JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech. in Minors in Autonomous Vehicles

(MECHANICAL ENGINEERING)

COURSE STRUCTURE and SYLLABUS (R25 Regulations)

Applicable from AY 2025-26 Batch

Semester	Theory (Which is not studied in regular course)	Credits	Laboratory	Credits	Total Credits
II Year II Sem.	Electronic Sensors and Embedded Systems for Autonomous Vehicles	3	Embedded Systems Laboratory	1	4
III Year I Sem.	Introduction to Autonomous Vehicles	3	--	--	3
III Year II Sem.	Drone Technologies	3	Drone Technologies Lab	1	4
IV Year I Sem.	Artificial Intelligence and Machine Learning for Autonomous Vehicles	3	--	--	3
IV Year I Sem.	Project/ Experiential Learning			--	4
			Total Credits		**18**

ELECTRONIC SENSORS AND EMBEDDED SYSTEMS FOR AUTONOMOUS VEHICLES

B.Tech., I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Programming languages, Digital electronics and logic design, computer architecture and microprocessor systems

Course Objectives:

1. To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
2. To know the principle of transduction and classifications of sensors used in healthcare applications.
3. To describe the characteristics of different sensors used in healthcare applications.
4. Explore interfacing of peripherals and sensors with embedded systems.
5. Enable students to program and debug embedded systems.
6. Focus on practical applications of embedded systems in various domains.

Course Outcomes: On successful completion of this course, the student will be able to

1. Illustrate the various characteristics of sensors and measurement systems.
2. Select appropriate passive or active transducers for measurement of displacement, temperature and pressure.
3. Evaluate the use of photoelectric and piezo electric sensors for biomedical applications.
4. Capability to interface peripherals and sensors with embedded systems.
5. Ability to analyse and optimize the performance of embedded systems.
6. Skills to apply theoretical concepts to real-world embedded system design challenges.

UNIT I: Science of Measurement

Measurement System, Instrumentation, Classification and Characteristics of Transducers, Static and Dynamic, Errors in Measurements and their Statistical Analysis, Calibration, Primary and Secondary Standards.

UNIT II: Sensors

Displacement, Pressure, Temperature sensors. Strain Gauge: Gauge factor, sensing elements, configuration and unbounded strain gauge. Capacitive transducer, various arrangements, Inductive transducer, LVDT. Passive types: RTD materials & range, Relative resistance vs temperature characteristics, Thermistor Characteristics, Thermocouple characteristics.

UNIT III: Photoelectric and Piezo Electric Sensors

Phototube, Scintillation Counter, Photomultiplier Tube (PMT), Photovoltaic, Photoconductive Cells, Photodiodes, Phototransistor, Comparison of Photoelectric Transducers. Spectrophotometric Applications of Photoelectric Transducers. Piezoelectric Active Transducer - Equivalent Circuit and its Characteristics, Pressure and Ultrasound Transducer.

UNIT IV: Device Interfaces & I/O Programming

I/O Devices, Timer and Counting Devices. Serial Communication: I2C, CAN, USB. Parallel Communication: ISA, PCI, PCI/X, ARM Bus, Interfacing with Devices/Ports, Device Drivers, Serial Port and Parallel Port, Intel I/O Instructions, Transfer Rate, Latency. Interrupt-Driven I/O: Non-Maskable Interrupts, Software Interrupts, Writing Interrupt Service Routines in C & Assembly, Preventing Interrupt Over run, Disabling Interrupts

UNIT V: RTOS & Multithreading in Embedded Systems

Basics of RTOS and Embedded Operating Systems. **RTOS Features:** Interrupt Handling, Task Scheduling. **Multi-threaded Programming:** Context Switching, Premature and Non-Premature Multitasking, Semaphores, Thread States, Pending Threads, Round Robin and Priority-Based Scheduling, Assigning Priorities, Deadlock, Watchdog Timers.

Embedded System Design Issues: Action Plan, Target System Use, Emulator, Software Tool Utilization.

TEXTBOOK:

1. Medical Instrumentation: Application and Design, J. G. Webster, Wiley India Pvt. Ltd., 5th Edition, 2020.
2. Electrical & Electronics Measurement and Instrumentation, A. K. Sawhney, Dhanpat Rai & Co., 19th Revised Edition, 2015.

REFERENCE BOOKS :

1. Principles of Applied Biomedical Instrumentation, A. Geddes and L. E. Baker, Wiley India Pvt. Ltd., 3rd Edition, 2008.
2. Handbook of Biomedical Instrumentation, R. S. Khandpur, Tata McGraw Hill, 3rd Edition, 2014.
3. Biomedical Instrumentation and Measurement, L. Cromwell, Prentice Hall of India, 2nd Edition, 2015.
4. Modern Electronic Instrumentation and Measurement Techniques, A. D. Helfrick and W. D. Cooper, Prentice Hall of India, 1st Edition, 2016.
5. An Embedded Software Primer, D. E. Simon, Pearson Education, 1st Edition, 2004.
6. Embedded System Design – A Unified Hardware & Software Introduction, F. Vahid, John Wiley & Sons, 1st Edition, 2002.
7. Embedded Real-Time Systems Programming, S. V. Iyer and P. Gupte, Tata McGraw Hill, 1st Edition, 2004.
8. Embedded System Design, S. Heath, Elsevier, 2nd Edition, 2003.
9. Measurement Systems: Application and Design, E. O. Doebelin and D. N. Manik, McGraw Hill, 6th Edition, 2012.
10. Embedded System – Architecture, Programming, Design, R. Kamal, Tata McGraw Hill, 3rd Edition, 2017.
11. Fundamentals of Embedded Software, D. W. Lewis, Prentice Hall of India, 1st Edition, 2004.
12. Embedded Systems Design: An Introduction to Processes, Tools, and Techniques, A. S. Berger, McGraw Hill, 1st Edition, 2001.

EMBEDDED SYSTEM DESIGN LAB

B.Tech., I Sem.

L	T	P	C
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Course Objectives:

1. IDE for Embedded System Design using MSP430;
2. Interfacing Switch & LED;
3. Timers-WDT, Configuring, Programming;
4. ADC-usage; Power down modes; DAC; PWM Generator;
5. Networking - SPI, Wi-Fi.

Course Outcomes:

1. On successful completion of the course, students will be able to
2. Demonstrate knowledge in designing complex energy-efficient embedded systems.
3. Analyse usage of various on-chip resources like GPIO, Timers, Interrupts, ADC, DAC, Comparator, and SPI.
4. Solve engineering problems by proposing potential solutions using industry-choice advanced Microcontrollers.

List of Exercises

1. Introduction to the MSP430 launch pad and Programming Environment. (Study Experiment)
2. Read input from the switch and Automatic control/flash LED (software delay).
3. Interrupts programming example using GPIO.
4. Configure the watchdog timer in watchdog mode & interval mode.
5. Configure timer block for signal generation (with given frequency)
6. Read the Temperature of MSP430 with the help of ADC.
7. Test various Power Down modes in MSP430.
8. PWM Generator
9. Use Comparator to compare the signal threshold level
10. Speed Control of DC Motor
11. Master-slave communication between MSPs using SPI
12. Networking MSPs using Wi-Fi
13. Code Composer Studio Version 6, MSP430-based launch pads, Wi-Fi booster pack.

Note: Conduct any 10 out of 13 Experiments.

INTRODUCTION TO AUTONOMOUS VEHICLE SYSTEMS

L	T	P	C
3	0	0	3

B.Tech., II Sem.

Prerequisites: Physics and Mathematics.

Course Objectives:

1. Introduce the fundamental principles of aerospace and submarine systems.
2. Teach the basics of aerodynamics and hydrodynamics applied in these systems.
3. Explore the design, functions, and operation of aircraft, spacecraft, and submarines.
4. Focus on key components and their integration in these systems.
5. Enable students to comprehend the challenges and innovations in these fields.

Course Outcomes:

1. Understanding Vehicle Dynamics
2. System Integration and Control
3. Electrical and Electronic Systems

UNIT I: **History of Flight**

Balloon Flight, Ornithopers, Early Airplanes by the Wright Brothers, Biplanes and Monoplanes, Developments in Aerodynamics, Materials, Structures and Propulsion Over the years. Aircraft Configurations and Its Controls: Different types of Flight Vehicles, Classifications Components of an Aeroplane and their Functions Conventional Control, Powered Control, Basic Instruments for Flying-Typical Systems for Control Actuation.

Basics of Aerodynamics: Physical Properties and Structures of the Atmosphere, Temperature, Pressure and Altitude Relationships, Newton's Law of Motions Applied to Aeronautics-Evolution of lift, Drag and Moment. Airfoils, Mach number, Maneuvers.

UNIT II: **Basics of Aircraft Structures**

General Types of Construction, Monocoque, Semi-Monocoque and Geodesic Constructions, Typical Wing and Fuselage Structure. Metallic and Non-Metallic Materials. Use of Aluminium Alloy, Titanium, Stainless Steel and Composite Materials. Stresses and Strains- Hooke's Law-Stress-Strain Diagrams Elastic Constants- Factor of Safety.

UNIT III: Introduction to Sea Keeping

Importance of Seakeeping Analysis. The Behaviour of a Ship in A Seaway. Regular Waves, Sinusoidal and Trochoidal Theories. Characteristics of Waves, Sea Surface. Analytical and Statistical Representations. Descriptive Characterization of the Sea. Average and Significant Wave Heights. Wave Histogram. Characterization by Energy Spectrum. Standard Sea Spectra. Beaufort Scale.

UNIT IV: **Stabilization of Ship Motions**

Roll Stabilisers, Bilge Keels, Gyroscopic Stabilisers, Movement of Weight, Rudder Action, Jet Flaps, Stabilizing Fins, Passive and Active Tank Stabilizers**.** Pitch Stabilization Methods: Ship Motion Experiments. Generation of Regular and Irregular Waves. Captive and Free Running Model Tests. Full-Scale Tests. Design Considerations for Seakeeping. Seakeeping Criteria. ITTC Guidelines. Effect of Design Parameters and Hull Form on Seakeeping.

UNIT V: Introduction to Manoeuvrability

Controlled and Uncontrolled Motions. Control Loop. Course Keeping. Motion Stability of Ocean Vehicles. Equations of Motion. Hydrodynamic Derivations. Stability Criterion. Course Changing. Tuning Circle, Zigzag and Spiral Manoeuvers. Heel While Turning. Manoeuvring Trials. Control Surfaces: Control Surface Geometry. Rudders, Types and Characteristics. Effect of Stall, Aeration and Cavitation. Flow Around Rudder, Influence of Ship, Features On Controls Fired Stability. Design of Rudders. Calculation of Steering Gear Torque. Bending Moment and Stresses in Rudder Stock. Structural Design of Rudders. Other Manoeuvring Devices. Maneuvering in Restricted Waters.

TEXTBOOK

1. Introduction to Flight, J. D. Anderson, McGraw-Hill, 8th Edition, 2015.
2. Flight Without Formulae, A. C. Kermode, Pearson Education, 11th Edition, 2011.

REFERENCE BOOKS

1. Dynamics of Marine Vehicles, R. Bhattacharya, Butterworth-Heinemann, 1st Edition, 1978.
2. Principles of Naval Architecture, Vol. III, Ed. V. Lewis, The Society of Naval Architects and Marine Engineers (SNAME), 1989.
3. Aircraft Propulsion, D. P. Raymer, AIAA Education Series, 1st Edition, 2018.
4. Aircraft Design: A Conceptual Approach, D. P. Raymer, AIAA Education Series, 6th Edition, 2018.
5. Fundamentals of Submarine Design, T. J. Mallick, Springer, 1st Edition, 2023.
6. Fluid Mechanics for Marine Ecologists and Oceanographers, S. Wilkinson, CRC Press, 1st Edition, 2017.
7. Introduction to the Design and Analysis of Composite Structures: An Engineer's Practical Guide Using OptiStruct, G. L. Harrell, SAE International, 1st Edition, 2016.
8. Introduction to Aerospace Engineering with a Flight Test Perspective, S. Corda, Wiley, 1st Edition, 2023.
9. Aerodynamics for Engineering Students, E. L. Houghton and P. W. Carpenter, Butterworth-Heinemann, 7th Edition, 2023.
10. Submarine Design and Engineering, H. S. Levie, Naval Institute Press, 1st Edition, 2023.
11. Introduction to Naval Architecture, E. C. Tupper, Butterworth-Heinemann, 5th Edition, 2023.

DRONE TECHNOLOGIES

L	T	P	C
3	0	0	3

B.Tech., III Sem.

Prerequisites: Physics, programming languages

Course Objectives:

1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of a flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

Course Outcomes: On successful completion of this course, the student will be able to

1. Know about various types of drone technology, drone fabrication and programming.
2. Execute the suitable operating procedures for functioning a drone
3. Select appropriate sensors and actuators for Drones
4. Develop a drone mechanism for specific applications
5. Create programs for various drones.

UNIT I: Introduction to Drone Technology

Drone Concept - Vocabulary Terminology, History of Drone, Types of the Current Generation of Drones Based on their Method of Propulsion, Drone Technology Impact on the Businesses, Drone Business Through Entrepreneurship, Opportunities/Applications for Entrepreneurship and Employability.

UNIT II: Drone Design, Fabrication and Programming

Classifications of the UAV, Overview of the Main Drone Parts, Technical Characteristics of the Parts, Function of the Component Parts, Assembling a Drone, The Energy Sources, Level of Autonomy, Drones Configurations, The Methods of Programming Drone, Download Program, Install Program on Computer Running Programs, Multi Rotor Stabilization, Flight Modes, Wifi Connection.

UNIT III: Drone Flying and Operation

Concept of Operation for Drone, Flight Modes, Operate a Small Drone in A Controlled Environment, Drone Controls Flight Operations, Management Tool, Sensors, Onboard Storage Capacity, Removable Storage Devices- Linked Mobile Devices And Applications.

UNIT IV: Drone Commercial Applications

Choosing A Drone Based on the Application, Drones in The Insurance Sector, Drones in Delivering Mail, Parcels and Other Cargo, Drones in Agriculture, Drones in Inspection of Transmission Lines and Power Distribution, Drones in Filming and Panoramic Picturing.

UNIT V: Future Drones and Safety

The Safety Risks, Guidelines to Fly Safely, Specific Aviation Regulation and Standardization Drone License, Miniaturization of Drones, Increasing Autonomy of Drones, The Use Of Drones in Swarms.

TEXTBOOK

1. Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation, D. Tal and J. Altschuld, John Wiley & Sons, 2021.
2. Make: Getting Started with Drones, T. Kilby and B. Kilby, Maker Media, 2016.

REFERENCE BOOKS

1. Drone University, J. Glover, Createspace Independent Publishing, 2016.
2. Mastering Drone Photography: Capture Stunning Aerial Photos and Videos with Your Drone, R. Harrington, Rocky Nook, 2017.
3. Drone Entrepreneurship: 30 Businesses You Can Start, D. John, Independently Published, 2018.
4. Unmanned Aircraft Systems (UAS): Role of Drones in the 21st Century, C. Valasek, Independently Published, 2019.
5. Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms, N. Correll, B. Scassellati and K. Yamokoski, MIT Press, 2022.
6. Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, J. Baichtal, Que Publishing, 2016.
7. Introduction to UAV Systems, P. Fahlstrom and T. Gleason, John Wiley & Sons, 2012.
8. Drone Technology Handbook, S. Cassidy, CreateSpace Independent Publishing Platform, 2017.

DRONE TECHNOLOGIES LAB

B.Tech., III Sem.

L	T	P	C
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Course Objectives:

1. To provide hands-on experience in drone assembly, configuration, and programming.
2. To familiarize students with flight controller software, PID tuning, and flight stabilization.
3. To enable students to perform pre-flight checks, calibration, and controlled flying operations.
4. To introduce applications of drones in surveying, payload delivery, and data collection.
5. To expose students to risk assessment, flight logging, and future trends like swarm simulation and drone miniaturization.

Course Outcomes:

1. On successful completion of the course, students will be able to:
2. Identify and describe the components of drones and their functionality.
3. Assemble and program drones for specific applications.
4. Perform drone calibration, pre-flight checks, and execute manual and automated flight operations.
5. Apply drones for applications like surveying, mapping, payload delivery, and sensor data collection.
6. Conduct risk assessments, document flight operations, and simulate advanced drone functionalities like swarm behavior and miniaturization design.

List of Lab Experiments:

Introduction to Drone Technology:

1. Identification of Drone Components.
2. Classification and Comparison of Drone Types.

Drone Design, Fabrication, and Programming:

3. Assembling a Quadcopter.
4. Installing Flight Controller Software (e.g., Betaflight, Mission Planner).
5. Basic Programming for Drone Movement.
6. PID Tuning and Multi-Rotor Stabilization.

Drone Flying and Operation:

7. Pre-Flight Safety Check and Calibration.
8. Manual and GPS-Assisted Flying.
9. Use of Mobile App for Drone Control.

Drone Applications:

10. Drone Surveying and Mapping (Simulated).
11. Payload Delivery Simulation.
12. Thermal/Visual Sensor Data Collection.

Future Drones and Safety:

13. Risk Assessment and Flight Logging.
14. Drone Swarm Simulation (Virtual Lab).
15. Drone Miniaturization Study and 3D Design.

Note: Conduct any 12 out of 15 Experiments.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR AUTONOMOUS VEHICLES

L	T	P	C
3	0	0	3

B.Tech., IV Sem.

Prerequisites: Computer science fundamentals, Programming languages

Course Objectives:

1. Introduce the fundamental principles and concepts of artificial intelligence (AI).
2. Teach the basics of problem-solving using AI techniques.
3. Explore machine learning algorithms and their applications.
4. Enable students to understand natural language processing and computer vision.
5. Focus on practical applications of AI in various domains.

Course Outcomes:

1. Understanding of the basic principles and history of artificial intelligence.
2. Proficiency in applying AI techniques for problem-solving.
3. Capability to analyse and design machine learning models.
4. Ability to implement natural language processing and computer vision systems.
5. Skills to apply theoretical concepts to practical AI problems.

UNIT I: Introduction to Al & Production Systems

Introduction, AI problems, foundation of AI and history of AI Intelligent Agents, Agents and Environments, Concept of rationality, Nature of Environments, Structure of Agents, Problem solving Agents, Problem Formulation.

UNIT II: Searching Techniques

Searching, Searching for Solutions, Uniformed Search Strategies, Breadth-First Search, Depthfirst Search. Search with Partial Information (Heuristic Search) Greedy Best, First Search, A* Search Game Playing, Adversial Search, Games, Minimax, Algorithm, Optimal Decisions in Multiplayer Games, Alphabeta Pruning, Evaluation Functions, Cutting of Search.

UNIT III: Representation of Knowledge

Knowledge Representation and Reasons Logical Agents, Knowledge-Based Agents, Wumpus World, Logic, Propositional Logic, Resolution Patterns in Propositional Logic, Resolution, Forward & Backward Chaining.

UNIT IV: First Order Logic

Inference in First-Order Logic, Propositional Vs. First-Order Inference, Unification and Lifts Forward Chaining, Backward Chaining, Resolution, Learning, Learning from Observations, Forms of Learning.

UNIT V: An Overview of Prolog

An example program: defining family relations - Extending the example program by rules -A recursive rule definition. How Prolog answers questions - Declarative and procedural meaning of programs - Syntax and Meaning of Prolog Programs - Lists, Operators, Arithmetic - Using Structures: Example Programs.

TEXTBOOK

1. Artificial Intelligence, E. Rich and K. Knight, 2nd edition, TMH, 2005.
2. AI – A Modern Approach, S. Russel and P. Norvig, 2nd edition, Pearson Education, 2007.
3. Artificial Intelligence: Foundations of Computational Agents, D. L. Poole and A. K. Mackworth, 2nd edition, Cambridge University Press, 2017.

REFERENCE BOOKS

1. Machine Learning: A Probabilistic Perspective, K. P. Murphy, MIT Press, 2012.
2. Deep Learning, I. Goodfellow, Y. Bengio and A. Courville, MIT Press, 2016.
3. Artificial Intelligence: A Guide for Thinking Humans, M. Mitchell, Farrar, Straus and Giroux, 2019.
4. Reinforcement Learning: An Introduction, R. S. Sutton and A. G. Barto, 2nd edition, MIT Press, 2018.
5. Artificial Intelligence: A Systems Approach, M. Negnevitsky, 2nd edition, Addison-Wesley, 2005.