



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Aeronautical Engineering

Subject Code: BE05001071

Subject Name: Introduction to UAV

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 2

<b>Prerequisite:</b>	Zeal to learn the subject
<b>Rationale:</b>	Fundamentals of Aeronautical Engineering, Fluid Mechanics, Aerodynamics, Flight Mechanics, Avionics.

## Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Explain the fundamental concepts of Unmanned Aerial Vehicles (UAVs)	10
CO-2	Identify and describe the major components and systems of UAVs	20
CO-3	Analyze the aerodynamic principles governing UAV flight	20
CO-4	Evaluate different UAV structural configurations and propulsion systems	20
CO-5	Apply UAV tuning and testing procedures	15
CO-6	Understand and interpret DGCA regulations and airworthiness requirements for UAV operations.	15

## Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/C A (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

*Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.*



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## Content:

Sr. No.	Content	Total Hrs	Total Weightage %
1	<b>Basics of Unmanned Aerial Vehicle:</b> Definition and characteristics of UAV, Classification of UAVs, Categories of UAVs, Advantages and limitations of UAVs, Comparison between UGVs and UAVs, Applications of UAVs, Future Scope of UAVs: Nano drones, Swarm Drones.	5	10
2	<b>Components and System of UAVs:</b> Basic Components of UAVs, Microcontrollers and its role in UAV Systems, Sensors in UAVs: Gyroscope, Accelerometer, Global Positioning System (GPS), Barometer, Integration of Sensors: The Inertial Measurement Unit (IMU), Flight Planning in UAV Systems: Mission Planning, Route Mapping, Transmitters and Receivers in UAVs, Flight Controllers in UAVs, Telemetry in UAVs, Binding in UAVs System.	8	20
3	<b>Aerodynamics of UAVs:</b> Understanding Degrees of freedom in UAVs, Control surfaces and their role in DOF, Understanding Stick movements in UAV Control, Flight modes in UAVs: Manual Flight mode, Autonomous Flight Mode, Hybrid Flight Mode, Manoeuvres in UAV Flight, Control Mechanisms of UAVs.	8	20
4	<b>Structure and Propulsion in UAVs:</b> UAV configurations, Comparison of UAV configurations, Payload Configurations, Batteries in UAV Power system: LiPO Battery, NiMH Battery, Li-ion Battery, Battery Capacity, Battery Safety, Hybrid Propulsion system in UAVs, Fuel efficiency in Hybrid Systems, Comparison of Hybrid and Conventional Propulsion System, Solar propulsion in UAVs.	9	20
5	<b>Tuning and Testing in UAVs:</b> <b>UAV Tuning:</b> PID (Proportional-Integral-Derivative) Tuning in UAVs, Effects of PID Parameters on UAV Flight behaviour, Flight Controller Calibration. <b>UAV Testing:</b> Flight testing of UAVs, Pre-flight Checks, Data Logging and Analysis< Simulator Training in UAV Operations.	9	20
6	<b>Airworthiness in UAVs:</b> DGCA Rules and Regulations for UAV Operation: Drone classification under DGCA, Airspace Zones and Operational Permissions, Operational Compliance and Safety Procedures, Flight Rules and Airspace Visibility Requirements, Remote Pilot Training Organizations(RPTO) and Permissions.	6	10
<b>TOTAL</b>		<b>45</b>	



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## Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	25	10	10	15

**R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**The syllabus of *Introduction to UAV* directly contributes to**

<b>SDG 4:</b>	<b>Quality Education</b> The course builds advanced technical knowledge in UAV systems, aerodynamics, control, and regulations, contributing to skill-based engineering education.
<b>SDG 7</b>	<b>Affordable and Clean Energy</b> Topics like solar propulsion systems and energy-efficient UAV designs support sustainable energy solutions.
<b>SDG 8</b>	<b>Decent Work and Economic Growth</b> UAV technology is a growing industry (surveillance, agriculture, logistics), enhancing employability and innovation-driven economic growth.
<b>SDG 9</b>	<b>Industry, Innovation and Infrastructure</b> UAV design, system integration, sensors, and avionics contribute directly to innovation and modern infrastructure development.
<b>SDG 11</b>	<b>Sustainable Cities and Communities</b> UAVs are used in smart city applications such as traffic monitoring, disaster management, surveillance, and urban planning.
<b>SDG 16</b>	<b>Peace, Justice and Strong Institutions</b> UAV regulations (DGCA), airspace management, and compliance contribute to safe and lawful drone operations.



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## Reference Books:

1. Douglas M. Marshall, Richard K. Barnhart, Eric Shappee, Michael Thomas Most. "Introduction to Unmanned Aircraft Systems, Second Edition. May 24, 2016 by CRC Press. Textbook.
2. Randal W. Beard & Timothy W. McLain. Small Unmanned Aircraft: Theory and Practice. Princeton University Press. 2012
3. Reg Austin. Unmanned Aircraft Systems: UAVS Design, Development and Deployment. 2010. Wiley. ISBN: 978-0-470-05819-0
4. Valavanis, Kimon P., Vachtsevanos, George J. (Eds.). Handbook of Unmanned Aerial Vehicles. Springer. 2015 Paul Fahlstrom,
5. Thomas Gleason. Introduction to UAV Systems, 4th Edition. ISBN: 978-1-119-97866-4; 306 pages; September 2012.
6. DingyüXue and YangQuan Chen. Modeling, Analysis and Design of Control Systems in MATLAB and Simulink. World Scientific Publishing Co. 580pp, Nov 2014, ISBN: 978-981-4618-45-8

## Standards and Act:

1. Aircraft Act 1934
2. Aircraft Rules 1937
3. Drone Rules 2021
4. DGCA CAR for RPAS
5. Digital Sky Platform
6. NPNT Compliance
7. Airspace Classification
8. RPTO Certification

## List of Experiments:

1. Introduction to Unmanned aerial vehicle.
2. Flight Simulator Familiarization and control checks.
3. Calibration of Flight Simulator Practice and Testing.
4. To understand parts and function of UAVs software.
5. To learn about manual control system of UAVs.
6. Circuit Flying Exercises in flight simulator.
7. To prepare the frame of Quadcopter using 3D Printer.
8. Assembly of Frame and Electronic circuits.
9. Flying practice of Assembled Drone.

**Major Equipment:** Flight Simulator, 3-D Printer.

**List of Open Source Software/learning website:**

<https://nptel.ac.in/course.php>



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## List of suggested activities for Term Work / Self Learning:

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Industry/Research laboratory Visit (Power converters/electronics/drives company)	Visit = 5hrs, Report preparation = 5hrs Total = 10hrs	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5hrs Report preparation = 5hrs Total = 10hrs	Report /presentation based on the video learning outcomes.
		Self-learning on-line course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
		Annotated Video Explanation of Concept/Problem	10hrs (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
3	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2hrs each. Total = 10hrs	Based on the assignment submitted.
		Blog or Technical Article Writing	10hrs (Research – 6hrs, Writing – 4hrs)	Based on originality, technical content, references cited, and clarity of communication.
4	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 15 hrs	Based on the depth of the solution submitted.
5	Research Paper Review / Analysis	Discussion on research paper based on relevant subject (SCOPUS Index/any reputed Journal)	5 research paper = 20 hrs	Summarize research paper and evaluation critical parameters
6	Poster/ Chart/ Power point presentation	Poster/chart/power point preparation on technical topics	Duration = 6 hrs	Based on poster/chart preparation and presentation skills
7	Micro Project	Working/non-working model on technical topics	Working = 10 hrs Non-working = 10 hrs	Based on inter department/external



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				evaluation
8	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 hrs each	Based on performance in group discussion, technical depth, knowledge etc.
		Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10hrs	Based on quiz scores and reflection report after each quiz.
9	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5hrs Report preparation = 5hrs Total = 10hrs	Based on in-depth study, technical depth, data collected, fact finding, etc.
10	Other	Patent Search and Innovation Gap Identification	10hrs (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

**Note:**

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Introduction to UAV* incorporates;

- Seminar activities – 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of UAVs. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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