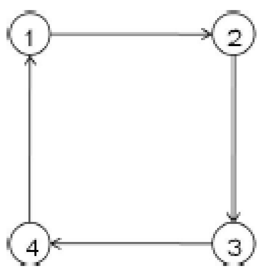
Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec 2021

Course: Aerial Robotics **Semester: I**
Program: M.Tech A&RE **Time 03 hrs.**
Course Code: ECER7001P **Max. Marks: 100**

S. No.	**SECTION A [Short Answers] 5x4=20 Marks**	**Marks**	**CO**
Q 1	Provide military applications of Drone in brief.	**4**	**CO1**
Q 2	Differentiate between MALE and HALE UAVs.	**4**	**CO1**
Q 3	Find angular velocity components [p q r] in body axis of Drone spinning with Ω=10 deg/sec, and Angle of Attack=15 deg	**4**	**CO2**
Q 4	Define the term aspect ratio and taper ratio of wing. Find the *aspect ratio* and *taper ratio* of a trapezoidal half wing with semi span(b/2)=3 m, root chord(c_r) 0.6 m and tip chord (c_t) 0.4m.	**4**	**CO1**
Q 5	A Hexa-rotor has a gross weight of 6 kg. The rotor diameter is 0.1 m. Assume FM=0.8, Compute power needed to hover.	**4**	**CO3**
	SECTION B [Long Answers] 10x4=40 Marks		
Q 6	Derive transformation matrix between earth fixed and body fixed coordiante of an aerial robot.	**10**	**CO2**
Q 7	A Unmanned Water vehicle model is tested at an angle of attack of 15 deg, sideslip of 10 deg, and a bank angle of 10 deg in a low-speed water tunnel. An internal strain gage balance measures the aerodynamic forces components in the body axes system. The measurements are Fx = 15.5 N, Fy = -20.0 N, and Fz = -25 N. Detemine 1) the transformation Matrix and 2) the lift, drag, and side forces acting on the model.	**10**	**CO2**
Q 8	An airship operates at an altitude of 2 km on a standard day having vehicle mass is 10kg. a) Calculate density of Helium and air at that altitude. b) Calculate buoyant lift required. c) Calculate the envelope volume if helium is used? Also, calculate the diameter if the envelope has a spherical geometry? Use: Gas constants (R=2080 N.m/kg.K) of *Helium*; and (R=287 N.m/kg.K) for *air*; **Refer Standard Atmosphere Table attached**, density$(\rho) = \frac{P}{RT}$ where P and T are pressure and Temperature, respectively.	**10**	**CO3**

<table>
<tr><td>Q 9</td><td>For airship of Q8 which operates at an altitude of 2 km on a standard day having vehicle mass 10kg.
a) If a wing is attached with this airship to provide 40% of total lift, then calculate wing area to provide dynamic lift at 20 m/s. (Assume C_L=0.4).
b) Also, Calculate the new airship envelope volume if 60% of buoyant lift is used? Also, calculate the new diameter if the envelope has a spherical geometry.
c) Suggest additional flight controls for new hybrid airship-wing combination.</td><td>10</td><td>CO3</td></tr>
<tr><td colspan="4">SECTION C [Case Based Study] 2x20=40 Marks</td></tr>
<tr><td>Q 10</td><td>Design an architecture for developing and deploying a Forest-fire detection and control system using UAVs. Consider the corridor of UPES and propose a technique to implement path planning technique to suppress the fire. Enlist the hardware and algorithm to be used for the complete system and propose an optimized architecture.</td><td>20</td><td>CO4</td></tr>
<tr><td>Q 11</td><td>Consider the four robot are connected in the following manner shown in below figure. [20 marks]


Using graph theory, obtain the vector matrix and comment on the stability. Assume $x_i(t)$ represents the state of each agent.</td><td>20</td><td>CO4</td></tr>
</table>

Standard Atmosphere Table

Altitude				
h_G, m	h, m	Temperature T, K	Pressure p, N/m^2	Density ρ, kg/m^3
1,000	1,000	281.66	8.9876 + 4	1.1117 + 0
1,100	1,100	281.01	8.8792	1.1008
1,200	1,200	280.36	8.7718	1.0900
1,300	1,300	279.71	8.6655	1.0793
1,400	1,400	279.06	8.5602	1.0687
1,500	1,500	278.41	8.4560	1.0581
1,600	1,600	277.76	8.3527	1.0476
1,700	1,700	277.11	8.2506	1.0373
1,800	1,799	276.46	8.1494	1.0269
1,900	1,899	275.81	8.0493	1.0167
2,000	1,999	275.16	7.9501 + 4	1.0066 + 0
2,100	2,099	274.51	7.8520	9.9649 − 1
2,200	2,199	273.86	7.7548	9.8649
2,300	2,299	273.22	7.6586	9.7657
2,400	2,399	272.57	7.5634	9.6673
2,500	2,499	271.92	7.4692	9.5696
2,600	2,599	271.27	7.3759	9.4727
2,700	2,699	270.62	7.2835	9.3765
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]