NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	M.Tech. in Electronics & Instrumentation Engineering (Robotics and Artificial Intelligence)
Semester:	II
Course Code:	6ME871ME25
Course Title:	Aerial Robotics
Course Type:	Elective
Year of introduction:	2025 - 26

L	T	Practical component				C
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Course Learning Outcomes (CLOs):

After successful completion of the course, student will be able to –

1. develop the mathematical model of quadrotor (BL3)
2. build a program for autonomous navigation of quadrotor (BL3)
3. distinguish suitable flight controllers for quadrotor (BL4)
4. select the basic components and systems for drones. (BL5)

Unit	Contents	Teaching Hours (Total 30)
Unit I	**Introduction to Aerial Robotics** Overview of aerial robotics and its applications, Historical development of drones and UAVs, Ethical and safety considerations in aerial robotics, classes of UAV system, Examples Safety systems: Hazardous operations, safety promotions, maintenance, risk analysis and prevention.	06
Unit II	**Drone components and system** Types of UAVs, Anatomy of a drone, Motors and propellers, propellers diameters and thrust, drone materials, Electronics speed controllers, Battery, Launching system, additional equipment, Propulsion systems, Sensors and cameras systems, Flight controllers and autopilots systems	08
Unit III	**Flight mechanics** Frames: Modelling representation, Geodetic coordinate system, Earth-centred frame, North-East-Down (NED) frame, Body based frame, Air relative frame Mechanics: Drone geometry, kinematics modelling 1D, 2D and 3D quadrotor, dynamics in longitudinal mode, dynamics in lateral mode, dynamic equation of motion for quadrotor. Performance: Atmospheric pressure, altitude, configuration design, analysis of weather factors, cruising flight, range, endurance, trim, stability	08

Unit IV	**Flight Planning and control** Controls system architectures, autopilot control station Sensors: Inertial navigation system, Compass, Barometer, GPS, Distance, sense and avoid techniques, Camera and Video: Camera types, First person view, FPV glasses, Head tracking Ground control system, FPV, Data fusion, Image processing Basic flight manoeuvres, control theory for aerial robot, linear and PID controllers, GPS and localization, Path planning and obstacle avoidance, Waypoint navigation, Indoor vs. outdoor navigation.	08

Self – Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/References:

1. Yasmina Bestaoui Sebbane, A First Course in Aerial Robots and Drones, CRC Press
2. Nikolaus Correl, Bradley Hayes, Introduction to Autonomous Robots, The MIT Press
3. Omar D Lopez Mejia, Jaime Escobar, Aerial Robots: Aerodynamics, Control and Applications, InTech publisher
4. Gravit Pandya, Basics of Unmanned Aerial Vehicles, Nation Press
5. Paul G Fahlstrom, Thomas J Gleason, Mohammand H Sadraey, Introduction to UAV systems, Willey publication.

Suggested List of tutorials:

1. Simulation of aerial robot using MATLAB advance tools
2. Development of kinematics and dynamics model for 1-D quadrotor
3. Development of kinematics and dynamics model for 2-D quadrotor
4. Development of kinematics and dynamics model for 3-D quadrotor
5. Simulation of quadrotors using MATLAB
6. Simulation of linear flight controller
7. Simulation of PID flight controller
8. Simulation of autonomous navigation

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. the academic year 2025 - 26 and onwards