Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

**End Semester Examination – Nov/Dec – 2016**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Semester :** | **2016-17 ODD** |
| **Code :** | **14AE2016** | **Duration :** | **3hrs** |
| **Sub. Name :** | **SPACE DYNAMICS** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Q. No. | Sub Div. | Questions | Course  Outcome | Marks |
| 1. | a. | Write Kepler laws of motion. Use third law of motion to calculate the orbital period of Jupiter if its distance from Sun is 5.2 Astronomical Units (AU). | CO2 | 5 |
| b. | From the Kepler’s equation M = E – e sin E, where e is the eccentricity of an elliptic orbit and E and M are eccentric and mean anomaly, respectively, if M = 35 degrees and e = 0.15, calculate the eccentric anomaly E in degrees. | CO2 | 10 |
| c. | Compute the eccentric anomaly E from the true anomaly θ and the eccentricity e using the following relations  cos E = ( e + cos θ) / (1 + e cos θ),  sin E = (1-e2)1/2 sin θ / (1 + e cos θ),  for e = 0.1 and θ = 70 degrees. | CO2 | 5 |
| (OR) | | | | |
| 2. | a. | Draw a neat diagram to show the six orbital elements of a satellite moving in an elliptic orbit. | CO2 | 4 |
| b. | If the position and velocity of a satellite are (6472.7, -7470.8, -2469.8) and (3.9914, 2.7916, -3.2948) km/s, respectively; find the angular momentum and the orbital elements: eccentricity (e), inclination (i), argument of perigee (ω), right ascension of ascending node (Ω) and true anomaly of the satellite. | CO2 | 16 |
| 3. | a. | Explain briefly heliocentric-inertial coordinate system. | CO2 | 3 |
|  | b. | Define Sun-synchronous orbits for Earth satellites. | CO2 | 2 |
|  | c. | Calculate the orbital inclination for an elliptic Sun-synchronous orbit, whose semi-major axis is 7000 km and eccentricity is 0.15. Earth’s gravitational constant (μ ) = 398600 km3s-2, J2 = 0.00108263 and Earth’s radius is 6378 km. | CO2 | 15 |
| (OR) | | | | |
| 4. | a. | Explain Cowell’s and Encke's methods. Give their advantages and disadvantages. | CO2 | 15 |
|  | b. | Explain briefly three important perturbing forces acting on an Earth satellite. | CO2 | 5 |
| 5. | a. | Find the additional velocity required for a Hohmann transfer from a circular Earth  satellite orbit of radius 7000 km to a circular Earth satellite orbit of radius 9000 km. | CO2 | 10 |
|  | b. | Calculate the velocity change required to transfer a satellite from a circular orbit of 450 km altitude with an inclination of 50°to an orbit of the same size at an inclination of 20°. Earth’s gravitational constant = 398600 km3s-2. | CO2 | 6 |
|  | c. | Calculate the synodic period of Mercury relative to the Earth. The orbital periods of Earth and Mercury are 365.26 days and 88 days, respectively. | CO2 | 4 |
| (OR) | | | | |
| 6. | a. | At a given point of a spacecraft’s geocentric trajectory, the radius is 15800 km, the speed is 8.4 km/s, and the flight path angle is 50 degrees. Show that the path is a hyperbola. Calculate the hyperbolic excess velocity, angular momentum, true anomaly, eccentricity and turn angle. Earth’s gravitational constant = 398600 km3s-2. | CO2 | 16 |
|  | b. | Calculate the radius of sphere of influence of the Jupiter. The mass of the Jupiter and the Sun are 1.899 x1027 kg and 1.989 x1030 kg, respectively. The radius of Jupiter’s orbit about Sun is 778.6 x106 km. | CO2 | 4 |
| 7. | a. | Describe briefly Earth's atmosphere. Show in a figure the change in temperature up to 100 km altitude. | CO2 | 10 |
|  | b. | A geocentric trajectory has perigee velocity of 12 km and perigee altitude of 422 km. Find its eccentricity. Find the radius vector when the true anomaly is 50 degrees. Earth’s gravitational constant is 398600 km3s-2. | CO2 | 6 |
|  | c. | Estimate the trip time T from the Earth to Mars along the Hohmann transfer orbit by assuming the orbits of Earth and Mars around the Sun to be circular with radii of 149.6 x 106 and 227.9 x106 km, respectively. The value of the Sun’s gravitational constant (µ) = 1.32715 x 1011 km3s-2. | CO2 | 4 |
| (OR) | | | | |
| 8. | a. | Explain static stability margin. | CO1 | 5 |
|  | b. | If the Isp of a rocket using hydrogen and oxygen as fuel and oxidizer is 380 s, and Vb is 9000 metres/s, calculate its mass ratio. (g0=9.8 m/s2). | CO1 | 5 |
|  | c. | A two-stage rocket has the following design characteristics.  First stage: propellant mass = 30000 kg, structural mass = 12000 kg.  Second stage: propellant mass = 15000 kg, structural mass = 4500 kg.  The payload mass is 100 kg. The specific impulse for first stage is 290 s and for the second stage is 370 s. Calculate the final burnout velocity (g0=9.8 m/s2). | CO1 | 10 |
|  | | **Compulsory:** |  |  |
| 9. | a. | From the first principles, derive the rocket equation  Vb = g0 Isp ln(Mi/Mf),  where Vb is the burnout velocity, g0 is the acceleration due to gravity at sea level, Isp is specific impulse and Mi/Mf is the mass ratio. | CO1 | 6 |
|  | b. | What is the purpose of fins on a rocket ? Explain static and dynamics stability of rockets. | CO1 | 14 |

ALL THE BEST