SHARDA UNIVERSITY
Beyond Boundaries

# Program and Course Structure

Department of Electrical and Electronics Engineering

## M.Tech in Electrical and Electronics Engineering

# Program Code: SET0407

## 1. Standard Structure of the Program at University Level

### 1.1 Vision, Mission and Core Values of the University

**Vision of the University**

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

**Mission of the University**

1. Transformative educational experience
2. Enrichment by educational initiatives that encourage global outlook
3. Develop research, support disruptive innovations and accelerate entrepreneurship
4. Seeking beyond boundaries

**Core Values**

- Integrity
- Leadership
- Diversity
- Community

### 1.2 Vision and Mission of the School

## Vision of the School

To become a globally acclaimed institution of higher learning in engineering and technology promoting excellence in research, innovation and entrepreneurship

## Mission of the School

1. To impart quality education with strong industry & academic connectivity in the expanding fields of Engineering and Technology in a conductive and enriching learning environment.
2. To product technocrats equipped with technical & soft skills and experiential learning required to stay current with the modern tools in emerging technologies to fulfill professional responsibilities and uphold ethical values.
3. To inculcate a culture of interdisciplinary research, innovation and entrepreneurship to provide sustainable solutions to meet the growing challenges and societal needs.
4. To foster collaborative learning and to play adaptive leadership role in professional career and pursuit of higher education through effective mentoring and counseling.

### 1.2.1 Vision and Mission of the Department

## Vision of the Department of Electrical and Electronics Engineering

To become an internationally acclaimed destination of academic excellence in the discipline of Electrical, Electronics, and Communication Engineering by promoting research, innovation, and entrepreneurship to serve society.

SHARDA UNIVERSITY
Beyond Boundaries

## Mission of the Department Electrical and Electronics Engineering

M1-To provide comprehensive technical knowledge in Electrical, Electronics and Communication Engineering.

M2- To facilitate and foster the industry-academia collaboration to enhance technical skills and employability.

M3- To promote interdisciplinary and multi-disciplinary research, innovations and entrepreneurship to serve society.

M4- To develop core values, professional ethics and lifelong learning skills through interactive support systems.

### 1.3 Programme Educational Objectives (PEO)

### 1.3.1 Writing Programme Educational Objectives (PEO)

The Educational Objectives of UG Program in Electrical and Electronics Engineering are:

**PEO1:** The Graduands will establish themselves with knowledge and technical skill to match the need of modern industries of power sector and automation.

**PEO2** : Graduates will be motivated for research and higher education and support their entrepreneurial learning.

**PEO3** : Graduates will demonstrate their the communication skills and critical reasoning skills to perform responsibilities ethically for the sustainable development of the society.

**PEO4**: The Graduands will be able to learn and adopt new technologies in a multi- and interdisciplinary work environment for innovative solutions for real world problems

### 1.3.2 Map PEOs with School Mission Statements:

| No. | PEO statement | School missions | | | |
|---|---|---|---|---|---|
| | | Mission statement 1 | Mission statement 2 | Mission statement 3 | Mission statement 4 |
| 1 | **PEO1:** The Graduands will establish themselves with knowledge and technical skill to match the need of modern industries of power sector and automation. | 3 | 2 | 2 | 3 |
| 2 | **PEO2** : Graduates will be motivated for research and higher education and support their entrepreneurial learning. | 2 | 3 | 3 | 2 |
| 3 | **PEO3** : Graduates will demonstrate their the communication skills and critical reasoning skills to perform responsibilities ethically for the sustainable development of the society. | 2 | 3 | 2 | 3 |
| 4 | **PEO4**: The Graduands will be able to learn and adopt new technologies in a multi- and interdisciplinary work environment for innovative solutions for real world problems | -2 | 3 | 2 | 2 |

### 1.3.2.1 Map PEOs with Department Mission Statements:

| DEPARTMENT PEOs / DEPT OF EEE MISSION STATEMENTS | 1. The Graduands will establish themselves with knowledge and technical skill to match the need of modern industries of power sector and automation. | 2. Graduates will be motivated for research and higher education and support their entrepreneurial learning. | 3. Graduates will demonstrate their the communication skills and critical reasoning skills to perform responsibilities ethically for the sustainable development of the society. | 4. The Graduands will be able to learn and adopt new technologies in a multi- and interdisciplinary work environment for innovative solutions for real world problems. | |
|---|---|---|---|---|---|
| M1-To provide comprehensive technical knowledge in Electrical, Electronics and Communication Engineering. | **3** | **3** | **2** | **3** | **11/12** |
| M2- To facilitate and foster the industry-academia collaboration to enhance technical skills and employability. | **2** | **3** | **2** | **3** | **10/12** |
| M3- To promote interdisciplinary and multi-disciplinary research, innovations and entrepreneurship to serve society. | **2** | **2** | **3** | **3** | **10/12** |
| M4- To develop core values, professional ethics and lifelong learning skills through interactive support systems. | **2** | **2** | **2** | **3** | **9/12** |
| | **9/12** | **10/12** | **9/12** | **12/12** | **83.3%** |

**1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

### 1.3.3 Program Outcomes (PO's)

**PO1: Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2: Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3: Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4: Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5: Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**PO6: The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7: Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO8: Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO9: Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO10: Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PSOs for M.Tech in EEE**

**PSO1:**To be able to critically investigate complex power system scenarios and arrive at possible solutions, by applying the acquired theoretical and practical knowledge.

**PSO2:**To be able to work on well-defined projects by interpreting available power system data to provide real time solutions pertaining to power system issues.

**PSO3** : To be able to identify optimal solutions for improvising power transfer capability, enhancing power quality and reliability

### 1.3.4 Mapping of Program Outcome Vs Program Educational Objectives

| Mapping | PEO1 | PEO2 | PEO3 | PEO4 | PEO5 |
|---|---|---|---|---|---|
| PO1 | 2 | 2 | 1 | - | 1 |
| PO2 | - | 3 | - | - | 1 |
| PO3 | 3 | 3 | 2 | 2 | 3 |
| PO4 | 3 | 2 | 2 | 1 | 1 |
| PO5 | 2 | 3 | 1 | - | 2 |
| PO6 | 2 | 1 | 1 | 3 | 1 |
| PO7 | - | 1 | 2 | 3 | 3 |
| PO8 | - | 2 | - | - | 2 |
| PO9 | 3 | 3 | 2 | 2 | 3 |
| PO10 | 3 | 2 | 2 | 1 | 1 |
| PSO1 | 3 | 2 | - | 1 | - |
| PSO2 | 3 | 3 | 2 | 2 | 3 |
| PSO3 | 3 | 2 | - | 1 | - |

***1. Slight (Low)*** ***2. Moderate (Medium)*** ***3.Substantial(high)***

**M.Tech in Electrical and Electronics Engineering**

**COURSE STRUCTURE**

| Department of Electrical and Electronics Engineering M.TECH in Electrical and Electronics Engineering | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Course Structure for batches admitted in session and onwards | | | | | | | | | | | | | | | | |
| Semester | Courses | | | | | | | | Courses | Labs | L | T | P | Weekly Contact | Credits |
| I | Optimization Techniques in Engineering (3-1-0) 4 | MEMS, Smart Sensors and WSN (3-0-2) 4 | Elective 1 (3-0-2) 4 | Elective 2 (3-1-0) 4 | Elective 3 (3-0-0) 3 | | | | 5 | 2 | 15 | 2 | 4 | 21 | 19 |
| II | PLC and SCADA(3-0-2) 4 | Elective 4 (3-1-0) 4 | Elective 5 (3-1-0)4 | Elective 6 (3-0-2) 4 | Elective 7 (3-0-0) 3 | Elective 8 (3-0-0) 3 | Community Connect (0-0-4) 2 | Research Methodology (0-0-4) 2 | 6 | 4 | 18 | 2 | 12 | 32 | 26 |
| III | Seminar (0-0-4) 2 | Dissertation -1 (0-0-20) 10 | | | | | | | 0 | 2 | 0 | 0 | 24 | 24 | 12 |
| IV | Dissertation -II (0-0-32) 16 | | | | | | | | 0 | 1 | 0 | 0 | 32 | 32 | 16 |
| **TOTAL CREDITS** | | | | | | | | | | | | | | | **73** |

| List Of Elective | | | |
|---|---|---|---|
| | With Specialization in **Power Systems** | With Specialization in **Instrumentation and Control** | With Specialization in **Industrial Automation** |
| 1 | Extra High Voltage Transmission | Advanced Control Engineering And Controllers | Advanced Control Engineering And Controllers |
| 2 | Modeling & Analysis Of Power System | Smart Power Grid And Micro grid | Smart Power Grid And Micro grid |
| 3 | Power Systems Operation & Control | Biomedical Instrumentation | Electrical Drives |
| 4 | Power System Reliability Assessment | Intelligent Actuators And Mechatronics | Intelligent Actuators And Mechatronics |
| 5 | Smart Power Grid And Micro grid | Virtual Instrumentation | Virtual Instrumentation |
| 6 | FACTS Devices And Systems | Analog And Digital Signal Processing | Digital Signal Processing Techniques |
| 7 | Digital Relaying For Power Systems | Industrial Network Protocols And IoT | Industrial Network Protocols And IoT |
| 8 | Power Quality | Robotics And Industrial Robots | Robotics And Industrial Robots |
| 9 | Wind And Solar Energy Systems | Embedded Systems | Embedded Systems |
| 10 | Wireless Sensor Networks And Application | Industrial Instrumentation | Mechatronics of Robotics |
| 11 | Sustainable Energy | Analog And Digital Communication Techniques | Wind And Solar Energy Systems |
| 12 | Electrical And Hybrid Vehicles | Sustainable Energy | Electrical And Hybrid Vehicles |
| 13 | Distributed Generation Technology | | |

| | | | |
|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch:EEE(Power system)** | | **Semester:1** | |
| 1 | Course Code | MIC104 | |
| 2 | Course Title | Optimization Techniques in engineering | |
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 3-1-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | This course provides the students with:<br>1. Knowledge of solving linear and nonlinear Algebraic equations<br>2. Knowledge of solving differential equations<br>3. Introduction to various concepts of Optimization Techniques.<br>4. Awareness to the importance of optimizations in real scenarios;<br>5. Knowledge of various classical and modern methods of constrained and unconstrained problems in both single and multivariable.<br>6. Knowledge of Various Evolutionary Techniques<br>7. Ideas to solve Integer Programming. | |
| 6 | Course Outcomes | CO1:Solve various linear and nonlinear Algebraic equations<br>CO2: Solve various Differential equations<br>CO3: Formulate optimization problems<br>CO4: Apply the concept of optimality criteria for various type of optimization problems and solve various constrained and unconstrained problems<br>CO5: Know various Evolutionary Techniquesand Solve integer Programming problems.<br>CO6: Apply Optimization Techniques in real time applications | |
| 7 | Course Description | Optimization is the process of obtaining the best result under given circumstances. In design, construction and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. A number of optimization methods have been developed for solving different types of optimization problems. | |
| 8 | Outline syllabus | | CO Mapping |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 1** | **Algebraic Equations** | | | |
| | A | Introduction of Algebraic Equations. Iterative methods for solving non linear equations-Bisection method, Regulafalsi method, Newton Raphson method, secant method. | | | CO1,CO6 |
| | B | Fixed Point method, Two equation Newton Raphson method. | | | CO1,CO6 |
| | C | Iterative methods for solving linear equations-Jacobi method, Gauss-seidel method | | | CO1,CO6 |
| | **Unit 2** | **Differential Equations** | | | |
| | A | Finite difference method | | | CO2,CO6 |
| | B | Euler's method | | | CO2,CO6 |
| | C | Runga-kutta methods(fourth order) | | | CO2,CO6 |
| | **Unit 3** | **Optimization Problems** | | | |
| | A | Requirements for the optimization methods, Types of optimization problem | | | CO3,CO6 |
| | B | Feasible solution and feasible region, Necessary and sufficient optimality conditions, Graphical method for optimal solution. | | | CO3,CO6 |
| | C | Simplex method and Dual Simplex method | | | CO3,CO6 |
| | **Unit 4** | **Optimization Techniques** | | | |
| | A | Lagrange multiplier, Kuhn-tucker conditions | | | CO4,CO6 |
| | B | Newtons method,Interior Penalty function method, | | | CO4,CO6 |
| | C | Rosen Gradient projection method | | | CO4,CO6 |
| | **Unit 5** | **Evolutionary Techniques and Integer Programming** | | | |
| | A | Genetic Algorithm, Particle swarm and ant colony optimization methods | | | CO5,CO6 |
| | B | Branch and Bound method | | | CO5,CO6 |
| | C | cutting plane method | | | CO5,CO6 |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1 Balagurusamy, E., "Numerical methods", Tata McGraw Hill<br>2 Rao S.S, "Enginering Optimization: Theory and Practice", wiley | | | |

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO104.1 | 3 | 1 | 2 | | | | | | | | 2 | | |
| CO104.2 | 2 | 3 | | 1 | | | | | | | 2 | | |
| CO104.3 | 2 | 3 | 2 | | | | | | | | 2 | | 2 |
| CO104.4 | 2 | 3 | 1 | 2 | | | 1 | | | | 3 | 2 | 2 |
| CO104.5 | 2 | 3 | 2 | 2 | | | 1 | | | | 2 | 2 | 2 |
| CO104.6 | 2 | 3 | 2 | 2 | | | 1 | | | | 2 | 1 | 1 |

| | | | |
|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch: EEE/EE** | | **Semester: 1** | |
| 1 | Course Code | MIA112 | |
| 2 | Course Title | **MEMS, Smart Sensors and WSN** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory /Elective/Open Elective | |
| 5 | Course Objective | To provide students with:<br>1. basic principles and techniques of MEMS and Smart Sensors<br>2. knowledge of various fabrication and machining process of MEMS along with its benefits in relation to applications<br>3. Knowledge in wireless sensor networks and to apply this knowledge in various industrial application like environmental monitoring, structural health and greenhouse monitoring | |
| 6 | Course Outcomes | CO1: To be able to understand architecture of smart sensors along with differences among smart, intelligent and network sensors.<br>CO2: To be familiar with the important concepts MEMS and smart sensor fabrication technologies.<br>CO3: To be able to select and apply the MEMS and smart sensors to different applications.<br>CO4: To understand principles of wireless sensor networks and differentiate among various wireless network protocols.<br>CO5:To apply principles of WSN in various industrial, environmental and Societalapplications.<br>CO6: To develop smart sensor and WSN based solution to real life problems. | |
| 7 | Course Description | This course is aimed at equipping students with basic knowledge on of MEMS (Micro electro Mechanical System), Smart sensor and its various fabrication techniques. This course also enables the student with appropriate knowledge of Wireless sensor network and its applications in industry. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Basics of MEMS and Smart Sensors** | |
| | A | Overview of measurement system, transducers, sensors, actuators and signal conditioners | CO1 |
| | B | Definition, working principle and construction of MEMS | CO1 |
| | C | Definition and architecture of smart sensor; different levels of integration in smart sensors; Differences between smart, intelligent and network sensors; Advantages of smart sensors | CO1 |
| | **Unit 2** | **MEMS and Smart Sensor Technologies** | |
| | A | Micro-machining processes: materials for micro-machining, wafer bonding, bulk and surface | CO2 |

| | | | |
|---|---|---|---|
| | | micromachining | |
| | B | IC Technologies: thick film, thin film technologies | CO2 |
| | C | Monolithic IC technology | CO2 |
| | **Unit 3** | **Case studies of MEMS and Smart Sensors** | |
| | A | Principles, characteristics and constructional details of MEMS based smart acceleration and pressure sensors | CO3,CO6 |
| | B | Principle, characteristics and constructional details of a smart temperaturesensor | CO3,CO6 |
| | C | Principle, characteristics and constructional details of a smart humidity sensor | CO3,CO6 |
| | **Unit 4** | **Wireless Sensor Network (WSN)** | |
| | A | Need and advantages of WSN, Network topologies; seven-layer OSI model of communication system | CO4,CO6 |
| | B | Zgbee (IEEE – 802.15.4) protocol, Merits of Zigbee over Wi-Fi (IEEE – 802.11) and Bluetooth for WSN, architecture of Wireless sensor node | CO4,CO6 |
| | C | Sensor and actuator network (SAN) - homogeneous and heterogeneous SAN | CO4,CO6 |
| | **Unit 5** | **WSN Applications in Industry** | |
| | A | Spectrum of applications; Case studies on WSN application: Environment monitoring | CO5,CO6 |
| | B | Condition monitoring - Structural health and Equipment health monitoring | CO5,CO6 |
| | C | Greenhouse monitoring and control | CO5,CO6 |
| | Mode of examination | Theory/Jury/Practi cal/Viva | |
| | Weightage Distribution | CA: 30% / MTE: 20% / ETE: 50% | |
| | Text book/s* | 3 D. Patranabis, "Sensors and Transducers", Prentice-Holl, 2nd Edition, 2003.<br>4 Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, 2000.<br>5 E.H. Callaway, "Wireless Sensor Networks : Architecture and Protocols" | |
| | Other References | 1. H.K. Verma, e-monograph on "Smart Sensors", at www.profhkverma.info, Chapter 1 – Basics of Smart Sensor, Chapter 2 – Smart Sensor Technologies, Chapter 3 – Case Studies of Smart Sensors.<br>2. H.K. Verma, e-monograph on "WSN", at www.profhkverma.info, Chapter 1 – Wireless Sensor Network, Chapter 2 – Wireless Sensor Node, Chapter 3 – | |

| | | | |
|---|---|---|---|
| | | Applications of Wireless Sensor Networks. | |

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | P09 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO112.1** | 3 | 1 | - | 2 | 1 | - | - | 1 | - | 2 | 3 | 3 | 2 |
| **CO112.2** | 3 | 1 | - | 2 | 1 | - | - | 2 | - | 2 | 3 | 3 | 2 |
| **CO112.3** | 1 | 2 | 3 | 2 | 2 | 1 | - | 2 | - | 3 | 1 | 2 | 1 |
| **CO112.4** | 3 | 1 | - | 2 | 1 | - | - | 1 | - | 2 | 3 | 3 | - |
| **CO112.5** | 1 | 2 | 3 | 2 | 2 | 1 | - | 2 | - | 2 | - | 2 | 1 |
| **CO112.6** | 1 | 2 | 3 | 2 | 2 | 1 | - | 2 | - | 1 | - | 2 | 1 |

| | | |
|---|---|---|
| **SET** | | |
| **Program: M.Tech** | | |
| **Branch: EEE** | **Semester: I** | |

| | | | |
|---|---|---|---|
| 1 | Course Code | MIA113 | |
| 2 | Course Title | Intelligent Actuators and Mechatronics | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Department Elective | |
| 5 | Course Objective | • Discussing of basic components of actuators and mechatronics<br>• Discussing of electronics and digital circuits concepts of the subject<br>• Explaining concept of intelligent and smart system<br>• Discussing of interfacing concepts of mechatronics systems<br>• Giving case studies and exploring knowledge on designing | |
| 6 | Course Outcomes | CO1: Getting knowledge on basic components of actuators and mechatronics<br>CO 2: Exploring knowledge and getting design concepts of circuits<br>CO 3: Identifying concepts smart and intelligent on mechatronics systems<br>CO 4: Able to design of interfacing circuits for the subject<br>CO 5: Able to design of tailor-made systems<br>CO6: Develop a simulation model for simple physical systems and explain mechatronics design process | |
| 7 | Course Description | The field of mechatronics has braddened the scope of the traditional field of elctromechanics. The subject is made to know modern trends on mechatronics system, hybrid of different engineerings, stand alone mechatronics systems. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Introduction** | |
| | A | Definitions: Mechatronics & actuator; Overview of sensors, current & voltage sources; Grounding | CO1 |
| | B | Solenoids, relays, electrical motors for actuators | CO1 |
| | C | Basics of open loop and closed loop systems , block diagram of mechatronics system ; Scope of the course | CO1 |
| | **Unit 2** | **Overview of Analog and Digital Electronics** | CO2 |
| | A | Active electronic devices for mechatroics, basics of operation amplifiers and instrumentation amplifiers | |
| | B | Display systems, measurement systems, testing and calibration | CO2 |
| | C | Combination logic and logic classes; Flip-flops and their applications; Microcontroller concepts | CO2 |
| | **Unit 3** | **Smart and Intelligent Actuators** | |
| | A | Definitions: Smart and intelligent actuators; Architecture and | CO3 |

| | | | | | |
|---|---|---|---|---|---|
| | | operation of smart actuator | | | |
| | B | Intelligent actuator without feedback sensor in detail | | | CO3 |
| | C | Intelligent actuator with feedback sensor in detail | | | CO3 |
| | **Unit 4** | **Mechanical-Electronic Interfacing** | | | |
| | A | Concept of three-state (tri-state) outputs; Interfacing of pushbutton, keyboard and sensors | | | CO4 |
| | B | Interfacing of relays, solenoids, DC, AC motors and special motors to microcontroller | | | CO4 |
| | C | Selecting of motor for actuators | | | CO4 |
| | **Unit 5** | **Case studies & Design Exercise** | | | |
| | A | Case study 1: Mechatronic design of a coin counter; Case study | | | CO5 |
| | B | Case study 2: Mechatronics for conveyor based material handling system | | | CO5 |
| | C | Design exercise on mechatronic system | | | CO5 |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | David G, Alciatore et al., "Introduction to Mechatronics and Measurement Systems", Tata McGraw Hill, 2003 | | | |
| | Other References | 1. W.Bolton, "Mechatronics ", Pearson Education, 2005<br>2. Godfrey C. Onwubolu, "Mechatronics", Elsevier, 2005 | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

| School: SET | | | |
|---|---|---|---|
| **Program: M.Tech** | | | |
| **Branch: EEE/EE** | **Semester: 1** | | |
| 1 | Course Code | MIA112 | |
| 2 | Course Title | **MEMS, Smart Sensors and WSN** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory /Elective/Open Elective | |
| 5 | Course Objective | To provide students with:<br>4. basic principles and techniques of MEMS and Smart Sensors<br>5. knowledge of various fabrication and machining process of MEMS along with its benefits in relation to applications<br>6. Knowledge in wireless sensor networks and to apply this knowledge in various industrial application like environmental monitoring, structural health and greenhouse monitoring | |
| 6 | Course Outcomes | CO1: To be able to understand architecture of smart sensors along with differences among smart, intelligent and network sensors.<br>CO2: To be familiar with the important concepts applicable to MEMS and their fabrication<br>CO3: To be able to select and apply the MEMS and smart sensors to different applications.<br>CO4: To understand principles of wireless sensor networks and differentiate among various wireless network protocols .<br>CO5:To apply principles of WSN in various industrial, environmental and societalapplications. | |
| 7 | Course Description | This course is aimed at equipping students with basic knowledge on of MEMS (Micro electro Mechanical System), Smart sensor and its various fabrication techniques. This course also enables the student with appropriate knowledge of Wireless sensor network and its applications in industry. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Basics of MEMS and Smart Sensors** | |
| | A | Overview of measurement system, transducers, sensors, actuators and signal conditioners | CO1 |
| | B | Definition, working principle and construction of MEMS | CO1 |
| | C | Definition and architecture of smart sensor; different levels of integration in smart sensors; Differences between smart, intelligent and network sensors; Advantages of smart sensors | CO1 |
| | **Unit 2** | **MEMS and Smart Sensor Technologies** | |
| | A | Micro-machining processes: materials for micro-machining, wafer bonding, bulk and surface micromachining | CO2 |

| | | | | |
|---|---|---|---|---|
| | B | IC Technologies: thick film, thin film technologies | | CO2 |
| | C | Monolithic IC technology | | CO2 |
| | **Unit 3** | **Case studies of MEMS and Smart Sensors** | | |
| | A | Principles, characteristics and constructional details of MEMS based smart acceleration and pressure sensors | | CO3 |
| | B | Principle, characteristics and constructional details of a smart temperaturesensor | | CO3 |
| | C | Principle, characteristics and constructional details of a smart humidity sensor | | CO3 |
| | **Unit 4** | **Wireless Sensor Network (WSN)** | | |
| | A | Need and advantages of WSN, Network topologies; seven-layer OSI model of communication system | | CO4 |
| | B | Zgbee (IEEE – 802.15.4) protocol, Merits of Zigbee over Wi-Fi (IEEE – 802.11) and Bluetooth for WSN, architecture of Wireless sensor node | | CO4 |
| | C | Sensor and actuator network (SAN) - homogeneous and heterogeneous SAN | | CO4 |
| | **Unit 5** | **WSN Applications in Industry** | | |
| | A | Spectrum of applications; Case studies on WSN application: Environment monitoring | | CO5 |
| | B | Condition monitoring - Structural health and Equipment health monitoring | | CO5 |
| | C | Greenhouse monitoring and control | | CO5 |
| | Mode of examination | Theory/Jury/Practical/Viva | | |
| | Weightage Distribution | CA / MTE / ETE<br>30% / 20% / 50% | | |
| | Text book/s* | 6 D. Patranabis, "Sensors and Transducers", Prentice-Holl, 2nd Edition, 2003.<br>7 Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, 2000.<br>8 E.H. Callaway, "Wireless Sensor Networks : Architecture and Protocols" | | |
| | Other References | 3. H.K. Verma, e-monograph on "Smart Sensors", at www.profhkverma.info, Chapter 1 – Basics of Smart Sensor, Chapter 2 – Smart Sensor Technologies, Chapter 3 – Case Studies of Smart Sensors.<br>4. H.K. Verma, e-monograph on "WSN", at www.profhkverma.info, Chapter 1 – Wireless Sensor Network, Chapter 2 – Wireless Sensor Node, Chapter 3 – Applications of Wireless Sensor Networks. | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

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|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch: EEE/EE** | | **Semester: 1** | |
| 1 | Course Code | MIA117 | |
| 2 | Course Title | **Advanced Control Engineering and Controllers** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To provide students with:<br>1. some advanced concepts in Control Systems Engineering and their applications<br>2.A theoretical understanding of advanced linear control systems and strategies, including the principles of digital control.<br>3 understanding of performing stability analysis of digital control systems.<br>4. knowledge of Analog controller, computer based controller and intelligent controller | |
| 6 | Course Outcomes | After completion of this course students will be able to:<br>CO1:Understand advanced concepts and approaches to control system designs..<br>CO2: Understand industrial controllers of continuous and discontinuous types and advanced control concepts of cascaded and feed forward controls.<br>CO3: design, develop and operate analog controllers, both electronic and pneumatic types.<br>CO4: Design develop and operate computer based control systems.<br>CO5: Understand simulate and design artificial intelligence based control system. | |
| 7 | Course Description | This course introduces systematic approaches to the design and analysis of advance control systems for industrial applications. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Overview of Control System** | |
| | A | Elements of control systems; Concept of open loop and closed loop systems; Examples and application of open loop and closed loop systems | CO1 |
| | B | Brief idea of multivariable control systems; Concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations. Correlation between time and frequency responses | CO1 |
| | C | State variable modelling of linear discrete systems, controllability and observability; Nonlinear control systems; Fundamentals-common nonlinearities (saturation, dead-zone, relay, on-off nonlinearity, backlash, hysteresis | CO1 |
| | **Unit 2** | **Controller Principles** | |
| | A | Process Characteristics; Control system parameters: error, | CO2 |

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|---|---|---|---|---|---|
| | | variable range, control parameter range, control lag, dead time, cycling | | | |
| | B | Discontinuous controller modes: two-position mode, multi-position mode; Continuous controller modes | | | CO2 |
| | C | proportional, integral and derivative control modes; Composite Control modes: proportional-integral (PI), proportional-derivative (PD) and three mode controller (PID); Cascaded and feed-forward controls | | | CO2 |
| | **Unit 3** | **Analog Controllers** | | | |
| | A | Introduction; General features | | | CO3 |
| | B | Electronics controllers : error detector, single mode and composite mode controller; | | | CO3 |
| | C | Pneumatic controllers: proportional, proportional-integral (PI), proportional-derivative (PD) and PID controller. | | | CO3 |
| | **Unit 4** | **Computer Based Control** | | | |
| | A | Introduction; Digital applications: alarms, two-position control | | | CO4 |
| | B | Computer based controller | | | CO4 |
| | C | hardware configurations, software requirements | | | CO4 |
| | **Unit 5** | **Intelligent Control Systems** | | | |
| | A | Fuzzy-logic control system: Fuzzy set theory, basic fuzzy set operations, fuzzy relations, fuzzy logic controller, methods of determination of membership functions | | | CO5 |
| | B | Methods of defuzzification, fuzzy rule base, design of fuzzy logic control system. | | | CO5 |
| | C | Neural-network control system :Artificial neural networks, operation of a single artificial neuron, network architecture, learning in neural networks, back-propagation, Neurofuzzy control | | | CO5 |
| | | | | | |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1. Curtis D. Johnson "Process Control Instrumentation Technology,"8th Edition Pearson.<br>2. I.J. Nagrath and M. Gopal, "Control Systems Engineering," 4th Edition, New Age International Publishers. | | | |
| | Other References | 1. S.N. Sivanandam and S.N. Deepa, "Principles of soft computing," Wiley India Pvt. Limited.<br>2. S.Rajashekaran and G.A. VijayalakshmiPai, " Neural | | | |

| | | Nwtworks,Fuzzy logic, and Genetic Algorithms," PHI Pvt. Limited. | |
|---|---|---|---|

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

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|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch: I&A and I&C** | | **Semester: II** | |
| 1 | Course Code | MIC101 | |
| 2 | Course Title | **Analog and Digital Signal Processing** | |
| 3 | Credits | 4 | |
| 4 | Contact Hours (L-T-P) | 3-1-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To provide the student with<br>1. Concepts so as to categorise various types of Signals and Systems.<br>2. İn-depth knowledge so that implemention of circuits related to linear applications of the opamp are acheivable.<br>3. Basic understanding for the implementatoion of active filters using opamp.<br>4. Strong foundation for designing of Digital Systems both FIR and IIR and analyses of systems using DFT and FFT. | |
| 6 | Course Outcomes | CO1: To categorise the various types of signals and systems and to perform various mathematical operations on signals.<br>CO2: To differentiate and design various applications of op-amp.<br>CO3: To design and implement various types of digital filters.<br>CO4: To do frequency analysis using DFT and FFT . | |
| 7 | Course Description | The course content of this subject includes introduction of signals and systems. It also covers the various linear and nonlinear applications of the opamp. Also the content elaborates the designing and implementation of digital filters along with DFT and FFT as the main frequency tool. | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Signals and Systems** | **CO1** |
| | A | Continuous-time and discrete-time signals and their mathematical representation, analog and digital signals, | |

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|---|---|---|---|
| | | analog signal processing (ASP) and digital signal processing (DSP) | |
| | B | Signal , Continuous time signals (CT signals), discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Exponential, Classification of CT and DT signals - periodic and aperiodic, Even and Odd, Power and Energy Invertible and Non-invertible, Deterministic and Random | |
| | C | System,Basic Types of Systems- Causal and Non-causal, Stable and Unstable, Static and Dynamic.Linear and Non-Linear Time Variant and Time Invariant, Basic operations on signals - addition, multiplication, shifting, folding, etc. | |
| | **Unit 2** | **Linear Applications of Opamp** | **CO2** |
| | A | Operational amplifier: block diagram, equivalent circuit, ideal and practical operational amplifier; inverting and non-inverting amplifier circuits | |
| | B | Practical Integrator and Differentiator circuits, | |
| | C | Summing and differential amplifier circuits; Instrumentation amplifier | |
| | **Unit 3** | **Opamp based Filters** | **CO2** |
| | A | Passive and active filters, their comparison; frequency response of low- pass, high- pass ,band- pass, band- stop and notch filters and their use in instrumentation; | |
| | B | Active filters: Basic low- pass filter circuit , first and second order low- pass and high- pass Butterworth filters | |
| | C | Band- pass filter, Band reject (notch) filter, Concept of higher order filter realization | |
| | **Unit 4** | **Digital Filters** | **CO3** |
| | A | Design of Digital Filters----- Design of FIR Filters: Symmetric and Anti-symmetric FIR Filters. Design of Linear phase FIR Filter using Windows, Gibbs phenomenon. | |
| | B | Design of IIR Filters: Design by Approximation of | |

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| | | Derivatives, Impulse Invariance and by Bilinear Transformation. | | | |
| | C | Direct form-1 and form-2 realizations, Cascade and Parallel realizations, recursive and non-recursive methods of realizations. | | | |
| | **Unit 5** | **Frequency Analysis** | | | **CO4** |
| | A | Digital Fourier transform (DFT), | | | |
| | B | DFT algorithm for frequency analysis | | | |
| | C | Fast Fourier transform (FFT), FFT algorithm for frequency analysis. | | | |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | *1.Ramakant A.Gayakwad, "Op-Amp and Linear Integrated Circuits" Pearson Education, 4th Edition*<br>*2.Sedra and Smith, "Microelectronic Circuits", 4th Edition, Oxford University Press.*<br>*3. G. Proakis and D.G. Manolakis, "Digital Signal Processing, Principals, Algorithms, and Applications", Pearson Education,*<br>*3..* | | | |
| | Other References | *1.A. Y. Oppenhein, R. W. Schater and J. R. Buck, "Discrete Time Signal Processing", PHI 1999*<br>*2.Michael Jacob, "Applications and Design with Analog Integrated Circuits, PHI,2nd Edn.2006*<br>*3.Jacob Milliman and Arvin Grabel, "Microelectronics" , 2nd Edition ,TMH, 2008*<br>1. | | | |

**COURSE ARTICULATION MATRIX**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

**Departmental Electives:**

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|---|---|---|
| **School:** | | |
| **Program:** | | |
| **Branch: EEE** | | **Semester:** |
| 1 | Course Code | MIC008 |
| 2 | Course Title | Virtual Instrumentation |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | Elective/Open Elective |
| 5 | Course Objective | 1. Introduction to the various models of Virtual Instruments, their comparison with traditional instruments and major application areas of VI.<br>2. Introduction to basics of LabVIEW<br>3. VI Programming techniques like loops, arrays, clusters, plotting and Strings and files.<br>4. Basics of signal conditioning techniques along with DAQ hardware and software and various signal processing techniques available in LABVIEW.<br>5. Advanced concepts in LabVIEW with main concepts of real time applications in Image acquisition and Motion control.<br>6. Building of Virtual Instruments with various types of controls and indicators.<br>7. Configuring DAQ card and acquisition of real time signals from sources and sensors.<br>8. Simulate a signal in LabVIEW and generate a virtual source using DAQ cards. |
| 6 | Course Outcomes | CO1: Understand various models and areas of application of Virtual Instrumentation.<br>CO2: Understand various components of LabVIEW required for the development of VI.<br>CO3: Understand and apply various programming functions of LabVIEW like loops, arrays, clusters and file I/Os for building of simple Virtual instruments.<br>CO4: Understand the concepts of Data acquisition hardware and software and to apply basic signal processing techniques available in LabVIEW.<br>CO5: Able build VI for simulated and real time applications. |
| 7 | Course Description | The course content of this subject includes an introduction to graphical |

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| | | system design. This course also focuses on introduction to LabVIEW which extensively elaborate the Graphical programming language .In Unit 3, building of VI by using loops, arrays, clusters etc. have been dealt with. Use of strings and I/O are also elaborated in this course. Data acquisition and various signal processing techniques are also covered in this course. Two real time applications motion control and Image acquisition by using LabVIEW have been elaborated in this course. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | **Unit 1** | **Introduction** | | | CO1 |
| | A | Graphical system design model - design model, prototype model, deployment model | | | |
| | B | Building blocks of VI; Virtual instrument versus traditional instrument, Hardware and software in VI | | | |
| | C | Graphical system Design using LabVIEW; Graphical programming and Textual programming | | | |
| | **Unit 2** | **Graphical system Design using LabVIEW** | | | CO2 |
| | A | Advantages of LabVIEW; Components of VI Software - Front panel windows, Block diagram windows, Icon /connector pane | | | |
| | B | Creating and saving a VI; Toolbars, Palettes, Front panel controls and indicators, Block diagram – terminals, nodes, functions | | | |
| | C | Sub VIs, Express VIs and VIs, wires; Data types, Data flow program | | | |
| | **Unit 3** | **Programming Techniques** | | | **CO3,CO5** |
| | A | Modular Programming in Lab View; Building VI front panel and block diagram | | | |
| | B | Loops – for and while loops, Local and Global variables in LabVIEW, Arrays in LabVIEW, | | | |
| | C | Clusters in LabVIEW; Conversion between arrays and clusters, Plotting data in LabVIEW, Strings and File I/O in LabVIEW | | | |
| | **Unit 4** | **Data Acquisition and Signal Processing in LabVIEW** | | | **CO4** |
| | A | Transducers and Signal conditioning ,sampling and aliasing | | | |
| | B | Basics of DAQ hardware and software, DAQ modules and drivers for building virtual instruments | | | |
| | C | Fourier transforms; Power spectrum, Correlation methods; Windowing & filtering | | | |
| | **Unit 5** | **Advanced concepts in LabVIEW** | | | **CO5,CO3,CO4** |
| | A | Data Socket, TCP/IP VI's synchronization | | | |
| | B | Serial interface buses - RS 232, RS485,USB | | | |
| | C | Concepts of real time systems; Image acquisition; Motion control | | | |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage | CA | MTE | ETE | |

| | | | | | |
|---|---|---|---|---|---|
| | Distribution | 30% | 20% | 50% | |
| | Text book/s* | 2. Jovitha Jerome, "Virtual Instrumentation and LABVIEW", PHI Learning | | | |
| | Other References | 1. C.L. Clark, "LabVIEW Digital Signal Processing", TMH Publishing Company.<br>3. Technical Manuals for DAQ Modules, Advantech and National Instruments<br>4. www.profhkverma.info: Chapter 2: Technologies/ Protocols for Wired Sensor Network<br>5. NI USER MANUAL http://www.ni.com/pdf/manuals/376445b.pdf<br>6. www.ni.com | | | |

**COURSE ARTICULATION MATRIX**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

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|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch: EEE/EE** | | **Semester: 1I** | |
| 1 | Course Code | MIA116 | |
| 2 | Course Title | **Industrial Network Protocols and IoT** | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory /Elective/Open Elective | |
| 5 | Course Objective | To provide students with:<br>7. basic principles network communications and communication system models and it's seven layers.<br>8. In depth knowledge of wired and wireless network protocols.<br>9. With the concept of IoT, M2M and IIoT along with typical applications thereof. | |
| 6 | Course Outcomes | CO1: To be able to understand the principles and types of data networks, especially those used in industry.<br>CO2: have in-depth knowledge of industrial wired network protocols and their comparative merits and limitations.<br>CO3:To be able to apply Ethernet/IP protocol for industrial control and automation applications.<br>CO4: To be able to select and apply wireless network protocol for instrument control and automation for industrial and societal applications.<br>CO5: To be able to apply the concepts of IoT and design and develop IoT systems for industrial, societal, environmental and domestic applications. | |
| 7 | Course Description | This course is aimed at equipping students with in-depth knowledge various industrial network protocols, both wired and wireless types and a working knowledge of the IoT concepts and systems. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Basics** | |
| | A | Principles of analog and digital communication and their comparison; Asynchronous and synchronous data transmission; Simplex, half duplex and full duplex transmissions; Baseband and broadband communications; Signal transmission media: UTP,STP and coaxial cables, PLCC, optical fibres and radio link; | CO1 |
| | B | Concept of LAN, PAN,MAN,WAN and Internet; Error detection techniques: Parity check, check sum and CRC; LAN topologies; Role of data communication and networks in industrial automation; Field-level, control-level and enterprise-level networks; | CO1 |
| | C | ISO's seven-layer OSI model: significance, scope, functions of various layers; IEC's four-layer EPA model: significance, functions of various layers; MAC techniques: reservation, | CO1 |

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| | | selection and contention techniques, polling, token passing, CSMA/CD ; Special requirements of industrial network protocols, list of important industrial wired and wireless network protocols. | |
| | **Unit 2** | **Industrial Wired–Network Protocols** | |
| | A | **Fieldbus:** Meaning and characteristic features of fieldbus, popular fieldbuses.<br>**RS485**: Highlights, balanced–mode transmission in half duplex and full duplex modes, MAC protocol, merits and limitations.<br>**Modbus:** Modbus protocol stack, Modbus address space and object types, data transmission frame formats for Modbus/RTU, Modbus/ASCII and Modbus/TCP, formats of data requests and responses for main function codes (examples only), merits and limitations of Modbus. | CO2 |
| | B | **Foundation Fieldbus**: FF protocol stack; physical layer, topologies supported, data link layer: FDLC and FMAC, application layer, merits and limitations of FF. | CO2 |
| | C | **Distributed Network Protocol:** DNP protocol stack, DNP version 3.3, physical layer and physical topologies, data link layer, pseudo-transport layer, application layer, merits and limitations of DNP3. | CO2 |
| | **Unit 3** | **Ethernet and Ethernet /IP** | |
| | A | **Ethernet:** IEEE802.3, physical layer, speed variants of Ethernet, MAC and frame format; TCP/IP model; Ethernet LAN components: repeater, bridge, router, gateway, hub and switch; Merits and limitations of Ethernet for industrial application | CO3 |
| | B | Common Industrial Protocol (CIP) | CO3 |
| | C | **Ethernet/IP:** Adaption of Common Industrial Protocol (CIP) to standard Ethernet, UDP, comparison between standard Ethernet and Ethernet /IP. | CO3 |
| | **Unit 4** | **Industrial Wireless Network Protocols** | |
| | A | **Zigbee:** Special features, IEEE802.15.4, data rates, ISM-frequency bands used and bandwidths, full-function and reduced-function devices, PAN coordinator, MAC protocol and data transfer types | CO4 |
| | B | Wireless network topologies | CO4 |
| | C | **Comparison** of Zigbee with Wi-Fi and Bluetooth. | CO4 |
| | **Unit 5** | **IoTand Industrial IoT** | |
| | A | IoT concept and definition; Technologies behind IoT; | CO5 |
| | B | CISCO's 7-tier IoT reference model; Components of IoT devices; M2M communication; Relation between IoT, M2M and IIoT; Modified OSI model for IoT/M2M/IIoT; | CO5 |

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|---|---|---|---|---|---|
| | C | Examples of applications of IoT, M2M and IIoT. | | | CO5 |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1. William Stallings, "Data and Computer Communications", 8th Edition, Pearson Prentice Hall, 2007.<br>2. Mini S. Thomas and John D. McDonald, "Power System SCADA and Smart Grids", CRC Press, 2015.<br>3. Raj Kamal, "Internet of Things: Architecture and Design Principles", Mc Graw Hill Education, 2017. | | | |
| | Other References | 1. David Bailey and Edwin Wright, "Practical SCADA for Industry", Newnes, 2009.<br>2. S.K. Singh, "Industrial Instrumentation and Control", Tata McGraw-Hill, 2003.<br>3. M.M.S. Anand, "Electronic Instruments and Instrumentation Techniques", Prentice Hall, 2004.<br>**4.** H.K. Verma, Sensor Networks, e-monograph at www.profhkverma.info, Chapter 2 – Wired Network Technologies/Protocols, Chapter 3 – Wireless Network Technologies/Protocols.<br>5. H.K. Verma, SCADA, e-monograph at www.profhkverma.info, Chapter 4: Network Technologies Deployed in SCADA Systems. | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

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|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch:EEE** | | **Semester:II** | |
| 1 | Course Code | | |
| 2 | Course Title | Robotics and Industrial Robots | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Elective /Compusory | |
| 5 | Course Objective | 1.To understand the construction industrial robotics<br>2.To explore knowledge on selection of end-effectors of robotics<br>3.To get knowledge of electrical drive systems of industrial robotics<br>4.To know types of sensors of industrial robotics<br>5.To understand of electrical and electronics interfacings<br>6.To study about applications of industrial robots | |
| 6 | Course Outcomes | CO1: Basic construction of robot and robotics components<br>CO2: Understanding interfacing & building techniques of robots<br>CO3: Knowing different types of actuators of robotics<br>CO4: Getting knowledge of robotics sensors and transducers<br>CO5: Developing interfacing circuits for robotics applications | |
| 7 | Course Description | This course gives coverage of robotics components, architecture, and electronics interfacing circuits knowledge. Students can also practice programming of robotics using embedded C on open source software after going through this subject. Finally students are able to do tailor-made projects on robotics engineering | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Introduction to Robotics and Motion Analysis** | |
| | A | Historical background; Laws of robotics and robot definitions; | CO1 |
| | B | Robotics systems and robot anatomy: Basic diagram, basic components and their uses; Specifications of robots. | CO1 |
| | C | Position representation; Forward and reverse transformation: 2 & 3 DOF | CO1 |
| | **Unit 2** | **Robot End-Effectors, Robot Drives and Actuators** | |
| | A | Classification of end-effectors; Mechanical grippers, Magnetic grippers and vaccum grippers; Gripper force analysis. | CO2 |
| | B | Functions of drive systems; Electrical drives: DC, BLDC motors, AC motors, stepper motor, piezoelectric actuators; | CO2,CO3 |
| | C | Drive Mechanisms: rack and pinion, ball screws, gear trains and harmonic drive. | CO2 |
| | **Unit 3** | **Sensors of Robotic System** | |
| | A | Uses of sensors in robotics; Shaft Encoders (linear and | CO4 |

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| | | rotational); | | | |
| | B | Proximity Sensors (inductive and capacitive); Tactile sensors; | | | CO4 |
| | C | Basic block diagram of vision systems of robotic system. | | | CO4 |
| | **Unit 4** | **Controlling Technologies of Industrial Robots** | | | |
| | A | Basics of PC interfacings | | | CO5 |
| | B | Microcontroller interfacings | | | CO5 |
| | C | Robot languages and classification; Robot software. | | | CO5 |
| | **Unit 5** | **Industrial Robot Applications** | | | |
| | A | Material handling robots | | | CO6 |
| | B | Welding Robots | | | CO6 |
| | C | Assembling robots | | | CO6 |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1.S.R. Deb and S. Deb, “Robotics Technology and Flexible Automation”, Second edition, McGraw Hill, 2011. | | | |
| | Other References | 2. Mikell P Groover et al., “Industrial Robotics”, fifth print, McGraw Hill, Special Indian Edition, 2013 | | | |

## Course Articulation Matrix

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

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|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch: EEE/EE** | | **Semester: 1** | |
| 1 | Course Code | MIA117 | |
| 2 | Course Title | Advanced Control Engineering and Controllers | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To provide students with:<br>1. some advanced concepts in Control Systems Engineering and their applications<br>2.A theoretical understanding of advanced linear control systems and strategies, including the principles of digital control.<br>3 understanding of performing stability analysis of digital control systems.<br>4. knowledge of Analog controller, computer based controller and intelligent controller | |
| 6 | Course Outcomes | After completion of this course students will be able to:<br>CO1: Understand advanced concepts and approaches to control system designs..<br>CO2: Understand industrial controllers of continuous and discontinuous types and advanced control concepts of cascaded and feed forward controls.<br>CO3: design, develop and operate analog controllers, both electronic and pneumatic types.<br>CO4: Design develop and operate computer based control systems.<br>CO5: Understand simulate and design artificial intelligence based control system. | |
| 7 | Course Description | This course introduces systematic approaches to the design and analysis of advance control systems for industrial applications. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Overview of Control System** | |
| | A | Elements of control systems; Concept of open loop and closed loop systems; Examples and application of open loop and closed loop systems | CO1 |
| | B | Brief idea of multivariable control systems; Concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations. Correlation between time and frequency responses | CO1 |
| | C | State variable modelling of linear discrete systems, controllability and observability; Nonlinear control systems; Fundamentals-common nonlinearities (saturation, dead-zone, relay, on-off nonlinearity, backlash, hysteresis | CO1 |
| | **Unit 2** | **Controller Principles** | |
| | A | Process Characteristics; Control system parameters: error, variable range, control parameter range, control lag, dead | CO2 |

| | | | |
|---|---|---|---|
| | | time, cycling | |
| | B | Discontinuous controller modes: two-position mode, multi-position mode; Continuous controller modes | CO2 |
| | C | proportional, integral and derivative control modes; Composite Control modes: proportional-integral (PI), proportional-derivative (PD) and three mode controller (PID); Cascaded and feed-forward controls | CO2 |
| | **Unit 3** | **Analog Controllers** | |
| | A | Introduction; General features | CO3 |
| | B | Electronics controllers : error detector, single mode and composite mode controller; | CO3 |
| | C | Pneumatic controllers: proportional, proportional-integral (PI), proportional-derivative (PD) and PID controller. | CO3 |
| | **Unit 4** | **Computer Based Control** | |
| | A | Introduction; Digital applications: alarms, two-position control | CO4 |
| | B | Computer based controller | CO4 |
| | C | hardware configurations, software requirements | CO4 |
| | **Unit 5** | **Intelligent Control Systems** | |
| | A | Fuzzy-logic control system: Fuzzy set theory, basic fuzzy set operations, fuzzy relations, fuzzy logic controller, methods of determination of membership functions | CO5 |
| | B | Methods of defuzzification, fuzzy rule base, design of fuzzy logic control system. | CO5 |
| | C | Neural-network control system :Artificial neural networks, operation of a single artificial neuron, network architecture, learning in neural networks, back-propagation, Neurofuzzy control | CO5 |
| | | | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA / MTE / ETE<br>30% / 20% / 50% | |
| | Text book/s* | 1. Curtis D. Johnson "Process Control Instrumentation Technology,"8th Edition Pearson.<br>2. I.J. Nagrath and M. Gopal, "Control Systems Engineering," 4th Edition, New Age International Publishers. | |
| | Other References | 1. S.N. Sivanandam and S.N. Deepa, "Principles of soft computing," Wiley India Pvt. Limited.<br>2. S.Rajashekaran and G.A. VijayalakshmiPai, " Neural Nwtworks,Fuzzy logic, and Genetic Algorithms," PHI Pvt. | |

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**COURSE ARTICULATION MATRIX**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

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|---|---|---|
| **School: SET** | | |
| **Program: M.Tech** | | |
| **Branch: EEE/EE** | | **Semester: 1** |
| 1 | Course Code | MIA112 |
| 2 | Course Title | **MEMS, Smart Sensors and WSN** |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | Compulsory /Elective/Open Elective |
| 5 | Course Objective | To provide students with:<br>10. basic principles and techniques of MEMS and Smart Sensors<br>11. knowledge of various fabrication and machining process of MEMS along with its benefits in relation to applications<br>12. Knowledge in wireless sensor networks and to apply this knowledge in various industrial application like environmental monitoring, structural health and greenhouse monitoring |
| 6 | Course Outcomes | CO1: To be able to understand architecture of smart sensors along with differences among smart, intelligent and network sensors.<br>CO2: To be familiar with the important concepts applicable to MEMS and their fabrication<br>CO3: To be able to select and apply the MEMS and smart sensors to different applications.<br>CO4: To understand principles of wireless sensor networks and differentiate among various wireless network protocols .<br>CO5: To apply principles of WSN in various industrial, environmental and societal applications. |
| 7 | Course Description | This course is aimed at equipping students with basic knowledge on of MEMS (Micro electro Mechanical System), Smart sensor and its various fabrication techniques. This course also enables the student with appropriate knowledge of Wireless sensor network and its applications in industry. |

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| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Basics of MEMS and Smart Sensors** | |
| | A | Overview of measurement system, transducers, sensors, actuators and signal conditioners | CO1 |
| | B | Definition, working principle and construction of MEMS | CO1 |
| | C | Definition and architecture of smart sensor; different levels of integration in smart sensors; Differences between smart, intelligent and network sensors; Advantages of smart sensors | CO1 |
| | **Unit 2** | **MEMS and Smart Sensor Technologies** | |
| | A | Micro-machining processes: materials for micro-machining, wafer bonding, bulk and surface micromachining | CO2 |

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|---|---|---|---|---|---|
| | B | IC Technologies: thick film, thin film technologies | | | CO2 |
| | C | Monolithic IC technology | | | CO2 |
| | **Unit 3** | **Case studies of MEMS and Smart Sensors** | | | |
| | A | Principles, characteristics and constructional details of MEMS based smart acceleration and pressure sensors | | | CO3 |
| | B | Principle, characteristics and constructional details of a smart temperaturesensor | | | CO3 |
| | C | Principle, characteristics and constructional details of a smart humidity sensor | | | CO3 |
| | **Unit 4** | **Wireless Sensor Network (WSN)** | | | |
| | A | Need and advantages of WSN, Network topologies; seven-layer OSI model of communication system | | | CO4 |
| | B | Zgbee (IEEE – 802.15.4) protocol, Merits of Zigbee over Wi-Fi (IEEE – 802.11) and Bluetooth for WSN, architecture of Wireless sensor node | | | CO4 |
| | C | Sensor and actuator network (SAN) - homogeneous and heterogeneous SAN | | | CO4 |
| | **Unit 5** | **WSN Applications in Industry** | | | |
| | A | Spectrum of applications; Case studies on WSN application: Environment monitoring | | | CO5 |
| | B | Condition monitoring - Structural health and Equipment health monitoring | | | CO5 |
| | C | Greenhouse monitoring and control | | | CO5 |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 9 D. Patranabis, "Sensors and Transducers", Prentice-Holl, 2nd Edition, 2003.<br>10 Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, 2000.<br>11 E.H. Callaway, "Wireless Sensor Networks : Architecture and Protocols" | | | |
| | Other References | 5. H.K. Verma, e-monograph on "Smart Sensors", at www.profhkverma.info, Chapter 1 – Basics of Smart Sensor, Chapter 2 – Smart Sensor Technologies, Chapter 3 – Case Studies of Smart Sensors.<br>6. H.K. Verma, e-monograph on "WSN", at www.profhkverma.info, Chapter 1 – Wireless Sensor Network, Chapter 2 – Wireless Sensor Node, Chapter 3 – Applications of Wireless Sensor Networks. | | | |

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## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO113.1 | 3 | 1 | 1 | - | 1 | - | - | - | - | 1 | 3 | 3 | - |
| CO113.2 | 2 | 3 | 2 | 3 | - | 2 | 1 | - | - | 1 | 3 | 3 | 2 |
| CO113.3 | 2 | 1 | 3 | 3 | 2 | 3 | 1 | 2 | - | 2 | 3 | 2 | 1 |
| CO113.4 | 1 | 2 | 1 | - | 2 | 1 | - | 2 | - | 1 | 3 | 2 | 2 |
| CO113.5 | 2 | 1 | 3 | 1 | - | 2 | - | - | - | 2 | 3 | 2 | - |
| CO113.6 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 2 | 3 | 2 | 2 |

| School: SET | | |
|---|---|---|
| **Program: B.Tech** | | |
| **Branch:EEE/EE/ECE** | | **Semester: 2** |
| 1 | Course Code | **EEE331** |
| 2 | Course Title | **PLC and SCADA** |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | Compulsory /Elective/Open Elective |
| 5 | Course Objective | To provide students with:<br>1.The conceptual as well as practical knowledge of the Industrial Automation & latest technologies being used to achieve Industrial Automation. |
| 6 | Course Outcomes | The students should be able to<br>CO1: understand the concepts of computer based Industrial Control, including PLC, DCS and SCADA.<br>CO2: understand hardware of PLC and ladder programming for PLC.<br>CO3: use various PLC functions and develop PLC programs for industrial control and automation applications.<br>CO4: understand the purpose, layout, components and functions of SCADA systems and use the knowledge for the operation of SCADA systems in Industry<br>CO5: design SCADA system including layout, communication system and software. |
| 7 | Course Description | This course is aimed at equipping students with appropriate knowledge and skills required in configuring, programming and operating Industrial automation systems with the use of Industrial Field Instruments, PLC and SCADA systems. |

| 8 | Outline syllabus | | CO Mapping |
|---|---|---|---|
| | **Unit 1** | **Computer Based Industrial Control** | |
| | A | Microprocessor/microcontroller based industrial controller: concept and configuration | CO1 |
| | B | Computer based industrial controller: concept and configuration | CO1 |
| | C | Introduction to direct digital control (DDC), distributed control system (DCS) and supervisory control and data acquisition (SCADA) | CO1 |
| | **Unit 2** | **PLC Basics** | |
| | A | Introduction to PLC, PLC versus microprocessor/microcontroller/computer; Advantages and disadvantages of PLC | CO2 |
| | B | Hardware, internal architecture and physical forms of PLC; Digital inputs/ outputs; Analog inputs/ outputs | CO3 |
| | C | PLC programming: ladder programming, function blocks, | CO2 |

| | | | | | |
|---|---|---|---|---|---|
| | | Instruction lists, Sequential function chart, mnemonic programming | | | |
| | **Unit 3** | **PLC Functions** | | | |
| | A | Registers: holding, input and output registers; Timers and timer functions; Counters and counter functions | | | CO4 |
| | B | Data handling functions; Bit functions; | | | CO4 |
| | C | Advanced functions; PLC programming using various functions | | | CO4 |
| | **Unit 4** | **SCADA Basics, Layout and Functions** | | | |
| | A | Introduction; Definition and purpose;Controlled / uncontrolled variables and remotely / locallycontrolled objects in controlled plant | | | CO5 |
| | B | Layout and parts of SCADA system; Detailed block schematic of SCADA system | | | CO5 |
| | C | Functions of SCADA system: data acquisition and transmission, monitoring, control, data collection and storage, data processing and calculation, report generation | | | CO5 |
| | **Unit 5** | **SCADA Design** | | | |
| | A | Master Terminal Unit (MTU): functions,single processor and multiprocessor MTU, single and dual computer configurations of MTU; Remote Terminal Unit (RTU): functions, architecture / layout; RTU programming | | | CO5 |
| | B | MTU-RTU communication and RTU-field device communication | | | CO5 |
| | C | Design of SCADA system : HARDWARE, Communication and Software. | | | CO5 |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1. J.W. Webb and R.A. Reis, Programmable Logic Controllers, Prentice-Hall India<br>2. . Stuart A. Boyer, Supervisory Control and Data Acquisition (SCADA), 4th Edition, International Society of Automation, 2010. | | | |
| | Other References | J.R. Hackworth and F.D. Hackworth, Programmable Logic Controllers, Pearson Edition<br>2. W. Boston, Programmable Logic Controllers, Newnes,( Elsevier).<br>3. H.K. Verma, SCADA, e-monograph at www.profhkverma.info, Chapter 1: Basics of SCADA, Chapter 2: Functions of SCADA System, Chapter 3: Hardware of SCADA System. | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | P09 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO331.1 | 3 | 3 | - | 1 | - | - | - | - | - | 2 | 1 | - | 1 |
| CO331.2 | 3 | 3 | - | 1 | 2 | - | - | - | - | 2 | 1 | 2 | 1 |
| CO331.3 | 3 | 3 | - | 1 | 2 | - | - | - | - | 2 | 3 | 2 | 1 |
| CO331.4 | 3 | 3 | - | 1 | - | - | - | - | - | 2 | 1 | - | 1 |
| CO331.5 | 2 | 2 | 3 | 3 | 3 | - | - | - | - | 2 | 3 | 2 | 1 |
| CO331.6 | 2 | 3 | 3 | 2 | 32 | - | - | - | - | 2 | 2 | 2 | 1 |

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|---|---|---|
| **School: SET** | | |
| **Program: B.Tech** | | |
| **Branch: EEE** | | |
| 1 | Course Code | |
| 2 | Course Title | **Advanced Control Engineering and Controllers** |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | |
| 5 | Course Objective | To provide students with:<br>1. some advanced concepts in Control Systems Engineering and their applications<br>2.A theoretical understanding of advanced linear control systems and strategies, including the principles of digital control.<br>3 understanding of performing stability analysis of digital control systems.<br>4. knowledge of Analog controller, computer based controller and intelligent controller |
| 6 | Course Outcomes | After completion of this course students will be able to:<br>CO1: Understand advanced concepts and approaches to control system designs..<br>CO2: Understand industrial controllers of continuous and discontinuous types and advanced control concepts of cascaded and feed forward controls.<br>CO3: design, develop and operate analog controllers, both electronic and pneumatic types.<br>CO4: Design develop and operate computer based control systems.<br>CO5: Understand simulate and design artificial intelligence based control system.<br>CO 6: Industrial experiences in control engineering |
| 7 | Course Description | This course introduces systematic approaches to the design and analysis of advance control systems for industrial applications. |

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|---|---|---|---|
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Overview of Control System** | |
| | A | Elements of control systems; Concept of open loop and closed loop systems; Examples and application of open loop and closed loop systems | CO1 |
| | B | Brief idea of multivariable control systems; Concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations. Correlation between time and frequency responses | CO1 |
| | C | State variable modelling of linear discrete systems, controllability and observability; Nonlinear control systems; Fundamentals-common nonlinearities (saturation, dead-zone, relay, on-off nonlinearity, backlash, hysteresis | CO1 |
| | **Unit 2** | **Controller Principles** | |
| | A | Process Characteristics; Control system parameters: error, variable range, control parameter range, control lag, dead | CO2 |

| | | | |
|---|---|---|---|
| | | time, cycling | |
| | B | Discontinuous controller modes: two-position mode, multi-position mode; Continuous controller modes | CO2 |
| | C | proportional, integral and derivative control modes; Composite Control modes: proportional-integral (PI), proportional-derivative (PD) and three mode controller (PID); Cascaded and feed-forward controls | CO2 |
| | **Unit 3** | **Analog Controllers** | |
| | A | Introduction; General features | CO3 |
| | B | Electronics controllers : error detector, single mode and composite mode controller; | CO3 |
| | C | Pneumatic controllers: proportional, proportional-integral (PI), proportional-derivative (PD) and PID controller. | CO3 |
| | **Unit 4** | **Computer Based Control** | |
| | A | Introduction; Digital applications: alarms, two-position control | CO4,CO6 |
| | B | Computer based controller | CO4,CO6 |
| | C | hardware configurations, software requirements | CO4,CO6 |
| | **Unit 5** | **Intelligent Control Systems** | |
| | A | Fuzzy-logic control system: Fuzzy set theory, basic fuzzy set operations, fuzzy relations, fuzzy logic controller, methods of determination of membership functions | CO5,CO6 |
| | B | Methods of defuzzification, fuzzy rule base, design of fuzzy logic control system. | CO5,CO6 |
| | C | Neural-network control system :Artificial neural networks, operation of a single artificial neuron, network architecture, learning in neural networks, back-propagation, Neurofuzzy control | CO5,CO6 |
| | | | |
| | Mode of examination | Theory/Jury/Practical/Viva | |
| | Weightage Distribution | CA / MTE / ETE<br>30% / 20% / 50% | |
| | Text book/s* | 1. Curtis D. Johnson "Process Control Instrumentation Technology,"8th Edition Pearson.<br>2. I.J. Nagrath and M. Gopal, "Control Systems Engineering," 4th Edition, New Age International Publishers. | |
| | Other References | 1. S.N. Sivanandam and S.N. Deepa, "Principles of soft computing," Wiley India Pvt. Limited.<br>2. S.Rajashekaran and G.A. VijayalakshmiPai, " NeuralNwtworks,Fuzzy logic, and Genetic Algorithms," PHI | |

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| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | - | - |

## COURSE ARTICULATION MATRIX

| | | |
|---|---|---|
| **School: SET** | | |
| **Program: M.Tech** | | |
| **Branch: EEE** | | **Semester:** |
| 1 | Course Code | |
| 2 | Course Title | Demand side management of smart grid |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | |
| 5 | Course Objective | • To introduce the concept of demand-side management for residential, commercial and industrial energy users.<br>• To give an overview of the different types of demand-side measures.<br>• To describe energy auditing and routine data collection and monitoring, andto indicate their benefits.<br>• To outline information dissemination on demand-side management.<br>• To provide an overview of the major implementation challenges for DSM programmes |
| 6 | Course Outcomes | CO1: To be able to define demand-side management.<br>CO2: To understand the different types of demand-side management measures and their suitability to various energy users.<br>CO3: To be aware of the benefits of good reliable data collection for regular performance analysis, and as an essential part of energy auditing<br>CO4: To appreciate the need for effective information dissemination.<br>CO5: To understand the challenges facing the implementation of demand-side management<br>CO6: To be able to design housekeeping and preventative maintenance in commerce and industry can be used to reduce energy demand. |
| 7 | Course Description | Demand-side management (DSM) has been traditionally seen as a means of reducing peak electricity demand so that utilities can delay building further capacity. In fact, by reducing the overall load on an electricity network, DSM has various beneficial effects, including mitigating electrical system emergencies, reducing the number of blackouts and increasing system reliability. Possible benefits can also include reducing dependency on expensive imports of fuel, reducing energy prices, and reducing harmful emissions to the environment. Finally, DSM has a major role to play in deferring high investments in generation, transmission and distribution networks. Thus DSM applied to electricity systems provides significant economic, reliability and environmental benefits |

| | | | |
|---|---|---|---|
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Energy Scenarios** | **CO1** |
| | A | Energy Conservation, Energy Audit, Energy Scenarios, | **CO1** |
| | B | Energy Consumption, Energy Security, | **CO1** |

| | | | | | |
|---|---|---|---|---|---|
| | C | Energy Strategy, Clean Development Mechanism | | | **CO1** |
| | **Unit 2** | **Energy Audit** | | | |
| | A | Definition of Energy Audit, Place of Audit, | | | **CO2** |
| | B | Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, | | | **CO2** |
| | C | Energy Monitoring and Training Solar power plant | | | **CO2** |
| | **Unit 3** | **Electrical-Load Management** | | | **CO3** |
| | A | Electrical Basics, Electrical Load Management, | | | **CO3** |
| | B | Variable- Frequency Drives, Harmonics and its Effects, | | | **CO3** |
| | C | Electricity Tariff, Power Factor, Transmission and Distribution Losses | | | **CO3** |
| | **Unit 4** | **Demand side Management** | | | **CO4, CO6** |
| | A | Scope of DSM, Evolution of DSM concept, DSM planning and Implementation | | | **CO4, CO6** |
| | B | Load management as a DSM strategy, Applications of Load Control, End use energy conservation, | | | **CO4, CO6** |
| | C | Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment | | | **CO4, CO6** |
| | **Unit 5** | **Energy Conservation** | | | **CO5,CO6** |
| | A | Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, | | | **CO5, CO6** |
| | B | Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, | | | **CO5, CO6** |
| | C | EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation | | | **CO5, CO6** |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1. Renewable Energy- Power for a sustainable future, third edition, Edited by Godfrey Boyle, Oxford University Press, 2013. | | | |
| | Other References | 1. Micrlandgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K, 2009 | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | - | - |

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|---|---|---|
| **School:** SET | | |
| **Program: B**.Tech | | |
| **Branch:**EEE | | **Semester:** |
| 1 | CourseCode | |
| 2 | CourseTitle | DigitalRelaying forPowerSystems |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | Compulsory |
| 5 | CourseO bjective | 1. tounderstandtheconcept ofdigitalprotectionandcomputerrelayingforpowersystem.<br>2. toacquireanin-depthknowledgeondifferentgenerationsofprotectiverelays<br>3. toidentifydifferentcomponentsofanumericalrelay<br>4. to apply discrete Fourier transform technique in Power SystemProtection<br>5. todesignanddevelop relayalgorithmsfor protectionofpower systemapparatus |
| 6 | CourseOu tcomes | CO1: To compare, analyses the advantages and disadvantages of all the three generations of protective relay and also identify the different components of a numerical relay<br>CO2: To develop relay algorithms based on relaying signals<br>CO3: To develop algorithm for digital protection of generator<br>CO4: To develop algorithm for digital protection of transformer<br>CO5: To apply ANN for protection of transmission line and power transformer<br>CO6: To design and evaluate protection algorithms for protection of any power system component |
| 7 | CourseDes cription | The first and foremost driving force for advances in relaying systems is theneedtoimprove reliability. In turn, this implies increasein dependabilityaswellassecurity.Thisneedtoimprovereliabilitypropelledthedevelopment of digital relaying. In this course, the students will have anexposure tothe threegenerationsofprotective relays.<br>Throughout the course, students will have an opportunity to be exposed todifferent numerical techniques for protection of generators, transformersandtransmissionlines. |

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| 8 | Outlinesyllabus | | COMapping |
| | **Unit1** | **IntroductionandArchitectureofDigitalRelay** | |
| | A | Threegenerationsofprotectiverelays:electromechanical, staticanddigital/numerical | CO1 |

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| | B | architectureand elementsofadigitalrelay | | | CO1 |
| | C | Multifunctionalrelays,managementrelaysandIEDRelays | | | CO1 |
| | **Unit2** | **RelayAlgorithmsandMathematicalBasis** | | | |
| | A | RelayAlgorithmsbased onpuresinusoidalrelaying signals,distortedrelayingsignalsanddifferentialequationrepresentationofsystem; | | | CO2 &CO6 |
| | B | Ztransform,sineandcosineFourierseries,Fourier TransformandDFT | | | CO2 &CO6 |
| | C | Walshfunctions,digitalfilters,windowsandwindowing. | | | CO2 &CO6 |
| | **Unit3** | **DigitalRelayingforGenerator** | | | |
| | A | Various protectionfunctions:differential,statorearthfault, lossofexcitationandreversepower protection | | | CO3&CO6 |
| | B | Abnormalfrequencyandvoltageprotection:overandunder frequency protection, over and under voltage protection | | | CO3&CO6 |
| | C | Numericaldifferentialprotectionofgenerator | | | CO3&CO6 |
| | **Unit4** | **DigitalRelaying forTransformer** | | | |
| | A | Typesoffaultsencounteredintransformer, basic considerationsfortransformerdifferentialprotection, | | | CO4 |
| | B | stabilizingofdifferentialprotectionduringmagnetizing inrushcurrent | | | CO4 |
| | C | Numericalprotectionoftransformer | | | CO4 |
| | **Unit5** | ArtificialIntelligenceBasedNumericalProtection | | | CO5 |
| | A | TypesofNeuralNetworkModels,ArtificialNeural Network,DesignProcedureandConsideration | | | CO5 |
| | B | ApplicationofANNtotransmissionlineprotection | | | CO5 |
| | C | ANNbasedpowertransformerprotection | | | |
| | Modeof examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Textbook/s* | 1. Arun G Phadke and James S. Thorp, “ComputerRelaying forPowerSystems”,JohnWileyandSonsInc,NewYork. 2. Badriram,D.N.Vishwakarma,‘PowerSystemProtection&Switchgear’,TataMcGraw–hill publishingcompanyltd, NewDelhi. | | | |
| | OtherReferences | 1.BhaveshBhalja, R.P. Maheswari and Nilesh G.Chothani,“ProtectionandSwitchgear”,Oxford. | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | - | - |

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|---|---|---|---|
| **School: SET** | | | |
| **Program: M.Tech** | | | |
| **Branch: EEE** | | **Semester:** | |
| 1 | Course Code | | |
| 2 | Course Title | Distributed Generation Technology | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | | |
| 5 | Course Objective | To introduce the concept of distributed generation, microgrids, electric vehicles and energy storage.<br>To familiarize the students with renewable generation system modelling, and their grid integration issues.<br>To impart an understanding of economics, policies and technical regulations for DG integration | |
| 6 | Course Outcomes | CO1: Analyse the concept and importance of distributed generation.<br>CO2: Understand different renewable energy sources, micro-grid and storage Devices.<br>CO3: Evaluate the technical impact of DG in power system<br>CO4: Analyze the operation and control strategies for grid connected and off-grid System.<br>CO5: Evaluate the effect of DG placement in the existing system<br>CO6: Industrial experiences in renewable energy integration | |
| 7 | Course Description | This syllabus gives an overview of distributed energy resources, photovoltaic systems, small hydro, fuel cells, energy storage technologies; wind turbines, Principles of control of distributed generation systems; Electric power distribution systems, installation, interconnection and integration; Economic and financial aspects of distributed generation, the regulatory environment and standards. | |
| **8** | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Distributed Generation** | **CO1** |
| | A | Concept of DG and, its definition, Current scenario in distributed generation | **CO1** |
| | B | Need for distributed generation | **CO1** |
| | C | Advantage and limitation of DG | **CO1** |
| | **Unit 2** | **Renewable based Distributed generation** | |
| | A | Wind power plant | **CO2** |
| | B | Solar power plant | **CO2** |
| | C | Small hydro other alternate DG | **CO2** |
| | **Unit 3** | **Technical impacts of DG** | **CO3** |
| | A | Transmission systems, Distribution systems | **CO3** |
| | B | Impact of DGs upon protective relaying | **CO3** |
| | C | Impact of DGs upon transient and dynamic stability of existing | **CO3** |

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| | | distribution systems | | | |
| | **Unit 4** | **Operation and Economic aspects of DGs** | | | **CO4, CO6** |
| | A | De-regulation of power system | | | **CO4, CO6** |
| | B | Voltage control techniques, Reactive power control, Harmonics, Power quality issues, Reliability of DG based systems | | | **CO4, CO6** |
| | C | Economic impacts: Market facts, issues and challenges | | | **CO4, CO6** |
| | **Unit 5** | **Grid integration of DGs** | | | **CO5,CO6** |
| | A | Optimal placement of DG sources in distribution systems | | | **CO5, CO6** |
| | B | Different types of interfaces , Inverter based DGs and rotating machine based interfaces , Aggregation of multiple DG units | | | **CO5, CO6** |
| | C | Energy storage elements, Batteries, ultra capacitors, flywheels | | | **CO5, CO6** |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 2. Renewable Energy- Power for a sustainable future, third edition, Edited by Godfrey Boyle, Oxford University Press, 2013. | | | |
| | Other References | 2. Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K, 2009 | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | - | - |

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| **School: SET** | | |
| **Program: B.Tech** | | |
| **Branch:EEE** | **Semester:** | |
| 1 | Course Code | |
| 2 | Course Title | **Operation and Control of smart grid** |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | |
| 5 | Course Objective | The objective of the subject on smart grid technologies is to integrate and optimize distributed energy resources to achieve a more efficient and reliable grid, enable active participation of consumers with more environmental constraints |
| 6 | Course Outcomes | The students should be able to<br>CO1: Identify different tools and approaches to modelling a Smart Grid.<br>CO2: Apply Optimal Power Flow (OPF) solutions to evaluate the performance of a power system with renewable energy sources.<br>CO3: Analyze power system dynamics (frequency stability) to achieve active power balance.<br>CO3: To familiarize the students with modelling of smart grids components.<br>CO5: Identify control-room technologies for system-wide remote monitoring, protection, and risk management of smart grid cyber security<br>CO6: Able to design, implementation, evaluation and management of smart electricity infrastructure. |
| 7 | Course Description | Smart grid communications and control, covering several special topics in the field of smart grid including advanced metering infrastructures, demand response, distributed storage, vehicle-to-grid systems, wide area measurement, smart grid cyber security, etc |

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| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Modeling of Smart Grids** | |
| | A | Operating principles and models of smart gird components,;. | CO1 |
| | B | Key technologies for generation, networks, loads and their control capabilities decision-making tools | CO1 |
| | C | Hardware, Software, Communication. Approaches to estimation, scheduling, management and control of next generation smart grid | CO1 |
| | **Unit 2** | **Smart Grid Communications** | |
| | A | Two-way Digital Communications Paradigm,Network Architectures | CO2 |
| | B | IP-based Systems, Power Line Communications | CO3 |
| | C | Advanced Metering Infrastructure, | CO2 |
| | **Unit 3** | **Security and Privacy** | |
| | A | Cyber Security Challenges in Smart Grid,Load Altering Attacks | CO4 |

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| | B | False Data Injection Attacks, Defense Mechanisms | | | CO4 |
| | C | Privacy Challenges Data handling functions; Bit functions | | | CO4 |
| | **Unit 4** | **IoT for power systems** | | | |
| | A | Internet of things for electricity infrastructure and energy management. | | | CO5,CO6 |
| | B | SCADA, Demand response, AMI, IoT aided smart grid, | | | CO5,CO6 |
| | C | Big data for power system and introduction to data analytics. | | | CO5,CO6 |
| | **Unit 5** | **Flexible AC transmission system (FACTS)** | | | |
| | A | Congestion management and loadability enhancement, reactive power compensation,. | | | CO5,CO6 |
| | B | concept of series compensation, shunt compensation, FACTS: working principle | | | CO5,CO6 |
| | C | Classification, series controllers, shunt controllers, series-series controllers, series-parallel controllers | | | CO5,CO6 |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley & sons inc, 2015.<br>2. . James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley & sons Inc, IEEE press 2012 | | | |
| | Other References | 1.Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012.<br>2.ClarkW.Gellings, “The smart grid: Enabling energy efficiency and demand response”, Fairmont Press Inc, 2009.<br>3. H.K. Verma, SCADA, e-monograph at ww.profhkverma.info,. | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | - | - |

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| **School: SET** | | |
| **Program: B.Tech** | | |
| **Branch:EEE** | | **Semester:** |

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| 1 | Course Code | | |
| 2 | Course Title | Robotics and Industrial Robots | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | | |
| 5 | Course Objective | 1.To understand the construction industrial robotics<br>2.To explore knowledge on selection of end-effectors of robotics<br>3.To get knowledge of electrical drive systems of industrial robotics<br>4.To know types of sensors of industrial robotics<br>5.To understand of electrical and electronics interfacings<br>6.To study about applications of industrial robots | |
| 6 | Course Outcomes | CO1:Basic construction of robot and robotics components<br>CO2:Understanding interfacing & building techniques of robots<br>CO3:Knowing different types of actuators of robotics<br>CO4:Getting knowledge of robotics sensors and transducers<br>CO5:Developing interfacing circuits for robotics applications<br>CO 6: Industrial experiences in Robotics | |
| 7 | Course Description | This course gives coverage of robotics components, architecture, and electronics interfacing circuits knowledge. Students can also practice programming of robotics using embedded C on open source software after going through this subject. Finally students are able to do tailor-made projects on robotics engineering | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | **Introduction to Robotics and Motion Analysis** | |
| | | | |
| | A | Historical background; Laws of robotics and robot definitions; | CO1 |
| | B | Robotics systems and robot anatomy: Basic diagram, basic components and their uses; Specifications of robots. | CO1 |
| | C | Position representation; Forward and reverse transformation: 2 & 3 DOF | CO1 |
| | **Unit 2** | **Robot End-Effectors, Robot Drives and Actuators** | |
| | A | Classification of end-effectors; Mechanical grippers, Magnetic grippers and vaccum grippers; Gripper force analysis. | CO2 |
| | B | Functions of drive systems; Electrical drives: DC, BLDC motors, AC motors, stepper motor, piezoelectric actuators; | CO2,CO3 |
| | C | Drive Mechanisms: rack and pinion, ball screws, gear trains and harmonic drive. | CO2 |
| | **Unit 3** | **Sensors of Robotic System** | |
| | A | Uses of sensors in robotics; Shaft Encoders (linear and | CO4 |

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| | | rotational); | | | |
| | B | Proximity Sensors (inductive and capacitive); Tactile sensors; | | | CO4 |
| | C | Basic block diagram of vision systems of robotic system. | | | CO4 |
| | **Unit 4** | **Controlling Technologies of Industrial Robots** | | | |
| | A | Basics of PC interfacings | | | CO5 |
| | B | Microcontroller interfacings | | | CO5 |
| | C | Robot languages and classification; Robot software. | | | CO5 |
| | **Unit 5** | **Industrial Robot Applications** | | | |
| | A | Material handling robots | | | CO6 |
| | B | Welding Robots | | | CO6 |
| | C | Assembling robots | | | CO6 |
| | Mode of examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 1.S.R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second edition, McGraw Hill, 2011. | | | |
| | Other References | 2. Mikell P Groover et al., "Industrial Robotics", fifth print, McGraw Hill, Special Indian Edition, 2013 | | | |

**Course Articulation Matrix**

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|---|---|---|
| **School:**SET | | |
| **Program: B**.Tech | | |
| **Branch:**EEE | **Semester:**I/II | |
| 1 | CourseCode | |
| 2 | CourseTitle | Smart PowerGridandMicro-Grid |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | |
| 5 | CourseObjective | 1. Tounderstandtheconceptsofsmartpowergridandmicrogrid<br>2. Toacquireindepthknowledgeofsmartdistribution,distributionautomation,smarttransmissionandsubstationautomation<br>3. Toidentifyvariouscomponentsofsmartgridandmicrogrid<br>4. Toapplyprinciplesofautomationtotransmissionand distribution<br>5. To designsmartmicrogridforagivenapplication |
| 6 | CourseOutcomes | CO1: To understand concept, motivation and benefits of Smart Power Grid<br>CO2: To develop knowledge of demand-side management as a tool of smart distribution<br>CO3:To design advanced metering infrastructure for Distribution Automation<br>CO4: To design AC, DC and hybrid micro grids<br>CO5:To design phasor measurement and develop wide area Monitoring system using PMU<br>CO6: Industrial experiences in renewable energy integration in distribution system |
| 7 | CourseDescription | The course deals with the concept of smart power grid and includes invdepthstudyofitsitsvariouscomponents,namelysmartdistribution,distributionautomationandmanagement,advancedmeteringinfrastructure ,smartmicrogrid,smarttransmissionandsubstationautomation. |

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| 8 | Outlinesyllabus | | COMapping |
| | **Unit1** | **Introduction toSmartPowerGrid( 4hours)** | |
| | A | Traditionalpowergrid,Smartpowergrid(orsmartgrid) concept andobjectives | CO1 |
| | B | Benefitsofsmartpowergrid,traditional-gridandsmart-gridcomparison | CO1 |
| | C | Stake-holdersinsmart-griddevelopment, Smart grid solutions. | CO1 |
| | **Unit2** | **SmartDistribution** | |
| | A | Demand-sidemanagement:Energyefficiency,timeofuse andspinningreserve | CO2 |

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| | B | Demandresponse:MarketdrivenDRandoperation-drivenDR,incentive-basedDRandTOU-basedratesDR | CO2 |

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| | C | Distributedgeneration,Energystorage,Useofplugged electricandhybridelectric vehicles | | | CO2 |
| | **Unit3** | **DistributionAutomationandManagement** | | | |
| | A | Overview of distribution system, Components of DA: customer automation, feed erau to mation and substation automation, Distribution control centre(DCC) | | | CO3 |
| | B | Distribution managementsystem(DMS),Outagemanagement system (OMS)- unplanned and plannedoutages,Assetmanagement system(AMS),Customerinformationsystem(CIS) | | | CO3 |
| | C | Meaning and benefits of advanced metering,Structure andcomponents of AMI,AMI integration with DA, DMS andOMS. | | | CO3 |
| | **Unit4** | **SmartMicrogrid** | | | |
| | A | Definition,componentsandbenefitsofmicrogrid | | | CO4,CO6 |
| | B | Typesofmicrogrid:AC,DCandhybrid,Modesof operation:grid-connectedandisland modes | | | CO4,CO6 |
| | C | Meaningofsmartmicro grid,Microgridoperationand control | | | CO4,CO6 |
| | **Unit5** | **SmartTransmissionandSubstationAutomation** | | | |
| | A | Meaningandchallengesofsmarttransmission | | | CO5,CO6 |
| | B | Phasormeasurementunit:concept,layout,componentsand applications, Wide area monitoring system: concept and impacton EMS and DMS | | | CO5,CO6 |
| | C | Needofsubstationautomation(SA),Technical issuesof SA,SAarchitecture,SAfunction. | | | CO5,CO6 |
| | Modeof examination | Theory | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Textbook/s* | 1.MiniS.Thomasand JohnD. McDonald,PowerSystem SCADA and Smart Grids, CRC Press,2015. | | | |
| | OtherRefer ences | 1. JanakEknayakeatel.,SmartGrid:TechnologyandApp lications,JohnWileyandSons,2012<br>2. H.K.Verma,e-Monographon“Smart–Grid”,www.profhkverma.info | | | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | - | - |

| School: | | School of Engineering and Technology |
|---|---|---|
| Program: | | Current Academic Year: |
| Branch: EEE | | Semester: |
| 1 | Course Code | |
| 2 | Course Title | Virtual Instrumentation |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | |
| 5 | Course Objective | 9. Introduction to the various models of Virtual Instruments, their comparison with traditional instruments and major application areas of VI.<br>10. Introduction to basics of LabVIEW<br>11. VI Programming techniques like loops, arrays, clusters, plotting and Strings and files.<br>12. Basics of signal conditioning techniques along with DAQ hardware and software and various signal processing techniques available in LABVIEW.<br>13. Advanced concepts in LabVIEW with main concepts of real time applications in Image acquisition and Motion control.<br>14. Building of Virtual Instruments with various types of controls and indicators.<br>15. Configuring DAQ card and acquisition of real time signals from sources and sensors.<br>16. Simulate a signal in LabVIEW and generate a virtual source using DAQ cards. |
| 6 | Course Outcomes | CO1:Understand various models and areas of application of Virtual Instrumentation.<br>CO2: Understand various components of LabVIEW required for the development of VI.<br>CO3: Understand and apply various programming functions of LabVIEW like loops, arrays, clusters and file I/Os for building of simple Virtual instruments.<br>CO4: Understand the concepts of Data acquisition hardware and software and to apply basic signal processing techniques available in LabVIEW.<br>CO5: Understand the real time applications of LabVIEW in motion control and Image acquisition.<br>CO6:Able to build VI for simulated and real time applications. |
| 7 | Course Description | The course content of this subject includes an introduction to graphical system design. This course also focuses on introduction to LabVIEW which extensively elaborate the Graphical programming language .In Unit 3, building of VI by using loops, arrays, clusters etc. have been dealt with. Use of strings and I/O are also elaborated in this course. Data acquisition and various signal processing techniques are also |

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| | | covered in this course. Two real time applications motion control and Image acquisition by using LabVIEW have been elaborated in this course. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | **Unit 1** | **Introduction** | | | CO1 |
| | A | Graphical system design model - design model, prototype model, deployment model | | | |
| | B | Building blocks of VI; Virtual instrument versus traditional instrument, Hardware and software in VI | | | |
| | C | Graphical system Design using LabVIEW; Graphical programming and Textual programming | | | |
| | **Unit 2** | **Graphical system Design using LabVIEW** | | | CO2,CO6 |
| | A | Advantages of LabVIEW; Components of VI Software - Front panel windows, Block diagram windows, Icon /connector pane | | | |
| | B | Creating and saving a VI; Toolbars, Palettes, Front panel controls and indicators, Block diagram – terminals, nodes, functions | | | |
| | C | Sub VIs, Express VIs and VIs, wires; Data types, Data flow program | | | |
| | **Unit 3** | **Programming Techniques** | | | **CO3,CO6** |
| | A | Modular Programming in Lab View; Building VI front panel and block diagram | | | |
| | B | Loops – for and while loops, Local and Global variables in LabVIEW, Arrays in LabVIEW, | | | |
| | C | Clusters in LabVIEW; Conversion between arrays and clusters, Plotting data in LabVIEW, Strings and File I/O in LabVIEW | | | |
| | **Unit 4** | **Data Acquisition and Signal Processing in LabVIEW** | | | **CO4,CO6** |
| | A | Transducers and Signal conditioning ,sampling and aliasing | | | |
| | B | Basics of DAQ hardware and software, DAQ modules and drivers for building virtual instruments | | | |
| | C | Fourier transforms; Power spectrum, Correlation methods; Windowing & filtering | | | |
| | **Unit 5** | **Advanced concepts in LabVIEW** | | | **CO5, CO6** |
| | A | Data Socket, TCP/IP VI's synchronization | | | |
| | B | Serial interface buses - RS 232, RS485,USB | | | |
| | C | Concepts of real time systems; Image acquisition; Motion control | | | |
| | Mode of examination | Theory/Jury/Practical/Viva | | | |
| | Weightage Distribution | CA | MTE | ETE | |
| | | 30% | 20% | 50% | |
| | Text book/s* | 7. Jovitha Jerome, "Virtual Instrumentation and LABVIEW", PHI Learning | | | |
| | Other References | 1. C.L. Clark, "LabVIEW Digital Signal Processing", TMH Publishing Company.<br>8. Technical Manuals for DAQ Modules, Advantech and National Instruments<br>9. www.profhkverma.info: Chapter 2: Technologies/ | | | |

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|---|---|---|---|
| | | Protocols for Wired Sensor Network<br>10. NI USER MANUAL http://www.ni.com/pdf/manuals/376445b.pdf<br>11. www.ni.com | |

## COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO.1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO.2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| CO.3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 2 |
| CO.4 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | - | 2 |
| CO.5 | 1 | 2 | 2 | 1 | - | - | - | - | - | -- | 3 | 2 | 2 |
| CO.6 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |