Minor Degree Certification Course in Drone Technology

(To be offered to students of other departments, excluding ECE)

S. No.	Sub Code	Semester	Subject Name	Contact Hours per week			Total Credits
				L	T	P	
1	MIEC- DT 01	V	Drone & Electronics Hardware	3	1	0	4
2	MIEC- DT 02	VI	Assembling of Drone	2	1	2	4
3	MIEC-DT 03	VII	Drone Designing	3	-	2	4
4	MIEC-DT 04	VIII	Drone Operation & Simulation	2	-	2	3
			Total	9	2	8	15

1 Hr Lecture	1 Hr Tutorial	2 Hr Practical
1 Credit	1 Credit	1 Credit

MIEC- DT 01	**Drone & Electronics Hardware**	**3L: 1T: 0 P (04 hrs.)**	**Credits: 04**

Prerequisite: Fundamentals of Mathematics, Physics, Electrical, Electronics & Control system.

Course Objective: 1. This module covers the fundamental electronic components directly responsible for a drone's ability to fly, stabilize, and receive power, delves into the electronic hardware that allows the drone to communicate with the outside world, navigate autonomously, and perform specialized tasks

MODULE I **(7 hrs.)**

Core Flight & Power Electronics: Flight Controller (FC): The "brain" of the drone, processing sensor data and pilot inputs to control motor speeds, Electronic Speed Controllers (ESCs): Convert signals from the FC into power for the motors, controlling their speed and direction, Brushless Motors: Efficient powerhouses that spin the propellers,

MODULE II **(7 hrs.)**

Communication, Navigation & Payload Electronics: **Radio Control (RC) System:** Transmitter (remote control) and Receiver for pilot input and control, GPS/GNSS Module: Provides precise location data for navigation, waypoint following, and autonomous modes, Video Transmission System (FPV): FPV Camera, Video Transmitter (VTX), and antennas for real-time video streaming, Telemetry Systems: Hardware for transmitting real-time drone data back to the ground station, On-Screen Display (OSD): Electronic overlay for flight data on the video feed.

MODULE III **(8 hrs.)**

Drone Aerodynamics, Propulsion, and Structure: Focuses on the mechanical aspects, including drone types, aerodynamic principles, motor and propeller theory, ESCs, and the physical construction of drone frames.

MODULE IV **(7 hrs.)**

Flight Controllers, Sensors, and Navigation Systems: Delves into the "brain" of the drone, exploring flight controller architectures, Inertial Measurement Units (IMUs), GPS, barometers, and their roles in stable flight and navigation.

MODULE V **(8 hrs.)**

Video Transmission and Power Management: Covers the critical systems for control and data transfer, including RC protocols, FPV/digital video systems, antennas, and the specifics of drone battery technologies and power distribution.

Course Outcome: -

Students earning credits will develop ability to:

1. Students will be able to identify fundamental electronic components, understand basic circuit principles, and safely handle electrical tools.
2. Students will be able to select and correctly wire motors, ESCs, and propellers, understanding their interdependencies for thrust generation.
3. Students will be able to connect and configure the flight controller with essential navigation sensors (IMU, GPS) for stable flight.
4. Students will be able to design and implement the drone's power distribution, select appropriate batteries, and integrate radio control and video transmission systems.
5. Students will be able to fully assemble a drone, perform comprehensive pre-flight checks, and diagnose and resolve common hardware-related issues.

Text/ Reference Book:

1. M. LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d.
2. Make: Drones , Teach an Arduino to Fly by David McGriffy.
3. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
4. D. Levy, Drone Programming: A Guide to Code Your Own Drones, Packt Publishing, n.d.
5. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
6. P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.
7. K. Sundar and R. V. Rajakumar, Multicopters: Principles and Applications, Springer, 2021.
8. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, Cengage Learning, 2018.
9. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone,Apress, 2019.
10. M. A. Banks, Building and Flying Electric Model Aircraft, O'Reilly Media, Inc., 2014.
11. G. C. Camara Leal, Flying Robots: An Introduction to Autonomous Aerospace Systems, Springer,2017.

MIEC- DT 02	Assembling of Drone	2L: 1T: 2P (04 hrs.)	Credits: 04

Prerequisite: Fundamentals of Mathematics, Physics, Electrical, Electronics, Control system & Drone.

Course Objective: To provide students with the practical skills and theoretical knowledge required to safely and correctly assemble,

MODULE I **(7 hrs.)**

Foundations & Pre-Assembly: Safety, component identification, essential tools, basic soldering, reading wiring diagrams, LiPo battery handling.

MODULE II **(7 hrs.)**

Frame & Propulsion System: Frame assembly, motor mounting, ESC installation & wiring (power, signal), PDB integration, initial cable management.

MODULE III **(8 hrs.)**

Flight Controller & Core Sensors: FC mounting, RC receiver connection, GPS module integration, buzzer/LED wiring, FC firmware flashing, basic FC software setup (ports, receiver check, calibration).

MODULE IV **(9 hrs.)**

Communication, Video & Payload: FPV camera & VTX installation, antenna mounting, OSD configuration, basic payload (e.g., action cam) mounting principles, advanced cable management.

MODULE V **(9 hrs.)**

Final Configuration, Testing & Troubleshooting: ESC calibration, motor direction verification, propeller mounting (safety!), flight mode setup, pre-flight checklists, basic troubleshooting (common issues), battery charging best practices.

List of Experiments:

1. Tool use & safety practice.
2. Basic soldering practice (wires, connectors).
3. Component ID & diagram interpretation

4. Drone frame assembly.
5. Motor mounting & initial ESC wire soldering (to motors, PDB/FC).
6. ESC signal wire connection to FC.
7. Mounting FC & connecting RC receiver.
8. Wiring GPS & buzzer/LED.
9. FC firmware flashing & basic configurator setup (sensor verification, RX inputs).
10. Mounting FPV camera & VTX.
11. VTX wiring & antenna attachment.
12. OSD configuration & verification.
13. Final cable management
14. ESC calibration & motor direction check.
15. Flight mode configuration on FC & transmitter.
16. Full pre-flight inspection (props off).
17. Simulated troubleshooting scenarios.
18. (Optional, supervised) Safe propeller attachment & battery connection for power-on tests/tethered hover.

Assessment: Internal viva, Continuous evolution of experiments, Journal write-up, Quiz and End semester exam.

Course Outcome:

Students should be able to:

1) Foundations & Pre-Assembly: Students will be able to identify drone components, understand basic electronic principles, and confidently use essential assembly tools and soldering techniques.
2) Frame & Propulsion System: Students will successfully assemble the drone frame and correctly install and wire the motors and Electronic Speed Controllers (ESCs).
3) Flight Controller & Core Sensors: Students will properly mount the flight controller, integrate core sensors (IMU, GPS), connect the RC receiver, and perform initial firmware flashing and basic software configuration.
4) Communication, Video & Payload: Students will install and wire the FPV camera and video transmitter, secure antennas, configure the On-Screen Display (OSD), and understand basic payload integration.
5) Final Configuration, Testing & Troubleshooting: Students will complete all software calibrations, perform thorough pre-flight checks, understand safe propeller mounting, and effectively troubleshoot common assembly and setup issues to prepare the drone for flight.

Text/ Reference Books:

1. "Drone Technology for Beginners: Learn | Build | Fly Drones" by Dharna Nar and Radhika K.
2. Make: Drones , Teach an Arduino to Fly by David McGriffy.
3. "Getting Started with Drones" by Terry Kilby and Belinda Kilby (O'Reilly Media).
4. "Building Your Own Drones: A Beginner's Guide to Drones, UAVs, and ROVs" by John Baichtal.
5. "How To Get Started With FPV Drone - The Ultimate Beginner's Guide" by Oscar Liang.
6."Electronics All-In-One for Dummies" by Doug Lowe (or similar "for Dummies" electronics books.
7. "Electronics for Beginners" by Jonathan Bartlett.
8 Flight Control Systems: Practical issues in design and implementation by Pratt R.W., though more advanced)

MIEC- DT 03	**Drone Designing**	**3L: 0T: 2P (04 hrs.)**	**Credits: 04**

Prerequisite: Fundamentals of Mathematics, Physics, Electrical, Electronics & Drone

Course Objective: To equip students with the theoretical knowledge and practical skills necessary to conceptualize, design, and analyze multi-rotor Unmanned Aerial Vehicles (UAVs) for various applications.

MODULE I **(7 hrs.)**

Drone Design Fundamentals & Requirements Analysis: Introduction to UAVs, History and evolution of drones, definitions, and terminology (UAV, UAS, RPA), Classification of Drones: Drone Applications Mission Requirements Analysis: Conceptual Design & High-Level Architecture:

MODULE II **(7 hrs.)**

Aerodynamics, Propulsion, and Structural Design: Fundamentals of Aerodynamics: Motor Selection & Sizing: Propeller Selection: Electronic Speed Controller (ESC) Sizing: Structural Design & Materials.

MODULE III **(8 hrs.)**

Electronic System Design & Integration: Flight Controller (FC) Architecture, Sensor Integration Power System Design Radio Communication Systems Video Transmission Systems

MODULE IV **(9 hrs.)**

Control System & Software Design: Introduction to Drone Control Systems, Flight Modes, Flight Controller Firmware Customization, Ground Control Station (GCS) Software, Telemetry & Data Logging Analysis, Introduction to Drone Programming/Scripting, High-level control with APIs (e.g., DroneKit for ArduPilot, MAVSDK for PX4), Basic Python scripting for simple autonomous tasks or data interaction.

MODULE V **(9 hrs.)**

Advanced Design Topics, Analysis & Prototyping: Design for Manufacturability (DFM) & Assembly (DFA), Reliability, Redundancy & Safety in Design, Advanced Sensor & Payload Integration, Simulation & Digital Prototyping, Testing Methodologies, Design Project Culmination

Assessment: Internal viva, Continuous evolution of experiments, Journal write-up, Quiz and End semester exam.

Course Outcome:

Students should be able to:

1. Students will conceptualize a drone based on defined operational requirements.
2. Students will select appropriate motors, propellers, ESCs, and create a basic structural frame design.
3. Students will design a comprehensive electronic system, including power budgets and wiring diagrams.
4. Students will implement basic flight modes and utilize ground control software for mission planning.
5. Students will analyze drone designs, apply simulation for testing, and produce a detailed drone design project.

List of Experiments:

This will involve designing, developing, coding and implement Arduino project. Projects will include:

1. Mission Requirements Traceability: Use a spreadsheet to map a drone's mission objectives to specific hardware/software component requirements.
2. Drone Type Suitability Matrix: Create a comparative matrix evaluating different drone configurations (e.g., quad, hex, fixed-wing) for various applications.
3. Propulsion System Simulator: Utilize an online tool (e.g., eCalc) to size motors, propellers, and ESCs for a given drone weight and desired flight time.
4. CAD Frame Design: Design a basic multi-rotor frame in a CAD software (e.g., Fusion 360), focusing on component mounting points.
5. Power Budget Calculation: Develop a detailed spreadsheet to calculate power consumption for all drone components and size the battery.
6. Full System Wiring Diagram: Create a complete electronic wiring diagram for a drone, showing all interconnections and power flows, using diagram software.
7. FC Firmware Configuration (Simulator): Access a flight controller configurator (e.g., Betaflight, Mission Planner) via a simulator and experiment with flight modes and basic settings.
8. Autonomous Mission Planning: Use Ground Control Station software (e.g., QGroundControl) to plan a complex waypoint mission and simulate its execution.
9. PID Controller Tuning Simulation: Adjust PID gains in a drone simulator or a dedicated control system simulation environment to observe their effect on flight stability.
10. Flight Log Analysis: Use a log viewer/analyzer tool (e.g., Blackbox Explorer, UAV Logbook) to interpret simulated or real drone flight data for performance and issue

diagnosis.

Text/ Reference Books:

1. "Small Unmanned Aircraft: Theory and Practice" by R. W. Beard and T. W. McLain; "Drone Technology for Beginners: Learn | Build | Fly Drones" by Dharna Nar and Radhika Kotecha.
2. "Model Aircraft Aerodynamics" by Martin Simons; "The Multirotor Guide" by Peter Rymer.
3. "Make: Drones: Build your own Quadcopter" by Darren Gaudry; Manufacturer datasheets.
4. "Feedback Control of Dynamic Systems" by Franklin, Powell, Emami-Naeini; Online FC firmware documentation.
5. "Drone Technology and Applications" by Francis Govers; Relevant simulation software manuals.

MIEC- DT 04	Drone Operation & Simulation	2L: 0T: 2P (4hrs.)	Credits: 03

Prerequisite: Fundamentals of Mathematics, Physics, Electrical, Electronics & Drone

Course Objectives: To equip individuals with the knowledge, skills, and regulatory understanding required to safely and proficiently operate drones in various scenarios, with a strong emphasis on simulation-based training.

MODULE I **(6 hrs.)**
Drone Fundamentals & Regulatory Compliance (Theory Focus):

MODULE II **(10hrs.)**
Motor to Chassis, Designing Robot PCB Layout and Board files, Etching PCB, Mounting Components.

MODULE III **(08hrs.)**
Interface with LED, LCD, MDC, motor, gearing, shaft bearing.

MODULE IV **(08hrs.)**
Assembling Robot, Understanding the structure of the robot and IDE, programming robot for: basic movements, testing line sensor, line following,

MODULE V **(08hrs.)**
Mechanical assembly of humanoid robot, Centre of gravity for balancing of humanoid.

Course Outcomes:

1. Student will be able to know the basic component used in robotics.
2. Student will know how to design PCB.
3. Knowledge of interfacing of different component of robots.
4. Student will be able to do basic programming of robots.
5. Ability to design basic application robots.

List of Experiments:

Students should be able to:

1. Study the basic components used in robot.
2. Designing of motor chassis of the robot.

3. Designing of PCB layout.
4. Assemble different components used in robot.
5. Learn the interface of LED and LCD with circuit.
6. Learn about the interface motor gearing and shaft bearing of robot.
7. Assemble the single shaft servo Motor Humanoid.
8. Assemble the double shaft servo motor Humanoid.
9. Assemble a line follower robot.
10. Assemble an obstacle avoider robot.

Text/ Reference Books:

1. Peter McKinnon , “Robotics: Everything You Need to Know About Robotics from Beginner to”
2. Neil Wilkins “Robotics: What Beginners Need to Know about Robotic Process Automation, Mobile Robots, Artificial Intelligence, Machine Learning, Autonomous Vehicles, Speech Recognition, Drones, and Our Future”
3. Virgilio Drossman,” Build A Robot: Learn To Solder Basic Electronics Into A Low-Tech Robot: Which Is The Best Book To Learn Robotics From A Beginner Level?”
4. Kailash Chandra Mahajan , “Robotics For Engineers”