Sant Dnyaneshwar Shikshan Sanstha's
Annasaheb Dange College of Engineering and Technology, Ashta
DEPARTMENT OF AERONAUTICAL ENGINEERING
An Autonomous Institute

Course Details:

Class	S.Y B.Tech., Sem - IV
Course Code and Course Name	**2AEUV201 - Introduction to Unmanned Aerial Vehicles (UAVs)**
Prerequisite	NIL
Teaching Scheme: Lecture/Tutorial/Practical	02/00/00
Credits	02
Evaluation Scheme : ISE/MSE/ESE	40/30/30

Course Objectives:

1. Cultivate a solid grasp of UAV fundamentals, encompassing types, characteristics, components, motivations, specifications, applications, payloads, and an exploration of aerodynamics.
2. Develop proficiency in DGCA rules, drone categorization, type certification, and regulations for UAV operations, including registration, certification, and pilot licensing, coupled with knowledge of RPTO, flying zones, DTCs, and CSUAS.
3. Merge theoretical and hands-on knowledge by researching the industrial applications of UAVs, understanding aerodynamics, and gaining practical skills in Quadcopter design, assembly, manufacturing, and ground testing, covering Ground Control Station, flight simulation, autonomous flight path planning, and testing.

Course Outcomes (CO's):

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

2AEUV201_1	Explain the Drone rules, regulations, guidelines of DGCA and various systems which applicable in drone industry & technology by using the current active gazettes of indian government & scientific research journals knowledge
2AEUV201_2	Classify and experiment the category, class, assembly & manufacturing techniques, testing & operating methods and its industrial applications aligned with drone technology by the active government gazette or scientific articles / book data
2AEUV201_3	Identify the forces and moments acting on the drone for various flying conditions/ applications by using fundamental physical principles and theories

Course Contents:

Unit 1	**Introduction, Classifications, Applications and Payloads of UAV**	**04**
Motivation - Types of UAV – Characteristics – Fixed Wing – Rotary Wing – Flapping Wing – Basic Parts of UAV – Specifications – Applications – Pay loads of UAV		
Unit 2	**DGCA Rules, Regulation & Guidelines**	**04**
Drone Categories Based on All-up weight – Type Certification of UAVs - DGCA Rules for UAV Registration, Certification and Pilot Licensing - Remote Pilot Training Organization (RPTO) – Flying Zones - Drone Training Circulars & Certification Scheme of Unmanned Aircraft Systems		

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Unit 3	**Industrial and Future Engineering Applications of UAVs**	**05**
Need of UAVs for Industrial Applications - Development of UAVs for Powerline Inspection - Telecom Structure Inspection and Radiation Measurement – Bridge and Heritage Structure Inspection – Collection of Seaweeds using UAV – Future Engineering Applications of UAVs.		
Unit 4	**Aerodynamics of UAV**	**04**
Basics of Aerodynamics – Angle of Attack - Lift and Drag – Bernoulli Theories and Equations - Peculiarities of Multicopters - Stability – Turning Flight – Stall conditions		
Unit 5	**Design, Assembly Processes & Manufacturing Techniques of Quadcopter**	**05**
Design of Quadcopter – Selection of Sub Systems - Airframe Assembly – Integration of Electronic Systems		
Unit 6	**Ground Testing for Drones**	**04**
Introduction to Ground Control Station – Flight Simulation – Autonomous Flight Path Planning – Testing of Quadcopter		

Text Books:

Sl.No	Title	Author	Publisher	Edition	Year
1	Unmanned aircraft systems: UAVS design, development and deployment	Austin, R.	John Wiley & Sons.	1st	2011
2	Introduction to UAV systems	Fahlstrom P, Gleason T	Wiley, UK	4th	2012
3	Build your own quadcopter	Norris D	McGraw-Hill Education, New York	1st	2014

Reference Books:

Sl.No	Title	Author	Publisher	Edition	Year
1	Handbook of unmanned aerial vehicles	Valavanis K. P.; Vachtsevanos, G. J., eds	Springer reference	1st	2015
2	A first course in aerial robots and drones	Sebbane, Y. B.	CRC Press	1st	2022

Online Reference Materials:

Sl.No	Source/Platform	Link to contents
1	Swayam	https://onlinecourses.swayam2.ac.in/ntr24_ed12/preview
2	Digital Sky Platform	https://www.dgca.gov.in/digigov-portal/jsp/dgca/homePage/viewPDF.jsp?pag

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Sl.No	Source/Platform	Link to contents
		e=InventoryList/headerblock/drones/Drone%20Rules%202021.pdf

Assessment Modes:

Sl.No	Method/Technique	CO's			Marks		Weightage
		1	2	3	Max	Min	
1	ISE : ABA	☑	☑	☑	40	16	40%
4	MSE	☑	☑	☐	30	24	60%
5	ESE	☐	☑	☑	30		

- ISE - In-Semester Examination, MSE - Mid-Semester Examination, ESE - End-Semester Examination
- ABA - Activity Based Assessment

CO's - PO's & PSO's Mapping: (Low - 1, Medium - 2, High -3, No Correlation - "-")

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2	1	1	-	3	3	3	-	3	-	3	-	-
2	3	3	2	3	1	-	1	-	3	3	3	1	-	-
3	3	3	2	2	1	-	-	-	-	-	-	2	-	-
Avg	3	3	2	2	1	3	2	3	3	3	3	2	-	-

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Course Details:

Class	T.Y B.Tech., Sem - V (Minors in Unmanned Aerial Vehicles)
Course Code and Course Name	**2AEUV301 - UAV Electronics and Sensors**
Prerequisite	2AEUV201 - Introduction to Unmanned Aerial Vehicles
Teaching Scheme: Lecture/Tutorial/Practical	3/0/0
Credits	3
Evaluation Scheme : ISE/MSE/ESE	40/30/30

Course Objectives:

1. To provide students with a comprehensive understanding of the electronic components and sensors used in unmanned aerial vehicles (UAVs).
2. To familiarize students with the principles of operation, design considerations, and applications of various electronic systems and sensors in UAVs.
3. To enable students to analyze, select, and integrate appropriate electronic components and sensors to meet specific mission requirements for UAVs.

Course Outcomes (CO's):

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

2AEUV301_1	Describe the functions and characteristics of key electronic components and sensors commonly employed in UAVs.
2AEUV301_2	Demonstrate the ability to evaluate the performance and suitability of electronic systems and sensors for different UAV applications.
2AEUV301_3	Proficient in designing and implementing electronic systems and sensor configurations for specific UAV missions.
2AEUV301_4	Possess the skills to troubleshoot and diagnose issues related to electronic systems and sensors in UAVs.

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Course Contents:

Unit 1	**Introduction to UAV Electronics**	**06**
Overview of UAVs and their components - Role of electronics in UAVs - Basic electronic components: resistors, capacitors, diodes, transistors - Introduction to sensor types used in UAVs		
Unit 2	**Power Systems and Communication**	**06**
Power sources and management in UAVs - Power distribution systems - Radiofrequency (RF) communication systems - Data link protocols and communication interfaces		
Unit 3	**Flight Control Systems**	**07**
Principles of flight control - Introduction to autopilot systems - Sensors for attitude estimation: accelerometers, gyroscopes, magnetometers - PID control algorithms		
Unit 4	**Navigation and Positioning**	**06**
GPS/GNSS fundamentals - Inertial navigation systems (INS) - Integration of GPS/INS for navigation - Altitude sensors: barometers, ultrasonic sensors		
Unit 5	**Payload Systems**	**06**
Types of payloads in UAVs: cameras, sensors, actuators - Payload integration, and interfacing - Image processing and analysis for UAV payloads - Sensor fusion techniques		
Unit 6	**Advanced Sensors and Future Trends**	**08**
Emerging sensor technologies for UAVs - Hyperspectral imaging and multispectral sensors - LiDAR and radar systems for UAVs - Integration of artificial intelligence and machine learning in UAV sensor systems		

Text Books:

Sl.No	Title	Authors	Publisher	Edition	Year
1	Introduction to UAV Systems	Paul Fahlstrom & Thomas McEwen	Wiley	5th	2022
2	Small Unmanned Aircraft: Theory and Practice	Randal W. Beard & Timothy W. McLain	Princeton University Press	1st	2012
3	Unmanned Aircraft Systems: UAV Design, Development and Deployment	Reg Austin	Wiley	2nd	2015

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Reference Books:

Sl.No	Title	Author	Publisher	Edition	Year
1	Flight Stability and Automatic Control	Robert C. Nelson	McGraw-Hill Education	2nd	1998
2	Principles of Electronic Materials and Devices	Safa O. Kasap	McGraw-Hill Education	4th	2017
3	Sensor Technologies: Healthcare, Wellness, and Environmental Applications	Michael J. McGrath and Cliodhna N. Foley-Fisher	Apress	1st	2017

E-Resources/Reference Papers:

1. ArduPilot - https://ardupilot.org/
2. PX4 Autopilot - https://px4.io/
3. ROS (Robot Operating System) - https://www.ros.org/
4. Dronecode - https://www.dronecode.org/
5. IEEE Robotics and Automation Society - https://www.ieee-ras.org/
6. DIY Drones - https://diydrones.com/

Assessment Modes:

Sl. No	Method/ Technique	Course Outcomes				Marks		Weightage
		1	2	3	4	Max	Min	
1	ISE: ABA	☑	☑	☑	☑	40	16	40 %
2	MSE	☑	☑	☐	☐	30	24	60 %
3	ESE	☐	☐	☑	☑	30		

- ISE - In-Semester Examination, MSE - Mid-Semester Examination, ESE - End-Semester Examination
- ABA - Activity Based Assessment, TA - Tutorial Assessment, PA - Practical Assessment

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CO's - PO's & PSO's Mapping: (Low - 1, Medium - 2, High -3, No Correlation - "-")

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1	-	-	-	-	-	-	3	3	-	2	-
2	3	1	1	1	2	-	-	-	2	2	-	-	1	-
3	3	3	3	-	3	2	2	3	-	3	3	3	3	3
4	3	2	2	3	2	-	-	-	1	3	-	3	2	-
Avg	**3.0**	**2.0**	**1.8**	**2.0**	**2.3**	**2.0**	**2.0**	**3.0**	**1.5**	**2.8**	**3.0**	**3.0**	**2.0**	**3.0**

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Course Details:

Class	T.Y B.Tech., Sem - VI
Course Code and Course Name	**2AEUV302 - Flight Control Systems**
Prerequisite	2AEUV201 - Introduction to Unmanned Aerial Vehicles (UAVs) 2AEUV301 - UAV Electronics and Sensors
Teaching Scheme: Lecture/Tutorial/Practical	03/00/00
Credits	03
Evaluation Scheme : ISE/MSE/ESE	40/30/30

Course Objectives:

1. To provide a comprehensive understanding of the theoretical principles behind UAV flight control systems and their various components.
2. To equip students with knowledge of advanced control mechanisms, including adaptive control and robust control techniques, for UAVs.
3. To analyze UAV flight control systems' performance, stability, and optimization in various operational conditions.

Course Outcomes (CO's): After successful completion of this course, the student will be able to,

2AEUV302_1	Apply open-source flight control systems (ArduPilot, PX4) to configure UAVs and integrate essential sensors for enhanced navigation and performance.
2AEUV302_2	Discover autonomous missions and real-time control algorithms to leverage advanced hardware and software platforms by specific operation requirements
2AEUV302_3	Analyze flight data logs to diagnose issues and optimize UAV systems for stability, efficiency, and mission-specific needs by using open source ground control softwares
2AEUV302_4	Evaluate UAV flight control systems, incorporating robust techniques to address environmental and operational challenges by the help of existing developer community

Course Contents:

Unit 1	**Introduction to Open Source UAV Flight Control Systems**	**6**
Overview of ArduPilot and PX4 autopilot systems: architecture and components. Practical setup and configuration of popular flight controllers (e.g., Pixhawk series). Introduction to ground control software, i.e., Mission Planner and QGroundControl. **Additional topics [Not for ESE]:** Configuring a quadcopter flight controller using PX4. Initial setup, firmware installation, and basic calibration.		
Unit 2	**Practical UAV Control Dynamics**	**6**
Flight dynamics: roll, pitch, yaw control, and motor mixing principles for multi-rotors. Real-world challenges in UAV		

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control, i.e., vibrations, load variations, and environmental factors.Controller tuning for different UAV airframes and flight conditions. Introduction to advanced flight modes, i.e., stabilize, loiter, and auto. Tuning PID values and testing stability using ground control software.		
Unit 3	**Sensor Integration and Calibration**	**7**
Overview of essential sensors (IMU, GPS, compass, barometer) and their role in flight control. Hardware integration of sensors with flight controllers (e.g., Herelink, T12 radios). Calibration techniques for sensors to ensure accuracy and reliability. **Additional topics [Not for ESE]:** Integrating additional sensors like LiDAR, radar, and airspeed sensors. Sensor calibration using QGroundControl and real-time data validation.		
Unit 4	**Autonomous Navigation and Mission Planning**	**6**
Autonomous mission planning: waypoint creation and uploading using MAVLink. Configuring autonomous flight parameters: altitude, speed, and fail-safes. Practical considerations for long-range and beyond-line-of-sight (BVLOS) missions. Introduction to real-time trajectory updates and obstacle avoidance. **Additional topics [Not for ESE]:** Hands-on Planning and executing autonomous missions on a simulated UAV.		
Unit 5	**Real-Time Data Processing and Control Algorithms**	**6**
Introduction to real-time flight control algorithms and custom coding. Writing and deploying control algorithms on hardware platforms like Raspberry Pi and Jetson. Data logging and post-flight analysis, i.e., interpreting flight logs for troubleshooting. Implementing fail-safe mechanisms for GPS loss, signal failure, and low battery. **Additional topics [Not for ESE]:** Hands-on Customizing flight behavior through algorithm adjustments and testing.		
Unit 6	**UAV System Optimization and Advanced Applications**	**8**
Flight control optimization for specific missions, i.e., reducing power consumption and improving agility. Advanced PX4 features, i.e., swarm intelligence and cooperative UAV operations. Practical implementation of robust control for dynamic payloads and environmental conditions. Safety considerations in autonomous UAV systems. **Additional topics [Not for ESE]:** Hands-on Optimizing flight performance and conducting real-world mission tests.		

Text Books:

Sl.No	Title	Authors	Publisher	Edition	Year
1	Unmanned aircraft systems: UAVS design, development and deployment	Austin, R.	John Wiley & Sons.	1st	2011
2	Designing Purpose-Built Drones for Ardupilot Pixhawk 2.1: Build drones with Ardupilot	Ty Audronis	Packt Publisher	1st	2017
3	Introduction to UAV systems	Fahlstrom P, Gleason T	Wiley, UK	4th	2012
4	Handbook of unmanned aerial vehicles	Valavanis K. P.; Vachtsevanos, G. J., eds	Springer reference	1st	2015
5	A first course in aerial robots and drones	Sebbane, Y. B.	CRC Press	1st	2022

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E-Resources/Reference Papers:

1. https://oscarliang.com/flight-controller/
2. https://docs.px4.io/main/en/hardware/reference_design.html
3. https://ardupilot.org/dev/docs/building-the-code.html
4. https://ardupilot.org/mavproxy/index.html#home
5. https://ardupilot.org/planner/docs/mission-planner-building.html
6. https://docs.cubepilot.org/user-guides/herelink/herelink-user-guides

Assessment Modes:

Sl. No	Method/ Technique	Course Outcomes				Marks		Weightage
		1	2	3	4	Max	Min	
1	ISE : ABA	☑	☑	☑	☑	20	16	40 %
2	MSE	☑	☐	☐	☐	30	24	60 %
3	ESE	☐	☑	☐	☐	30		

- ISE - In-Semester Examination, MSE - Mid-Semester Examination, ESE - End-Semester Examination
- ABA - Activity Based Assessment, TA - Tutorial Assessment, PA - Practical Assessment

CO's - PO's & PSO's Mapping: (Low - 1, Medium - 2, High -3, No Correlation - "-")

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	2	-	3	-	2	1	2	-	3	2	1
2	3	3	1	1	2	-	-	3	3	2	1	1	1	2
3	3	3	2	3	3	-	3	2	3	2	-	2	3	1
4	3	3	3	3	3	-	1	2	3	1	-	2	3	3
Avg	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**

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Course Details:

Class	B.Tech., Sem - VII
Course Code and Course Name	**2AEUV401 - UAV Safety and Regulations**
Prerequisite	NIL
Teaching Scheme: Lecture/Tutorial/Practical	03/00/00
Credits	03
Evaluation Scheme : ISE/MSE/ESE	40/30/30

Course Objectives:

1. To provide an in-depth understanding of UAV regulations in India, including legal frameworks, operational guidelines, and compliance requirements.
2. To equip students with the knowledge and skills to implement safety protocols, risk management strategies, and advanced safety technologies for UAV operations.
3. To foster awareness of ethical considerations, privacy concerns, and emerging trends in UAV safety and regulatory practices for responsible and secure UAV usage.

Course Outcomes (CO's): After successful completion of this course, the student will be able to,

2AEUV401_1	Understand the legal and regulatory framework governing UAV operations in India, including guidelines and Drone Rules with the help of the regulatory bodies like DGCA, ICAO.
2AEUV401_2	Apply UAV safety protocols and risk management strategies to ensure safe and compliant operations in various operating environments.
2AEUV401_3	Analyze the challenges and solutions for operating UAVs in restricted and urban areas, incorporating advanced safety technologies and geo-fencing mechanisms.
2AEUV401_4	Evaluate ethical considerations and future trends in UAV safety and regulations emphasizing privacy, security, and evolving legal standards.

Course Contents:

Unit 1	**Introduction to UAV Safety and Regulations**	**6**
Importance of UAV safety and regulatory compliance - Overview of global UAV regulations: FAA, EASA, and ICAO guidelines - Indian drone regulations: DGCA's Civil Aviation Requirements (CAR) for UAVs - Classification of drones as per Indian regulations (Nano, Micro, Small, Medium, and Large) - Role of Unmanned Aircraft System Traffic Management (UTM) in safe UAV operations.		
Unit 2	**Legal Framework for UAV Operations in India**	**6**
Key provisions of the Drone Rules 2021 - Drone registration and certification process in India - Guidelines for obtaining the Unique Identification Number (UIN) and Operator Permit - No Permission No Takeoff (NPNT) compliance - Airspace categorization: Green, Yellow, and Red zones - Penalties for regulatory violations in India.		

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Unit 3	**UAV Safety Protocols and Risk Management**	**6**
Pre-flight and post-flight safety checks - Risk assessment techniques for UAV operations - Developing and following Standard Operating Procedures (SOPs) for UAVs - Safety considerations during takeoff, flight, and landing phases - Case studies of UAV accidents: causes and preventive measures.		
Unit 4	**Drone Operation in Restricted and Urban Areas**	**7**
Challenges of operating UAVs in urban and restricted environments - Permissions required for flying in restricted zones - Safety measures for operations near airports, highways, and densely populated areas - Handling emergencies: GPS loss, signal jamming, and mid-air collisions - Use of geo-fencing and Return-to-Home (RTH) systems for safe navigation.		
Unit 5	**Advanced UAV Safety Technologies**	**7**
Role of fail-safe mechanisms in ensuring UAV safety - Collision avoidance systems and their implementation in drones - Integration of ADS-B and remote identification systems - Advanced sensor technologies for situational awareness (LiDAR, radar) - Introduction to counter-UAV technologies and their implications.		
Unit 6	**Ethical and Future Perspectives in UAV Operations**	**7**
Ethical considerations in UAV usage: privacy, security, and surveillance concerns - UAV applications with safety implications: delivery, inspection, and search and rescue - Evolving UAV regulatory frameworks and trends in India - International collaboration for UAV safety and standardization - Future challenges in UAV safety and regulation.		

References:

Sl.No	Title	Author	Publisher	Edition	Year
1	The Drone Rules, 2021	Amber Dubey	Ministry of Civil Aviation, Controller of Publications, Delhi	1st	2021
2	Drone (Amendment) Rules, 2022	Amber Dubey	Ministry of Civil Aviation, Controller of Publications, Delhi	1st	2022
3	National Unmanned Aircraft System Traffic Management (UTM) Policy Framework	Amber Dubey	Ministry of Civil Aviation, Controller of Publications, Delhi	1st	2021
4	Certification Scheme for Unmanned Aircraft Systems	Amber Dubey	Ministry of Civil Aviation, Controller of Publications, Delhi	1st	2022

Assessment Modes:

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Sl.No	Method/Technique	CO's				Marks		Weightage
		1	2	3	4	Max	Min	
1	ISE : ABA	☐	☐	☐	☐	40	16	40%
3	MSE	☐	☐	☐	☐	30	24	60%
5	ESE	☐	☐	☐	☐	30		

CO's - PO's & PSO's Mapping: (Low - 1, Medium - 2, High -3, No Correlation - "-")

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2	-	-	-	3	-	2	-	-	-	2	-	-
2	2	3	2	-	-	3	1	3	-	-	-	-	-	-
3	2	3	3	-	2	2	1	-	-	-	-	-	-	-
4	-	2	-	-	-	3	2	3	-	-	-	3	-	-
Avg	2	3	3	-	2	3	1	3	-	-	-	3	-	-

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