Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

FIRST SEMESTER M.TECH. (AEROSPACE ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: ORBITAL MECHANICS [ICE 5103]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

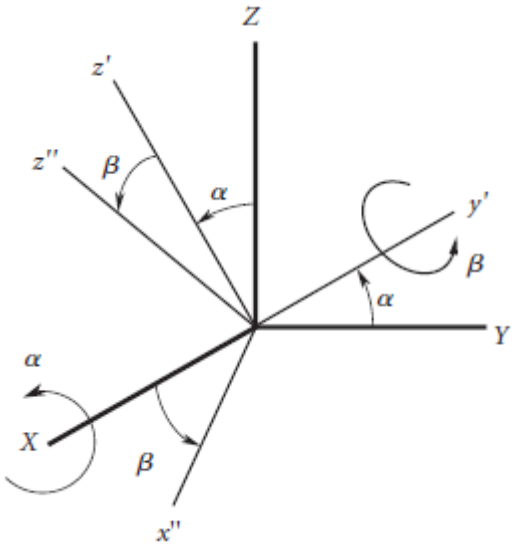
- Answer **ALL the** questions.
- Missing data may be suitably assumed.

1A. Derive the two-body equation of motion. **2**

1B. The elements of the Magellan mapping orbit about Venus are as follows: **4**
a = 10,424.1 km
e = 0.39433
The mapping pass is started at a true anomaly of 280 deg. What are the altitude, flight path angle, velocity, and time since periapsis at this point?

1C. At a given instant the position **r** and velocity **v** of a satellite in the geocentric equatorial frame are: $\vec{r} = 12670\ \hat{K}\ (km), \vec{v} = -3.874\ \hat{J} - 0.7905\ \hat{K}(^{km}/_{s})$. Find the orbital elements. **4**

2A. Calculate the transformation matrix [**Q**] for the sequence of two rotations: α=40^0 about the positive *X* axis, followed by β=25^0 about the positive *y*'axis. The result is that the *XYZ* axes are rotated into the *x''y'z''* axes. **4**



2B. What is the inertial position vector of a point 6.378 km above mean sea level on the equator, 57.296^0 W longitude at 0600 GMT, 2 January 1970? [Note: Assume Day 1=1 January 1970] **3**

2C. Describe the process of improving the preliminary orbit by differential correction method. **3**

3A. Illustrate solution of gauss problem using 'f' and 'g' series. **4**

3B. Illustrate the sensitivity of Hohmann transfer due to small inaccuracies of the transfer injection impulse. **3**

3C. A spacecraft is in a 300 km circular parking orbit. It is desired to increase the altitude to 600 km and change the inclination by 20^0. Find the total delta-v required if (a) the plane change is made after insertion into the 600 km orbit (so that there are a total of three delta-v burns); (b) the plane change and insertion into the 600 km orbit are accomplished simultaneously (so that the total number of delta-v burns is two); (c) the plane change is made upon departing the lower orbit (so that the total number of delta-v burns is two). **3**

4A. On 15 August 2005 a spacecraft in a 190 km, 52^0 inclination circular parking orbit around the earth departs on a mission to Mars, arriving at the red planet on 15 March 2006, whereupon retro rockets place it into a highly elliptic orbit with a periapsis altitude of 300 km and a period of 35 hours. Determine the total delta-v required for this mission. **5**

4B. Define a lunar trajectory using the patched conic technique assuming circular coplanar transfer. Calculate the elements of the transfer ellipse and the arrival hyperbola given the following: **5**
Injection velocity at perigee of transfer ellipse = 10.738 km/s
Injection altitude = 500 km
Arrival angle λ= 30 deg

5A. Explain stability and dynamics at Lagrangian points. **4**

5B. Describe Cowell's method in orbit perturbation. **3**

5C. Determine the semi-major axis of an earth satellite orbit with eccentricity = 0.17 and $\dot{\omega} = 0$ and the orbit is sun-synchronous. **3**

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