



End Semester Examination – Nov/Dec – 2016

Code : 15AE3006
Sub. Name : Rocket Dynamics

Semester : 2016-17 ODD
Duration : 3hrs
Max. marks : 100

ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)

Q. No.	Sub Div.	Questions	Course Outcome	Marks
1.	a.	A sounding rocket of initial mass m_o and mass m_f after all propellant is consumed is launched vertically ($\gamma = 90^\circ$). The propellant mass flow rate m_e is constant. Neglecting drag and the variation of gravity with altitude, calculate: i) The maximum height h attained by the rocket. (10) ii) For what flow rate is the greatest altitude reached? (10)	CO1	20
(OR)				
2.	a.	A space object is being tracked by ground-based radar situated in the orbital plane. When the radial line joining the radar and the center of mass of the object makes an angle $\theta = 20^\circ$ with the vertical, the radial distance, radial speed, and angular speed relative to the station are measured as $r = 250$ km, $\dot{r} = 3$ km/s, and $\dot{\theta} = 1^\circ/\text{s}$, respectively. Assuming that the object experiences only the gravitational acceleration, $g = 9.081$ m/s ² , at the given point, calculate the speed, radial acceleration, and angular acceleration of the object relative to the ground station.	CO1	20
3.	a.	How do you estimate the performance of rockets?	CO1	20
(OR)				
4.	a.	A two-stage rocket has a payload of 1000 kg, the first-stage specific impulse of 200 s, and the second-stage specific impulse of 455 s. Both stages have the same structural ratio of 0.07, and the same payload ratio of 0.2. It is desired to use the same rocket, without any structural modifications, to launch a heavier payload into a lower orbit. Find the new payload if the reduction in the total velocity impulse compared to that of the original mission is 500m/s.	CO1	20
5.	a.	Derive the normal force and pitching moment coefficient of rockets	CO1	10
	b.	Find the optimal mass for a three-stage launch vehicle that is required to lift a 5000kg Payload to a speed of 10 km/s. For each stage, given that Stage 1 : $I_{sp1} = 400\text{s}$ ($C_1 = 3.924\text{Km/s}$) $\epsilon_1 = 0.10$ Stage 2 : $I_{sp2} = 350\text{s}$ ($C_2 = 3.434\text{Km/s}$) $\epsilon_2 = 0.15$ Stage 3 : $I_{sp3} = 300\text{s}$ ($C_3 = 2.943\text{Km/s}$) $\epsilon_3 = 0.20$	CO1	10
(OR)				
6.	a.	A two-stage launch vehicle has a first-stage specific impulse of 250 s, and a second-stage specific impulse of 350 s. Both stages have the same structural ratio of 0.05. Determine the minimum propellant mass required to place a 1000 kg payload into a 200km high, circular earth orbit. (Assume an additional 1.5 km/s of velocity impulse required to overcome drag, gravity, and propulsive losses)	CO1	20

7.	a.	Derive the propellant mass equation for two stage rockets	CO1	20
(OR)				
8.	a.	Derive the dynamic longitudinal derivatives for rocket vehicles	CO2	20
		<u>Compulsory:</u>		
9.	a.	Derive the Directional stability derivatives for rocket vehicles	CO2	20

ALL THE BEST