Reg.No. ____________

Karunya 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 Saturn if its distance from Sun is 9.6 Astronomical Units (AU).	2	**5**
	b.	(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 = 65 degrees and e = 0.1, calculate the eccentric anomaly E in degrees.	2	**10**
	c.	Compute the eccentric anomaly E from the true anomaly θ and the eccentricity e using the following relations $\cos E = (e + \cos\theta) / (1 + e \cos\theta)$, $\sin E = (1-e^2)^{1/2} \sin\theta / (1 + e \cos\theta)$, for e = 0.2 and θ = 45 degrees.	2	**5**
		(OR)		
2.	a.	Draw a neat diagram to show the six orbital elements of a satellite moving in an elliptic orbit.	2	**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.	2	**16**
3.	a.	Explain briefly geocentric-inertial coordinate system.	2	**3**
	b.	Define Sun-synchronous orbits for Earth satellites.	2	**2**
	c.	Calculate the orbital inclination for an elliptic Sun-synchronous orbit, whose semi-major axis is 7150 km and eccentricity is 0.05. Earth's gravitational constant (μ) = 398600 km^3s^{-2}, J_2 = 0.00108263 and Earth's radius is 6378 km.	2	**15**
		(OR)		
4.	a.	Explain Cowell's and Encke's methods. Give their advantages and disadvantages.	2	**15**
	b.	Explain briefly three important perturbing forces acting on an Earth satellite.	2	**5**
5.	a.	Find the additional velocity required for a Hohmann transfer from a circular Earth satellite orbit of radius 6800 km to a circular Earth satellite orbit of radius 8000 km.	2	**10**
	b.	Calculate the velocity change required to transfer a satellite from a circular orbit of 500 km altitude with an inclination of 40° to an orbit of the same size at an inclination of 20°. Earth's gravitational constant = 398600 km^3s^{-2}.	2	**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.	2	**4**
		(OR)		
6.	a.	At a given point of a spacecraft's geocentric trajectory, the radius is 15200 km, the speed is 8.5 km/s, and the flight path angle is 45 degrees. Show that the path is a	2	**16**

		hyperbola. Calculate the hyperbolic excess velocity, angular momentum, true anomaly, eccentricity and turn angle. Earth's gravitational constant = 398600 km^3s^{-2}.		
	b.	Calculate the radius of sphere of influence of the Mars. The mass of the Mars and the Sun are 6.419 $x10^{19}$ kg and 1.989 $x10^{30}$ kg, respectively. The radius of Mars's orbit about Sun is 227.9 $x10^6$ km.	2	**4**
7.	a.	Describe briefly Earth's atmosphere. Show in a figure the change in temperature up to 120 km altitude.	2	**10**
	b.	A geocentric trajectory has perigee velocity of 13 km and perigee altitude of 322 km. Find its eccentricity. Find the radius vector when the true anomaly is 70 degrees. Earth's gravitational constant is 398600 km^3s^{-2}.	2	**6**
	c.	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 10^6 and 778.6 x 10^6 km, respectively. The value of the Sun's gravitational constant (μ) = 1.32715 x 10^{11} km^3s^{-2}.	2	**4**
		(OR)		
8.	a.	Explain static stability margin.	1	**4**
	b.	If the Isp of a rocket using hydrogen and oxygen as fuel and oxidizer is 370 s, and V_b is 9800 metres/s, calculate its mass ratio. (g_0=9.8 m/s^2).	1	**4**
	c.	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 = 4200 kg. The payload mass is 100 kg. The specific impulse for first stage is 280 s and for the second stage is 360 s. Calculate the final burnout velocity (g_0=9.8 m/s^2).	1	**8**
		<u>Compulsory:</u>		
9.	a.	From the first principles, derive the rocket equation $$V_b = g_0 I_{sp} \ln(M_i/M_f),$$ where V_b is the burnout velocity, g_0 is the acceleration due to gravity at sea level, I_{sp} is specific impulse and M_i/M_f is the mass ratio.	1	**6**
	b.	What is the purpose of fins on a rocket ? Explain static and dynamics stability of rockets.	1	**14**

ALL THE BEST