



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	UNMANNED AIR VEHICLES				
Course Code	AAE506				
Program	B.Tech				
Semester	SEVEN				
Course Type	Professional Elective				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Praveen Kumar Balguri, Associate Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Introduce the major subsystems and the fundamental design phases of Unmanned Air Vehicle Systems (UAS)
II	Familiarize the basic aerodynamics and airframe configurations of unmanned air vehicles (UAVs)
III	Acquaint the various communication and navigation systems of UAVs
IV	Accustom the basic control and stability aspects of UAVs

COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO 1	Recall the functions of each major sub-systems of the unmanned air vehicle systems to select the suitable subsystem.	Remember

CO 2	Demonstrate the knowledge of basic design phases which will be considered for the design of unmanned air vehicle systems	Understand
CO 3	Recognize the significant role requirement parameters which determine the shape, size, performance, and costs of UAV systems as per role requirement	Understand
CO 4	Demonstrate the knowledge of the different types of drag in fixed, rotary-wing aircraft and UAV response to air turbulence in selecting the suitable airframe configuration	Understand
CO 5	Illustrate the different types of airframe configurations available for unmanned air vehicle systems	Understand
CO 6	Outline the scaling effects, package density, basic aerodynamics, and structures concepts used during the design of UAVs	Understand
CO 7	Select a suitable power-plant based on power generation systems for the given role requirement	Apply
CO 8	Analyze the attributes, performance, design issues and compromises of different types of aircrafts for UAV systems	Analyze
CO 9	Identify the appropriate communication and navigation systems for the UAVs as per the role requirements	Apply
CO 10	Categorize the different techniques used to achieve the control and stability of UAV systems.	Analyze
CO 11	Apply the fundamental concepts of UAS in design and development of UAV systems for real-world application	Apply

MAPPING OF EACH CO WITH PO(s), and PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 7	2	-	-	3	-	-	-	-	-	-	-	-	1	-	-	-
CO 8	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 9	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 11	2	-	3	-	-	-	-	-	-	-	-	2	-	-	-	-

TUTORIAL QUESTION BANK

MODULE-I				
INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS				
Part - A (Short Answer Questions)				
S. No	Question	Blooms Taxonomy Level	How does this Subsume the level below	Course Outcome
1	What are UAS? Give two applications of UAS.	Remember	---	CO 1
2	What is HALE? Give two applications with an example.	Remember	---	CO 1
3	Compare RC Model aircraft with Drones.	Understand	This would require the learner to recall the basic definitions of RC model and drones and compare them.	CO 1
4	Define MALE? Give two applications with an example.	Remember	---	CO 1
5	Differentiate Drones and UAV	Understand	This would require the learner to recall the basic definitions of drones and UAVs and differentiate them.	CO 1
6	Define TUAV? Give two applications with an example.	Remember	---	CO 1
7	Explain MUAV with applications and examples.	Understand	This would require the learner to recall the basic definition, applications and examples of MUAV.	CO 1
8	Define MAV? Give two applications with an example.	Remember	---	CO 1
9	Describe NAVs? Give two applications with an example.	Understand	This would require the learner to recall the basic definition and applications of NAV.	CO 3
10	What is RPH?	Remember	---	CO 1
11	Differentiate UCAV and UCAR?	Understand	This would require the learner to recall the basic definitions of UCAV and UCAR and differentiate them.	CO 1
12	Explain DDD roles?	Understand	This would require the learner to recall the necessity of UAVs.	CO 1
13	List the elements of UAS?	Remember	---	CO 1
14	Define Radar tracking?	Remember	---	CO 1
15	Discuss Radio tracking technique.	Understand	This would require the learner to recall the method of radio tracking system.	CO 1
16	Explain covert roles? Give examples of suitable UAVs for covert roles.	Understand	This would require the learner to recall the definition of covert roles, examples of UAS for covert roles.	CO 1

17	What is the purpose of 'Up-link'?	Remember	This would require the learner to recall the purpose of Up-link.	CO 1
18	Explain the purpose of 'Down-link'?	Understand	This would require the learner to recall the purpose of Down-link.	CO 1
19	Describe GCS, SCS and ACS?	Remember	This would require the learner to recall different control stations and express them.	CO 1
20	What are factors involved in the selection of the airframe?	Understand	This would require the learner to recall the factors involved in the selection of the airframe for UAS.	CO 3

Part - B (Long Answer Questions)

1	Write short notes on categories of systems based upon air vehicle types.	Understand	This would require the learner to recall the basic definition of tactical unmanned air vehicle systems and describe the system and applications of TUAV.	CO 3
2	Describe the need for UAS? Discuss in detail.	Understand	This would require the learner to recall the basic the necessity of UAVs and explain.	CO 1
3	Draw the functional structure of UAV system and discuss the control station and payload.	Understand	This would require the learner to recall the functional structure of UAV system and discuss the control station and payload.	CO 1
4	Discuss about the 'Air vehicle' in UAV system functional structure (system composition)	Understand	This would require the learner to recall the role and types of Air vehicles in UASs. .	CO 5
5	Write short notes on launch, recovery and retrieval equipment for UAVs as a part of UAVs system functional structure.	Understand	This would require the learner to recall the role and types of on launch, recovery and retrieval equipment for UAVs.	CO 1
6	Discuss the important parameters involved in 'Selection of Systems' for UAS.	Understand	This would require the learner to recall the important parameters of UAS and their roles.	CO 3
7	Describe the conceptual phase of design of UAS.	Understand	This would require the learner to recall the design phases of UAV systems and explain conceptual phase.	CO 2
8	Discuss the preliminary design and detailed design phases of UAVs.	Understand	This would require the learner to recall the design phases of UAV systems and explain preliminary design and detailed design phases.	CO 1
9	Discuss the UAV system selection as categories	Understand	This would require the learner to recall the UAV system selection as categories based on air vehicle type and range and explain them.	CO 3
10	Write short notes on the following design consideration	Understand	This would require the learner to recall the design considerations and	CO 3

	of UAS i) Air vehicle selection based on speed ii) Environmental conditions		issues and explain Air vehicle selection based on speed and environmental conditions	
11	Discuss 'Navigation Systems' and 'Communication Systems' of UAS	Understand	This would require the learner to recall the 'Navigation Systems' and 'Communication Systems' of UAS and explain them.	CO 9
12	Identify the applications of UAS for civilian and military uses.	Apply	This would require the learner to recall the features of different UAS and explain their applications civilian and military.	CO 1
13	Write short notes on the importance of 'Interface' between the sub-systems and with the other systems of UAS.	Understand	This would require the learner to recall the importance of 'Interface' between the sub-systems and with the other systems of UAS and explain.	CO 1
14	Write short notes on 'payload consideration' for design of UAS.	Understand	This would require the learner to recall the role requirement of the payload for design of UAS.	CO 1
15	Identify the importance of considering environmental conditions during the selection of UAS system	Apply	This would require the learner to recall the effects of environmental conditions on UAS and effects of UAS on environmental conditions and apply the knowledge of these effects during the selection of UAS system and explain.	CO 2
Part – C (Critical Thinking Questions)				
1	Classify the UAVs based on altitude, range, mass and wing span?	Understand	This would require the learner to recall the different categories of UAVs.	CO 4
2	Explain the different roles where UAVs can perform better than manned aircrafts, discuss them in detail?	Understand	This would require the learner to recall the necessity of UAVs and their advantages in comparison with manned aircrafts.	CO 3
3	Compare UAVs economically with manned aircrafts, discuss with respect to initial cost and operating costs?	Understand	This would require the learner to recall the design considerations, initial cost and operating costs of UAVs.	CO 2
4	Explain different types of control stations and the roles of CS in UAS operation?	Understand	This would require the learner to recall the different types of control stations and the roles of CS in UAS operation	CO 1
5	Identify the effect of payload, endurance and speed range on selection of air vehicle for UAS?	Apply	This would require the learner to recall the role of payload, endurance and speed range of air vehicle in UAS and explain their effects on selection of air vehicle for UAS.	CO 1

6	Explain the different means of navigation (or fall- back options) when GPS system is blocked?	Understand	This would require the learner to recall the navigation systems and fallback options.	CO 9
7	Describe the functions of up-link and down-link?	Understand	This would require the learner to recall the functions of up-link and down-link in communication system.	CO 9
8	Identify the importance of the interfaces between UAS system components and other systems, discuss briefly?	Apply	This would require the learner to recall the role of the interfaces among the subsystems of UAS and other systems and explain the importance of the interfaces between UAS system components and other systems.	CO 1
9	Discuss the different design phases of most aircraft based systems.	Understand	This would require the learner to recall the	CO 2
10	Outline the reasons for considering environmental conditions during the selection of UAS system?	Understand	This would require the learner to recall the	CO 2

MODULE-II

AERODYNAMICS AND AIRFRAME CONFIGURATIONS

Part - A (Short Answer Questions)

1	Define 'Lift induced drag'	Remember	----	CO 4
2	How do you calculate the lift induced drag for fixed wing aircraft? Mention the variables involved.	Remember	----	CO 4
3	Explain the components of the lift induced drag? How do they affect lift induced drag?	Understand	This would require the learner to recall the formula to calculate the lift induced drag	CO 4
4	Discuss 'Parasitic drag'?	Understand	This would require the learner to recall the definition of parasitic drag	CO 4
5	Describe the parasitic drag for rotary- wing aircraft? Mention the variables involved.	Understand	This would require the learner to recall the formula to calculate the parasitic drag coefficient.	CO 4
6	How can be parasitic drag estimated for any level flight condition? Mention the variables involved.	Remember	----	CO 4
7	Describe the components of the parasitic drag? How do they affect lift induced drag?	Understand	This would require the learner to recall the components of the parasitic drag and lift induced drag	CO 4
8	What is the expression for parasitic drag when the aircraft	Remember	----	CO 4

	is operated at high incidence? Mention the variables involved.			
9	Explain 'absolute minimum flight speed'	Understand	This would require the learner to recall the definition of absolute minimum flight speed.	CO 4
10	Give the expression to calculate V_{\min} for a fixed wing aircraft? Mention the variables involved.	Remember	----	CO 4
11	Express V_{\min} for a UAV with flaps?	Understand	This would require the learner to recall the formula to calculate V_{\min} for a UAV with flaps	CO 4
12	Define disc loading for a rotary wing?	Remember	----	CO 4
13	Illustrate few HTOL aircraft configurations	Understand	This would require the learner to recall the HTOL aircraft configurations	CO 5
14	Explain of few VTOL configurations	Understand	This would require the learner to recall the VTOL configurations	CO 5
15	What are the few hybrid aircraft configurations?	Remember	----	CO 5
16	Comment on how minimum flight speed and wing loading are varying at sea level and at 15000 m altitude?	Understand	This would require the learner to recall the relation between minimum flight speed and wing loading at different altitudes (data diagram).	CO 4
17	How V_{\min} and wing loading varies for MAVs?	Remember	----	CO 4
18	How induced drag can be calculated by for the helicopter At a forward speed of about 70 km/hr? Mention the variables.	Understand	This would require the learner to recall the relationship to calculate induced drag for the helicopter.	CO 4
19	Describe the profile power in hover flight? Mention the variables.	Understand	This would require the learner to recall the expression to calculate profile power in hover flight	CO 4
20	Describe the calculation of acceleration in response to a 1 m/s vertical gust. Mention the variables.	Understand	This would require the learner to recall the expression to calculate the vertical acceleration in response to vertical gust	CO 4

Part - B (Long Answer Questions)

1	Explain the 'Lift Induced Drag' in detail with necessary diagrams.	Understand	This would require the learner to recall the lift induced drag and explain	CO 4
2	Write notes on the calculation of lift induced drag?	Understand	This would require the learner to recall the calculation of lift induced drag	CO 4
3	Discuss in detail the 'Parasitic Drag' of a fixed wing aircrafts.	Understand	This would require the learner to recall the parasitic drag and explain.	CO 4
4	Explain 'Rotary-wing Aerodynamics'.	Understand	This would require the learner to recall the rotary-wing aerodynamics.	CO 4

5	Identify the main causes for an aircraft to have a high response to atmospheric turbulence and explain the possible methods to reduce it?	Apply	This would require the learner to recall the causes for an aircraft to have a high response to atmospheric turbulence, explain them and recognize the possible methods to reduce the high response.	CO 4
6	Describe the wing loading of various UAVs.	Understand	This would require the learner to recall the wing loading of various UAVs and explain	CO 4
7	Write notes on 'Different HTOL Airframe Configurations'.	Understand	This would require the learner to recall the different HTOL airframe configurations	CO 5
8	Categorize 'Different VTOL Airframe Configurations'.	Analyze	The learner to recall different VTOL airframe configurations, identify their features and then apply the knowledge to categorize them.	CO 5
9	Explain 'Coaxial Rotor' airframe with necessary diagram.	Understand	This would require the learner to recall the coaxial rotor airframe for UAVs	CO 5
10	Write short notes on 'Convertible Rotor Aircraft' and 'Tilt-wing-body Aircraft'.	Understand	This would require the learner to recall the Convertible rotor aircraft' and Tilt-wing-body aircraft	CO 5
11	Compare 'Ducted Fan Aircraft' and 'Jet-life Aircraft' airframe configurations.	Analyze	This would require the learner to recall the ducted fan aircraft and Jet-life aircraft's airframe configurations, describe the features and differentiate them.	CO 5
12	Write notes on 'Scale Effects' with necessary diagrams.	Understand	This would require the learner to recall the scaling effects.	CO 6
13	What is 'Packaging Density', discuss in detail with respect to UAVs?	Understand	This would require the learner to recall the packaging density and its importance	CO 6
14	Explain in detail the 'Undercarriage Design'.	Understand	This would require the learner to recall the different undercarriages available for UAVs	CO 6
15	Write short notes on 'Structure Design' of UAVs with necessary diagrams.	Understand	This would require the learner to recall the structure design of UAVs	CO 6
16	Explain 'Mechanical Design' and 'Wear and Fatigue' of UAVs.	Understand	This would require the learner to recall the mechanical design and wear and fatigue of UAVs and explain	CO 6
17	Write short notes on 'Piston engines' for UAVs.	Understand	This would require the learner to recall the piston engines for UAVs.	CO 7
18	Outline the importance points in selection of power-plants for UAVs with the help of power-generation systems.	Understand	This would require the learner to recall the selection criteria of power-plants for UAVs	CO 7
19	Identify the gas turbine engines for UAVs.	Apply	This would require the learner to recall the different gas turbine	CO 7

			engines, describe their features and identify the suitable gas turbine engines for UAVs	
20	Describe the role of electric motors for UAVs.	Understand	This would require the learner to recall the role of electric motors for UAVs	CO 7
Part – C (Critical Thinking Questions)				
1	How does airspeed, wing loading and drag are related? Discuss with necessary diagrams	Understand	This would require the learner to think and recall the relation between airspeed, wing loading and drag and discuss.	CO 4
2	How does drag of rotary wing aerodynamics are different from fixed wing aerodynamics?	Understand	This would require the learner to recall the difference between rotary wing aerodynamics and fixed wing aerodynamics	CO 4
3	Describe the two main causes for an aircraft to have a high response to atmospheric turbulence, discuss by considering wing loading?	Understand	This would require the learner to recall the main causes for an aircraft to have a high response to atmospheric turbulence	CO 4
4	Identify the importance of 'Airframe configuration' in design of UAVs?	Apply	This would require the learner to recall the different airframe configurations, describe their features and identify the importance of 'Airframe configuration' in design of UAVs	CO 5
5	Compare the performance of 'Hybrid Airframe Configurations' with HTOL and VTOL?	Analyze	This would require the learner to recall the hybrid airframe configurations, describe the features and compare them with regular configurations	CO 5
6	Rephrase the airframe design of UAVs with respect to packaging density and scaling effects	Understand	This would require the learner to recall the packaging density and scaling effects and explain them with respect to airframe design.	CO 6
7	Explain the importance of structures and mechanisms by taking AUM of aircraft in to consideration	Understand	This would require the learner to recall the importance of structures and mechanisms by taking AUM of aircraft in to consideration	CO 6
8	Identify the importance of undercarriage for UAVs and discuss the design parameters.	Apply	This would require the learner to recall the role of undercarriages, describe their features and identify undercarriage for UAVs and discuss the design parameters	CO 6
9	Write the important points in selection of power-plants for UAVs with the help of power-generation systems.	Understand	This would require the learner to recall the selection of power-plants for UAVs with respect to power generation systems	CO 7

10	How modular construction concept does helps in the design of UAVs.	Understand	This would require the learner to recall the modular construction concept in the design of UAVs.	CO 6
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MODULE -III

CHARACTERISTICS OF AIRCRAFT TYPES

Part - A (Short Answer Questions)

1	What are the airframe options available for MAV?	Remember	---	CO 5
2	Give two names and applications of MAVs.	Remember	---	CO 5
3	Explain NAVs?	Understand	This would require the learner to recall the NAVs.	CO 5
4	Mention two examples and applications of UCAV?	Remember	---	CO 5
5	What are the important parameters of UCAV airframe?	Understand	This would require the learner to recall the important parameters of UCAV airframe	CO 5
6	Give two examples and applications of novel hybrid aircraft configurations.	Remember	---	CO 5
7	How UAVs can be used for research purpose?	Understand	This would require the learner to recall the applications of UAVs for research purpose	CO 5
8	Describe 'disposable load fraction'?	Understand	This would require the learner to recall the definition of disposable load fraction	CO 6
9	Explain the three important design parameters for HALE and MALE UAVs?	Understand	This would require the learner to recall the important design parameters for HALE and MALE UAVs	CO 5
10	Why longer wing span is preferred for long range UAVs, discuss with an example?	Remember	---	CO 5
11	Explain 'Span loading'?	Understand	This would require the learner to recall the definition of span loading.	CO 8
12	Define 'aspect ratio of wing' and its importance for HALE and MALE.	Remember	---	CO 8
13	Comment on 'sfc' of HALE at height altitudes and medium altitudes.	Understand	This would require the learner to recall the 'sfc' of HALE at height altitudes and medium altitudes.	CO 8
14	Give any two possible forms of airframes for MAVs with necessary examples.	Remember	---	CO 5
15	Describe the limiting factors of large wing area for HALE UAV?	Understand	This would require the learner to recall the limiting factors of large wing area for HALE UAV	CO 8

16	Explain the importance of 'rotor diameter' with necessary examples.	Understand	This would require the learner to recall the role of 'rotor diameter' in the design of rotor wing UAV	CO 8
17	Define the blade loading.	Remember	---	CO 8
18	Give few applications of Close-range/Battlefield aircrafts with necessary examples.	Remember	---	CO 8
19	Compare the issues related to long ramp and short ramp.	Understand	This would require the learner to recall the issues related to long ramp and short ramp	CO 8
20	Write short notes on Scan Eagle.	Understand	This would require the learner to recall the Scan eagle UAV's specifications and applications	CO 8

Part - B (Long Answer Questions)

1	Write notes on (i) Low aerodynamic drag, (ii) High disposable load fraction for Long-endurance, Long-range Role UAV designer.	Understand	This would require the learner to recall the main concerns of the long-endurance, long range airframe designer, (i) Low aerodynamic drag, and (ii) High disposable load fraction	CO 8
2	Identify the effects of airspeed, altitude, aspect ratio and aircraft mass on performance of a HALE UAV	Apply	This would require the learner to recall the performance parameters of a HALE UAV, describe their importance and identify their effects on performance of HALE	CO 8
3	Outline the various aspects of power-plant selection for HALE UAVs.	Understand	This would require the learner to recall the various aspects of power-plant selection for HALE UAVs like trade-off between engine mass and fuel consumption, and satisfactory performance at altitude,	CO 7
4	Explain the performance of a HALE UAV considering power required to maintain height with airspeed, altitude and AUM.	Understand	This would require the learner to recall the performance of a HALE UAV considering power required to maintain height with airspeed, altitude and AUM.	CO 8
5	Compare MALE and HALE UAVs.	Analyze	This would require the learner to recall the features of MALE and HALE UAVs and compare them	CO 8
6	Elucidate the Medium-range, Tactical fixed wing UAVs	Understand	This would require the learner to recall the features, examples, and application of Medium-range, Tactical fixed wing UAVs	CO 8
7	Discuss Medium-range, Tactical VTOL (Rotary wing) UAVs.	Understand	This would require the learner to recall the features, examples, and application of Medium-range, Tactical VTOL (Rotary wing) UAV	CO 8
8	Explain Close-range/ Battlefield Non- VTOL aircraft systems	Understand	This would require the learner to recall the features, examples, and	CO 5

	with necessary diagrams.		application of Close-range/ Battlefield Non- VTOL aircraft systems	
9	Explain Close-range/ Battlefield VTOL aircraft systems with necessary details.	Understand	This would require the learner to recall the features, examples, and application of Close-range/ Battlefield VTOL aircraft systems	CO 8
10	Compare Close-range UAV systems	Analyze	This would require the learner to recall the features of all Close-range UAV systems and compare them.	CO 8
11	Write about Close-range UAV systems	Remember	This would require the learner to recall the Close-range UAV systems	CO 5
12	What are the different types of MAVs, discuss in detail?	Remember	This would require the learner to recall the features, examples and applications of different types of MAVs	CO 8
13	Explain the Nano air vehicle systems	Understand	This would require the learner to recall the features, examples and applications of Nano air vehicle systems	CO 5
14	Identify the different novel hybrid aircraft configurations, discuss with necessary examples?	Apply	This would require the learner to recall the different novel hybrid aircraft configurations and describe their features, examples and identify their applications	CO 5
15	Discuss how the ramp size affects the UAVs.	Understand	This would require the learner to recall the launch system (ramp) for Non-VTOL UAVs and explain how the ramp size affects UAVs	CO 8
Part – C (Critical Thinking Questions)				
1	Identify the three main concerns of the Long-endurance, Long-range Role UAV designer, discuss in detail with the necessary diagram?	Understand	This would require the learner to think and recall the three main concerns of the Long-endurance, Long-range Role UAV designer and discuss them	CO 8
2	Distinguish MUAV, MAV, NAV and UCAVs.	Analyze	This would require the learner to recall the MUAV, MAV, NAV, UCAVs and describe their features, and differentiate them	CO 8
3	Explain the performance of a HALE UAV considering i) Variation of aircraft drag with airspeed and altitude (ii) Effect of wing aspect ratio on aircraft drag at high altitudes	Understand	This would require the learner to recall the performance of a HALE UAV considering variation of aircraft drag with airspeed and altitude, and wing aspect ratio at high altitudes	CO 4
4	Compare Ramp-launched and VTOL Close-range UAV systems	Analyze	This would require the learner to recall Ramp-launched and VTOL Close-range UAV and describe their features, and compare them	CO 8

5	Identify the need for Close-range UAV systems, discuss few design aspects.	Apply	This would require the learner to think about the need of Close-range UAV systems and recall the design aspects	CO 8
6	Discuss the design aspects of high-altitude long endurance UAS.	Understand	This would require the learner to recall the design aspects of HALE UAS	CO 8
7	Describe the design aspects of medium-altitude long endurance UAS.	Understand	This would require the learner to recall the design aspects of MALE UAS	CO 8
8	Discuss different types of TUAVs and give their applications	Understand	This would require the learner to recall the applications and different types of TUAVs	CO 8
9	Identify the need for Nano air vehicle systems? Explain the developments of NAVs.	Apply	This would require the learner to recall the NAV systems describe their developments, and identify their applications.	CO 8
10	Explain the different performance parameters of a HALE UAV.	Understand	This would require the learner to recall the different performance parameters of a HALE UAV.	CO 8

MODULE -IV

COMMUNICATIONS NAVIGATION

Part - A (Short Answer Questions)

1	How the data does is transmitted between UAV and CS and what type of data could be transmitted?	Understand	This would require the learner to recall the data transfer links (communication links).	CO 9
2	Explain the importance of maintenance of the communications in UAS operations?	Understand	This would require the learner to recall the importance of the communications in UAS	CO 9
3	List few reasons for the loss of communication during UAS operations.	Remember	---	CO 9
4	What is 'data rate', how is it measured?	Remember	---	CO 9
5	Describe 'bandwidth' and how is it measured?	Understand	This would require the learner to recall the definition of band width and its measurement	CO 9
6	Why the laser method of communication is abandoned?	Remember	---	CO 9
7	For what kind of roles data transmission by fibre-optics is suitable option?	Understand	This would require the learner to recall the data transmission by fibre-optics for UAS.	CO 9
8	Explain NAVSTAR GPS?	Understand	This would require the learner to recall the expansion and definition of NAVSTAR GPS	CO 9

9	How LOS Range can be calculated? Mention the variables involved.	Understand	This would require the learner to recall the expression to calculate LOS Range	CO 9
10	Describe 'System of Systems (SoS)' for UAS?	Understand	This would require the learner to recall the System of Systems (SoS) in UAS network.	CO 9
11	Explain the three systems in use to designate frequency bands?	Understand	This would require the learner to recall the systems in use to designate frequency bands	CO 9
12	Discuss 'Line Losses' in radio communications.	Understand	This would require the learner to recall the definition of line losses in radio communications.	CO 9
13	Describe the path loss in radio communications?	Understand	This would require the learner to recall the definition of path loss in radio communications	CO 9
14	Define 'multi-path propagation'.	Remember	---	CO 9
15	Describe the two ways in which a UAV system may be vulnerable?	Understand	This would require the learner to recall the different ways in which a UAV system may be vulnerable	CO 9
16	Explain the three types of anti-jam (AJ) measures?	Understand	This would require the learner to recall the different types of anti-jam (AJ) measures	CO 9
17	Describe the different navigation systems developed by different countries?	Understand	This would require the learner to recall the different navigation systems developed by different countries	CO 9
18	What are PPS and SPS?	Remember	---	CO 9
19	Explain patch antennae?	Understand	This would require the learner to recall the definition of patch antennae	CO 9
20	Write short notes on Yagi-Uda antennae?	Understand	This would require the learner to recall the features of Yagi-Uda antennae	CO 9

Part - B (Long Answer Questions)

1	Explain the different communication media between UAV and control station.	Understand	This would require the learner to recall the different communication media between UAV and control station and explain	CO 9
2	Outline various radio frequencies for radio communication. Give the radio frequency spectra.	Understand	This would require the learner to recall the various radio frequencies for radio communication	CO 9
3	Discuss radio LOS derivation with necessary diagrams.	Understand	This would require the learner to recall the LOS range and show the radio LOS derivation.	CO 9
4	Identify the relation between communication range and height	Apply	This would require the learner to recall the communication range and height of operating UAV and	CO 9

	of operating UAV, discuss with the help of necessary diagram?		describe the relation between them.	
5	Write a short notes on radio/microwave frequency allocation and different international organizations involved in it.	Understand	This would require the learner to recall the radio communications, radio/microwave frequency allocation and different international organizations involved in it.	CO 9
6	Identify the different radio frequency band designations systems with their frequency designations.	Apply	This would require the learner to recall the different radio frequency band designations systems and describe the designation systems with their frequency designations	CO 9
7	Write short notes on (i) Transmitter power output and receiver sensitivity, (ii) Antenna gain, (iii) Path loss, and (iv) Multi-path propagation.	Understand	This would require the learner to recall the radio communications, Transmitter power output and receiver sensitivity, Antenna gain, Path loss, and Multi-path propagation.	CO 9
8	Identify the possible 'Vulnerability' of UAV system and measures to reduce it.	Apply	This would require the learner to recall the different ways in which a UAV system may be vulnerable and explain them and identify the possible measures to reduce it	CO 9
9	Write detailed notes on multi-agent communication and interoperability.	Understand	This would require the learner to recall the multi-agent communication between CS and UAV, and interoperability	CO 9
10	Explain the communications data rate and bandwidth usage.	Understand	This would require the learner to recall the communications data rate and bandwidth usage in UAS.	CO 9
11	Identify the different types of Antennas, discuss them briefly.	Apply	This would require the learner to recall the different types of Antennas, discuss them	CO 9
12	Explain NAVSTAR GPS mentioning different types and detailed services.	Understand	This would require the learner to recall the features and different types, services of NAVSTAR GPS	CO 9
13	Write short notes on (i) Inertial navigation and (ii) Radio Tracking systems.	Understand	This would require the learner to recall the inertial navigation and radio Tracking systems.	CO 9
14	Explain briefly the 'Way-point Navigation' for UAVs.	Understand	This would require the learner to recall the 'Way-point Navigation' for UAVs.	CO 9
15	Write short notes on 'Navigation' systems for UAVs.	Understand	This would require the learner to recall the 'Navigation' systems for UAVs	CO9
Part – C (Critical Thinking Questions)				
1	Why the communication is of paramount importance in UAS operations? Discuss the possible	Understand	This would require the learner to recall the importance of communication in UAS and reasons	CO 9

	reasons for loss of communication during the operations.		for loss of communication during the operations	
2	Explain the importance of multi-agent communication and interoperability for UAVs.	Understand	This would require the learner to recall the importance of multi-agent communication and interoperability for UAVs	CO 9
3	Identify the different radio frequencies for radio communication with the help of radio frequency spectra?	Apply	This would require the learner to recall the communication systems and describe different radio frequencies with the help of radio frequency spectra	CO 9
4	How line of sight range can be calculated, mention the variables involved with necessary diagram?	Understand	This would require the learner to recall the expression to calculate LOS range and explain	CO 9
5	How line of sight radio range will vary with the height of UAV operation, discuss with necessary diagram?	Understand	This would require the learner to recall the relationship between height of UAV operation and LS range	CO 9
6	What are the different ways in which UAV may be vulnerable and discuss how can they be reduced?	Understand	This would require the learner to recall the different ways in which a UAV system may be vulnerable and possible measures to reduce it	CO 9
7	Identify the different ways of achieving communication between GCS and UAV, explain in detail?	Apply	This would require the learner to recall the importance of communication between GCS and UAV and describe the different ways of it	CO 9
8	Discuss the popular methods of position fixing and navigation between UAV and CS.	Understand	This would require the learner to recall the popular methods of position fixing and navigation between UAV and CS	CO 9
9	Compare the most usual types of antenna for UAS with necessary diagrams.	Analyze	This would require the learner to recall the antenna for UAS and describe their features and compare them with the help of diagrams	CO 9
10	Explain the different methods by which UAV controller may direct the UAV to any point within its range, discuss them briefly?	Understand	This would require the learner to recall the different methods by which UAV controller may direct the UAV to any point within its range	CO 9

MODULE -V

COMMUNICATIONS NAVIGATION

Part - A (Short Answer Questions)

1	Give any two variables of control and stability system of UAS?	Remember	---	CO 10
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2	Describe few flight variables for HTOL aircraft?	Understand	This would require the learner to recall the flight variables for HTOL aircraft	CO 10
3	How the aircraft heading is measured and monitored in UAV?	Understand	This would require the learner to recall the measuring of aircraft heading of UAV	CO 10
4	What is 'tape height'? Is it accurate for all ranges of speed?	Remember	---	CO 10
5	Explain 'pressure height'?	Understand	This would require the learner to recall the pressure height	CO 10
6	Discuss 'Directional airframe'? Give an example.	Understand	This would require the learner to recall the definition of Directional airframe	CO 10
7	Describe the different sensors used in UAS?	Understand	This would require the learner to recall the different sensors used in UAS	CO 10
8	Describe AFCS? List few components of automatic flight control system.	Understand	This would require the learner to recall the AFCS and its components.	CO 10
9	Explain 'transitional flight'?	Understand	This would require the learner to recall the definition of transitional flight.	CO 10
10	Discuss PSH mentioning the advantages.	Understand	This would require the learner to recall the plan-symmetric helicopter and its advantages.	CO 10
11	List the two sets of coordinate axes an FCS operates.	Remember	---	CO 10
12	Describe the systems used to measure airspeed of UAVs?	Understand	This would require the learner to recall the different systems used to measure airspeed of UAVs	CO 10
13	Explain are the difficulties with laser system based sensors?	Understand	This would require the learner to recall the difficulties with laser system based sensors	CO 10
14	How does dead reckoning system works?	Understand	This would require the learner to recall the working of dead reckoning system	CO 10
15	Define the 'Kalman filter'?	Understand	---	CO 10
16	How hover-position-hold sensing does varies at established base and away from base?	Understand	This would require the learner to recall the holding station sensing in a hover can be achieved at an established base and away from base	CO 10
17	Write about different convertible rotor aircraft.	Understand	This would require the learner to recall the different convertible rotor aircraft	CO 10
18	Write any two control commands of SMR UAV.	Understand	This would require the learner to recall the control commands of single-main-rotor UAV	CO 10

19	Explain canard airframe configuration?	Understand	This would require the learner to recall the canard airframe configuration	CO 10
20	Explain the need for multiplier K for speed channel?	Understand	This would require the learner to recall the need for multiplier K for speed channel	CO 10
Part - B (Long Answer Questions)				
1	Construct the AFCS for HTOL spatially stabilized configuration and explain.	Apply	This would require the learner to recall the HTOL spatially stabilized configuration, illustrate AFCS explain.	CO 10
2	Illustrate the HTOL aircraft basic AFCS.	Understand	This would require the learner to recall the Automatic flight control system of HTOL aircraft	CO 10
3	Illustrate the control and stability aspects of Single-main- rotor helicopter with AFCS diagram.	Understand	This would require the learner to recall the control and stability aspects of SMR helicopter with AFCS diagram	CO 10
4	Illustrate the control and stability aspects of Coaxial-rotor Helicopter with necessary AFCS.	Understand	This would require the learner to recall the control and stability aspects of CRH with necessary AFCS	CO 10
5	Identify the need for payload control and how can it be achieved in UAS?	Apply	This would require the learner to recall the necessity of controlling the payload in UAS, and explain the different means of controlling the payload.	CO 10
6	Explain the control commands of hover flight and cruise flight of tilt rotor aircraft.	Understand	This would require the learner to recall the control commands of hover flight and cruise flight of tilt rotor aircraft	CO 10
7	Describe briefly the transition flight of tilt rotor aircraft.	Understand	This would require the learner to recall the transition flight of tilt rotor aircraft and explain the challenges in it.	CO 10
8	Outline the functions of speed channel, the heading channel and the height channel.	Understand	This would require the learner to recall the functions of speed channel, the heading channel and the height channel	CO 10
9	Identify the need and challenges of 'Autonomy' for UAVs operation.	Apply	This would require the learner to recall the definition of autonomy of UAVs operation and describe the main systems drivers for autonomy and identify the challenges	CO 10
10	Explain height and altitude sensors used for UAVs.	Understand	This would require the learner to recall the height and altitude sensors used for UAVs and explain their functions.	CO 10

11	Write short notes on the airspeed sensors.	Understand	This would require the learner to recall the airspeed sensors for HTOL and VTOL	CO 10
12	Compare the stability and control aspects of SMR and CRH configurations.	Analyze	This would require the learner to recall the SMR and CRH configurations, describe their features and compare them	CO 10
13	Write a brief notes on 'Directional' airframe coaxial-rotor helicopter.	Understand	This would require the learner to recall the features of directional airframe coaxial-rotor helicopter	CO 10
14	Write a brief notes on 'Symmetrical airframe coaxial-rotor helicopter'.	Understand	This would require the learner to recall the features of symmetrical airframe coaxial-rotor helicopter	CO 10
15	Explain 'Hover-position-hold sensing' for a VTOL aircraft.	Understand	This would require the learner to recall the hover-position-hold sensing for a VTOL aircraft	CO 10
Part – C (Critical Thinking Questions)				
1	How the stability of HTOL can be achieved using (i) The Speed Channel, (ii) The Heading Channel, and (iii) The Height or Altitude Channel, explain?	Understand	This would require the learner to recall the roles of the speed channel, the heading channel, and the height or altitude channel to achieve stability of HTOL UAV.	CO 10
2	Distinguish the aerodynamic stability and aerodynamically neutral stability designs of HTOL aircraft.	Analyze	This would require the learner to recall the aerodynamic stability and aerodynamically neutral stability designs of HTOL aircraft and understand the stability aspects and differentiate them.	CO 10
3	Explain the influence of aircraft speed, rate of climb and engine power on the stability of HTOL, with help of AFCS?	Understand	This would require the learner to recall the influence of aircraft speed, rate of climb and engine power on the stability of HTOL using AFCS	CO 10
4	Compare the stability and control of SMR with fixed- wing aircraft.	Understand	This would require the learner to recall the stability and control aspects of SMR and fixed- wing aircraft and compare them	CO 10
5	Identify the challenges in achieving the control and stability for SMR helicopter, and explain the AFCS for SMR helicopter with necessary diagrams and examples.	Apply	This would require the learner to recall the challenges in achieving the control and stability for SMR, interpret them and recognize suitable AFCS and explain with necessary diagrams.	CO 10
6	Illustrate the method of aerodynamic control of Coaxial-rotor helicopter using AFCS.	Understand	This would require the learner to recall the method of aerodynamic control of coaxial-rotor helicopter using AFCS	CO 10
7	Distinguish 'Directional' Airframe Coaxial-rotor Helicopter (CRH) and	Analyze	This would require the learner to recall the features of directional' airframe coaxial-rotor helicopter and	CO 10

	Symmetrical Airframe Coaxial-rotor Helicopter.		symmetrical airframe coaxial-rotor helicopter, understand the working mechanism, AFCS and differentiate them.	
8	Explain the techniques to control the Convertible Rotor Aircraft during different flying conditions.	Understand	This would require the learner to recall the techniques to control the convertible rotor aircraft during different flying conditions	CO 10
9	Identify the different sensors to measure the height of UAV? Discuss them briefly.	Apply	This would require the learner to recall the need for measuring the height of UAV in operation and describe the methods to measure the height and identify the suitable sensors for UAVs.	CO 10
10	Outline different sensors used to measure airspeed of an UAV for HTOL and VTOL aircrafts.	Understand	This would require the learner to recall the different sensors used to measure airspeed of an UAV for HTOL and VTOL aircrafts	CO 10

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