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10AE763

Seventh Semester B.E. Degree Examination, Dec.2015/Jan.2016
Space Mechanics and Launch Vehicles

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Give an expression for rotating coordinates in terms of total derivative relative to inertial axes. **(04 Marks)**

b. With the help of coordinate transformations, derive the transfer matrix and inverse of transfer matrix. **(06 Marks)**

c. What do you mean by, angular rates of Euler angles for transformation of angular velocities? **(10 Marks)**

2 a. Explain the two-body problem in terms of resultant force. **(08 Marks)**

b. Derive the well-known Kepler equation for planetary motion. **(12 Marks)**

3 a. The satellite orbit was characterized by e = 0.308 and $\frac{a}{R} = 3.34$, and its launch point was $\frac{r_0}{R} = 2.0$, $\theta = 62^0 23'$. If the satellite continues along this orbit to $\theta = 150°$, at which time the orbit is to be increased to a value $\frac{a}{R} = 3.60$ without rotating the apse line, determine the required increment in the velocity and its direction-consider $\frac{r_1 v_1^2}{K} = 0.68$, $v_1 = 0.823\sqrt{\frac{K}{r_1}}$, $\beta_1 = 24°$. **(12 Marks)**

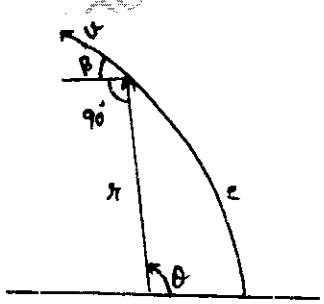

Fig. Q3 (a)

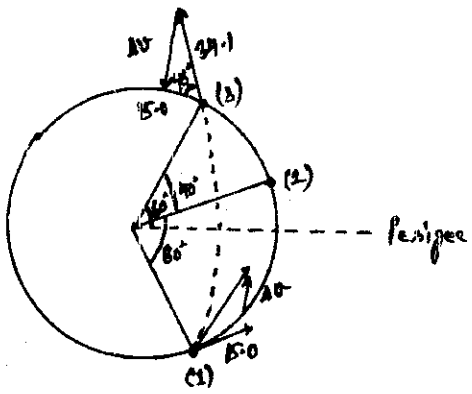

Fig. Q3 (b)

b. Given two vehicles on the same circular orbit of $\frac{r}{R} = 3.0$, with vehicle 1 lagging vehicle 2 by 80°. It is desired for 1 to intercept and rendezvous with 2 at a position 3 which is 40° ahead of 2. Determine the transfer orbit and the required increments of velocity. **(08 Marks)**

4 a. Derive the energy equation for general motion of a symmetric Gyro or top with the help of neat sketch. **(12 Marks)**

b. How will you define total velocity increment for the Hohmann Transfer orbit? **(08 Marks)**

PART – B

5 a. Write a short notes on:
i) Solid Rocket Engine
ii) Liquid Rocket Engine.
iii) Cryogenic Rocket Engine **(12 Marks)**

b. The following data are given for a certain rocket unit: thrust, 8896 Newton, Propellant consumption, 3.867 kg/sec, Velocity of vehicle, 400 m/sec, energy content of propellant, 16.9 megajoule/kg. Determine
i) the effective exhaust velocity.
ii) the kinetic jet energy for 1 kg of propellant.
iii) the internal efficiency.
iv) the propulsive efficiency.
v) the overall efficiency.
vi) the specific impulse
vii) the specific propellant consumption. **(08 Marks)**

6 a. How will you define the velocity and altitude reached by a vertically ascending rocket-powered vehicle? **(08 Marks)**

b. Determine the burnout velocity and burnout altitude for a dragless projectile with the following parameters for a simplified vertical trajectory: $\overline{C} = 2209$ m/sec. $\frac{m_p}{m_o} = 0.57$, $t_p = 5.0$ sec and $v_0 = h_0 = 0$ **(12 Marks)**

7 a. What are the initial conditions at injection into orbit? Explain it with reference frame and suitable derivation. **(10 Marks)**

b. How to do optimization of multistage rockets in terms of mass ratio for each stage? Derive it. **(10 Marks)**

8 a. How will you define manned and unmanned space missions? Explain it by examples. **(08 Marks)**

b. What are the selections of materials for space craft? Explain. **(04 Marks)**

c. How to make life time estimation for a satellite? **(08 Marks)**

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For Study consideration document