Code No: 07A82106 **R07** **Set No. 2**

IV B.Tech II Semester Examinations,APRIL 2011
SPACE MECHANICS
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Explain the geometry of an elliptical orbit with the help of a neat diagram.
   (b) Plot the variation of circular velocity and circular period as a function of distance for some planets and moon. [16]

2. Explain in detail about:
   (a) Hohmann transfer Ascent trajectory.
   (b) Direct Ascent trajectory.
   Explain in which trajectory the satellite will attain a low-altitude circular parking orbit. Make use of neat sketches. [16]

3. Explain the following:
   (a) Sphere of influence
   (b) Patched conic method of interplanetary trajectory
   (c) Parking orbit and impulsive shot. [4+4+8]

4. Explain:
   (a) Ionosphere, thermosphere, exosphere
   (b) Sidereal and solar time
   (c) First point of Libra
   (d) Apparent solar time. [16]

5. (a) State the assumptions made for calculation of free fall trajectory and explain the effect of these assumptions on the free fall trajectory of a missile.
   (b) Name the two angles which define the orientation of the trajectory plane and derive their expressions as a function of components of injection state of the missile. [6+10]

6. Show the inertial reference frame and the rotating reference frame with the help of a neat diagram and explain it. Finally obtain an expression for potential function. [16]

7. A spacecraft following an escape trajectory with constant tangential thrust is using electrical propulsion system. Show that $(M_p / M_o)_{esc} = \alpha V_{co} / c$, where
   M_p = mass of propellant required
   M_o = initial mass

C = effective exhaust velocity
V_{co} = velocity of space craft in circular parking orbit
α = correction factor. [16]

8. Show that Lagrange planetary equation for right ascension ofascending node Ω of the perturbed satellite orbit can be expressed as
$d\Omega/dt = r \sin(\omega+\theta)W/\{\sin i \sqrt{(\mu p)}\}$
where p = semi-latus rectum
W= perturbed acceleration component normal to orbital plane, in the direction of orbital angular momentum vector
θ = true anomaly, ω = argument of perigee. [16]

⋆⋆⋆⋆⋆

Code No: 07A82106 **R07** **Set No. 4**

IV B.Tech II Semester Examinations,APRIL 2011
SPACE MECHANICS
Aeronautical Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Explain the methodology of launching a spacecraft for interplanetary mission and hence explain the following terms.
   i. Flyby mission
   ii. orbiter mission
   iii. lander mission.

   (b) Discuss the salient features of interplanetary mission vis-a-vis earth satellite mission or lunar mission. [8+8]

2. (a) Explain points of equilibrium positions with the help of neat diagrams.
   (b) Obtain an expression for Coriolis and Centripetal accelerations. [8+8]

3. (a) Discuss the influence of ratio of injection and re-entry radius, ρ_i, and flight path angle, γ_i, on the angular range of a missile.
   (b) Explain the meanings of different conditions of injection velocity parameter, K_i , for $K_i < 1$, $K_i = 1$ and $K_i > 1$. Also explain the terms 'low trajectory' and 'high trajectory'. [8+8]

4. Prove that for the analysis of Lagrange's planetary equations, the Lagrange Bracket $[e, \omega] = e \cdot \sqrt{\{\mu a/(1-e^2)\}}$ where symbols carry their usual meaning. [16]

5. (a) Explain the difference between a sidereal day and a solar day with the help of a neat diagram.
   (b) Explain earth's atmosphere between 60 and 400 km. [8+8]

6. A spacecraft of mass M is moving in inverse square gravitational field with thrust acting in radial outward direction. If a_o is thrust acceleration for constant thrust to mass ratio and g_o is gravitational acceleration in the parking orbit, prove that radial velocity will be zero in parking orbit if $a_o > g_o/8$. [16]

7. Explain in detail about:
   (a) Injection errors.
   (b) n-plane and out-of-plane injection parameters.
   (c) Dependence of orbital elements on injection parameters. [16]

8. (a) Design a transfer ellipse from earth at a heliocentric position of r_1=1.00 AU and a longitude of 41.26 degrees to Pluto at r_2=39.5574 AU and a longitude of 194.66 degrees. Place the line of apsides at a longitude of 25 degrees.

(b) Explain flight path angle with the help of a neat diagram and obtain an expression for it. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A82106 **R07** **Set No. 1**

IV B.Tech II Semester Examinations,APRIL 2011
SPACE MECHANICS
Aeronautical Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Derive an expression for velocity and potential function.
   (b) Derive Clausius theorem. [8+8]
2. Explain the orbit used for earth departure on planetary flights and planetary arrival and targeting with the help of a neat sketch. Also obtain an expression which shows that velocity at infinite is finite. [16]
3. (a) State the assumptions made to derive equations of motion of a spacecraft in non-rotating geocentric equatorial reference frame and prove that rate of change of angular momentum is maximum if the thrust is directed perpendicular to the radius vector.
   (b) Draw a diagram which describes the trajectory parameters like angular position of the spacecraft, flight path angle and thrust angle. [10+6]
4. By using the method of variation of parameters, obtain the expression for Lagrange's planetary equation in the form of time derivative of the osculating element 'i', di/dt, of the perturbed satellite orbit, where 'i' is inclination of the perturbed orbit. [16]
5. What do you understand by 'fast interplanetary trajectory'? Obtain the values of trajectory parameters $V_{\infty e}$, $V_{\infty t}$, γ_2, V_2, & θ_2 as a function of q for this trajectory. Where symbols carry their usual meaning. [16]
6. (a) Explain the motion of the First point of Aries on the celestial sphere? Also explain the origin of the name "First point of Aries".
   (b) Explain the reference frames where earths center of mass is chosen as the origin. [8+8]
7. With the help of a diagram determine the four different cases for Lambert's equation for elliptical motion and determine the time of flight for the case when area A does not include foci F_1 and F_2. [16]
8. Explain the deviations in in-plane injection parameters for specified maximum departures in perigee and apogee altitude with the help of neat graphs. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A82106 **R07** **Set No. 3**

IV B.Tech II Semester Examinations,APRIL 2011
SPACE MECHANICS
Aeronautical Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks
⋆⋆⋆⋆⋆

1. Explain the terms:
   (a) Impulsive shot.
   (b) Tsiolkovsky's Equation.
   (c) Parking orbit.
   (d) Launch vehicle characteristic velocity. [16]
2. (a) Describe the characteristics of electrical propulsion system used for space missions
   (b) Prove that for the motion of a spacecraft in non-rotating geocentric equatorial reference frame, the instantaneous rate of change of energy is maximum if the thrust is acting tangentially to the trajectory. [8+8]
3. Consider the meridians passing through Greenwich, any point on the earth and through any celestial body. Draw a figure showing these meridians and explain the various angles associated with them. [16]
4. (a) Show eccentricity anomaly and true anomaly with the help of a neat diagram. Explain them in detail. Also explain the mean motion and the variation of E and θ with respect to 'e.
   (b) The elements of the Magellan mapping orbit about Venus are as follows: a = 10,424.1 km e = 0.39433 The mapping pass is started at a true anomaly of 280 degrees. What are the altitude, flight path angle, velocity and time since periapsis at this point? [8+8]
5. What conditions in terms of eccentricity and semi-latus rectum must be satisfied by an interplanetary trajectory to an outer planet and find the expression for spacecraft's heliocentric velocity at leaving the earth's orbit. Draw and explain the diagram showing possible interplanetary trajectories in e-q plane for various values of ΔV_0/ V_e for a mission to Mars. [16]
6. (a) With the help of examples explain in detail about Sphere of influence.
   (b) Derive Lagrange-Jacobi identity. [8+8]
7. Prove that for the analysis of Lagrange's planetary equations, the Lagrange Bracket [a, Ω] = -1/2 .cos i $\sqrt{\{\mu(1-e^2)/a\}}$ where symbols carry their usual meaning. [16]

8. With the help of a diagram, determine the four different cases for Lambert's equation for elliptical motion and determine the time of flight for the case when area A does not include F_1 but includes F_2. [16]

⋆ ⋆ ⋆ ⋆ ⋆