INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**UNMANNED AIR VEHICLES**				
Course Code	AAE506				
Programme	B.Tech				
Semester	VII	AE			
Course Type	Professional Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. Praveen Kumar Balguri, Assistant Professor				
Course Faculty	Mr. Praveen Kumar Balguri, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced key concepts related tounmanned aircraft systems (UAS), including basic types, characteristics, applications and current and future uses. It is designed for users with commercial, private/recreational, and public and educational interest in UAS applications. Specific importance is placed on safety of flight within the National Airspace System (NAS), including where to fly and where to find flight planning tools.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AAE004	IV	Low speed Aerodynamics
UG	AAE010	V	Aircraft systems and control

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Unmanned Air Vehicles	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two subdivisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Presentation
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	2	Seminar
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamicand challenging environment for design and development of new products	1	Assignments
PSO 2	**Problem-solving Skills:** Imparted through simulation language skills and general-purpose CAE packages to solve practical, design and analysis problemsofcomponents to complete the challenge of airworthiness for flight vehicles.	-	--
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	--
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aeronautical/aerospaceallied systems to become technocrats.	--	--

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Introduce to the student about the basic ideas of Unmanned AirVehicles
II	Familiarize the students about the aerodynamics and airframeconfigurations
III	Accustom the student to the wide variety of unmanned airvehicles
IV	Acquaint the student about the various communication and navigation systems of unmanned air vehicles

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the concept of UAS-system composition and design concepts with some applications of UAS	CLO 1	Understand the unmanned aerial vehicle types based on the design and application
		CLO 2	Understand different elements of UAS (composition) and their importance.
		CLO 3	Describe the design concepts of UAS
		CLO 4	Apply the knowledge of selection of the system
CO 2	Understand the concept of aerodynamics, airframe configurations,structures, mechanisms, selection of power-plants, modular construction and ancillary equipment	CLO 5	Understand the different types of drags for UAVs.
		CLO 6	Describe the range of airframe configurations available for UAVs
		CLO 7	Remember the aerodynamic efficiency factors
		CLO 8	Analyze the structures and mechanical designfactors in the design of UAVs
		CLO 9	Understand the design of a UAS-based flight mission.
		CLO 10	Apply the knowledge of different types of power-plants in selection.
CO 3	Explore the concept of Long-endurance, long range, Medium-range, tactical aircraft and aircraft configurations	CLO 11	Recognize and recommend potential airframe for long- endurance long-range UAVs
		CLO 12	Apply acquired knowledge and critical thinking skills to select airframe for medium-range, tactical aircraft
		CLO 13	Understand theMUAV types
		CLO 14	Analyze the different types of MAV, NAV and UCAV
		CLO 15	Understand thenovel hybrid aircraft configurations and UAVs for Research purpose
CO 4	Describe the concept ofcommunications, Mid-aircollisionavoidance, communications data rate and bandwidth usage Inertial Navigation - Radio Tracking - Way-point Navigation	CLO 16	Understand the communication media and radio communication between GCS and aircraft
		CLO 17	Apply the knowledge of regulations to avoid mid-air collision
		CLO 18	Understand the technology of communication data rate and bandwidth usage
		CLO 19	Apply knowledge of GPS
		CLO 20	Identify the different navigation systems and tracking
CO 5	Understand the concept of convertible rotor aircraft	CLO 21	Understandthe issues and challenges of control and stability of different types of UAVs

COs	Course Outcome	CLOs	Course Learning Outcome
	payload control, culmon filter and autonomy	CLO 22	Apply the knowledge of payload control
		CLO 23	Ability to understand the role of different sensors and autonomy in control and stability of UAV systems

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE506.01	CLO 1	Understand the unmanned aerial vehicle types based on the design and application	PO 1	3
AAE506.02	CLO 2	Understand different elements of UAS (composition) and their importance.	PO 3	2
AAE506.03	CLO 3	Describe the design concepts of UAS	PO 1	3
AAE506.04	CLO 4	Apply the knowledge of selection of the system	PO 1	3
AAE506.05	CLO 5	Understand the different types of drags for UAVs.	PO 3	2
AAE506.06	CLO 6	Describe the range of airframe configurations available for UAVs	PO 3	2
AAE506.07	CLO 7	Remember the aerodynamic efficiency factors	PO 3	2
AAE506.08	CLO 8	Analyze the structures and mechanical design factors in the design of UAVs	PO 3	2
AAE506.09	CLO 9	Understand the design of a UAS-based flight mission.	PO 5	1
AAE506.10	CLO 10	Apply the knowledge of different types of power-plants in selection.	PO 5	1
AAE506.11	CLO 11	Recognize and recommend potential airframe for long- endurance long-range UAVs	PO 3	2
AAE506.12	CLO 12	Apply acquired knowledge and critical thinking skills to select airframe for medium-range, tactical aircraft	PO 3	2
AAE506.13	CLO 13	Understand theMUAV types	PO 1	1
AAE506.14	CLO 14	Analyze the different types of MAV, NAV and UCAV	PO 1	3
AAE506.15	CLO 15	Understand thenovel hybrid aircraft configurations and UAVs for Research purpose	PO 1	3
AAE506.16	CLO 16	Understand the communication media and radio communication between GCS and aircraft	PO 1 PO 3	2
AAE506.17	CLO 17	Apply the knowledge of regulations to avoid mid-air collision	PO 1 PO 3	3
AAE506.18	CLO 18	Understand the technology of communication data rate and bandwidth usage	PO 1 PO 3	2
AAE506.19	CLO 19	Apply knowledge of GPS	PO 1 PO 3	3
AAE506.20	CLO 20	Identify the different navigation systems and tracking	PO 1 PO 3	3
AAE506.21	CLO 21	Understandthe issues and challenges of control and stability of different types of UAVs	PO 1	3
AAE506.22	CLO 22	Apply the knowledge of payload control	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE506.23	CLO 23	Ability to understand the role of different sensors and autonomy in control and stability of UAV systems	PO 1	3

3= High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)
	PO 1	PO 3	PO 5	PSO1
CO 1	3	2		1
CO 2		2	1	
CO 3	3	2		1
CO 4	3	2		1
CO 5	3			

3= High; 2 = Medium; 1 = Low

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3												1			
CLO 2			2													
CLO 3	3												1			
CLO 4	3												1			
CLO 5			2													
CLO 6			2													
CLO 7			2													
CLO 8			2													
CLO 9					1											
CLO 10					1											
CLO 11			2										1			
CLO 12			2										1			
CLO 13	1															

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 14	3															
CLO 15	3															
CLO 16	2		2										1			
CLO 17	3		2										1			
CLO 18	2		2										1			
CLO 19	3		2										1			
CLO 20	3		2										1			
CLO 21	3															
CLO 22	3															
CLO 23	3															

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XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO3, PO5,PSO1	SEE Exams	PO1, PO3, PO5,PSO1	Assignments	PSO1	Seminars	PO1, PO3, PO5,PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO3, PO5,PSO1						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Unit-I	INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS
The systemic basis of UAS-system composition; Conceptual phase; Preliminary design; Selection of the system; Some applications of UAS.	
Unit-II	**AERODYNAMICS AND AIRFRAME CONFIGURATIONS**
Lift-induced Drag; Parasitic Drag; Rotary-wing aerodynamics; Response to air turbulence; Airframe configurations scale effects; Packaging density; Aerodynamics; Structures and mechanisms; Selectionofpower-plants; Modular construction; Ancillary equipment.	
Unit-III	**CHARACTERISTICS OF AIRCRAFT TYPES**
Long-endurance, long-range role aircraft; Medium-range, tactical aircraft; Close-range / battlefieldaircraft; MUAV types; MAV and NAV types; UCAV; Novel hybrid aircraft configurations; Research UAV	

Unit-IV	COMMUNICATIONS NAVIGATION
Communication media; Radio communication; Mid-air collision (MAC) avoidance; communications data rate and bandwidth usage; Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN -LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation	
Unit-V	**CONTROL AND STABILITY**
HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control -Sensors – culmon filter- Autonomy	
Text Books:	
Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.	
Reference Books:	
1. Milman&Halkias ―Integrated Electronics, McGraw Hill, 1999. 2. Malvino& Leach―Digital Principles & Applications, McGraw Hill, 1986. 3. Collinson R.P.G ―Introduction to Avionics, Chapman and Hall, India, 1996 4. BernadEtikin―Dynamic of flight stability and control, John Wiley, 1972	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to UAS, need of UAS.	CLO 1	T1:1.4
2-3	The systemic basis of UAS-system composition;	CLO 2	
4	Conceptual phase; Preliminary design;	CLO 2	T1:2.1.2.2
5-6	Selection of the system	CLO 2	T1:2.4
7	Some applications of UAS	CLO 3	T1:1.1
8-9	Lift-induced Drag; Parasitic Drag; Rotary-wing aerodynamics;	CLO 3	T1:3.1, 3.2, 3.3
10-13	Response to air turbulence; Airframe configurations	CLO 3	T1:3.4,3.5
14-16	Scale effects, Packaging density; Aerodynamics;	CLO 5	T1:6.1, 6.2,6.3
17-19	Structures and mechanisms; Selection of power-plants;	CLO 7	T1:6.4,6.5
20-22	Modular construction; Ancillary equipment	CLO 9	T1:6.6, 6.7
23-24	Long-endurance, long-range role aircraft	CLO 13	T1:4.1
25-26	Medium-range, tactical aircraft;	CLO 13	T1:4.2
27	Close-range / battlefield aircraft	CLO 15	T1:4.3
28	MUAV types; MAV and NAV types; UCAV;	CLO 15	T1:4.4, 4.5, 4.6
29	Novel hybrid aircraft configurations; Research UAV	CLO 11	T1:4.7, 4.8

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
30-31	Communication media; Radio communication;	CLO 16	T1:9.1
32-33	Mid-air collision (MAC) avoidance; communications data rate and bandwidth usage;	CLO 16	T1:9.3, 5.2.2
34	Antenna Types NAVSTAR Global Positioning System (GPS)	CLO 16	T1:9.5,11.1 R3: 6.5, 10
35-37	TACAN -LORAN C - Inertial Navigation	CLO 16	T1:11.2, 11.3, 11.4 R3: 6.2,10
38	Radio Tracking - Way-point Navigation	CLO 17	T1:11.5, 11.6
39	HTOL Aircraft	CLO 17	T1:10.1 R4:3.5,3.6, 3.9
40-41	Helicopters	CLO 19	T1:10.2
42	Convertible Rotor Aircraft -	CLO 19	T1:10.3
43-44	OTE/OTE/SPH, Payload Control -Sensors	CLO 20	T1:10.4
45	Culmon (Kalman) filter- Autonomy	CLO 20	T1:11.1, 10.6 R4: 12.2,12.3, 12.4

XVII. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No.	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts	Seminars	PO 1	PSO 1
2	Encourage students to solve real time applications with projects	Seminars	PO 3	PSO 1

Prepared by:
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