Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati Autonomous

Academic Year 2020-2021(2019 Pattern)

Course Structure For M.Sc.- II : Electronic Science

Semester	Paper Code	Title of Paper	No. of Credits
IV	ELE4401	Control Systems	4
	ELE4402	Advanced Power Electronics	4
	ELE4403	Mechatronics and Robotics	4
	ELE4404	Wireless Sensor Networks	4
	ELE4405	Project	8

ELE4401: Control Systems **Credit :4**

Semester-IV

Objectives:

1. To make student familiar with basic concepts of control theory.
2. To understand the use of transfer function models for analysis physical systems and introduce the control system components.
3. To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of system.
4. To get acquainted with the methods for analyzing the time response and Stability of system.
5. To Introduce and analyze the frequency response and Stability of System stems.
6. To introduce stability analysis and design of compensators.
7. To Introduce concept of root locus, Bode plots, Nyquist plots.
8. To get acquainted with Concepts of PI, PD,PID controllers.

Course Outcome: On completion of the course, learner will be able to –

CO1: Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
CO2: Determine the (absolute) stability of a closed-loop control system.
CO3: Perform time domain analysis of control systems required for stability analysis.
CO4: Perform frequency domain analysis of control systems required for stability analysis.
CO5: Apply root-locus, Frequency Plots technique to analyze control systems.
CO6: Express and solve system equations for stability using different plots.
CO7: Differentiate between various digital controllers and understand the role of the controllers.

Unit-1: Basics of Control system

Elements of control system, concept of closed loop control and open-loop control, continuous and discrete state control, control strategies such as feedback and feed forward, mathematical models of systems, transfer function and its use, obtaining transfer function, block diagram reduction rules and signal flow graph, Mason's gain formula.

Unit-2: Stability and frequency response

Concept of stability, Routh stability criterion, Routh- Hurwitz criterion, Construction of Root locus, Bode plots- phase margin and gain margin, Lead, lag, lead-lag compensation using bode plot, Polar plot, Nyquist plots, process loop tuning, Open loop transient response method, Zeigler- Nichols method.

Unit-3: Analog and Digital Controllers

Classification of controllers, Controller terms Discontinuous controllers: On-OFF Controller, three position controller.

Continuous controllers: Proportional, Integral and Derivative control

Composite control modes: PI, PD and PID controllers. Derivative overrun and integral windup in PID control mode, concept of DCS, SCADA supervisory, Fuzzy logic, applications.

Unit-4: Control system components and system examples

Principle and characteristics of control values, synchro-servo motors, Solenoids, actuators, annunciators, alarms, recorders, Standard Graphics Symbols for Process Control and Instrumentation.

Control system examples: Speed control system, position control systems,temperature and level control systems, reel drives, tension control system for paper.

Text / Reference Books:

1. Process control: Principles and applications, Surekha Bhanot, Oxford University Press 2nd Edition.
2. Control Engineering Noel. M. Morris, 3rd Edition Mac Graw Hill.
3. Process control instrumentation technology, C. D Johanson, PHI.
4. Control system engineering, Nagrath and Gopal, New age international limited.
5. Control Systems, U.A. Bakshi and V. U. Bakshi, Technical Publications Pune.
6. Modern Control engineering, Ogata, Prentice Hall, EEE.
7. Control engineering theory and practice, N.M. Bandhopadhyay, PHI

Course Outcome	Program Outcome								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	-	3	3	3	1	1	2
CO2	3	3	-	2	3	2	1	1	2
CO3	3	3	-	3	3	3	-	1	3
CO4	3	3	-	3	3	3	-	1	3
CO5	3	3	1	3	3	2	-	1	3
CO6	3	3	1	2	2	2	1	1	2
CO7	3	3	1	3	3	2	-	-	2

Justification for the mapping

PO1 Disciplinary Knowledge

CO1: Understanding and determining models of physical systems are foundational skills in control systems engineering, contributing to the overall disciplinary knowledge.

CO2: Determining stability, expressing system equations, and utilizing different plots require a deep grasp of control systems principles, aligning with the disciplinary knowledge of control systems engineering.

CO3: Time and frequency domain analysis, crucial for stability assessment, directly connects to the disciplinary knowledge of control systems engineering.

CO5: Applying root-locus and frequency plots techniques for analysis is a practical application of disciplinary knowledge in control systems engineering.
CO7: The ability to differentiate between digital controllers and comprehend their roles is an application of disciplinary knowledge in the field of control systems engineering.

PO2 Critical Thinking and Problem solving

CO1: Critical thinking is essential in determining and using models of physical systems for control systems, ensuring effective analysis and design.
CO2: The ability to determine stability, express system equations, and use different plots for solving stability problems requires critical thinking in control systems engineering.
CO3: Performing time and frequency domain analysis for stability assessment demands critical thinking skills to interpret and analyze complex control system behaviors.
CO5: Applying root-locus and frequency plots techniques for analysis necessitates critical thinking to understand and interpret the implications of the obtained results.
CO7: Differentiating between various digital controllers and understanding their roles involves critical thinking to make informed decisions in control systems engineering problem-solving.

PO3 Social competence:

CO5: Applying root-locus and frequency plots techniques for analysis requires communication skills to convey the results and collaborate with others in control systems engineering.
CO6: Expressing and solving system equations for stability using different plots requires communication skills to convey findings and collaborate with others in control systems engineering
CO7: Differentiating between various digital controllers and understanding their roles involves effective communication to convey information about controller choices and collaborate on control system design.

PO4 Research-related skills and Scientific Temper

CO1: The ability to determine and use models of physical systems requires research skills to explore and understand various modeling approaches in control systems engineering.
CO2: Expressing and solving system equations for stability using different plots involves scientific temper in critically analyzing and applying stability concepts in control systems research.
CO3: Performing time and frequency domain analysis for stability assessment demands research-related skills to investigate control system behaviors and draw meaningful conclusions.
CO5: Applying root-locus and frequency plots techniques for analysis involves research skills to explore and apply advanced methods in control systems research.
CO7: Differentiating between various digital controllers and understanding their roles necessitates a scientific temper to stay updated on controller technologies and their applications in control systems engineering.

PO5 Trans-disciplinary knowledge:

CO1: Integrating models of physical systems involves trans-disciplinary knowledge, incorporating insights from various scientific and engineering disciplines to enhance the analysis and design of control systems.

CO2: Determining stability and expressing system equations requires an integration of knowledge from different domains to comprehensively address the complexities of closed-loop control systems.
CO3: Performing time and frequency domain analysis for stability analysis demands a trans-disciplinary approach to leverage insights from different fields in control systems engineering.
CO5: Applying root-locus and frequency plots techniques for analysis necessitates the integration of knowledge from diverse sources to obtain a comprehensive understanding of control system behavior.
CO7: Distinguishing between various digital controllers and understanding their roles involves trans-disciplinary knowledge, incorporating insights from electronics, computer science, and control systems engineering to make informed decisions.

PO6 Personal and professional competence

CO1: Developing models of physical systems and using them effectively requires personal and professional competence in understanding and applying theoretical concepts to practical control system design.
CO2: Determining stability and solving system equations demand personal and professional competence in applying mathematical and analytical skills to assess and improve closed-loop control systems.
CO3: Performing time and frequency domain analysis for stability assessment requires personal and professional competence in utilizing analysis techniques and tools for effective control systems engineering practice.
CO5: Applying root-locus and frequency plots techniques for analysis necessitates personal and professional competence in utilizing advanced control system analysis methods for practical applications.
CO7: Differentiating between various digital controllers and understanding their roles involves personal and professional competence in making informed decisions and applying appropriate controllers in control systems engineering.

PO7 Effective Citizenship and Ethics:

CO1: Determining and using models of physical systems involves ethical considerations in ensuring accurate representations and responsible use of models for control systems analysis and design.
CO2,CO6: Assessing the stability of closed-loop control systems requires ethical decision-making in expressing and solving system equations to ensure the safety and reliability of engineered systems.

PO8 Environment and Sustainability:

CO1: Determining and using models of physical systems involves considering environmental factors and sustainability concerns to ensure that control systems are designed with minimal impact on the environment.
CO2: Assessing the stability of closed-loop control systems requires an understanding of the environmental implications, as stable systems contribute to energy efficiency and sustainability in control systems engineering.
CO3: Performing time and frequency domain analysis for stability analysis demands awareness of environmental impact, ensuring that control system designs align with sustainability principles.

CO5: Applying root-locus and frequency plots techniques for analysis involves considering the environmental impact of control system designs and optimizing for sustainability.

PO9 Self-directed and Life-long learning:

CO1: Being able to determine and use models of physical systems requires a commitment to continuous learning and staying updated with advancements in control systems modeling techniques.
CO2: Continuous learning is essential for staying abreast of evolving stability analysis methods and applying them to express and solve system equations using different plots in control systems engineering.
CO3: Self-directed and life-long learning is necessary for staying informed about the latest time and frequency domain analysis techniques for stability analysis in control systems.
CO5: Staying current with advancements in root-locus and frequency plots techniques through self-directed learning is crucial for effective analysis and design of control systems.
CO7: Distinguishing between various digital controllers and understanding their roles requires a commitment to life-long learning to keep pace with evolving controller technologies in control systems engineering.

ELE4402: Advanced Power Electronics (Credit :4) Semester-IV

Objectives:

1. To study the basic principles and applications of power electronics
2. To understand the solid-state devices required for power electronic circuits
3. To study and understand the power conversion and power transmission principles
4. To study the industrial and domestic applications
5. To study the industrial and domestic applications
6. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
7. To provide strong foundation for further study of power electronic circuits and systems.

Course Outcome

Upon successful completion of this course the students will be able to,

1. Compare the characteristics of switching devices and use them in practical systems.
2. Student will be able to discuss various turn on and OFF method.
3. Design different types of power converters.
4. Student knows the operation of various phase power supply.
5. Design power circuit and protection circuit of devices and converter
6. Identify suitable power electronic converter to enable integration of various renewable resources.
7. Design and analyses power electronic circuit for a given application.

Unit-1: Introduction to Power Devices and Circuits

Overview of Power circuits, concept of load, Application areas, and Basic concepts of electrical and magnetic circuits. Construction, I-V characteristics, switching characteristics, types, Selection criteria and applications of Power diodes, Power BJT, MOSFET, IGBTs

Thyristors: SCR Characteristics, two-transistor model, turn-on and turn-off methods of SCR

Unit-2: Power Circuits

Rectifiers: Single phase rectifiers performance parameters overview (half-wave and full wave) Controlled rectifiers: Single phase and three phase R and RL load – half-wave, semi-full wave and dual converters, Single phase series converters, Powerfactor improvement techniques
AC voltage controllers: ON-OFF control, Concept of phase control, single phase Uni-directional and bidirectional controllers with resistive & inductive loads.
Cycloconverter: Introduction to cycloconverter, types of cycloconverter, Single Phase Cycloconverter, Mid point cycloconverter, Bridge type cycloconverter, step up cycloconverter. Reduction of output harmonics.

DC-DC converters: step-up and step-down converters, performance parameters, control strategies.

Unit-3: Applications of Power Electronics

DC power supplies: switch mode DC power supplies, flyback, forward, push pull, half bridge, full bridge-converters, resonant DC power supplies, resonant power supplies, bi- directional power supplies AC Power supplies (UPS): switch mode AC Power supplies, resonant and bidirectional AC Power supplies DC drives: Basic characteristics of DC motors, Operating modes, single phase and 3 phase drives, DC –DC converter Drives, Closed loop control of DC drives AC drives: Induction motors drives-squirrel cage and wound rotor motor, Performance characteristics, control methods Synchronous motor drives-cylindrical rotor, Reluctance, Permanent magnet, switched reluctance- motors, control methods, Brushless DC and AC Motors and Stepper Motor: types and Control

Unit-4: Practical Design Considerations

Snubber circuits, Turn-on and turn-off and over voltage snubbers, isolation methods, Control Circuits: Current mode and voltage mode PWM Cooling and heat sinks, reverse recovery transients, supply and load side transients, Selenium diodes and MOVs for voltage protections, Current protection methods, EMI standards, sources and shielding methods, Induction and capacitive heating, modern electric welding

Text /Reference books:

1. Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid, 3rd Edition, Pearson.
2. Industrial and Power Electronics – Deodatta Shingare Electrotech publication,
3. Power Electronics: Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd Edition, Wiley.
4. Power Electronics, P. C. Sen, Tata McGraw-Hill Education.
5. Power Electronics: A First Course, Ned Mohan, 2012.
6. Power Electronics Handbook, edited by Muhammad Rashid, Elsevier
7. Fundamentals of Power Electronics, Robert W. Erickson, Dragan Maksimovic, Springer
8. Power Electronics, Daniel Hart, Tata McGraw-Hill Education, 2011

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Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	-	-	3	-	-	-	-	-
CO2	2	1		2	3	3	-	-	-
CO3	1	2	2	3	2	2	-	-	2
CO4	1	2	3	2	3	2	-	-	2
CO5		2	-	3	-	-	-	-	-
CO6	1	2	-	2	-	-	-	2	3
CO7	1	1	2	2	2	2	-	3	1

Justification for the mapping

PO1: Disciplinary Knowledge

The course outcomes (COs) contribute to the development of students' disciplinary knowledge in power electronics. For example, CO1, CO2, CO3, CO4 CO6 and CO7 require students for understanding of the principles and functioning of power electronic devices and their applications, operation of various phase power supplies and fundamental disciplinary knowledge in the field of electrical engineering.

PO2: Critical Thinking and Problem Solving

All of the COs contributes to the development of students' critical thinking and problem-solving skills. For example, CO2 to CO4 require students to think critically about various turn-on and turn-off methods, designing power converters and problem-solving skills to meet specific requirements. CO5 to CO7 required to designing power and protection circuits involves critical thinking and problem-solving to ensure the reliability and safety of devices and converters.

PO3: Social competence

CO3, CO4 and CO7: It is required for analyses power electronic circuit for a given application.

.**PO4: Research-related skills and Scientific temper**

The entire COs contributes to the development of students' research-related skills and scientific temper. All COs require students for designing involves applying scientific principles and possibly engaging in research to improve or innovate power converter designs and understand the scientific principles behind the chosen design.

PO5: Trans-disciplinary knowledge

All the COs contribute to the development of students' trans-disciplinary knowledge. CO2, CO3, CO4 and CO7 require to identifying suitable converters for renewable resources.

Require knowledge that spans different disciplines, such as understanding the characteristics of renewable sources and integrating them into the power system.

PO6: Personal and professional competence

CO3, CO4 and CO7 all contribute to the development of students' personal and professional competence. For example, learning advanced power electronics technology enhances personal and professional competence in keeping up with technological advancements in the field.

PO8: Environment and Sustainability

CO6, CO7: Trans-disciplinary knowledge is often essential when dealing with environmental and sustainability aspects, such as integrating renewable resources.

PO9: Self-directed and Life-long learning

CO3, CO4, CO6 and CO7 all contribute to the development of students' ability to engage in self-directed and life-long learning. For example, the entire COs is essential for staying updated in the rapidly evolving field power electronics.

ELE4403: Mechatronics and Robotics. (4 Credits) Semester-IV

Course Objectives:

1. To introduce the students of Electronic Science to the subject of mechatronics
2. To review the concepts of sensors, transducers and actuators, with a view to use them in Mechatronic systems
3. Enable the learner to acquire basic knowledge of mechanical systems to be used with Electronic systems
4. To introduce robot dynamics and robot joint control systems.
5. To study various mechanical system.
6. To understand role of computer in robotics.
7. To provide a quick overview of the Artificial intelligence and role of computer in Mechatronics and Robotics.

Course Outcomes:

CO1:- Understand the concept of mechatronics.
CO2:- Various application of mechatronics.
CO3: Sensor working.
CO4: Concept of robotics.
CO5:-Working of mechanical system
CO6:Role of computer in robotics.
CO7:Concept of artificial intelligence.

Unit-1:

Introduction to Mechatronics, Sensors and Transducers Introduction to Mechatronics: Introduction to Mechatronics, design Process, System, modeling of the system measurement systems, control systems, Open and closed loop systems, examples on mechatronics systems, Real Time Mechatronics systems, advantages and disadvantages of mechatronics systems, Applications of mechatronics systems . Sensors and Transducers: Introduction to sensors and transducers, sensitivity analysis, measurement of motion, digital sensors for motion measurement of force, torque and tactile sensors, vibration- acceleration sensors, flow measurement, temperature sensors and devices, applications of sensors

Unit-2:

Mechanical and Electrical Actuation Systems Mechanical actuation systems: mechanisms and their role in mechatronic systems, Translational and rotational motion – degrees of freedom, kinematic chains – examples of links, toggle linkage, slider-crank etc. cams, gears – types, gear trains, gear ratios, uses of rotation-to-translational motion – rack and pinion, ball screw and links, Ratchet and pawl, belt and chain drives, bearings– types and uses, consideration of moment of inertia and torque for motor selection Electrical actuation systems: Relays and applications with driver circuits, Solid state switches- diodes, thyristors, BJTs and MOSFETs and their applications as switches and driver circuits DC Motor-: types, basic construction and working, DC motor driver circuits, and speed control AC motors- basic idea of single phase and three phase motors and their speed control Stepper motors- types, construction, features, specifications, control of drives.

Unit-3:

Robotics and system of a Robot. Classification of robots, applications, Basic components of robot system, functions of robots, robot specifications. Mechanical systems: review of elementary mechanical concepts, motion conversion, modeling of mechanical systems, end effectors, resolution, repeatability, accuracy of manipulators.

Unit-4:

Mechatronic system and case studies. Artificial intelligence-basic ideas, meaning, perception and cognition, reasoning and learning Role of Computers in Robotics -Imaging, image representation, picture coding, object recognition and categorization, control-using computer Mechatronic systems - Mechatronic designs and case studies

Text / Recommended Books:

1. Mechatronics by W.Bolton, 4th Edition, Pearson.
2. Mechatronics System Design, by DevdasShetty and Richard Kolk, 2nd Edition, Cengage Learning.
3. Robotics Engineering – An integrated approach. By Richard W. Klafter, Thomas A. Chmielewski and Michael Negin, PHI Learning Pvt. Ltd.

Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	3	1	2	1	2	2	1
CO2	3	3	2	1	3	-	3	-	-
CO3	-	3	-	2	-	3	-	2	-
CO4	-	-	-	2	3	-	1	3	1
CO5	1	2	2	3	-	2	-	-	-
CO6	-	-	-	1	2	-	1	-	-
CO7	2	1	-	-	-	-	-	-	-

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1:This outcome ensures that students acquire fundamental knowledge in mechatronics, a key discipline combining mechanical, electrical, and computer engineering.

CO2:Application based knowledge.

CO5: Mechanical Application based knowledge.

CO7:Ai based application.

PO2:Critical Thinking and Problem solving

CO1: Understand the concept of mechatronics

CO2: Various application of mechatronics.

CO3: Sensor working.

CO5: Working of mechanical systems.

CO7:Concept of artificial intelligence.

Justification: These outcomes provide students with the ability to analyze problems in the mechatronics domain, considering applications, sensor functionalities, robotic concepts, and mechanical systems

PO3 Social competence

CO1: Understand the concept of mechatronics

CO2: Various application of mechatronics.

CO5: Working of mechanical systems.

Justification: Understanding sensor functionalities, robotics concepts, mechanical systems, and the role of computers contributes to the skills needed for designing and developing mechatronic systems.

PO4: Research-related Skills and Scientific Temper:

CO1: Understand the concept of mechatronics

CO2: Various application of mechatronics.

CO3: Sensor working.

CO4: Concept of robotics.

CO5: Working of mechanical systems.

CO6: Role of computer in robotics.

Justification: These outcomes contribute to developing research-related skills by introducing students to advanced concepts in robotics and artificial intelligence, fostering a scientific temper.

P05: Trans-disciplinary knowledge

CO1: Understand the concept of mechatronics

CO2: Various application of mechatronics.

CO4: Concept of robotics.

CO6: Role of computer in robotics.

Justification: Understanding the role of computers in robotics implies familiarity with modern tools used in the field, contributing to this outcome.

P06: Personal and professional competence

CO1: Understand the concept of mechatronics

CO3: Sensor working.

CO5: Working of mechanical systems

Justification: As students learn about the role of computers and artificial intelligence, ethical considerations and social responsibility are inherently integrated into discussions about the use and impact of technology.

P07: Effective Citizenship and Ethics

CO1: Understand the concept of mechatronics

CO2: Various application of mechatronics.

CO4: Concept of robotics.

CO6: Role of computer in robotics.

Justification: The complexity of mechatronics, artificial intelligence concepts requires effective communication skills to convey ideas, challenges, and potential societal impacts.

PO8: Environment and Sustainability:

CO1: Understand the concept of mechatronics

CO3: Sensor working.

CO4: Concept of robotics.

Justification: The outcome directly emphasizes the importance of both individual and collaborative work, which is crucial in mechatronics projects that often involve interdisciplinary teams.

PO9: Self-directed and Life-long learning:

CO1: Understand the concept of mechatronics

CO4: Concept of robotics.

Justification: The rapid advancements in mechatronics, robotics, and related fields make continuous learning essential. This outcome encourages students to embrace a mindset of continuous learning.

ELE4404: Wireless Sensor Networks (4 Credits) Semester-IV

Course Objectives:

1. To understand the basics of Ad-hoc & Sensor Networks.
2. To familiarize with wireless sensor network.
3. To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
4. To understand the nature and applications of Ad-hoc and sensor networks.
5. To provide a background of single-node architecture and wireless networking protocols.
6. To study currently available sensor platforms and tools.
7. To study provisional for network security.

Course Outcomes:

1. Understand and explain common wireless sensor node architectures.
2. Be able to carry out simple analysis and planning of WSNs.
3. 3. Demonstrate knowledge of MAC protocols developed for WSN.
4. Demonstrate knowledge of routing protocols developed for WSN.
5. Understand and explain mobile data-centric networking principles.
6. Be familiar with WSN standards.
7. Get knowledge about wireless protocols like ZigBee, hardware and software platforms.

Unit-1: Introduction and Overview of Wireless Sensor Networks Introduction, background of sensor network technology, challenges and hurdles, Examples of WSN applications: home control, industrial automation, medical applications. Radio technology primer: propagation and propagation impairments, modulation, ISM band, Specifications of WSN devices

Unit-2: Architecture Considerations and Networking Sensors

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts Physical Layer and Transceiver Design considerations, Introduction to protocols, Overview of Communication Protocols for Sensor Networks, wireless networking protocols (IEEE 802.11, 802.15, 802.16, GPRS, MAC protocol.

Unit-3: Infrastructure formation, Available Sensor Platforms and Tools

Introduction to the RF Modules, architecture of the Zigbee module, on-chip resources of the Zigbee Pro, programming the Zigbee, designing of WSN with Zigbee modules Topology

Control, Clustering, Time Synchronization, Localization. Hardware platforms – Berkeley Motes or equivalent, Programming Challenges, Introduction to Simulators: NS2, OPNET, OMNET, WSN Planner Tool etc.

Unit-4: Sensor Network Security

Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks.

Text /Reference Books:

Text / Recommended Books:

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, “Wireless Sensor Networks Technology

2. Protocols and Applications”, John Wiley & Sons, 2007.

3. Ananthram Swami, Qing Zhao, Yao-Win Hong, Lang Tong, “Wireless Sensor Networks-Signal Processing and Communications Perspectives” John Wiley & Sons,2009

4. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, ELSEVIER publications, 2005.

5. Kaveh Pahlavan and Prashant Krishnamurthy, “Principle of Wireless network- A unified approach”, Prentice Hall, 2006.

6. “Theoretical and algorithmic aspects of sensor, Ad Hoc Wireless and Peer to Peer Networks”, Edited by Jie Wu, Auerbach Publications.

7. Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems, CRC 8. PRESS Publication, Edited by Mohammad Ilyas and Imad Maugoub

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	-	-	-	-	-	-	-	1
CO2	2	1	-	1	1	-	-	-	-
CO3	2	2	-	1	1	1	-	-	1
CO4	3	3	-	-	-	-	-	-	3
CO5	3	1	-	1	1	-	-	-	-
CO6	3	-	-	-	1	-	-	-	1
CO7	3	2	-	-	-	-	-	1	1

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Students will be able to understand comprehensive knowledge about wireless sensor nodes, wireless sensor networks, sensor functioning and installation of a wireless sensor network theoretically and practically with its architectures.

CO2: Students will be able to demonstrate cognizant knowledge of carrying out simple analysis of any WSN as well as planning of wireless sensor network with its any of architectures.

CO3: Students will be able to demonstrate and develop extensive education about medium access protocols of wireless sensor network.

CO4: Students will be able to develop and manifest the education about the process of selection of good enough way to reach from input to output or from source to destination depending upon the network type and other parameters.

CO5: Students will be able to understand about the data that it is a primary and permanent resource but the applications may change as per the need.

CO6: Students will be able to get knowledge about the wireless sensor network standards and which standard or protocol can be more suitable like OSI model protocol or IEEE standards, to the particular established network.

CO7: Students will be capable of all inclusive knowledge of the protocols such as ZigBee protocols with their hardware modules like XBee series modules based on IEEE 802.15.4 protocols and the software platforms like NS2, OPNET, OMNET, WSN Planner Tool etc.

PO2: Critical Thinking and Problem Solving

CO2: Students will be able to exhibit Wireless Sensor Network analysis with taken observation after installation of the network for a particular network which refers to critical thinking and problem solving also.

CO3: Students will be able to design a Medium Access Protocol and their knowledge towards developing a wireless sensor network will be demonstrated.

CO4: Students will be capable of design some protocols that are used to determine the best path tp transmit and receive information within the wireless sensor network.

CO5: Students will be able to get educational knowledge about the information that it is a basic and permanent service and the peripheral applications can be varied in accordance with the requirements.

CO7: Students will develop their knowledge by thinking on designing the wireless sensor systems with the help of various protocols like ZigBee and some simulators.

PO4: Research-related skills and Scientific temper

CO2: Students will be able to research on analysis of applications run on wireless sensor network and can be also able to develop some laboratory experiments which can be independent and bring towards the research.

CO3: Students will be able to have the designing of the wireless sensor network systems as per the medium access protocols and further they can lead to the literature survey or any new application using the MAC protocol.

CO5: Students will get knowledge about the data centric methods and its need in today's era as they will go through the difference between network centric and data centric networking protocols.

PO5: Trans-disciplinary knowledge

CO2: Students will be capable of creating a new conceptual application to carry out simple analysis having theoretical and methodological understanding of wireless sensor network architecture.

CO3: Students will be able to create new ideas regarding wireless sensor network methodologies using medium access protocols which can be towards and beyond the specific study of wireless sensor networks.

CO5: Students will be able to know, understand as well as explain the principles of mobile data centric methods.

CO6: Students will be capable of learn, design, run, apply the different wireless sensor network standards like OSI model, IEEE standard etc.

PO6: Personal and Professional Competence

CO3: Students will be able to learn that with the help of medium access control address, every sensor node can select the address by themselves and so more and more data packets can be sent over large network.

PO8: Environment and Sustainability

CO7: Students will get knowledge about the analysis of experimental data with different environmental conditions and may inspire to demonstrate new methods that can be performed for better estimation of a wireless sensor network.

PO9: Self-directed and Life-long learning

CO1: Students will acquire the ability to know and also describe general wireless sensor nodes along with their designed architecture which in turn engage them individually in any socio-technological changes.

CO3: Students will gain the capability to demonstrate their knowledge about the medium access protocols along with their designed wireless sensor network.

CO4: Students will be able to know that wireless sensor network is nothing but the group of densely deployed autonomous sensor nodes carrying a particular task.

CO6: Students will be known that the socio-technical system is that system which considers the necessary hardware, software, personal and community aspects which further can be applied to wireless sensor network.

CO7: Student will involve the knowledge of wireless sensor protocols as like XBEE modules and related software to run the application which engages them individually.