Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, JUNE 2018

SUBJECT: SPACEFLIGHT DYNAMICS [AAE 4015]

REVISED CREDIT SYSTEM
(22/06/2018)

Time: 3 Hours | MAX. MARKS: 50

Instructions to Candidates:

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

1A. Suppose a spacecraft in permanent orbit around the earth is to be used for delivering payloads from low earth orbit (LEO) to geostationary equatorial orbit (GEO). Before each flight from LEO, the spacecraft is refueled with propellant which it uses up in its round trip to GEO. The outbound leg requires four times as much propellant as the inbound return leg. The delta-v for transfer from LEO to GEO is $4.22\ Km/s$. The specific impulse of the propulsion system is $430\ s$. If the payload mass is $3500\ kg$, calculate the empty mass of the vehicle. **(06)**

1B. Explain the stability condition for a satellite in torque free motion. **(04)**

2A. A sounding rocket of initial mass m_0 and final mass m_f after all propellant is consumed is launched vertically ($\gamma\ = 90^0$). The propellant mass flow rate m_e is constant. Neglecting drag and the variation of gravity with altitude, calculate the maximum height *h* attained by the rocket. For what flow rate is the greatest altitude reached? **(06)**

2B. What is an equilibrium glide and lifting ballistic coefficient? **(04)**

3A. Calculate the moments of inertia of a slender, homogeneous straight rod of length l and mass m. One end of the rod is at the origin and the other has coordinates (a, b, c). **(06)**

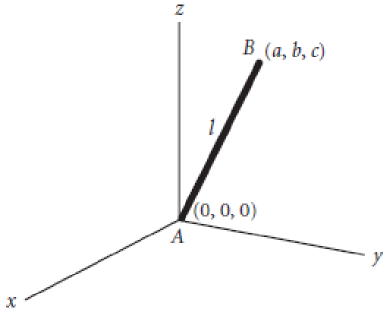
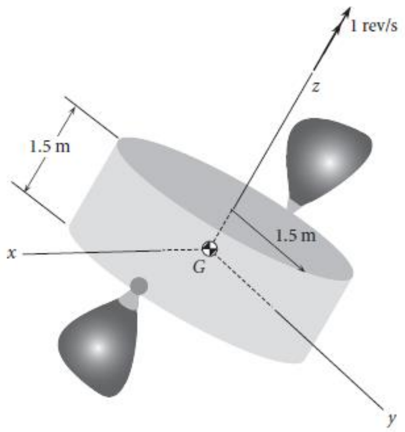
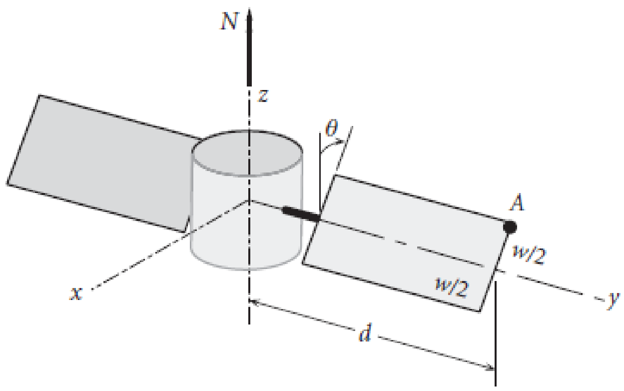


Figure 1

3B.	Find the theoretical maximum value of exhaust velocity and specific impulse for a fluorine-hydrogen combination with $M = 10\, Kg/mol$, $T_c = 3500\, K$ and $\Upsilon = 1.33$.	**(04)**
4A.	The body-fixed xyz axes are principal axes of inertia passing through the center of mass of the $300\, kg$ cylindrical satellite as shown in figure 2, which is spinning at 1 revolution per second about the z axis. What impulsive torque about the y axis must the thrusters impart to cause the satellite to precess at 0.1 revolution per second?  Figure 2	**(06)**
4B.	What is Gravity Gradient Stabilization? Explain with a suitable diagram, construction and working of a Gyrostat.	**(04)**
5A.	The satellite is rotating about the z axis at a constant rate N. The xyz axes are attached to the spacecraft, and the z axis has a fixed orientation in inertial space. The solar panels rotate at a constant rate θ in the direction shown in figure 3. Calculate the absolute velocity and acceleration of point A on the panel relative to point O which lies at the center of the spacecraft and on the centerline of the panels.  Figure 3	**(06)**
5B.	What happens to the vehicle if the ballistic coefficient and reentry angle both are increased leading to a steep trajectory.	**(04)**