Matrix theory in Electrical Engineering problems.
- **CO2** Use calculus of variation techniques to solve various engineering problems.
- **CO3** Solve electrical engineering problems involving one-dimensional random variables.
- **CO4** Formulate and solve linear programming problems in electrical engineering.
- **CO5** To solve engineering problems using Fourier series techniques.

**REFERENCES:**

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RM3151 RESEARCH METHODOLOGY AND IPR LT P C 2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9
Sampling, sampling error, measures of central tendency and variation,; test of hypothesis-concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for wring thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,

CO3101 INSTRUMENTATION SYSTEM DESIGN LT P C
3 0 0 3

UNIT I SIGNAL CONDITIONING AND INTERFACE 9

UNIT II SMART SENSORS 9

UNIT III COMMUNICATION PROTOCOLS 9
Introduction-Evolution of signal standard – HART communication protocol – applications OSI models - Foundation field bus & Profibus - CAN bus, LIN bus, MOD bus, Industrial Ethernet.

UNIT IV PC-BASED INSTRUMENTATION SYSTEMS 9
Functional components of an instrument platform - Multiple-processor systems - Architecture of instruments for automated environments - The complete "computer-on-a-chip" and portable instrumentation - Choosing a PC platform - Computer operating systems - Applications of programming languages and packages.

UNIT V DATA PROCESSING CONSIDERATIONS 9
Computer-based instrument capacities - Organizing data (data structures) - Time or frequency basis of modeling - Software architectures for input/output – Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, students will be able to
CO1: To impart the knowledge on signal conditioning and interfacing.
CO2: To equip students with the necessary knowledge and skills to work effectively with smart sensors and related technologies in both academic and professional settings.
CO3: To understand communication protocols and to effectively design, implement, and manage advanced automation systems.
CO4: To understand components and considerations for designing and implementing effective and efficient instrumentation platforms for automated environments.
CO5: To provide students with a comprehensive understanding of computer-based instrument capacities, effective data organization, modeling principles, and software architectures.
REFERENCES:
5. Gerard C.M. Meijer, Smart Sensor Systems, John Wiley and Sons, 2008

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Note: 1-low, 2-medium, 3-high, ‘-’- no correlation

UNIT I ANALYSIS OF LINEAR SYSTEMS 12

UNIT II DESIGN OF SISO SYSTEM 12
Design Specifications – In continuous domain – Limitations – Controller Structure – Multiple degrees of freedom – PID controllers and Lag-lead compensators - Design – Discretization and direct discrete design - Design in continuous and discrete domain

UNIT III STATE SPACE DESIGN 12

UNIT IV OPTIMAL CONTROL 12
UNIT V  
OPTIMAL FILTERING

Filtering – Linear system and estimation – System noise smoothing and prediction – Kalman Filter – Recursive estimation.

TOTAL: 60 PERIODS

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

CO1 Analyse controllers for linear systems defined in transfer function and state space forms.
CO2 Design controllers for linear systems defined in transfer function and state space forms.
CO3 Apply state space forms to continuous and discrete systems.
CO4 Apply optimal control to linear systems in continuous and discrete systems.
CO5 Apply filtering concepts to linear systems in continuous and discrete systems.

TEXT BOOKS:

REFERENCES:

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Note: 1-low, 2-medium, 3-high, ‘-‘- no correlation
UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC


UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL

Generation of training data - optimal architecture – Model validation- Control of non-linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller – Casestudy - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL


UNIT IV GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques Firefly algorithm, Differential Evolution and Particle Swarm Optimization.

UNIT V HYBRID CONTROL SCHEMES

Fuzzification and rule base using ANN–Neuro fuzzy systems–ANFIS –Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization -Case study– Familiarization of ANFIS Tool Box.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Understand the basic architectures of NN and Fuzzy sets
CO2 : Design and implement ANN architectures, algorithms and know their limitations.
CO3 : Identify and work with different operations on the fuzzy sets.
CO4 : Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
CO5 : Understand and explore hybrid control schemes and PSO

REFERENCES:

5. George J. Klir and Bo Yuan, “Fuzzy Sets &amp; Fuzzy Logic Theory And Applications” VISIONIAS, 2020.
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**Note:** 1-low, 2-medium, 3-high, ‘-‘- no correlation

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**CO3111 CONTROL SYSTEM DESIGN LABORATORY**

**LIST OF EXPERIMENTS**

1. Analog simulation of linear systems
2. Digital simulation of linear and non-linear systems
3. Modelling and analysis of physical systems
4. Tuning methods of PID controller
5. Design of Lag-Lead compensators
6. Design of state feedback and optimal controller
7. Design of optimal estimator
8. Real time simulation of physical systems
9. Hardware in loop simulation of closed loop system
10. Design a closed loop controller for a physical system

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the students will demonstrate the ability

- CO1: Model, simulate and analyze the physical process in analog and digital platforms
- CO2: Design and implement various control strategies to improve the system response
- CO3: Develop hardware in loop simulation of closed loop control system

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**Attested**

**Director**

Centre for Academic Courses
Anna University, Chennai-600 025
LIST OF EXPERIMENTS

1. To implement adaline and madaline with bipolar inputs and outputs using NN toolbox.
2. To implement back propagation for a given input pattern using NN toolbox.
3. To implement Maxnet – Mexican Hat net network and test for given input pattern using NN toolbox.
4. To implement fuzzy set operation and properties using FUZZY toolbox.
5. To perform max-min composition of two matrices obtained from Cartesian product using ‘m file’ in MATLAB.
6. Write a program to verify the various laws associated with fuzzy set using FUZZY toolbox.
7. Write a matlab program for maximizing f(x) =x^2 using GA, where x is ranges from 0 to 31 (Perform only 5 iterations). Find the function and ‘x’ value.
9. Design a Neuro model for an inverted pendulum using NN toolbox.
10. Design Fuzzy model for an inverted pendulum using FUZZY toolbox.

TOTAL: 60 PERIODS

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

CO1: Equip students with the knowledge and practical skills required to implement and test neural network models using the NN toolbox.

CO2: Focus on understanding of fuzzy set operations, properties, and laws, allowing students to apply these concepts to real-world problems.

CO3: Equip students with the fundamental understanding and practical skills required to utilize optimization algorithms like Genetic Algorithms and advanced techniques like Fuzzy Logic, Neural Networks for control system design and optimization.

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Note: 1-low, 2-medium, 3-high, '-'- no correlation

CO3201 MACHINE LEARNING FOR INSTRUMENTATION  LT P C 3 0 0 3

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

UNIT II SUPERVISED LEARNING 9

UNIT III UNSUPERVISED LEARNING AND BAYSIAN LEARNING 9

UNIT IV REINFORCEMENT LEARNING 9

UNIT V APPLICATIONS AND CASE STUDIES 9
Machine Learning algorithms in Measurements, Monitoring, Parameter estimation, Identification, optimization and control.

TOTAL: 45 PERIODS

COURSE OUTCOMES
On completion of this course, the students will be able to
CO1: Understand basic AI algorithms.
CO2: Identify appropriate AI methods to solve a given problem.
CO3: Acquire knowledge about AI/ ML/DL techniques in Industrial instrumentation.
CO4: Understand the levels instrumentation
CO5: Equip students with the knowledge, skills, and practical experience required to leverage machine learning algorithms effectively in measurements, monitoring, parameter estimation, identification, optimization, and control applications.

TEXT BOOKS
1. Stuart Russell and Peter Norvig Artificial Intelligence - A Modern Approach, Prentice Hall, 3rd
REFERENCES

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CO3252 NON LINEAR CONTROL

UNIT I PHASE PLANE ANALYSIS 9+3
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- Existence of Limit Cycles. Analysis using computer simulations

UNIT II DESCRIBING FUNCTION 9+3

Attested

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UNIT III  LYAPUNOV THEORY  9+3

UNIT IV  FEEDBACK LINEARIZATION  9+3

UNIT V  SLIDING MODE CONTROL  9+3

L: 45 + T: 15  TOTAL: 60 PERIODS

COURSE OUTCOMES:
Ability to
CO1: Analyse system performance in the presence of control non-linearity
CO2: Analyse system performance using describing function method
CO3: Analyse non-linear system performance by constructing Lyapunov function
CO4: Analyse and Design robust controllers for non-linear systems for parameter variations but with stable zero-dynamics.
CO5: Implement controllers for MIMO systems using computer simulations

REFERENCES:
2. K. P. Mohandas, Modern Control Engineering, Sanguine, India, 2006

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Centre for Academic Courses
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UNIT I  INTRODUCTION TO AUTOMATION  9
Sensing and actuation, Communication – Globalization and emerging issues – Cyber Physical systems - Cyber security - Challenges and prospective of AI and 5G enabled technologies – Effect of integrated IT systems on enterprise competitiveness - requirement for automation – Automation system controllers, Industry 4.0 and 5.0 standards and implementation – Robotics 4.0

UNIT II  PLC  9
PLC — Hardware – Internal architecture – Ladder and functional block programming – IL, SFC and ST programming methods - Communication Networks for PLC – Case study.

UNIT III  DCS AND SCADA  9

UNIT IV  VIRTUAL INSTRUMENTATION  9
Virtual Instrumentation (VI) – Architecture – Programming Techniques – Front Panel and Block diagram – Data flow programming – G programming concepts – Creating and saving VIs – Wiring, Editing and Debugging of Vis – Creating Sub Vis – Control structures – Nodes – Arrays – Cluster controls and indicators – Error handling – String controls – File I/O VIs and functions – Augmented Reality – Case Study

UNIT V  INDUSTRIAL INTERNET OF THINGS  9
INDUSTRIAL INTERNET OF THINGS: Introduction – Architecture – Sensing, communication – Big data analytics – Security and Fog computing, cloud computing- Internet for energy – Case Study

TOTAL: 45 PERIODS

COURSE OUTCOMES:
In the end of the course the students will be:
CO1: able to gain the knowledge on fundamentals of automation.
CO2: able to understand the concepts of PLC, DCS and SCADA
CO3: able to understand Virtual Instrumentation for engineering processes.
CO4: able to gain the knowledge on Industrial Internet of Things
CO5: able to apply the concepts and develop automation for different systems.

REFERENCES:
3. Giacomo Veneri, Antonio Capasso, “Hands on Industrial Internet of things”, Packt, 2018
5. Dag H. Hanssen, Programmable Logic Controllers, A Practical Approach to IEC 61131-3 using CODESYS, John Wiley & Sons Ltd., 2015
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Note: 1-low, 2-medium, 3-high, ‘—’- no correlation

CO3211

AUTOMATION LABORATORY

LT P C 0 0 4 2

LIST OF EXPERIMENTS

1. Configuration of instrumentation bus protocols
2. Development of an alarm and monitoring system to detect abnormal levels in a physical system
3. Design a GUI application to mimic closed loop performance of physical systems.
4. Control of flow and pressure in a tank process using Variable Frequency Drive.
5. Development of Ladder logic programme for control of process
6. Design of combinational and sequential logic application using PLC
7. Development of Cascade, ratio and feedback controller using DCS simulation software
8. Simulation of SCADA based control of physical system.
9. Mathematical modelling and transfer function analysis of a physical system using Virtual Instrumentation packages.
10. Mathematical modelling and state space analysis of a physical system using virtual Instrumentation packages.
12. Design and development of IOT based transmitter
14. Analysis and control of EV motors
15. Mini Project

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability

CO1: To understand the concepts of configuring instrumentation, developing monitoring and control systems, designing graphical interfaces, and implementing control strategies using various techniques and tools.

CO2: To gain expertise in PLC programming, DCS simulation, SCADA-based control, and mathematical modeling using various software tools.
CO3: To gain proficiency in developing state diagram-based applications, IoT-enabled devices, robotic systems, and control strategies for electric vehicle motors.

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CO3212 ADVANCED MEASUREMENTS LABORATORY LT P C 0 0 4 2

EXPERIMENT LIST
1. Position measurement using LVDT and LDR by real-time and interfacing.
2. Measurement of physical parameters using Data Acquisition System.
3. PC based measurement of Temperature using Temperature transducers.
6. Design of signal conditioning circuits for physical systems.
7. Analyzing the characteristics of IOT based transmitters in Machine Learning environment.
8. Physical parameter estimation using Gray box model of industrial process.
9. Classification of measurement data using Supervised learning algorithm.
10. Clustering physical parameters using Unsupervised learning algorithm.
12. Calibration and characterization of industrial instruments.
13. PID Controller tuning using optimization algorithm.
14. Mini project

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability
CO1: To measure and interface a physical parameter using data acquisition system.
CO2: To design signal conditioning circuits for various transducers.
CO3: To analyse the measurement data in machine learning environment
CO4: To estimate the physical parameters using system identification method
CO5: To measure the parameters in a physical system and evaluate its performance.

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CO3001  ADVANCED NON-LINEAR CONTROL  LT P C
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UNIT I  PERTURBATION THEORY 9

UNIT II  SINGULAR PERTURBATIONS 9
Standard singular perturbation model – Time scale properties – Singular perturbation on the infinite interval – Slow and fast manifolds – stability analysis – exercises

UNIT III  GAIN SCHEDULING AND FEEDBACK LINEARIZATION 9

UNIT IV  INPUT-OUTPUT STABILITY 9

UNIT V  BAKSTEPPING CONTROL ALGORITHMS 9
Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL : 45 PERIODS

COURSE OUTCOMES
CO1 :Understanding different types of perturbation models.
CO2 :Analysis of Stability of various perturbation models.
CO3 :Apply gain schedule all kind of perturbation systems.
CO4 :Apply L stability and lyapunov stability conditions for systems
CO5 :Apply Bakstepping control algorithms.

REFERENCES
1. Hasan Khalil," Nonlinear systems and control", 3\textsuperscript{rd} ed. PHI,
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CO3002 CONVERTERS AND ELECTRICAL DRIVES LT P C 3 0 0 3

UNIT I  POWER ELECTRONIC CONVERTERS FOR DRIVES 9
Power electronic switches- Working of AC-DC converters for RLE load; single phase and three phase; DC – DC converters for RLE load, AC- AC converters and DC- AC Converters; Single phase and three phase.

UNIT II  CONTROL OF DC DRIVES 9

UNIT III  REFERENCE FRAME THEORY 9
Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame – transformation of balanced set-variables observed from several frames of reference.

UNIT IV  VSI AND CSI FED STATOR CONTROLLED INDUCTION MOTOR CONTROL 9
AC voltage controller – six step inverter voltage control-closed loop variable frequency PWM inverter fed induction motor (IM) with braking-CSI fed IM variable frequency motor drives – pulse width modulation techniques – simulation of closed loop operation of stator controlled induction motor drives.

UNIT V  ROTOR CONTROLLED INDUCTION MOTOR DRIVES 9

TOTAL: 45 PERIODS

COURSE OUTCOMES
CO1: understand Power Electronic Converter Switches and different PWM approach.
CO2: design and analyze converter and chopper driven dc drives.
CO3: analyze converter and chopper driven dc drives.
CO4: understand conventional control techniques of induction motor drive.
CO5: understand V/f Control and Vector control

REFERENCES

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CO3057  OPTIMAL CONTROL AND FILTERING  LT P C 3 0 0 3

UNIT I  INTRODUCTION  9

UNIT II  LINEAR QUADRATIC TRACKING PROBLEMS  9

UNIT III  NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL  9
Numerical solution of 2-point boundary value problem by steepest descent and Fletcher-Powell method - solution of Ricatti equation by negative exponential and interactive Methods
UNIT IV FILTERING AND ESTIMATION

UNIT V KALMAN FILTER AND PROPERTIES

TOTAL: 45 PERIODS

COURSE OUTCOMES
Ability to
CO1: Understand the concept of Optimal Control problem.
CO2: Identify, Formulate and measure the performance of Optimal Control.
CO3: understand the Linear Quadratic Tracking Problems and implement dynamic programming application for discrete and continuous systems.
CO4: Solve Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method.
CO5: Understand Filtering problem their properties, linear estimator property of Kalman Filter and Time invariance and asymptotic stability of filters.

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UNIT I MODELS FOR IDENTIFICATION

UNIT II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATION

UNIT III NON-LINEAR IDENTIFICATION

UNIT IV CONVERGENCE, DISTRIBUTION AND COMPUTING THE PARAMETER ESTIMATES

UNIT V CASE STUDIES
Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

TOTAL : 45 PERIODS

COURSE OUTCOMES
Ability to
CO1: Model LTI system and to analyse the Non-linear state-space model of a black box.
CO2: Analyse frequency, spectral, correlation and transient response of a system
CO3: Identify the Open & closed Loop of a Non-linear system by Neural network and Fuzzy Logic controller.
CO4: Understand the distribution and computation of parameter estimates
CO5: Apply different Identification techniques to various applications

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**CO3058 SYSTEM THEORY**

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**UNIT II SOLUTION OF STATE EQUATIONS**

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**UNIT III CONTROLLABILITY AND OBSERVABILITY**

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<tr>
<td>Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.</td>
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**UNIT IV STABILITY**

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**UNIT V MODAL CONTROL**

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<tr>
<td>Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems – The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISOand MIMO Systems-Full Order and Reduced Order Observers.</td>
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**TOTAL : 45 PERIODS**
COURSE OUTCOMES
CO1: To understand the concept of State-State equation for Dynamic Systems and the uniqueness of state model.
CO2: To understand the concept of the uniqueness of state model.
CO3: Analyse Controllability and Observability for Time varying and Time invariant case
CO4: Analyse the linear systems in state space
CO5: Design controllers in state space

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Note: 1-low, 2-medium, 3-high, ‘-’- no correlation

CO3004 ROBOTICS AND CONTROL

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

UNIT II KINEMATICS
Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics- solution and programming-degeneracy and dexterity

UNIT III DIFFERENTIAL MOTION AND PATH PLANNING
Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-RobotPath planning
UNIT IV  DYNAMIC MODELLING  9
Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton- Euler formulation – Inverse dynamics

UNIT V  ROBOT CONTROL SYSTEM  9
- Linear control schemes- joint actuators- decentralized PID control- computed torque control – force control- hybrid position force control- Impedance/ Torque control

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Ability to
CO1 :understand the components and basic terminology of Robotics
CO2 :understand kinematic relations and dynamic model of robots
CO3 :understand differential motion, path planning and dynamic model of robots
CO4 :develop kinematic and dynamic models for two degrees of freedom
CO5 : apply control techniques for robot position and force control.

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Note: 1-low, 2-medium, 3-high, ‘-‘- no correlation
UNIT I  INTRODUCTION  9
Norms of vectors and Matrices – Norms of Systems – Calculation of operator Norms – vector
Random spaces- Specification for feedback systems – Co-prime factorization and Inner
functions – structured and unstructured uncertainty- robustness.

UNIT II  H₂ OPTIMAL CONTROL  9
Linear Quadratic Controllers – Characterization of H₂ optimal controllers – H₂ optimal estimation- Kalman Bucy Filter – LQG Controller.

UNIT III  H-INFINITY OPTIMAL CONTROL-RICCATI APPROACH  9

UNIT IV  H-INFINITY OPTIMAL CONTROL- LMI APPROACH  9

UNIT V  SYNTHESIS OF ROBUST CONTROLLERS & CASE STUDIES  9
Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration- Control of Inverted Pendulum- Control of CSTR – Control of Aircraft – Robust Control of Second-order Plant- Robust Control of Distillation Column.

TOTAL : 45 PERIODS

COURSE OUTCOMES
Ability to
CO1 :Understand the structured and unstructured uncertainty of robustness.
CO2 :Design an H₂ optimal controller and to implement kalman Bucy filter.
CO3 :Design an H-Infinity optimal control using Riccati and LMI Approach.
CO4 :synthesis of Robust Controller and application of small gain theorem.
CO5 : Implement robust Controllerfor CSTR and Distillation Column.

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Note: 1-low, 2-medium, 3-high, ‘-’- no correlation

CO3006  DYNAMICS AND CONTROL OF INDUSTRIAL PROCESS          LT P C
3 0 0 3

UNIT I  PROCESS DYNAMICS & CONTROL  9

UNIT II  PID CONTROLLER TUNING – SINGLE LOOP REGULATORY CONTROL  9

UNIT III  MODEL BASED CONTROL SCHEMES  9

UNIT IV  MULTIVARIABLE SYSTEMS & MULTI-LOOP REGULATORY CONTROL  9

UNIT V  CASE STUDIES  9
Introduction to Multivariable control – Multivariable PID Controller –Predictive PID
Control - Control Schemes for Distillation Column, CSTR, Four-tank system and Additive Dosing Control.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
CO1 : Ability to Apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes.
CO2 : Ability to determine the advanced Features supported by the Industrial Type PID Controller.
CO3 : Ability to Design, tune and implement SISO P/PI/PID Controllers to achieve desired Performance for various processes.
CO4 : Ability to Analyze Multivariable Systems and Design Multi-variable and Multi-loop Control Schemes for various processes namely four-tank system, pH process, bio-reactor, distillation column.
CO5 : Ability to Identify, formulate, and solve problems in the process control domain.

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**Note:** 1-low, 2-medium, 3-high, '-' - no correlation
UNIT I  INTRODUCTION 9
Models for MPC-Linear Dynamic Models, Input-Output Models, Distributed Models, Constraints and Unconstrained model.

UNIT II  MODEL ANALYSIS AND DISTURBANCE MODELING 9
Model stability; Observability and controllability Representing uncertainty; White, colored and integrating noise

UNIT III  STATE ESTIMATION AND MULTIVARIABLE MPC 9
State observer; Pole placement; Stability; Kalman Filter; Stochastic filtering theory; Multivariate MPC.

UNIT IV  CONSTRAINED AND UNCONSTRAINED LQ CONTROL 9
Constrained LQ-Time variant and Invariant case: Estimation, control and output; Unconstrained LQ control; Nonlinear Constrained system

UNIT V  STATE-SPACE MPC AND CASE STUDIES 9
State-space MPC; deterministic formulation; state feedback control, State-Space Output-Feedback MPC-separation principle; Implementation of output feedback MPC; MPC-Applications : solar power plant.

TOTAL: 45 PERIODS

BOOKS AND REFERENCES

COURSE OUTCOMES:
CO1 :Ability to understand the concepts of developing various models for a physical system.
CO2 :Ability to analyze the models and incorporate the uncertainties.
CO3 :Ability to comprehend State Estimation And Multivariable MPC
CO4 :Ability to understand the design of Linear Quadratic control techniques and state space MPC.
CO5 :Ability to design a model predictive controller to various applications

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Note: 1-low, 2-medium, 3-high, '-' - no correlation
CO3056  MULTI SENSOR DATA FUSION  LT P C  3 0 0 3

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

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

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

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

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

TOTAL : 45 PERIODS

COURSE OUTCOMES
CO1 : Ability to explain and use multiple sensor data in data fusion model.
CO2 : Capable to use algorithms for data fusion.
CO3 : Ability to estimate using kalman filter.
CO4 : Ability to estimate using advance filtering such as data, extended information
filtering.
CO5 : Ability to handle various high performance data structures.

REFERENCES:
1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House,
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Note: 1-low, 2-medium, 3-high, ‘-‘- no correlation

CO3007 NETWORKED CONTROL SYSTEM LT P C 3 0 0 3

UNIT I  FUNDAMENTALS OF STOCHASTIC PROCESSES 9
Stochastic process – Introduction to random variables and their role in probability theory and statistics, discrete and continuous random variables, probability mass/density functions, cumulative distribution functions, and transformations. Expectations, Moments, variance, skewness, and kurtosis to analyze the distribution of random variables., stationary and non-stationary process: significance. Differentiating between stationary and non-stationary processes, properties and implications in modeling and analysis.

UNIT II  NETWORK MODELING AND CONSTRAINTS 9

UNIT III  ESTIMATION 9
Estimation of networked control system – Observer for networked system - types – design and implementation - estimate the unmeasured states of a system, Kalman filter - discrete-time and continuous-time.

UNIT IV  CONTROL STRATEGIES 9
Control strategies – State feedback control - state-space representation, controllability, state feedback controllers. Output feedback control - observability, observers, controller design, Predictive control - modeling, optimization-based control.

UNIT V  GRAPH THEORY 9
Introduction to graph theory: an overview - nodes, edges, graphs, graph representations, algorithms, applications - network analysis, routing, scheduling- Simulation of network control system: principles and techniques - Application of networkcontrol system.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
On completion of this course, the students will be able to
CO1: Model the network control system with packet delay, loss and uncertain observation.
CO2: Design control system in the presence of quantization, network delay or packet loss.
CO3: Understand distributed estimation and control suited for network control system.
CO4: Develop simple application suited for networked control systems.
CO5: Equip students with a solid foundation in graph theory and its applications in control systems.

TEXT BOOKS

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Note: 1-low, 2-medium, 3-high, "-" no correlation
UNIT I  ARCHITECTURE OF WIRELESS SENSOR NETWORKS
Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture — Hardware components, energy consumption of sensor nodes, Network architecture — Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, design principles, Development of wireless sensor networks.

UNIT II  FUNDAMENTALS OF WIRELESS COMMUNICATION AND CHANNEL CHARACTERISTICS
Wireless channel and communication fundamentals — frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, energy usage profile, choice of modulation, power management.

UNIT III  MAC AND LINK LAYER PROTOCOLS
MAC protocols — fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols — fundamentals task and requirements, error control, framing, link management

UNIT IV  METHODS OF NETWORKING COMMUNICATION, ROUTING, DESIGN
Gossiping and agent-based uni-cast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, mobile nodes, Data –centric and content-based networking – Data –centric routing, Data aggregation, Data-centric storage, Higher layer design issue

UNIT V  SENSOR NETWORK APPLICATIONS
Target detection and tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Sensor Network Platforms and tools-Sensor node hardware, Node-level software platforms, node –level simulators.

TOTAL: 45 PERIODS

COURSE OUTCOMES
On completion of this course, the students will be able to
CO1: Understand challenges, architectural components, energy considerations, network scenarios, and design principles of wireless sensor networks,
CO2: Equip students with a comprehensive understanding of wireless communication fundamentals and their specific application in wireless sensor networks.
CO3: Design, analyse, and implement efficient MAC protocols for reliable communication in wireless environments.
CO4: Gain advanced knowledge in gossiping, energy-efficient communication, geographic routing, and data-centric networking.
CO5: Design and implement wireless sensor network solutions for real-world applications.

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CO3052 CYBER PHYSICAL SYSTEMS LT P C 3 0 0 3

UNIT I INTRODUCTION 9
Introduction-key features of cyber physical systems- Continuous dynamics: Newtonian mechanics-actor models-properties of systems-feedback control-Discrete dynamics: Discrete systems- Finite state machines.

UNIT II SYNCHRONOUS AND ASYNCHRONOUS MODEL 9
Synchronous model: Reactive components-properties of components-composing components- synchronous design, Asynchronous model- asynchronous processes-asynchronous design primitives- coordination protocols.

UNIT III SAFETY AND LIVENESS REQUIREMENT 9
Safety specifications- verifying invariants- Enumerative search- Temporal logic- Model checking- reachability analysis- proving live-ness

UNIT IV TIMED MODEL AND REAL-TIME SCHEDULING 9

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UNIT V   HYBRID SYSTEMS


TOTAL : 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the students will be able to
CO1: Apply mathematical knowledge and basis of science and engineering to develop model for continuous and discrete systems.
CO2: Develop synchronous and asynchronous models
CO3: Assess the safety requirements of the cyber physical systems
CO4: Apply automata for modeling timed systems
CO5: Analyze the stability of hybrid systems

REFERENCES:


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Note:  1-low, 2-medium, 3-high, "-"- no correlation
UNIT I  BIOMEDICAL MEASUREMENTS AND SAFETY CONSIDERATIONS  9
Physiological systems and measurable variables - Nature and complexities of biomedical measurements - Medical equipment standards - organization, classification and regulation - Biocompatibility - Human and Equipment safety — Physiological effects of electricity, Micro and macro shocks, thermal effects.

UNIT II  MODELING AND SIMULATION IN BIOMEDICAL INSTRUMENTATION  9

UNIT III  CLASSIFICATION OF BIOLOGICAL SIGNALS  9
Types and Classification of biological signals - Signal transactions – Noise and artifacts and their management - Biopotential electrodes- types and characteristics - Origin, recording schemes and analysis of biomedical signals Electrocardiography(ECG), with typical examples of and Electroencephalography(EEG), Electromyography (EMG)— Processing and transformation of signals - applications of wavelet transforms in signal compression and denoising.

UNIT IV  IMAGING MODALITIES AND ANALYSIS  9
Advanced medical imaging techniques and modalities -Instrumentation and applications in monitoring and diagnosis - Computed tomography, Magnetic Resonance Imaging and ultrasound- Algorithms and applications of artificial intelligence in medical image analysis and Diagnosis- Telemedicine and its applications in tele monitoring.

UNIT V  IMPLANTABLE MEDICAL DEVICES  9
Artificial valves, vascular grafts and artificial joints - cochlear implants - cardiac pacemakers - Microfabrication technologies for biomedical Microsystems- microsensors for clinical applications – biomedical microfluid systems

TOTAL: 45 PERIODS

COURSE OUTCOMES
On completion of this course, the students will be able to
CO1: Gain a comprehensive understanding of physiological systems, biomedical measurements, and the critical aspects of safety in medical equipment
CO2: Create mathematical models for various physiological systems, allowing for in-depth analysis and simulation of complex biomedical phenomena.
CO3: Manage noise and artifacts, utilizing biopotential electrodes, and applying signal processing techniques, including wavelet transforms, to biomedical signals.
CO4: Understand the applications and benefits of artificial intelligence in medical image analysis and diagnosis, along with the potential of telemedicine in enhancing healthcare through remote monitoring and consultations.
CO5: Understand the various implantable biomedical devices and microsystems.

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Note: 1-low, 2-medium, 3-high, ‘-’- no correlation

CO3054 INTELLIGENT TRANSPORTATION SYSTEMS LT P C 3 0 0 3

UNIT I INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS 9

UNIT II TELECOMMUNICATIONS IN ITS 9
Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC), Vehicle – Road side communication – Vehicle Positioning System

UNIT III ITS FUNCTIONAL AREAS 9

UNIT IV ITS USER NEEDS AND SERVICES 9

UNIT V AUTOMATED HIGHWAY SYSTEMS 9
Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries, Case studies.

TOTAL : 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students should be able to:
CO1: understand the sensor technologies
CO2: understand the communication techniques
CO3: apply the various ITS methodologies
CO4: understand the user needs
CO5: define the significance of ITS under Indian conditions

REFERENCES:
1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.

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CO3008                    BUILDING AND INFRASTRUCTURE SYSTEMS AND AUTOMATION                        3 0 0 3

UNIT I  INTRODUCTION TO BUILDING & INFRASTRUCTURE SYSTEMS & AUTOMATION
Overview of buildings & campuses – residential community, commercial, industrial, Concept and application of buildings automation (BA) - Requirements and design considerations of BA. Effect on energy & utility services efficiency of building services operations. Architecture and components of BA, BMS (Building Management Systems) concept and overview.

UNIT II  BUILDINGS & INFRASTRUCTURE SYSTEMS
UNIT III  LIGHTING AND ACCESS CONTROL SYSTEMS  
Various components of lighting systems, efficient use of electricity, lighting control systems, components of CCTV system like cameras, cables, etc., concept of automation in access control system

UNIT IV  VERTICAL TRANSPORTATION SYSTEM  
Structure of lift and escalator, traffic analysis, lift drives, supervisory control and remote monitoring of lift, safety aspects -Fire & Alarm system - Other utility & subsystems: Water sources-storage-distribution - cooking gas source-distribution system, community halls & gym, air/gas utility supply & distribution systems, facility-estate management, safety, O&M

UNIT V  ELECTRICAL UTILITY AND AUTOMATION  
Typical sources - power-grid utility & diesel-gensets, stable and uninterrupted power supply, components of electrical power distribution in buildings- infrastructure, transformers, meters, distribution system components, wiring, common/large loads – pumps, compressors, motors & drives, VFDs Building Automation: Role of automation in operation of B&I System/subsystems (HVAC/Lighting/Lifts/Electricity etc.). Relevant sensors-actuators, BA controllers DDC, PLC,SCADA, HMI, RMVCD Centers.

TOTAL: 45 PERIODS

COURSE OUTCOMES
On completion of this course, the students will be able to
CO1: Understand the architecture and basic building blocks of Building and Infrastructure of Automation systems
CO2: Design and evaluate various subsystems for Building Automation systems
CO3: To design and implement control strategies for HVAC systems for energy management system
CO4: Grasp the advanced principles for incorporating the safety and acquire efficient resource management skills within Building Automation systems.
CO5: Enhance energy efficiency, operational effectiveness, and overall functionality in various built environments.

REFERENCES:
8. Other resources like Published journal/conference papers, industrial products & manuals, Internet search/survey.

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DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
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Note: 1-low, 2-medium, 3-high, '-'- no correlation

UNIT I      INTERNET PRINCIPLES 9
Definition and Characteristics - IoT enabling technologies — Levels of deployment — Domainspecific IoTs - SDN and NFV for IoT — ISO/OSI model — MAC address and IP address - Overview of TCP/IP and UDP -Basics of DNS - Classes of IP addresses - Static and dynamic addressing -Salient features of IPV4 — Specifications of IPV6 and 6LoPAN.

UNIT II      PHYSICAL AND LOGICAL DESIGN METHODOLOGIES 9
Requirements and Specifications – Device and Component Integration —Physical design using prototyping boards - Sensors and actuators, choice of processor, interfacing and networking - Logical Design — Open source platforms - Techniques for writing embedded code - Case studies and examples using Python programming and Arduino/Raspberry Pi prototyping boards

UNIT III      PROTOCOLS AND CLOUDS FOR IOT 9
Application layer protocols for IoT – MQTT and –Introduction to cloud storage models and communication APIs – Web application framework – Designing a web API – Web services - IoT device management.

UNIT IV      INDUSTRIAL IOT AND SECURITY 9

UNIT V      PROCESS DATA ANALYTICS 9
Process analytics - Dimensions for Characterizing process- process Implementation technology Tools and Use Cases- open source and commercial tools for Process
analytics—Big data Analytics for process data — Analyzing Big process data problem — Crowdsourcing and Social BPM - Process data management in the cloud.

COURSE OUTCOMES:
On completion of this course, the students will be able to
CO1: Apply the knowledge of Internet principles and protocols to understand the architecture and specifications of a given network
CO2: Design simple IoT applications using prototyping boards
CO3: Select the appropriate protocol for a specific network implementation
CO4: Identify the security level needed for a particular industrial IoT application
CO5: Analyze the process data using cloud based process data management tools

TOTAL : 45 PERIODS

REFERENCES:
1 Arshdeep Bahga and Vijay Madisetti, “Internet of Things A Hands-on Approach”, Universities Press (India), 2015
3 Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley & Sons, 2014

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Note: 1-low, 2-medium, 3-high, ‘-’ no correlation
UNIT I  INTRODUCTION  9

UNIT II  PROTECTION LAYERS AND SAFETY REQUIREMENT SPECIFICATIONS  9

UNIT III  SAFETY INTEGRITY LEVEL (SIL)  9
Evaluating Risk, Safety Integrity Levels, SIL Determination Method : As Low As Reasonably Practical ( ALARP ), Risk matrix, Risk Graph, Layers Of Protection Analysis ( LOPA ) – Issues related to system size and complexity –Issues related to field device safety – Functional Testing.

UNIT IV  SYSTEM EVALUATION  9

UNIT V  CASE STUDY  9

TOTAL : 45 PERIODS

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

CO1 understand Non-SIS layers of protection and the need for SIS in process industries.
CO2 state the associated SIS standards.
CO3 implement hazard analysis & risk assessment to identify process hazards & risks.
CO4 determine the target SIL & safety requirements specifications
CO5 develop detailed SIS design, installation & operation.
CO6 implement SIS analysis & design for a furnace/ fired heater system.
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ET3151 DESIGN OF EMBEDDED SYSTEMS

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

UNIT II EMBEDDED NETWORKING BY PROCESSORS 9
UNIT III  RTOS BASED EMBEDDED SYSTEM DESIGN
Introduction to basic concepts of RTOS- Synchronising and Scheduling in Uniprocessor and Multiprocessor OS- Task, process & threads, interrupt routines ,Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, inter task communication- context switching, interrupt latency and deadline, shared memory, message passing-, Interprocess Communication – synchronization between processes-semaphores,Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems:VxWorks, OS for mobile applications.

UNIT IV MODELLING WITH HARDWARE/SOFTWARE DESIGN APPROACHES

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT
DSPProcessors - Architectural requirement and applications- Computational Features of DSPProcessors for signal processing- Shifting , Buffering, IIR/FIR Filtering operation, Addressing Capabilities, Onchip peripherals and Features for External Interfacing& Program Execution–Case example of DSPProcessor (TMS320CXXX/ TMS320C67xx/ any other)based embedded application using audio, video processing.

TOTAL: 45 PERIODS

NOTE:
Practice through Mini Project/Exercise/Discussions on Design ,Development of embedded Products like : Digital Camera /Adaptive Cruise control in a Car /Mobile Phone / Automated Robonoid /discussions on interface to Sensors, GPS, GSM, Actuators

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability
CO1: To understand the functionalities of processor internal blocks, with their requirement.
CO2: Observe that Bus standards are chosen based on interface overheads without sacrificing processor performance.
CO3: Understand the role and features of RT operating system, that makes multitask execution possible by processors.
CO4: Understand that using multiple CPU based on either hardcore or softcore helps data overhead management with processing- speed reduction for uC execution.
CO5: Guidelines for consumer product design based on DSP based Embedded processor

REFERENCES:
6. Advanced Computer architecture , By Rajiv Chopra, S Chand , 2010

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**ET3252 EMBEDDED CONTROL FOR ELECTRIC DRIVES**

**UNIT I INTRODUCTION ELECTRICAL DRIVES**

**UNIT II EMBEDDED PROCESSOR**
Embedded Processor architecture - RTOS - Hardware/software co-design Programming and optimization with SoC processors - control algorithms implementation for power converter.

**UNIT III INDUCTION MOTOR CONTROL**
Types - Speed control methods - PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three phase induction motor - FPGA based three phase induction motor control.

**UNIT IV BLDC MOTOR CONTROL**
Overview of BLDC Motor - Speed control methods - PWM techniques - ARM processor based BLDC motor control - ANN for BLDC Motor control and operation.

**UNIT V SRM MOTOR CONTROL**
Overview of SRM Motor - Speed control methods - PWM techniques - FPGA based SRM motor control - DNN for SRM Motor control and operation.

**30 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice / Seminar/ Mini Project/etc)**

**30 PERIODS**

1. Laboratory exercise: Use any System level simulator/MATLAB/open-source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phase inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

**Attested**

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COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Interpret the significance of embedded control of electrical drives
CO2: Deliver insight into various control strategy for electrical drives.
CO3: Developing knowledge on Machine learning and optimization techniques for motor control.
CO4: Develop embedded system solution for real time application such as Electric vehicles and UAVs.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

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ET3063 PYTHON PROGRAMMING FOR MACHINE LEARNING LT P C 3 0 0 3

UNIT I INTRODUCTION TO MACHINE LEARNING AND PYTHON 9
Introduction to Python and its significance - Difference between C, C++ and Python Languages; Compiler and Interpreters - Python3 Installation & Running - Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User - Arrays/List, Dictionary and Set - Conditional Statements - Control Flow and loop control statements

UNIT II PYTHON FUNCTIONS AND PACKAGES 9
File Handling: Reading and Writing Data - Errors and Exceptions Handling - Functions & Modules - Package Handling in Python - Pip Installation & Exploring Functions in python package - Installing the NumPy Library and exploring various operations on Arrays: Indexing, Slicing, Multi-Dimensional Arrays, Joining NumPy Arrays, Array intersection and Difference, Saving and Loading NumPy Arrays - Introduction to SciPy Package & its functions - Introduction to Object Oriented
UNIT III  IMPLEMENTATION OF MACHINE LEARNING USING PYTHON

Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset - Introducing the concepts of Regression - Linear, Polynomial & Logistic Regression with analytical understanding - Introduction to SciPy Package & its functions - Python Application of Linear Regression and Polynomial Regression using SciPy - Interpolation, Overfitting and Underfitting concepts & examples using SciPy

UNIT IV  CLASSIFICATION AND CLUSTERING CONCEPTS OF ML

Introduction to ML Concepts of Clustering and Classification - Types of Classification Algorithms - Support Vector Machines (SVM) - Decision Tree - Random Forest - Introduction to ML using scikit-learn - Using scikit-learn, loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting - Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv, Types of Clustering Algorithms & Techniques - K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm - Introduction to Python Visualization using Matplotlib: Plotting 2-dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph - Implementation of K-means Algorithm and Mean Shift Algorithm using Python

UNIT V  INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING


TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Develop skill in system administration and network programming by learning Python.

CO2: Demonstrating understanding in concepts of Machine Learning and its implementation using Python.

CO3: Relate to use Python’s highly powerful processing capabilities for primitives, modelling etc.

CO4: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

CO5: Apply the concepts acquired over the advanced research/employability skills

REFERENCES:


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DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
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ET3060  IoT FOR SMART SYSTEMS  LT P C
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UNIT I  INTRODUCTION TO INTERNET OF THINGS
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Data streaming and cloud services tools- Typical IoT applications, Trends and implications.

UNIT II  IOT ARCHITECTURE

UNIT III  PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT PROTOCOLS
NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), LoWPAN, Proprietary systems - Recent trends.

UNIT IV  IOT PROCESSORS
Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT: Introduction to Python programming - Building IOT with RASPPY R and Arduino.

UNIT V  CASE STUDIES
Data streaming and cloud services tools Industrial IoT, IoT for Utilities - Home Automation, IOE-Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IoT for Defense - Smart Energy Management system - Smart Sustainable Cities and Smart Buildings.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications
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ET3055 EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM

UNIT I BUILDING SYSTEM AUTOMATION

UNIT II EMBEDDED NETWORKING OF INSTRUMENT CLUSTER

54
UNIT III    AUTOMATION OF SUBSTATION

UNIT IV    METERING OF SMART GRID
Characteristics of Smart Grid - Generation by Renewable Energy Sources based on solar grid - Challenges in Smart Grid and Microgrids - electrical measurements with AMI - Smart meters for EV plug in electric vehicles power management - Home Area Net metering and Demand side Energy Management applications.

UNIT V    SMART METERS FOR PQ MONITORING
Power Quality issues of Grid connected Renewable Energy Sources -Smart meters for Power Quality monitoring and Control - Power Quality issues -Surges - Flicker - Interharmonics - Transients - Power Quality Benchmarking - Power Quality Meters- Meter data management In Smart Grid-, communication enabled Power Quality metering

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Demonstrate criteria of choice of sensors, components to build meters.
CO2: Illustrate the demand for BUS communication protocols are introduced
CO3: Analyse the need and standards in Substation automation
CO4: Deployment of PAN for metering networked commercial applications
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications.

REFERENCES:
1. Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006
4. Mohammad Ilyas And Imad Mahgoub. 'Handbook of sensor Networks: Compact wireless and wired sensing systems', CRC Press,2005

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UNIT I INTELLIGENT SYSTEMS AND PYTHON PROGRAMMING 9
Introduction to Machine Learning and Deep Learning - Performance Improvement with Machine Learning - Building Intelligent Systems - Introduction to Python - Python Programming

UNIT II PYTHON FOR ML 9
Python Application of Linear Regression and Polynomial Regression using SciPy - Interpolation, Overfitting and Underfitting concepts & examples using SciPy - Clustering and Classification using Python.

UNIT III EMERGING TRENDS IN HARDWARE ARCHITECTURES FOR DEEP LEARNING 9
Quantization and Precision Reduction Techniques - Hardware aware neural Architecture. Hardware-software co-design for deep learning systems Memory hierarchy and cache optimization for deep learning Parallelization and distributed training of deep learning models Energy-efficient deep learning hardware architectures Hardware acceleration for specific deep learning applications (e.g., natural language processing, computer vision)

UNIT IV PYTHON FOR DL 9
Python Applications for DL - Python for CNN and YOLO

UNIT V CASE STUDIES 9
Development of Intelligent System for Power system protection - Smart Energy - IOE- Motor control - BMS - Intelligent systems for Industry 4.0 and Industry 5.0

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability in
CO1: Able to gain proficiency in the Python programming language and learn how to apply it in the context of intelligent systems
CO2: Able to learn Python libraries such as NumPy, Pandas, and scikit-learn to preprocess data, build and train Machine Learning models, and evaluate their performance
CO3: Able to learn Deep Learning libraries such as TensorFlow or PyTorch to build, train, and evaluate Deep Learning models for tasks such as image classification, natural language processing, and computer vision.
CO4: Able to learn hardware components, such as processors, memory, and accelerators, and how they are integrated.
CO5: Able to learn intelligent systems implementations, examine their design choices, evaluate their performance, and understand the challenges.

REFERENCES:
1."Intelligent Systems: Principles, Paradigms, and Pragmatics" by Rajendra P. Srivastava (Published in 2013)
2."Intelligent Systems: A Modern Approach" by Thomas Bäck, David B. Fogel, and Zbigniew Michalewicz (Published in 2000)
3."Intelligent Systems: Modeling, Optimization, and Control" by Grzegorz Bocewicz and Konrad Jackowski (Published in 2016)
4."Intelligent Systems: Architecture, Design, and Control" by Janos Sztipanovits and Gabor Karsai (Published in 2018)
5."Intelligent Systems: Concepts and Applications" by Veera M. Boddu (Published in 2017)
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ET3053                  DIGITAL IMAGE PROCESSING AND COMPUTER VISION                LT P C
3 0 0 3

UNIT I    IMAGE PROCESSING AND VISION BASICS

UNIT II    IMAGE PROCESSING CONCEPTS AND IMAGE FEATURES

UNIT III    IMAGE PROCESSING WITH OPENCV
Introduction to OpenCV and Python: Setting up OpenCV - Image Basics in OpenCV - Handling Files and Images - Constructing Basic Shapes in OpenCV. Image Processing in OpenCV: Image Processing Techniques - Constructing and Building Histograms - Thresholding Techniques.

UNIT IV    OBJECT DETECTION

UNIT V     APPLICATIONS AND CASE STUDIES

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Understand the major concepts and techniques in computer vision and image processing
CO2: Infer known principles of human visual system
CO3: Demonstrate a thorough knowledge of Open CV
CO4: Develop real-life Computer Visions Applications.

TOTAL: 45 PERIODS
CO5: Build design of a Computer Vision System for a specific problem.

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ET3058 INTELLIGENT CONTROL AND AUTOMATION LT P C 3 0 0 3

UNIT I ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC 9

UNIT II GENETIC ALGORITHM 9
Basic concept of Genetic algorithm and detail algorithmic steps - Hybrid genetic algorithm - Solution for typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization.

UNIT III HYBRID CONTROL SCHEMES 9
Fuzzification and rule base using ANN-Neuro fuzzy systems-ANFIS-Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization.

UNIT IV AUTOMATION 9

UNIT V INTELLIGENT CONTROLLER FOR AUTOMATION APPLICATION 9
Applications of Intelligent controllers in Industrial Monitoring, optimization and control- Smart Appliances- Automation concept for Electrical vehicle- Intelligent controller and Automation for Power System.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability in
CO1: Demonstrate the basic architectures of NN and Fuzzy logics
CO2: Design and implement GA algorithms and know their limitations.
CO3: Explain and evaluate hybrid control schemes and PSO
CO4: Interpret the significance of Automation concepts.
CO5: Develop the intelligent controller for automation applications.

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ET3065 ROBOTICS AND AUTOMATION LT P C
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UNIT I INTRODUCTION TO ROBOTICS & AUTOMATION

UNIT II SENSORS AND DRIVE SYSTEMS
Hydraulic, Pneumatic And Electric Drive Systems - Understanding how motor power, current torque, friction co-efficient affect the design of a Robot - Determination of Motor HP and Gearing Ratio - Variable Speed Arrangements. Sensors - Classification based on sensing type (including Optical, Acoustic, Magnetic) - Proximity Sensors - Ranging Sensors - Speed & Displacement Sensing - Tactile Sensors - Vision Sensing - Smart Sensors - MEMS sensors.

UNIT III MANIPULATORS AND GRIPPERS
Introduction to Manipulators - Joints and Degrees of Freedom - Construction of Manipulators - Manipulator Dynamics and Force Control - Electronic And Pneumatic Manipulator Control Circuits - End Effectors - Various Types Of Grippers - Design Considerations.

UNIT IV KINEMATICS AND PATH PLANNING
UNIT V  CASE STUDIES

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Choose suitable embedded boards for robots
CO2: Demonstrate the concepts of robotics & automation and Working of Robot
CO3: Analyze the Function of Sensors and actuators In the Robot
CO4: Develop Program to Use a Robot for a Typical Application
CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on Embedded system-based robot development

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ET3062 MEMS AND NEMS TECHNOLOGY LT P C 3 0 0 3

UNIT I  INTRODUCTION TO MEMS and NEMS
Overview of micro and Nano technologies - Miniaturization significance and advantages -Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling - Survey of materials - Smart Sensors - Applications of MEMS and NEMS.

UNIT II  MICRO-MACHINING AND MICROFABRICATION TECHNIQUES
Photolithography - material Synthesis techniques - Film deposition - Etching Processes- wafer bonding - Bulk micro machining, silicon surface micro machining - LIGA process.
UNIT III MICRO SENSORS AND MICRO ACTUATORS 9
Transduction mechanisms in different energy domain-Micromachined capacitive, Piezoelectric, piezoresistive and Electromechanical and thermal sensors/actuators and applications

UNIT IV NANOELECTRONICS DEVICES AND NEMS TECHNOLOGY 9

UNIT V MEMS AND NEMS APPLICATION 9

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Explain the material properties and the significance of MEMS and NEMS for industrial automation.
CO2: Demonstrate knowledge delivery on micromachining and micro fabrication.
CO3: Apply the fabrication mechanism for MEMS sensor and actuators.
CO4: Apply the concepts of Nano electronics and NEMS to models, simulate and process the sensors and actuators.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.

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TOTAL: 45 PERIODS
UNIT I  EMBEDDED SYSTEM AND ELECTRIC VEHICLES ARCHITECTURE  

UNIT II POWERTRAIN CONTROL AND ENERGY MANAGEMENT SYSTEM IN EV  
Powertrain Components - Powertrain control and Optimization - Embedded Controllers for motor control- ECU for Energy Management system - Battery Management System (BMS) - Battery State of Charge (SoC) Estimation - Energy Consumption Monitoring - Charging Optimization- ECU for Charging.

UNIT III COMMUNICATION AND CONNECTIVITY IN EV  
Vehicle-to-Vehicle Technology(V2V) - Vehicle-to-Infrastructure(V2I) Technology Communication - Communication Protocol (CAN, LIN, Ethernet, etc.) - Wireless Charging and Communication for EV - Over the air (OTA) Updates and Remote diagnostics in EV.

UNIT IV FAULT MONITORING AND DIAGNOSTICS IN EV  
Overview of Fault Monitoring and Diagnostics in EV - Fault detection techniques - Fault Monitoring in Electric Powertrain - Fault Monitoring in Charging Infrastructure - On-board Diagnostics (OBD) with self-check mechanisms - Diagnostics and Reporting - Case studies on fault detection, Diagnosis and Resolution

UNIT V SAFETY, SECURITY AND AUTONOMOUS SYSTEMS IN EV  
Safety Standards and Regulations for EVs - Functional Safety and ISO26262 in EV -Cybersecurity in EVs - Threats and Countermeasures - Antilock Braking system(ABS) -Electronic Stability Control (ESC) - Advanced driver Assistance systems (ADAS) -Autonomous Driving in EVs.

COURSE OUTCOMES:  
CO1: Able to understand the principles and components of electric vehicles, including powertrain systems, energy storage systems, motor controllers, and vehicle dynamics.  
CO2: Able to learn about the unique requirements and challenges associated with embedded controllers in EV applications.  
CO3: able to learn about hardware platforms, such as microcontrollers and microprocessors, as well as communication protocols and interfaces used for control and monitoring of EV.  
CO4: Able to gain hands-on experience in developing embedded control algorithms for various EV systems, including motor control, battery management, regenerative braking, and charging systems.  
CO5: able to understand the integration of embedded controllers in autonomous electric vehicles

REFERENCES:  
1."Embedded Control Systems for Electric Machines" by Jiming Wang, Shan Chai, and Shuxin Zhou (Published in 2011)  
2."Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain (Published in 2013)  
3."Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure, and the Market" by Gérard-André Capolino (Published in 2010)  
4."Embedded Systems for Electric Vehicles" by Jürgen Valldorf and Wolfgang Gessner (Published in 2011)  
5."Power Electronics and Electric Drives for Traction Applications" by Gonzalo Abad, J. Miguel Guerrero, and Juan de la Casa (Published in 2016)
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**ET3057 INFORMATION MODELLING FOR SMART PROCESS**

**UNIT I INTRODUCTION TO IMMERSIVE TECHNOLOGIES**
Introduction on Virtual reality - Augmented reality - Mixed reality - Extended reality - VR Devices - AR Devices - Applications

**UNIT II SOFTWARE TOOLS**
Intro to Unity - Unity editor workspace - Intro to C# and visual studio - Programming in Unity - Intro to Unreal Engine - UE4 Editor workspace - Intro to Blueprint programming - Programming in

**UNIT III BUILDING AR AND VR APPLICATIONS**
AR SDKs for unity and unreal engine - Working with SDKs for unity - Developing AR application in unity - Building AR application Developing VR application in - Building VR application-

**UNIT IV UAE**
DRONE concept - DESIGN, FABRICATION AND PROGRAMMING - Drone Flying and Operation- Applications of Drone for Electrical Infrastructure Development and Monitoring.

**UNIT V CASE STUDIES**
AR, VR ,ER and MR based Applications development for Industrial Automation .

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
At the end of this course, the students will have the ability to
CO1: Able to understand the core concepts and principles behind immersive technologies, such as virtual reality (VR), augmented reality (AR), and mixed reality (MR)
CO2: Able to learn software tools specifically designed for information modeling in the context of smart processes.
CO3: Able to learn the principles and techniques for creating immersive AR/VR experiences, including 3D modeling, interaction design.
CO4: Able to learn about the unique challenges, opportunities, and requirements associated with implementing smart processes in the UAE.
CO5: Able to develop the ability to analyze and evaluate real-world case studies that demonstrate the use of augmented reality (AR), virtual reality (VR), extended reality (ER), and mixed reality (MR) technologies in smart process environments.

**REFERENCES:**
1. "Smart Process: Designing the Future Enterprise" by Peter Fingar and Harsha Kumar (Published in 2009)
2. "Information Modeling and Relational Databases: From Conceptual Analysis to Logical Design" by Terry Halpin, Tony Morgan, and Steve Morgan (Published in 2008)
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ET3052 BLOCKCHAIN TECHNOLOGIES

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN
Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain-Hardware architecture for Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY

UNIT III INTRODUCTION TO ETHEREUM
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING

UNIT V BLOCKCHAIN APPLICATIONS
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After the completion of this course, student will be able to
CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain
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ET3051 BIG DATA ANALYTICS L T P C

UNIT I  INTRODUCTION TO BIG DATA 9

UNIT II  SEARCH METHODS AND VISUALIZATION 9
Search by simulated Annealing - Stochastic, Adaptive search by Evaluation - Evaluation Strategies - Genetic Algorithm - Genetic Programming - Visualization - Classification of Visual Data Analysis Techniques - Data Types - Visualization Techniques - Interaction techniques - Specific Visual data analysis Techniques

UNIT III  MINING DATA STREAMS 9

UNIT IV  FRAMEWORKS 9
MapReduce - Hadoop, Hive, MapR - Sharding - NoSQL Databases - S3 - Hadoop Distributed File Systems - Case Study - Preventing Private Information Inference Attacks on Social Networks - Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation
UNIT V R LANGUAGE


TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4: Gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

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UNIT I PRINCIPLES OF ELECTRO MAGNETIC ENERGY CONVERSION 9
Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf – determination of winding resistances and inductances of machine windings – determination of friction coefficient and moment of inertia of electrical machines.

UNIT II DC MACHINES 9

UNIT III REFERENCE FRAME THEORY 9
Historical background of Clarke and Park transformations – power invariance and phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame - variables observed from several frames of reference.

UNIT IV INDUCTION MACHINES 9

UNIT V SYNCHRONOUS MACHINES 9

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to optimally design magnetics required in power supplies and drive systems.
CO2: Ability to acquire and apply knowledge of mathematics of machine dynamics in Electrical engineering.
CO3: Ability to model, simulate and analyze the dynamic performance of electrical machines using computational software.
CO4: Ability to formulate, design, simulate power supplies and loads for complete electrical machine performance
CO5: Ability to verify the results of the dynamic operation of electrical machine systems

TEXT BOOKS:

2. R Ramanujam,”Modelling and Analysis of Electrical Machines”, I.K International Publishing Pvt. Ltd., New Delhi, 2018

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PE3252 SPECIAL ELECTRICAL MACHINES LT P C 3 0 0 3

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS 9

UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS 9
Rotor Configurations - EMF and Torque equations – Synchronous reactance - Phasor diagram - Power controllers – Circle Diagram - Torque speed characteristics – Torque / Ampere and kVA / kW for Sine wave and Square wave motors - Synchronous reluctance motor.

UNIT III SWITCHED RELUCTANCE MOTORS 9
Torque equation – Converter circuits - Control of SRM drive - Speed control – Current Control – Sensor less operation of SRM - Applications.

UNIT IV STEPPER MOTORS 9
Stepper Motor – Classification – Modes of Excitation – Static and Dynamic Characteristics – Static Torque Production – Motor Driver andSuppressor Circuits - Input Controller – Need for Closed loop Control – Concept of lead angle.

UNIT V OTHER SPECIAL MACHINES 9
Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to model and analyze power electronic systems and equipment using computational software.
CO2: Ability to optimally design magnetics required in special machines based drive Systems using FEM based software tools.
CO3: Ability to analyse the dynamic performance of special electrical machines
CO4: Ability to understand the operation and characteristics of other special electrical machines.
CO5: Ability to design and conduct experiments towards research.

TEXT BOOKS:

1. T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’, Claredon press,
REFERENCES:


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PE3051 CONTROL OF POWER ELECTRONIC CIRCUITS

UNIT I CONTROLLER DESIGN FOR BASIC DC-DC CONVERTERS- PART I 9
Introduction, Review of Linear Control Theory, Linearization of Various Transfer Function Blocks, Feedback Controller Design in Voltage-Mode Control, Peak-Current Mode Control, Feedback Controller Design in DCM

UNIT II CONTROLLER DESIGN FOR BASIC DC-DC CONVERTERS- PART II 9

UNIT III CONTROLLER DESIGN FOR BASIC AC-DC CONVERTER CIRCUITS 9
Introduction, Operating Principle of Single-Phase PFCs, Control of PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

UNIT IV SLIDING MODE CONTROL 9
UNIT V  FLATNESS BASED CONTROL

Flatness, the use of the differential flatness property, Controller development using flatness-Application to power converters

TOTAL : 45 PERIODS

COURSE OUTCOMES:
After completing the above course, students will be able to
- CO1: Design controller for front end power factor corrector circuits.
- CO2: Design controllers for UPS application.
- CO3: Design controllers for AC-DC converters.
- CO4: Design sliding mode control for power converters.
- CO5: Design flatness based control for power converters.

TEXT BOOKS:

REFERENCES:
1. Farzin Asadi and Kei Eguchi, Morgan &Claypool,"Dynamics and Control of DC-DC Converters", 2018
3. Azar, Ahmad Taher, Zhu, Quannmin,” Advances and Applications in sliding mode control systems” Springer, 2015

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PE3055  VECTOR CONTROL OF AC MACHINES  L  T  P  C
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UNIT I  VECTOR CONTROL OF PM SYNCHRONOUS MACHINE
Introduction-Smooth Air gap machine and salient pole machines- flux linkage space phasors- voltage equation- expression for electromagnetic torque. PMSM with surface mounted magnets- control scheme for of rotor oriented controlled PMSM with interior magnets

UNIT II  VECTOR CONTROL OF SALIENT POLE MACHINE WITH ELECTRICALLY EXCITED ROTOR
Magnetizing flux oriented control- variable frequency operation of salient pole synchronous machine-rotor oriented control of reluctance machines-considerations of the effects of main flux saturation
UNIT III  STATOR FLUX ORIENTED CONTROL OF INDUCTION MACHINE  
Squirrel cage machine - Electromagnetic torque-voltage equations, doubly fed induction machines-control-static converter cascade

UNIT IV  ROTOR FLUX ORIENTED CONTROL OF INDUCTION MACHINE  
Control by a VSI – voltage equation-decoupling circuits- electromagnetic torque-voltage equations- current controlled PWM inverter- control by CSI – current controlled operation - control of slip ring induction machines

UNIT V  MAGNETIC FLUX ORIENTED CONTROL OF INDUCTION MACHINE  
The magnetizing flux oriented control of induction machine: Control by a VSI – voltage equation-decoupling circuits- electromagnetic torque-voltage equations- current controlled PWM inverter.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to carry out space phasor model for electrical machines.
CO2: Ability to synthesis the vector controller for surface mount permanent magnet synchronous machines.
CO3: Able to synthesis the vector controller for buried type permanent magnet synchronous machines.
CO4: Able to compute and analyze the controllers of salient pole machines.
CO5: Able to understand and select the various control schemes suitable for induction motor.
CO6: Ability to comprehend the flux oriented control concepts of induction motor drive.

TEXT BOOKS:


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PS3252 SMART GRID L T P C
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UNIT I INTRODUCTION TO SMART GRID
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, Functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES (TRANSMISSION)
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT III SMART GRID TECHNOLOGIES (DISTRIBUTION)
DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High- Efficiency Distribution Transformers, Phase Shifting Transformers, and Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT V COMMUNICATION PROTOCOLS FOR POWER SYSTEM AUTOMATION
Introduction to Communication Protocol, Comparison of Communication media and different communication network topologies Description of Different Communication Protocol - Physical based Protocol(RS-232,RS-485) - Layered Based Protocol(IEC-61850 - Substation Automation) (C37.118 - Wide Area Monitoring and Protection),(DNP3 - Distribution Automation),MODBUS.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Students will be able to:
CO1: Understand on the concepts of Smart Grid and its present developments.
CO2: Analyze about different Smart Grid transmission technologies.
CO3: Analyze about different Smart Grid distribution technologies.
CO4: Acquire knowledge about different smart meters and advanced metering infrastructure.
CO5: Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

REFERENCES
4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey”, IEEE Transaction on Smart Grid

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PS3053 OPTIMIZATION TECHNIQUES TO POWER SYSTEM ENGINEERING L T P C

UNIT I CLASSICAL OPTIMIZATION TECHNIQUES 9

UNIT II LINEAR PROGRAMMING 9
Introduction, Applications of Linear Programming, Standard Form of a Linear Programming, Basic Terminology and Definitions, Exceptional cases, Simplex method, Revised Simplex method, Duality.

UNIT III NONLINEAR PROGRAMMING 9

UNIT IV DYNAMIC PROGRAMMING 9
Multistage decision processes, concept of sub-optimization and principle of optimality – solution of unit commitment problem.

UNIT V GENETIC ALGORITHM 9
Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, global optimization using GA, Applications to power system problems.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: learn about different classifications of optimization problems and classical optimization techniques.
CO2: analyze linear programming problems
CO3: analyze non-linear programming problems
CO4: explain the concepts of dynamic programming
CO5: explain Genetic algorithm and its application to power system optimization problems.

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PS3054 WIND ENERGY CONVERSION SYSTEMS

UNIT I INTRODUCTION
Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin’s theory-Aerodynamics of Wind turbine

UNIT II WINDTURBINES
HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control- stall control-Schemes for maximum power extraction.

UNIT III FIXED SPEED SYSTEMS
Generating Systems- Constant speed constant frequency systems -Choice of Generators- Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.
UNIT IV  VARIABLESPEED SYSTEMS
Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V  GRIDCONNECTED SYSTEMS
Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Students will be able to:
CO1: Attain knowledge on the basic concepts of Wind energy conversion system.
CO2: Attain the knowledge of the mathematical modelling and control of the Wind turbine
CO3: Develop more understanding on the design of Fixed speed system
CO4: Study about the need of Variable speed system and its modelling.
CO5: Learn about Grid integration issues and current practices of wind interconnections with power system.

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PS3051  COMPUTATIONAL INTELLIGENCE TECHNIQUES TO POWER SYSTEMS

UNIT I  ARTIFICIAL NEURAL NETWORKS (ANN)
UNIT II  DEEP LEARNING  

UNIT III  FUZZY LOGIC  

UNIT IV  GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION  
Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters- Application to Economic load dispatch.

UNIT V  MULTI OBJECTIVE OPTIMIZATION  
Introduction- Concept of Pareto optimality - Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to general two objective optimization problem - Application to combined economic emission dispatch.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: analyze functional operation of a ANN and their bio-foundations
CO2: analyze functional operation of deep neural networks
CO3: design and develop fuzzy logic for simple control applications
CO4: design and develop genetic algorithms and particle swarm optimization for simple systems
CO5: solve multi-objective optimization problems to obtain Pareto fronts

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UNIT I HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENT 9
History of Evolution of Electric Vehicles (EV) - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power Train Components and Sizing, Gears, Clutches, Transmission and Brakes

UNIT II MECHANICS OF HYBRID ELECTRIC VEHICLES 9

UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9
Speed control for Constant Torque, Constant HP operation of all Electric Motors - DC/DC chopper based Four Quadrant Operation of DC Motor Drives, Inverter-based V/f Operation (motoring and braking) of Induction Motor Drives, Vector Control Operation of Induction Motor and PMSM, Brushless DC Motor Drives, Switched Reluctance Motor (SRM) Drives

UNIT IV ENERGY STORAGE SYSTEMS 9
Battery: Principle of operation, Types, Estimation Of Parameters, Battery Modeling, SOC of Battery, Traction Batteries and their capacity for Standard Drive Cycles, Vehicle to Grid operation of EV's -Alternate sources: Fuel cells, Ultra capacitors, Fly wheels

UNIT V HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT 9
HEV Supervisory Control - Selection of modes - Power Spilt Mode - Parallel Mode - Engine Brake Mode - Regeneration Mode - Series Parallel Mode - Energy Management of HEV's

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1: Learn the electric vehicle architecture and power train components.
CO2: Acquire the concepts of dynamics of Electrical Vehicles.
CO3: Understand the vehicle control for Standard Drive Cycles of Hybrid Electrical Vehicles (HEVs).
CO4: Ability to model and understand the Energy Storage Systems for EV.
CO5: Acquire the knowledge of different modes and Energy Management in HEVs.

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PW3055  
IOT FOR SMART POWER SYSTEMS  
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UNIT I  
INTRODUCTION  
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UNIT II  
IOT ARCHITECTURE AND PROTOCOLS  
9  
IoT Architecture – Layers – Protocol: SCADA, RFID – Internet of Energy (IoE) architecture and its requirements for Power Systems - IoT communication topologies for power system application

UNIT III  
IOT FOR SMART GRID  
9  
Integration of Internet of Things (IoT) into Smart Grid (SG) – Smart Grid Architectures: Four layered IoT, Web-enabled SG Architecture - Big Data and Cloud for IoT aided SG system- Sensors for Smart Power Grids: Smart Metering and Grid Configuration- Synchronization of Current and Voltage Transducers - Phasor Measurement Units (PMU) - Sending Sensor data over the internet - Cyber Security for Smart Grid

UNIT IV  
IOT BASED SMART MONITORING SYSTEMS  
9  

UNIT V  
IOT FOR ENERGY MANAGEMENT  
9  
Smart Energy Management – Cyber Physical Systems – Smart Electricity Management – Demand Side Management-Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1: Gain knowledge about various IoT technologies and its importance in power system
CO2: Able to analyze different IoT architectures and communication topologies for power system applications
CO3: Understand IoT for Smart Grid
CO4: Attain knowledge about various IoT based smart monitoring systems
CO5: Apply IoT for Energy Management

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HV3152 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

UNIT I INTRODUCTION 9
Review of basic field theory – Maxwell’s equations – Constitutive relationships and Continuity equations – Laplace’s, Poisson’s and Helmholtz’s equation – principle of energy conversion – force/torque calculation.

UNIT II BASIC SOLUTION METHODS FOR FIELD EQUATIONS 9
Limitations of the conventional design procedure, need for the field analysis based design, problem definition, boundary conditions, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods-Finite Difference Method

UNIT III FORMULATION OF FINITE ELEMENT METHOD (FEM) 9
Concept of FEM - Integral Formulation – Energy minimization – Discretization – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problems
UNIT IV  COMPUTATION USING FEM PACKAGES

UNIT V  ELECTROMAGNETIC FIELD MODELLING AND ANALYSIS
Three phase transmission lines, Magnetic actuators, Transformers, Insulators, Rotating machines.

TOTAL = 45 PERIODS

COURSE OUTCOMES:
Upon the successful completion of the course, students will be able to:
CO1 explain the concepts of electromagnetic field theory and energy conversion
CO2 formulate and compute Electromagnetic Field problems from Maxwell's equations
CO3 formulate FEM problems from the fundamental concepts
CO4 compute the respective fields and circuit parameters using FEM (post processing)
CO5 check and optimize the design of electrical power equipment

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Director

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Anna University, Chennai-600 025