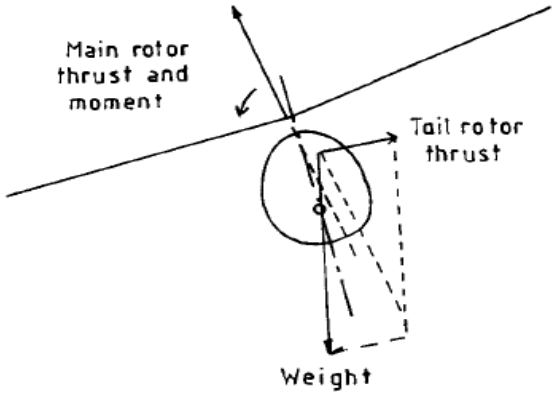
Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

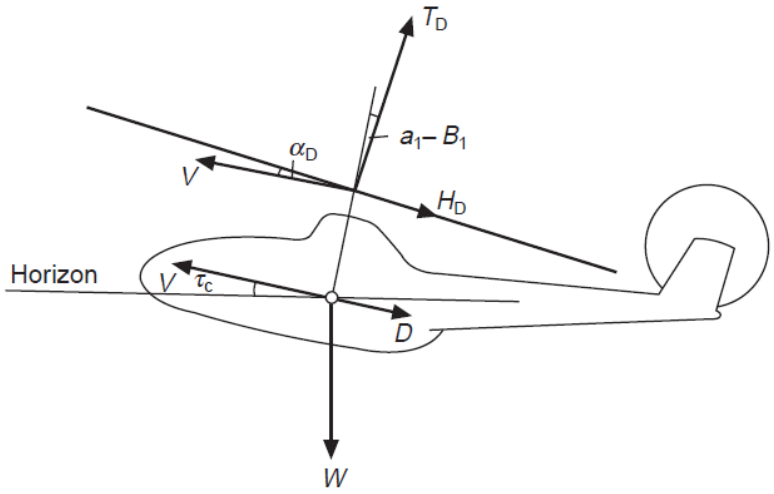
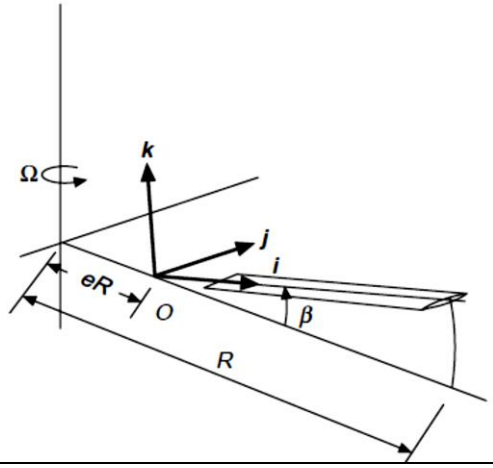
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec 2020

Course: Helicopter Engineering **Semester: VII**
Program: B.Tech ASE **Time 03 hrs.**
Course Code: ASEG 4007 **Max. Marks: 100**

Instructions:

1. **Read the Instructions carefully before attempting**
2. **For Theory based : Type the Answers briefly**
3. **For Figures if any : Draw a free hand sketch and scan**
4. **For Numerical : Solve it in a paper and scan**

S. No.	**SECTION A [Short Answers] 5x6=30 Marks**	**Marks**	**CO**
Q 1	Categorise different types of Helicopters.	**5**	**CO1**
Q 2	Explain lateral stability characteristics of Helicopter as shown below 	**5**	**CO3**
Q 3	What is the effect of *Forward speed* disturbance on Helicopter stability?	**5**	**CO4**
Q 4	What is the effect of *Pitch disturbance* on Helicopter stability?	**5**	**CO4**
Q 5	Why *vibration absorbers* are used in Helicopter?	**5**	**CO5**
Q 6	Why control of Helicopter Vibration is important?	**5**	**CO5**
	SECTION B [Long Answers] 10x5=50 Marks		
Q 7	Compare flight control systems for Helicopters with different rotor configurations.	**10**	**CO1**
Q 8	A) If the thrust of a helicopter rotor of radius 4 m in hover at sea level is 1500, determine the induced velocity. B) If the induced power coefficient of a helicopter climbing at 16 m/s is 0.0008, when the rotor of diameter 4 m rotating at 200 rpm, find the thrust coefficient.	**10**	**CO2**

Q 9	 Derive the expression for trim angle of attack of rotor disc plane as shown above. Estimate trim angle of attack of rotor disc plane with following data: four-bladed helicopter in level flight at sea level at tip speed ratio 0.3. The helicopter is represented by the following data: $W = 45\ 000$ N, solidity $s = 0.05$, $R = 8$ m, $h = 0.25$ $\delta = 0.013$, $\Omega R = 208$ m/s, $S_{FP} = 2.3$ m^2, $b = 4$, $a = 5.7$ Blade data: $M_b = 74.7$ kg; in terms of R, $x_g = 0.45$, $e = 0.04$ It will be assumed that the fuselage pitching moment, M_f, including, possibly, a tailplane, is zero. The above data give $sA = 10$ m^2, $d_0 = 0.23$, $w_c = 0.085$, $\frac{1}{2}\mu^2 d_0 = 0.0104$ $v_0 = 9.6$ m/s	**10**	**CO3**
Q 10	Derive equation for flapping motion of helicopter rotor blade as shown below. 	**10**	**CO4**
Q 11	Explain different types of Vibrations and control methods of Helicopter.	**10**	**CO5**

SECTION C 20 Marks			
Q 12	A) If the solidity of three bladed helper rotor of radius 2 m is 0.14, determine the average chord of the rotor. [6 Marks] B) If a three bladed rotor of radius 5.5 m generates a thrust of 12000 N at sea level, determine the rotational speed of the rotor, if the thrust coefficient is 0.0053. Also, find the power supplied to the rotor, if the figure of merit is 0.8.[14 Marks] *OR* B) A Helicopter of rotor diameter 10 m hovers at sea level. If the weight of the helicopter is 1000 kg, determine the induced power, induced velocity and the velocity of air sucked by the rotor. If the figure of merit is 0.8, find the profile power.[14 Marks]	**20**	**CO2**