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10AE763

Seventh Semester B.E. Degree Examination, Dec.2016/Jan.2017
Space Mechanics & Launch Vehicles

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Write short notes on space vehicles. **(06 Marks)**

b. What is inertial and earth fixed co-ordinate reference frames? **(04 Marks)**

c. Show that the transformation of fixed co-ordinate system to moving co-ordinate system is the inverse of transformation. **(10 Marks)**

2 a. Derive the basic differential equation of motion for the two body system as,

$$\frac{d^2r}{d\epsilon^2} + \frac{\mu}{r^3}r = 0, \text{ where } \mu = G(m_1 + m_2)$$ **(10 Marks)**

b. Derive the equation, $\frac{Gm_2}{r^3} = \frac{m_2}{m_1 + m_2}\left(\frac{2\pi^2}{\tau}\right)$ for the earth-moon system, where m_2 and m_1 are the mass of the moon and earth respectively, 'r' the distance between their centers and τ the period of rotation of the moon about the earth. **(06 Marks)**

c. State the Kepler's I, II and III law. **(04 Marks)**

3 a. Determine the eccentiricity and true anomaly for orbit establishment. **(10 Marks)**

b. Write short notes on ballistic trajectory. **(04 Marks)**

c. Briefly describe orbital perturbations. **(06 Marks)**

4 a. Obtain the equation of total increment for the Hohmann transfer orbit. **(10 Marks)**

b. A satellite is launched from a circular equatorial parking orbit at an altitude of 160 km into a coplanar circular synchronous orbit by using a Hohmann transfer ellipse. Assume a homogeneous spherical earth with a radius of 6374 km. Determine the velocity increments for entering the transfer ellipse and for achieving the synchronous orbit at 42,200 km altitude. Assume $\mu = 3.986 \times 10^5$ km^3/s^2. **(10 Marks)**

PART – B

5 a. Write short notes on liquid rocket engine and hybrid rocket engine. **(10 Marks)**

b. A rocket projectile has the following characteristics:
Initial mass = 200 kg, Mass after rocket operation = 130 kg, Payload, non propulsive structure, etc. = 110 kg, Rocket operating duration = 3.0 sec, Average specific impulse of propellant = 240 sec. Determine the vehicles mass ratio, propellant mass fraction, propellant flow rate, thrust, thrust-to-weight ratio, acceleration of vehicle, effective exhaust velocity, total impulse and the impulse-to-weight ratio. **(10 Marks)**

6 a. What are the typical criteria used in the selection of a particular rocket engines? **(10 Marks)**

b. Obtain the basic relations of motion for two-dimensional rocket motions in free space. **(10 Marks)**

7 a. At the end of a rocket launch of a space vehicle, the burnout velocity is 9 km/sec in a direction due north and 3° above the local horizontal. The altitude above sea level is 805 km. The burnout point is located at the 27° above the equator. Calculate and plot the trajectory of the space vehicle. Assume $\mu = 3.986 \times 10^{14}$ m^3/s^2. **(10 Marks)**

b. Write short notes on staging of rockets. **(10 Marks)**

8 Write short notes on:

a. Space craft.

b. Manned and unmanned space mission.

c. Spacecraft power generation.

d. Selection of materials for space craft. **(20 Marks)**

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