Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Autonomous)

Two Year Degree Program in Electronics
(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. (Electronics) Part-II Semester -IV

For Department of Electronics

Tuljaram Chaturchand College, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2024-2025

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science andCommerce, Baramati

(Autonomous)

Academic Year 2024-2025

NEP Pattern

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

Semester	Course Type	Course Code	Course Title	Theory/ Practical	No. of Credits
III	Major (Mandatory)	ELE-601-MJM	Advanced Communication System	Theory	04
	Major (Mandatory)	ELE-602-MJM	Emerging Trends in Embedded Systems	Theory	04
	Major (Mandatory)	ELE-603-MJM	Practical Course –V	Practical	02
	Major (Mandatory)	ELE-604-MJM	Practical Course –VI	Practical	02
	Major (Elective)	ELE-611-MJE(A)	Fundamentals of Programmable Logic Controller (PLC) and Programming	Theory	02
		ELE-611-MJE(B)	IoT and Raspberry Pi Programming		
	Major (Elective)	ELE-612-MJE(A)	Programmable Logic Controller (PLC) -Lab	Practical	02
		ELE-612-MJE(B)	IoT and Raspberry pi-Lab		
	Research Project(RP)	ELE-621-RP	Project	Practical	04
	Total Credits Semester III				**20**
IV	Major (Mandatory)	ELE-651-MJM	Control Systems	Theory	04
	Major (Mandatory)	ELE-652-MJM	Fundamentals of Artificial Intelligence and ML	Theory	04
	Major (Mandatory)	ELE-653-MJM	Practical Course -VII	Practical	02
	Major (Elective)	ELE-661-MJE(A)	Wireless Sensor Network	Theory	02
		ELE-661-MJE(B)	Advanced Power Electronics		
	Major (Elective)	ELE-662-MJE(A)	Wireless Sensor Network -Lab	Practical	02
		ELE-662-MJE(B)	Power Electronics - Lab		
	Research Project(RP)	ELE-681-RP	Project+ Research Paper Publication	Practical	06

	Total Credits Semester IV	**20**

ELE-651-MJM: Control Systems (4 Credits)

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.
9. To understand the knowledge of fuzzy set, fuzzy logic and fuzzy system.

Course Outcomes: 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 and frequency domain analysis of control systems required for stability analysis.
CO4: Apply root-locus, Frequency Plots technique to analyze control systems.
CO5: Differentiate between various digital controllers and understand the role of the controllers.
CO6: Understand the basic ideas of fuzzy sets, operations and properties of fuzzy sets.
CO7: Understand the basic features of membership functions and operations on fuzzy set.

Unit-1: Basics of Control system (15 L)

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 (18 L)

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, Nyquist plots.

Unit-3: Analog and Digital Controllers (15 L)

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.

Unit-4: Fundamentals of Fuzzy Logic (12 L)

Fuzzy Logic, Crisp (classical) set, fuzzy sets/models, properties of fuzzy sets, operations on fuzzy sets, fuzzy rules, comparison crisp sets and fuzzy sets, fuzzy logic system, architecture of Fuzzy Logic Control/ Controller (FLC), designing steps of FLC, applications of fuzzy logic.

Reference Books:

1. Process control instrumentation technology, C. D Johanson, PHI.
2. Control system engineering, Nagrath and Gopal, New age international limited.

3. Control Systems, U.A. Bakshi and V. U. Bakshi, Technical Publications Pune.
4. Modern Control engineering, Ogata, Prentice Hall, EEE.
5. Introduction to Fuzzy sets Fuzzy logic and Fuzzy control systems, Guanrong Chen.
6. Timothy J. Ross, Fuzzy logic with Engineering applications, 2nd edn, McGraw Hill.
7. Zimmerman H.J, Fuzzy set theory and its applications, 4th ed, Springer, 2001.
8. Ganesh M, Introduction to fuzzy sets and Fuzzy logic, PHI,

Course Outcome	Program Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	2	1	-	-	2
CO2	3	2	1	3	3	2	1	-	-	2
CO3	3	3	2	3	3	2	1	-	-	3
CO4	3	3	2	3	2	2	1	-	-	3
CO5	2	3	2	2	2	2	2	-	-	2
CO6	2	2	1	2	2	3	1	-	-	2
CO7	2	2	1	2	2	3	1	-	-	2

CO-PO Mapping Justifications:

PO1: Comprehensive Knowledge and Understanding

CO1: Essential for developing a thorough understanding of physical system modeling for control systems. Modeling a mechanical system for control involves applying comprehensive theoretical knowledge.

CO2: Fundamental to understanding control system stability and design. Assessing stability is crucial for designing reliable control systems.

CO3: Essential for a deep understanding of control system analysis techniques. Mastery of time and frequency domain analysis is crucial for comprehensive control system design.

CO4: Fundamental techniques for understanding control system behavior. Mastery of root-locus and frequency plots is essential for control system analysis.

CO5: Provides essential knowledge of different digital controllers and their roles. Understanding various digital controllers contributes to comprehensive control system design.

CO6: Provides foundational knowledge of fuzzy sets and their properties. Understanding fuzzy sets is important for a comprehensive grasp of advanced control systems.

CO7: Essential for understanding fuzzy logic and its applications. Knowledge of membership functions is crucial for designing fuzzy logic controllers.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Directly applicable to practical tasks in control system design and analysis. Using system models to design controllers in real-world applications demonstrates procedural expertise.

CO2: Practical knowledge for evaluating system stability in professional settings. Applying stability criteria to real-world control systems is a key professional skill.

CO3: Directly applicable in professional control system analysis and design. Performing these analyses is a key procedural skill in control systems engineering.

CO4: Directly applicable to control system design and analysis tasks. Applying these techniques in practical settings demonstrates professional procedural knowledge.

CO5: Practical knowledge for selecting and implementing digital controllers in control systems. Selecting appropriate digital controllers is crucial for professional control system design.

CO6: Useful for applying fuzzy logic in practical control systems. Applying fuzzy set theory to design control systems requires procedural knowledge.

CO7: Important for applying fuzzy logic in practical control systems. Implementing fuzzy logic systems involves using membership functions effectively.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding

CO1: Understanding system modeling can contribute to innovative solutions in control systems. Developing new control strategies for industry applications shows an innovative approach.

CO2, CO6, CO7: Minimal direct connection to entrepreneurship or business understanding. Stability analysis is more technical and less focused on business innovation.

CO3: Contributes to innovative control system designs with practical business applications. Advanced analysis techniques can lead to innovative solutions in commercial systems

CO4: Can contribute to innovative solutions and business applications in control systems. Using root-locus and frequency plots can lead to novel solutions for industry challenges.

CO5: Knowledge of digital controllers can lead to innovative solutions and business opportunities. Developing new control strategies with digital controllers can drive business innovation.

CO6, CO7: Limited direct connection to entrepreneurship or business understanding. Fuzzy sets and Membership functions are more theoretical and less related to business innovation.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving

CO1: Involves critical thinking and problem-solving to accurately model and analyze systems. Determining the appropriate model for a complex system requires specialized analytical skills.

CO2: Involves specialized skills and critical thinking for stability analysis. Determining stability requires deep analytical skills and problem-solving abilities.

CO3: Requires specialized skills and critical thinking for accurate analysis. Applying both time and frequency domain analysis involves complex problem-solving.

CO4: Involves specialized skills for analyzing control systems effectively. Applying these techniques requires critical thinking and problem-solving abilities.

CO5: Involves critical thinking to differentiate and select the appropriate controllers. Choosing the right controller requires specialized skills and problem-solving abilities.

CO6: Involves specialized knowledge and problem-solving in fuzzy logic. Understanding and applying fuzzy sets requires specialized analytical skills.

CO7: Involves specialized skills for applying fuzzy logic and membership functions. Designing fuzzy systems requires critical thinking and problem-solving abilities.

PO5: Research, Analytical Reasoning, and Ethical Conduct

CO1: Supports research by providing a basis for analysis and experimentation with system models. Developing new models for research projects requires strong analytical reasoning.

CO2: Critical for research and ensuring ethical design practices in control systems. Research on control system stability involves rigorous analytical reasoning.

CO3: Supports research and development with robust analytical techniques. Advanced analysis techniques are used in research to develop new control system solutions.

CO4: Supports research with advanced analytical techniques for system design. Research in control systems often uses these techniques for detailed analysis.

CO5: Supports research by providing a basis for evaluating and comparing digital controllers. Researching controller performance involves analytical reasoning.
CO6: Supports research in fuzzy logic and its applications. Research into fuzzy set theory involves analytical reasoning.
CO7: Supports research in fuzzy logic and its implementation. Research on membership functions involves detailed analytical reasoning.

PO6: Communication, Collaboration, and Leadership

CO1: Limited direct impact on communication and leadership skills. Modeling is more technical and does not directly involve collaborative or leadership activities.
CO2: Limited impact on communication or leadership skills. Stability analysis is technical and does not typically involve collaborative or leadership aspects.
CO3: Limited direct connection to communication and leadership skills. Analysis techniques are technical and do not involve direct collaborative efforts.
CO4: Minimal impact on communication and leadership skills. Technical focus on analysis techniques with limited direct collaboration.
CO5: Knowledge helps in communicating and collaborating on control system designs. Effective communication about controller options is important for collaborative projects.
CO6: Minimal impact on communication or leadership skills. Fuzzy set theory is technical and does not directly involve collaborative efforts.
CO7: Minimal impact on communication and leadership skills. Focuses on technical aspects with limited collaborative or leadership aspects.

PO7: Digital Proficiency and Technological Skills

CO1 to CO4, CO6, CO7: Involves using software tools for modeling, reflecting technological proficiency. Utilizing simulation software to create and analyze system models demonstrates digital skills.
CO5: Directly related to digital technologies and controllers. Understanding digital controllers involves proficiency with technology and digital tools.

PO10: Autonomy, Responsibility, and Accountability

CO1: Requires autonomy in creating and using models for system design and analysis. Independent development and use of models reflect responsibility in engineering tasks.
CO2: Requires responsibility in evaluating and ensuring system stability. Ensuring system stability reflects accountability in control system design.
CO3: Requires autonomy and responsibility in performing accurate analyses. Students must take responsibility for accurate analysis to ensure system stability.
CO4: Requires autonomy in applying techniques and accountability for accurate analysis. Students must independently apply these techniques to ensure control system performance.
CO5: Requires responsibility in selecting and implementing digital controllers. Students must be accountable for the performance and selection of digital controllers.
CO6: Requires responsibility in applying fuzzy logic techniques. Students must take responsibility for accurate implementation of fuzzy set operations.
CO7: Requires responsibility for accurate implementation of membership functions. Students must ensure correct application of fuzzy logic principles.

ELE-652-MJM: Fundamentals of Artificial Intelligence and ML **(4 Credits)**

Objectives:

1. To Understand the Foundations of AI
2. To Differentiate AI and Machine Learning
3. To Develop Problem-Solving Skills
4. To Explore Knowledge Representation and Reasoning
5. To Introduce Core Concepts of Machine Learning
6. To Implement Supervised and Unsupervised Learning Algorithms
7. To Evaluate Machine Learning Models

Course Outcome:

CO1. Student will be able to understand the foundational concepts, definitions, history, and evolution of Artificial Intelligence, and distinguish between AI and Machine Learning.

CO2. Student will be able to identify and classify different types of AI agents and environments, and explain the concept of rationality and the structure of intelligent agents, including the Turing Test.

CO3. Student will be able to apply various search algorithms (uninformed, informed) and heuristic search techniques such as Generate-and-Test, Hill Climbing, and the A* algorithm for problem-solving in AI.

CO4.Student will be able to design and analyze knowledge-based agents, applying knowledge representation techniques, propositional and first-order logic, and reasoning methods (forward and backward chaining).

CO5. Student will be able to explain the different components and models of Machine Learning, including geometric, probabilistic, and logic models, and understand key learning concepts like PAC Learning and VC Dimension.

CO6. Student will be able to implement supervised learning algorithms, including decision trees, regression models, and neural networks, and evaluate their effectiveness in classification and prediction tasks.

CO7. Student will be able to apply unsupervised learning techniques, such as clustering (K-means, K-mode), and understand the differences between supervised, unsupervised, and reinforcement learning.

UNIT 1: Introduction to AI **16**

Basic Definitions and terminology, Foundation and History of AI, Overview of AI problems, Evolution of AI,- Applications of AI, Classification/Types of AI. Artificial Intelligence vs Machine learning. Intelligent Agent: Types of AI Agent, Concept of Rationality, nature of environment, structure of agents. Turing Test in AI.

Problem Solving:- Search Algorithms in Artificial Intelligence: Terminologies, Properties of search Algorithms, Types of search algorithms: uninformed search and informed search, State Space search Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best-first Search; Problem Reduction.

Unit 2:- Knowledge and Reasoning **15**

Knowledge-Based Agent in Artificial intelligence: Architecture, Approaches to designing a knowledge-based agent, knowledge representation: Techniques of knowledge representation, Propositional logic, Rules of Inference, First-Order Logic, Forward Chaining and backward chaining in AI, Reasoning in Artificial intelligence: Types of Reasoning and Probabilistic

reasoning, Uncertainty.

Unit 3: Introduction to Machine Learning **15**

Introduction to Machine Learning Introduction ,Components of Learning , Learning Models , Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, Designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension.

UNIT 4: Supervised and Unsupervised Learning **14**

Supervised and Unsupervised Learning Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K Nearest Neighbors. Introduction to clustering, K-means clustering, K-Mode Clustering.

REFERENCE BOOKS:

1. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI., 2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011.
2. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.
3. Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson.
4. Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT.
5. CharuC.Aggarwal,"DataClassificationAlgorithmsandApplications",CRCPress,2014.
6. Charu C. Aggarwal, "DATA CLUSTERING Algorithms and Applications", CRC Press, 2014.
7. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012

TEXT BOOKS:

1. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall
2. J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition , 2016
3. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3rd Edition2014.
4. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar " Foundations of Machine Learning", MIT Press,2012
5. Tom Mitchell, "Machine Learning", McGraw Hill, 3rdEdition, 1997. 6. MACHINE LEARNING - An Algorithmic Perspective, Second Edition, Stephen Marsland, 2015.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	2	1	1	2
CO2	3	2	1	2	2	1	2	1	1	2
CO3	2	3	2	3	3	2	3	1	1	2
CO4	2	3	2	3	3	2	3	1	1	3
CO5	3	3	1	2	3	2	3	1	1	2

CO6	2	3	2	3	3	2	3	1	1	3
CO7	2	3	2	3	3	2	3	1	2	3

Justification for Mapping:

- **CO1** (Foundations of AI): Strongly related to **PO1** (Comprehensive Knowledge) because it provides a broad understanding of AI. Moderately related to **PO2** (Practical, Professional, and Procedural Knowledge) as it builds knowledge applicable to practice, and to **PO7** (Digital Proficiency) due to its relevance to AI technology.
- **CO2** (AI Agents & Rationality): Strongly related to **PO1** (Comprehensive Knowledge) because it deepens understanding of AI agents. Moderately related to **PO2** and **PO4** (Specialized Skills, Critical Thinking) due to the focus on AI agent structure and decision-making.
- **CO3** (Search Algorithms): Strongly related to **PO2** and **PO4** as it involves applying problem-solving techniques. Strongly related to **PO5** (Research and Analytical Reasoning) due to the nature of algorithm development.
- **CO4** (Knowledge-Based Agents): Strongly related to **PO4** and **PO5** as it requires critical thinking and research in logic and reasoning methods. Also strongly related to **PO10** (Autonomy, Responsibility) as it involves designing AI systems responsibly.
- **CO5** (Machine Learning Models): Strongly related to **PO1**, **PO2**, and **PO5** because understanding various learning models is essential for knowledge, procedural skills, and research.
- **CO6** (Supervised Learning): Strongly related to **PO4** and **PO7** because it involves practical implementation of complex algorithms and digital tools, as well as research skills in analyzing models.
- **CO7** (Unsupervised Learning): Strongly related to **PO4**, **PO5**, and **PO7** because it involves advanced algorithm design, data analysis, and use of technological tools.

ELE-653-MJM : Practical Course –VII (2 Credits)

Objectives:

1. To understand the programming in MATLAB.
2. To make the students aware for design digital filter using MATLAB
3. Calculate the steady-state error for a given transfer function.
4. Design PID controllers for first and second-order systems to meet desired specifications.
5. Design a PID controller for controlling the speed of a DC motor.
6. Examine how a lead compensator affects the performance of a linear feedback control system.
7. Learn the basics of Python programming.
8. Learn about various Python libraries used for machine learning.
9. Study of AI and ML tools and Implement the various algorithms for informed search.

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

CO1: Ability to develop MATLAB code.
CO2: Ability to compute steady-state errors for different types of inputs (step, ramp, parabolic).
CO3: Skill in generating and interpreting Bode plots.
CO4: Understand the impact of system type and feedback on steady-state performance.
CO5: Understanding of motor dynamics and control strategies.
CO6: Skill in tuning PID parameters to achieve desired system performance.
CO7: Ability to write and debug Python code for various applications.
CO8: Understanding of the functionality and use cases of Python libraries in machine learning projects.
CO9 :Ability to write and understand various code for algorithms.
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Laboratory Practical: Any 10 Practical's from following sections

1. Plot root locus of given transfer function, locate closed loop poles for different values of k.
2. Determine the steady state errors of a given transfer function.
3. Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
4. Plot Nyquist plot for given transfer function and to discuss closed loop stability. Also determine the relative stability by measuring gain and phase margin.
5. Construct Root locus plot of a second-order system using MATLAB
6. Experiment with Bode plot of a second-order system using MATLAB
7. Construct Nyquist plot of a second-order system using MATLAB
8. Examine the effect of a forward-path lead compensator of a linear feedback control system
9. Analyze the effect of addition of poles to the forward path transfer function of a closed loop system.
10. Analyze the effect of addition of zeros to the forward path transfer function of a closed loop system
11. Stability Analysis using Routh- Hurwitz Method
12. Stability Analysis of Linear System using Root Locus
13. Frequency Response Analysis Using Bode Plot
14. Design of PID Controller for first order and second order systems
15. Design of PID Controller for speed control of DC Motor System.
16. Introduction of various python libraries used for machine learning.
17. Write a Program to implement Uninformed Search Technique: Breadth First Search
18. Write a Program to implement Uninformed Search Technique: Depth First Search.

19. Write a Program to implement Informed Search Technique: A* Algorithm.

20. Write a Program to implement Informed Search Technique: AO* Algorithm.
21. Write a Program to implement Local Search Technique: Hill Climbing Algorithm.
22. Write a Program to implement Game Playing Algorithms: Minimax and Alpha Beta Pruning
23. Implementing basic ML algorithms
24. Introduction to Python programming language
25. Data cleaning and preprocessing techniques

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	-	-	2	-	1	2
CO2	3	3	1	3	2	-	-	-	1	2
CO3	2	3	3	3	-	-	3	-	-	-
CO4	2	2	3	2	3	-	-	2	1	-
CO5	3	3	1	2	-	2	3	-	-	-
CO6	2	2	2	2	-	2	-	-	1	-
CO7	2	3	3	3	-	-	3	-	2	3
CO8	2	2	3	2	1	-	2	2	3	2
CO9	2	2	-	3		-	2	-	-	-

Justification

PO1: Comprehensive Knowledge and Understanding is supported by most COs, as each involves understanding core concepts and principles.

PO2: Practical, Professional, and Procedural Knowledge aligns with CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, and CO9, highlighting practical application and procedural knowledge.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding is indirectly related to CO8, especially in innovative applications of machine learning.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving are covered by CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, and CO9, involving specialized knowledge and problem-solving abilities.

PO5: Research, Analytical Reasoning, and Ethical Conduct align with CO2, CO4, and CO8, involving analytical and research skills.

PO6: Communication, Collaboration, and Leadership might be indirectly related to CO6, depending on teamwork and presentation.

PO7: Digital Proficiency and Technological Skills are demonstrated by CO1, CO3, CO5, CO7, CO8, and CO9, reflecting proficiency with digital tools and technologies.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy could be related to CO8 if projects address diverse issues.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices are not directly covered but can be indirectly related to ethical considerations in engineering practices.
PO10: Autonomy, Responsibility, and Accountability are reflected in CO1, CO7, and CO8

ELE-661-MJE(A): Wireless Sensor Network (2 Credits)

Course Objectives:

1. To familiarize with wireless sensor network.
2. To provide a background of single-node architecture and wireless networking protocols.
3. To study currently available sensor platforms and tools.
4. To understand the basic WSN technology and supporting protocols.
5. To understand the medium access control protocols.
6. To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
7. Knowledge about the security of wireless sensor network.

Course Outcomes:

CO1: Knowledge about deploying Wireless Sensor Network.
CO2: Understand various application of WSN.
CO3: Get knowledge about node architecture.
CO4: Understand and explain common wireless sensor node architectures.
CO5: Be able to carry out simple analysis and planning of WSNs.
CO6: Demonstrate knowledge of MAC protocols developed for WSN.
CO7: Knowledge about the wireless protocols.

Unit-1: Wireless Sensor Network, Architecture and Networking sensors (15)

Introduction, background of sensor network technology, challenges and hurdles Examples of WSN applications: home control, industrial automation, medical and agricultural applications. ISM band, Specifications of WSN devices, Comparison with ad hoc network.

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.

Unit-3: WSN Protocols, Sensor Network Platforms and sensor network security (15)

Overview of Communication Protocols for Sensor Networks, wireless networking protocols (IEEE 802.11, 802.15, 802.16, GPRS, MAC Protocols: Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, IEEE 802.15.4. Berkeley Motes, Programming Challenges, Node-level software platforms, Node level Simulators, State-centric programming. Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, and Layer wise attacks in wireless sensor networks.

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.

Table of Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	3	-	2	-	-	2	-
CO2	-	2	-	-	2	-	-	-	-	3
CO3	-	-	-	-	-	1	-	2	-	-
CO4	-	-	2	-	-	-	2	-	1	-
CO5	-	-	3	-	3	-	-	-	-	-
CO6	2	-	-	-	-	-	2	-	-	2
CO7	-	-	-	7	-	-	-	2	-	-

Justification of Mapping

PO1. Comprehensive Knowledge and Understanding:
CO1: Deploying WSN directly demonstrates comprehensive knowledge and understanding of key concepts and methodologies in the field of wireless technologies, which is a core part of multidisciplinary context.
CO6: Understanding MAC protocols contributes to knowledge but is more specific, not fully covering the broad multidisciplinary understanding required by PO.

PO2. Practical, Professional, and Procedural Knowledge:
CO1: Deploying a WSN involves practical and professional skills, such as adhering to industry standards and applying theoretical knowledge to real-world implementation.
CO2: Knowledge of WSN applications directly supports professional tasks by enabling students to apply WSN technology in diverse practical scenarios across industries.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding:
CO4: While important for explaining technologies, this outcome only moderately supports business and entrepreneurial insights, as it is more technical in nature.
CO5: Planning and analysis are essential for understanding market needs, developing innovative WSN solutions, and managing risks in a business context.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving:
CO1: Deploying a WSN requires specialized technical skills, problem-solving, and the ability to adapt to varying circumstances, aligning well with this PO.
CO7: While wireless protocol knowledge contributes to technical proficiency, it only moderately involves critical thinking or complex problem-solving scenarios.

PO5. Research, Analytical Reasoning, and Ethical Conduct:
CO2: Understanding applications provides insight into research contexts but doesn't heavily involve formulating research questions or ethical considerations.

CO5: Planning and analysis of WSNs require analytical reasoning and often involve research methodologies, aligning well with this PO.

PO6. Communication, Collaboration, and Leadership:
CO1: Deploying WSN requires some level of collaboration and communication, but the focus is more on technical execution than leadership or team collaboration.
CO3: While important technically, knowledge of node architecture does not directly involve communication, collaboration, or leadership development.

PO7. Digital Proficiency and Technological Skills:
CO4: Understanding and explaining architectures requires some digital skills but primarily focuses on conceptual knowledge rather than practical technological proficiency.
CO6: Knowledge of MAC protocols contributes to an understanding of technology, but it does not heavily involve direct use of ICT or software tools.

PO8. Multicultural Competence, Inclusive Spirit, and Empathy:
CO3: Knowledge of node architecture is primarily technical and does not directly promote empathy or engagement in multicultural settings.
CO7: Knowledge of wireless protocols is a technical competency and does not inherently foster multicultural competence or empathy.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices:
CO1: Deploying WSN can contribute to environmental monitoring and sustainability, but it does not explicitly address ethical values or practices.
CO4: While useful technically, understanding node architectures does not foster value inculcation or environmental awareness.

PO10. Autonomy, Responsibility, and Accountability:
CO2: Understanding various WSN applications contributes to societal well-being, requiring responsibility and accountability in selecting the appropriate use cases, aligning well with the PO.
CO6: Knowledge of MAC protocols requires some responsibility in applying protocols, but it does not heavily emphasize autonomy or managing complex projects.

ELE-661-MJE(B): Advanced Power Electronics (2 Credits)

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 working principle of controlled Rectifier.
4. To study and understand the power conversion and power transmission principles
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. Design and model different types of power converters.
3. Design controller and implement them in simulation.
4. Design power circuit and protection circuit of devices and converter
5. Distinguish between multilevel and modular power electronic converters and their conventional converters counterpart.
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 08

Overview of Power circuits, concept of load, Application areas. Controlled rectifiers: Single phase and three phase R and RL load – half-wave, full wave and dual converters, Single phase series converters, Powerfactor improvement techniques.

Unit2: Voltage Controller and Converters 10

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.

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

Unit-3: Applications of Power Electronics 12

DC power supplies: switch mode DC power supplies, flyback, forward, push pull, half bridge, full bridge-converters, resonant DC 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, DC –DC converter Drives. AC drives: Induction motors drives- Performance characteristics, control methods, Synchronous motor drives-cylindrical rotor, Reluctance, Permanent magnet, switched reluctance- motors, Brushless DC and AC Motors and Stepper Motor: types and Control. Snubber circuits, Electromagnetic interference, Cooling and heat sinks.

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

Course Outcome	Program Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	-	-	1	-	-	-	-	-	-
CO2	2	3		2	1	1	-	-	-	-
CO3	3	2	2	1	2	2	-	-	2	-
CO4	3	2	1	2	1	2	-	-	2	-
CO5	-	2	-	1	-	-	-	-	-	-
CO6	3	2	-	2	-	-	-	2	1	-
CO7	3	3	2	2	2	2	-	1	3	-

Mapping Justification:

PO1: Comprehensive Knowledge and Understanding

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: Practical, Professional, and Procedural Knowledge

All of the COs contributes to the development of students' Practical, Professional and Procedural Knowledge. For example, CO2 to CO4 require students to think critically about various turn-on and turn-off methods, designing power converters and Practical, Professional 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: Entrepreneurial Mindset, Innovation, and Business Understanding

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

.**PO4: Specialized Skills, Critical Thinking, and Problem-Solving**

The entire COs contributes to the development of students' Skills, Critical Thinking and Problem-Solving. 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: Research, Analytical Reasoning, and Ethical Conduct

All the COs contribute to the development of students' Research, Analytical Reasoning. 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 Research, Analytical Reasoning, and Ethical Conduct them into the power system.

PO6: Communication, Collaboration, and Leadership

CO3, CO4 and CO7 all contribute to the development of students' personal and professional competence. For example, learning advanced power electronics technology enhances

Collaboration and Leadership competence in keeping up with technological advancements in the field.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO6, CO7: Multicultural Competence, Inclusive Spirit and Empathy is often essential when dealing with environmental and sustainability aspects, such as integrating renewable resources.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices

CO3, CO4, CO6 and CO7 all contribute to the development of students' ability to engage in Value Inculcation, Environmental Awareness. For example, the entire COs is essential for staying updated in the rapidly evolving field power electronics.

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.

ELE-662-MJE(A): Wireless Sensor Network –Lab (2 Credits)

Objectives:

1. To learn operations of analog and digital Sensors.
2. To learn various libraries required for Arduino.
3. To learn serial communication techniques.
4. To make students aware of various actuators
5. To learn interfacing of various wireless devices.
6. To study different types of protocol used for communuication.
7. To study architecture of WSN.
8. To know the Raspberry Pi programming.

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

CO1. Ability to interface sensor modules with Arduino.
CO2. Ability to Control Electronic Devices Using Arduino
CO3. Expertise in Wireless Communication Modules
CO4. Designing different motor controlling techniques.
CO5. Practical Knowledge in Automation and Control Systems
CO6. Student will able to Update and Manage Sensor Data Online
CO8: Understanding of Advanced Networking Concepts
CO7. Ability to Perform Network Protocol Simulation

Laboratory Practical: Any 10 Practical's from following sections

1. Control Buzzer Operation by using Arduino
2. Relay Operation using Arduino
3. Serial Communication Programming.
4. Study of Interfacing of Analog Sensor
5. Study of Interfacing of Digital Sensor.
6. Interfacing Zigbee.
7. Interfacing Bluetooth
8. Interfacing Wi-Fi module
9. Display Temperature / Humidity Sensor's data on the LCD by using Arduino.
10. Automatic Door Opener Experiment with motor and Ultrasonic Sensor by using Arduino
11. Perform Blinking of LED Experiment by using Raspberry Pi Board.
12. Setup & Update the DTH Sensor Values online to ThingSpeak?
13. Implement a Low Energy Adaptive Hierarchy protocol using Simulation Tool.
14. Implement a Power Efficient Gathering in Sensor Information System using Simulation Tool.
15. Implement a Sensor Protocol for Information via Negotiation (SPIN) using Simulation Tool.
16. Implement a Wireless Sensor Network simulation.
17. Create a MAC protocol simulation.
18. Building and testing mobile AD hoc Network.
19. Using three Routers reading and analyzing routing table of network.
20. Study of ZigBee protocol
21. Distributed clustering in WSN
22. Mobile Target Tracking Wireless Sensor Network Simulation.
23. Netsim Simulation of Wireless Sensor Network WSN without Energy Harvesting.

Activity: Industrial Visit / Hobby project (equivalent to two practical experiments)

Course Outcome		Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	-	1	2	-	2	-	-	2
CO2	2	3	-	2	-	-	3	-	-	3
CO3	3	2	2	1	2	-	2	-	2	-
CO4	3	2	-	2	-	-	2	-	2	-
CO5	2	2	-	1	3	-	2	-	3	-
CO6	3	2	2	2	-	2	2	2	-	3
CO7	3	3	-	2	2	-	3	-	-	2
CO8	2	2	-	2	2		2	-	-	-

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding is supported by CO1, CO2, CO3, CO4, CO5, CO6, CO7 and CO8 as these outcomes involve a deep understanding of various technological and control concepts.

PO2: Practical, Professional, and Procedural Knowledge aligns with CO1, CO2, CO3, CO4, CO5, CO6, CO7 and CO8 reflecting hands-on skills and procedural knowledge.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding is indirectly related to CO3 and CO6, where managing data and expertise in communication technologies can lead to innovative applications.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving are demonstrated by CO1, CO2, CO3, CO4, CO5, CO6, CO7, and CO8, showcasing the need for specialized knowledge and problem-solving.

PO5: Research, Analytical Reasoning, and Ethical Conduct align withCO1, CO3, CO5, CO7 and CO8 involving analytical reasoning and research in network protocols and advanced concepts.

PO6: Communication, Collaboration, and Leadership can be reflected in CO6, particularly in collaborative data management and online integration.

PO7: Digital Proficiency and Technological Skills are demonstrated by CO1, CO2, CO3, CO4, CO5, CO6, CO7, and CO8, showcasing proficiency in digital tools and technologies.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy is indirectly related to CO6, especially in global data sharing.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices are related to CO4 and CO5, focusing on responsible and efficient design.

PO10: Autonomy, Responsibility, and Accountability are reflected in CO1, CO2, CO6, and CO7, demonstrating independence and responsibility in project execution.

ELE-662-MJE(B):Power Electronics - Lab (2 Credits)

Objectives:

1. To learn various power devices and its characteristics.
2. To make students aware of various commutation techniques of SCR
3. To learn various types power supply Circuit.
4. To study different types of Motor.
5. To learn different control system for motor.
6. To know the working Inverter
7. To understand the working simulation software for Single, three phase power supply

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

CO1. Design different Commutation Techniques for SCR.
CO2. Design Various Power supply Circuit.
CO3. Understand the operation of Power devices.
CO4. Designing different motor controlling techniques.
CO5. Student will able to design Inverter
CO6. Student will able to design and simulate the different circuits.
CO7. Understand the operation of three-phase power supply.

Laboratory Practical: Any 10 Practical's from following sections

1. Study the Characteristics of SCR.
2. Gate firing circuits for SCR's.
3. Study of Commutation method of SCR.
4. Design Dual Power supply using Transformer.
5. Design Variable Power supply.
6. Design fixed power supply.
7. To study I-V Characteristics of power device MOSFET
8. DC motor speed /AC motor speed control/ Stepper motor control
9. Practical based on Inverter.
10. Single Phase half-controlled converter with R / RL loads
11. Single Phase fully controlled bridge converter with R/RL loads
12. Single Phase AC Voltage Controller with R / RL Loads
13. Single Phase series inverter with R and RL loads (PSPICE /Proteus)
14. DC Chopper with R and RL Loads
15. Design single phase on-off controller (PSPICE /Proteus).
16. To design, build and test triggering circuit of SCR (PSPICE /Proteus).
17. Simulation of three-phase half wave rectifier circuit.
18. Single-phase full converter using RLE loads using Simulator(PSPICE /Proteus)
19. Single-phase AC voltage controller using RLE loads using PSPICE/Proteus.
20. Resonant pulse commutation circuit using PSPICE/Proteus.
21. Buck chopper using PSPICE/Proteus.
22. Single phase Inverter with PWM control using PSPICE/Proteus.

Activity: Industrial Visit / Hobby project (equivalent to two practical experiments)

Course Outcome		Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	2	-	-	-	-	-	-
CO2	2	3	2	3	2	2	-	2	2	-
CO3	2	1	2	2	2	-	2	1	-	-
CO4	3	3	-	3	1	2	-	3	2	-
CO5	2	1	-	2	-	-	-	-	-	-
CO6	2	2	2	2	2	3	2	2	2	-
CO7	2	3	-	3	-	2	-	2	-	-

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

The course outcomes (COs) contribute to the development of students' **Comprehensive** knowledge in electrical and electronics engineering. For example, CO1, CO5 require to know the modulation techniques and design the necessary circuit. CO2, CO4 and CO6 required getting knowledge of controlling techniques. CO3 and CO7 require students to understand concepts of power supply.

PO2: Practical, Professional, and Procedural Knowledge

The entire COs contributes to the development of students' Practical, Professional, Procedural Knowledge and problem-solving skills. For example, CO1 and CO5 require students to think critically about operation of analog and digital modulation circuit. CO2, CO4 and CO6 require students to think critically about how to design analog or digital circuit for controlling dedicated application and its response. CO3 and CO7 require students to think critically about the power supply design.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding

CO2, CO3, CO4, CO6 and CO7: contributes to the development of students' for Entrepreneurial Mindset, Innovation skills. They think the solution and design circuit for social need in automation, controlling and power supply design.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving

The entire COs contributes to the development of students' Specialized Skills, Critical Thinking, and Problem-Solving. CO1, CO2, CO3, CO4, CO5 CO6 and CO7 require for students to think to design circuit for problem solving and formulate the hypothesis.

PO5: Research, Analytical Reasoning, and Ethical Conduct

CO2, CO3, CO4, CO6 and CO7 contribute to the development of students' Research, Analytical Reasoning knowledge. Student will able to design system for practical problems solve interdisciplinary field.

PO6: Communication, Collaboration, and Leadership

CO3, CO4, CO5 and CO6 all contribute to the development of students' Communication, Collaboration, and Leadership. Students to develop their ability to work independently or as

a team to solve real-world problems. Students develop their skills for starting own start-up in electronics design. Students use their knowledge to develop suitable solution for

interdisciplinary field such as physics, chemistry, agriculture, industrial, botany etc.

PO7: Digital Proficiency and Technological Skills

CO3 and CO6 contribute to the development of automation system; controlling or security system design for understanding the ethical considerations in technology aligns for effective citizenship.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO2, CO3, CO4, CO6 and CO7 required to student for Multicultural Competence, Inclusive Spirit, and Empathy thinking development of analog or digital circuit for simplified practical problems for soil, water or environment parameter monitoring and easy handling laboratory instruments.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices

CO2, CO4 and CO6 all contribute to the development of students' ability to engage in Environmental Awareness, and Ethical Practices. For example, the entire COs requires students to develop their ability to learn new concepts of designing and apply them to new problems. It is lifelong learning due to hands on practical.

ELE-681-RP :Project+ Research Paper Publication (6 Credits)

Course Objectives

1. Understand and apply fundamental research methodologies relevant to research questions or hypotheses.
2. Conduct comprehensive literature reviews to identify current trends, technologies and gaps in the concern field or project.
3. Develop skills in project planning, including defining objectives, setting timelines and resource management.
4. Design and develop an electronics project, integrating theoretical knowledge with practical skills.
5. Collect and analyze data related to the project using appropriate statistical and analytical tools.
6. Prepare detailed documentation of the research process, including methodologies, results, and conclusions.
7. Present project findings effectively to a technical audience, demonstrating clear communication of complex ideas. Work collaboratively in teams to enhance project outcomes, fostering communication and leadership skills.

Course Outcomes

CO1: Clearly define a research topic and demonstrate the ability to formulate research questions and conduct thorough literature reviews in the field or application.

CO2: Successfully design and implement an electronics circuit that addresses a specific problem or need, showcasing technical proficiency.

CO3: Analyze experimental or project data using appropriate tools, demonstrating the ability to draw meaningful conclusions from the results.

CO4: Create comprehensive project documentation that includes design specifications, methodologies, results, and recommendations.

CO5: Present project findings through oral presentations and written reports, clearly articulating the significance and impact of the work.

CO6: Exhibit teamwork skills by effectively collaborating with peers in planning, executing, and evaluating the project.

CO7: Understand and apply ethical considerations in research and project development, ensuring integrity and responsibility in engineering practices.

CO8: Demonstrate creativity and critical thinking in addressing engineering challenges and proposing innovative solutions.

Standard Operating Procedure (SOP) and Guidelines for Research Project:

1. The research project spans across Semester III (4 credits) and Semester IV (6 credits), comprising a total of 10 credits. This is a single, continuous research project divided into two parts over the two semesters of the PG program.
2. The research project must be completed under the supervision and guidance of an in- house research mentor.
3. In Semester III, students are required to present their plan of work and conduct a literature review related to their project.
4. The actual research work will be conducted during Semester IV.
5. The department may organize necessary lectures, workshops, and laboratory training exercises as part of the research project.
6. Students may undertake the research project individually or in groups of up to three members, selecting relevant research topics in consultation with their dissertation supervisor.
7. Supervisors will assist students in reading research articles relevant to selected research topic

and guide them in selecting a topic for their dissertation project.

8. With the guidance of their supervisors, students will discuss the research objectives, approach, methodology, data collection methods, and other critical aspects of their project.
9. Students are expected to prepare a comprehensive proposal in a scientific format for their dissertation project.
10. A printed copy of the project proposal must be submitted for internal assessment.
11. Students must also prepare a PowerPoint presentation of their project proposal for the final evaluation.
12. Building on the project proposal from the previous semester, students will plan and engage in an independent and thorough investigation of their chosen research topic.
13. Students may engage in activities such as surveys, interviews, field observations, or experiments to achieve their research objectives.
14. Midway through the semester, students will present their preliminary findings to an internal examiner. Feedback from this session should be incorporated into the final analysis and report.
15. At the conclusion of the dissertation project, students will write a thesis that includes the aim, methodology, results, discussion, and future implications of their research.
16. Students must adhere to ethical principles and standards throughout all stages of their research.
17. A printed and hardbound copy of the dissertation thesis must be submitted for internal assessment.
18. Additionally, students will prepare a PowerPoint presentation of their dissertation thesis for the oral presentation during the Viva-voce, as part of the external evaluation.
19. For the external assessment, students must submit the final report and participate in a viva-voce.
20. The Project Report must be duly signed by the supervisor and the Head of the Department before being submitted to the concerned department.

The final Research Project thesis shall be presented in accordance with the following specifications whenever necessary:

(a) The paper used for printing shall be of A4 size.
(b) Printing shall be in a standardized form on both sides of the paper and in 1.5 line spacing.
(c) A margin of 1.5 inches shall be on the left-hand side.
(d) The card for cover shall not be more than 330 GSM.
(e) The title of the thesis/dissertation, name of the candidate, degree, name of the Research Supervisor, place of research and the month and year of submission shall be printed on the title page and the front cover. The name of the Co-supervisor, if any, may be mentioned on the title page and the front cover.
(f) Use the standard referencing style for bibliography/references as per the discipline.
(g) The hard-bound cover of the thesis/dissertation shall be of black color.

Topics and Learning Points

UNIT 1: Title Framing/Planning of research project for designing, fieldwork for data collection **Teaching Hours**

1.1 Define research topic, Scope, questions/Hypothesis **30**
1.2 Search for Relevant Literature
1.3 Preparation of questionnaire/field sheet/field book
1.4 fieldwork/survey
1.5 Carrying out fieldwork/survey for primary data collection
1.6 Filling up questionnaires/collection of samples
1.7 Literature Review

UNIT 2: Laboratory analysis/data analysis **70**

2.1 Planning of Experimental arrangement/Design

2.2 Sample analysis/questionnaire analysis to obtain data
2.3 Data entry and data rectification

2.4 Statistical analysis of the data
2.5 Representation of the data
2.6 Interpretation of the data

UNIT 3: Research project writing **60**

3.1 Introduction
3.2 Literature Review
3.3 Study area
3.4 Objectives
3.5 Hypothesis
3.6 Methodology
3.10 Chapter Scheme (Main text of the project)
3.11 References
3.12 Preparation of Research paper and Publication

UNIT 4: Submission of research project and viva-voce **20**

4.1 Submission of print copy of research project in prescribed format
4.2 Research project viva-voce