Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

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

Course: Flight Mechanics I **Semester: V**
Program: B.Tech ASE/ASE+AVE **Time 03 hrs.**
Course Code: ASEG 3001 **Max. Marks: 100**

S. No.	SECTION A [Short Answers] 5x4=20 Marks	Marks	CO
Q 1	Classify different layers of standard atmosphere.	**4**	**CO1**
Q 2	Compare different types of Drag forces acting on aircraft.	**4**	**CO2**
Q 3	Find the velocity of an airplane at a standard altitude of 3 Km. At a point on the wing, the airflow velocity is 70 m/s and pressure 6.9509.2 N/m^2. Assume the flow incompressible. [at 3 km: P=7.010x10^4 N/m^2 ρ=0.9090 kg/m^3]	**4**	**CO3**
Q 4	Show that climb angle (θ) is given by $\theta = \sin^{-1}\left(\frac{T-D}{W}\right)$ Where T is thrust, D is drag and W is weight forces acting on airplane.	**4**	**CO4**
Q 5	Show that for minimum power(*mp*) condition of airplane $C_{d_{mp}} = 4C_{d_0}$	**4**	**CO5**
	SECTION B [Long Answers] 10x4=40 Marks		
Q 6	Determine at what geometric altitude that the error between the geometric altitude and the geopotential altitude is greater than 5% of the geometric altitude. The radius of the Earth is 6378.135 km.	**10**	**CO1**
Q 7	An aircraft weighing 250000 N has a wing area of 80 m^2 and its drag equation is $C_D = 0.016 + 0.04\,C_L^2$ 1) Calculate minimum thrust required for steady level Flight and corresponding speed at sea level 2) Calculate minimum power required and corresponding speed at sea level	**10**	**CO2**
Q 8	The altimeter of a low-speed aircraft reads 2500m. A Pitot tube mounted on the wing tip measures a pressure of 8056. kg/m^2. If the outside air temperature is 277 deg K. What is the true velocity of the airplane? What is the equivalent airspeed? [At 8000 ft P=7 674.6 kg/m^2]	**10**	**CO3**

<table>
<tr><td>Q 9</td><td>Show that radius of turn (R) and turn rate (ω) for airplane level turn is given by

$$R = \frac{V_\infty^2}{g\sqrt{n^2 - 1}}$$

$$\omega = \frac{g\sqrt{n^2 - 1}}{V_\infty}$$</td><td>10</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION C [Case Based Study] 2x20=40 Marks</td></tr>
<tr><td>Q 10</td><td>A small aircraf is powered by a piston engine. The propulsive efficiency is a depedent on airspeed and is given below, that is the HP given is the HP available. The aircraft has a wing area of S=28 m^2, W= 18000 N, $C_D = 0.036 + 0.105\ C_L^2$, $C_{L_{max}} = 1.37$ (no flaps) and $C_{L_{max}} = 2.00$ (with flaps). The engine properties are given in the follwoign table.

a) Plot HP_{req} vs Velocity for sea level
b) On same plot as a) plot HP_{avail} vs Velocity
c) From the same plot, find V_{max} and V_{min}

<table><tr><td>V(ft/sec)</td><td>83.9</td><td>102.7</td><td>117.3</td><td>132.0</td><td>146.7</td><td>161.3</td><td>176.0</td><td>190.7</td><td>205.3</td><td>212.7</td><td>220.0</td></tr><tr><td>HP (sea level)</td><td>216</td><td>248</td><td>270</td><td>289</td><td>305</td><td>318</td><td>328</td><td>337</td><td>344</td><td>346</td><td>347</td></tr></table></td><td>20</td><td>CO5</td></tr>
<tr><td>Q 11</td><td>A) Derive Brequet Range and Endurance formula for Jet engine aircraft.[10 Marks]

B) An airplane weighing 15000 N is powered by a single piston engine delivering 220 Hp. Its specific fuel consumption is 7.3x10^{-7} N/w.s. wing span =10 m, wing area 15 m^2 .,$C_{D_0} = 0.03$, e=0.95, prop eff. $\eta_{pr} = 0.85$. If this airplane is loaded with 1450 N fuel weight, estimate maximum range and edurance. .[10 Marks]</td><td>20</td><td>CO4</td></tr>
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