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

G:\logo and QP Template\logo 3 Feb 2018 final.tif

**End Semester Examination – Nov/Dec – 2018**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **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. | From the first principles, derive the rocket equation  Vb = g0Isp 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. If the Isp of a rocket is 400 s, and Vb is 10000 metres/s, calculate its mass ratio (g0=9.8 m/s2). | CO1 | 10 |
| b. | A two-stage rocket has the following design characteristics.  First stage: propellant mass = 25000 kg, structural mass = 10000 kg.  Second stage: propellant mass = 12000 kg, structural mass = 4000 kg. The payload mass is 75 kg. The specific impulse for both the stages is 350 s. Calculate the final burnout velocity (g0=9.8 m/s2). | CO1 | 10 |
| (OR) | | | | |
| 2. | a. | Explain static stability margin. | CO1 | 4 |
| b. | Explain the purpose of fins on a rocket. | CO1 | 4 |
| c. | Explain static and dynamics stability of rockets. | CO1 | 12 |
|  |  |  |  |  |
| 3. | 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 | 9 |
| 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 = 70 degrees and e = 0.05, calculate the eccentric anomaly E in degrees. | CO2 | 11 |
| (OR) | | | | |
| 4. | a. | Explain geocentric-inertial coordinate system. | CO2 | 5 |
| b. | Define Sun-synchronous orbit. Calculate the orbital inclination for an ellipticSun-synchronous orbit, whose semi-major axis is 7300 km and eccentricity is 0.02.Earth’s gravitational constant (μ ) = 398600 km3s-2,J2= 0.00108263 and Earth’s radius is 6378 km. | CO2 | 15 |
|  |  |  |  |  |
| 5. | a. | Find the additional velocity required for a Hohmann transfer from a  circular Earth satellite orbit of radius 8000 km to a circular Earth  satellite orbit of radius 10000 km. | CO2 | 10 |
| b. | Calculate the velocity change required to transfer a satellite from a circular orbit of 500 km altitude with an inclination of 60° 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 Venus relative to the Earth. The orbital periods of Earth and Venus are 365.26 days and 224.7 days, respectively. | CO2 | 4 |
| (OR) | | | | |
| 6. | a. | Name four important perturbing forces acting on an Earth satellite. Explain one of them briefly. | CO2 | 6 |
| b. | Explain Cowell’s and Encke's methods. Give their advantages and disadvantages. | CO2 | 14 |
|  |  |  |  |  |
| 7. | a. | Draw a neat sketch of hyperbolic trajectory. Show in the sketch, true anomaly of the asymptote, turn angle, periapsis, apoapsis and semi-major axis. | CO2 | 5 |
| b. | Calculate the radius of sphere of influence of the Earth. The mass of the Earth and the Sun are 5.974x1024 kg and 1.989 x1030 kg, respectively. The radius of Earth’s orbit about Sun is 149.6x106km. | CO2 | 5 |
| c. | At a given point of a spacecraft’s geocentric trajectory, the radius is 16500 km, the speed is 8.3 km/s, and the flight path angle is 45 degrees. Show that the path is a hyperbola. Calculate the hyperbolic excess velocity, angular momentum, true anomaly and eccentricity of the orbit. Earth’s gravitational constant = 398600 km3s-2. | CO2 | 10 |
| (OR) | | | | |
| 8. | a. | Describe briefly Earth's atmosphere. | CO2 | 10 |
| b. | A geocentric trajectory has perigee velocity of 13 km and perigee altitude of 350 km. Find its eccentricity. Earth’s gravitational constant is 398600 km3s-2. | CO2 | 5 |
| c. | Using Kepler’s third law, estimate the trip time T from the Earth to Jupiter along the Hohmann transfer orbit by assuming the orbits of Earth and Jupiter around the Sun to be circular with radii of 149.6 x 106 and 778.6x106 km, respectively. The value of the Sun’s gravitational constant (µ) = 1.32715 x 1011 km3s-2. | CO2 | 5 |
|  | |  |  |  |
|  | | **Compulsory**: |  |  |
| 9. | a. | Draw a neat diagram to show the six orbital elements of a satellite moving in an elliptic orbit. | CO2 | 5 |
| b. | If the position and velocity of a satellite are (-6045, -3490, 2500) and (-3.457, 6.618, 2.533) 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 | 15 |