Code No: 07A62106 **R07** **Set No. 2**

III B.Tech II Semester Examinations,APRIL 2011
INTRODUCTION TO SPACE TECHNOLOGY
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Write a short note on the following aspects related to combustion of solid propellants:
   (a) Burning rate augmentation
   (b) Erosive burning
   (c) Different types of grains. [5+5+6]

2. Write a note on the following:
   (a) Launch vehicles
   (b) Satellites and Interplanetary probes. [8+8]

3. (a) Write a brief note on Noise in satellite communication link.
   (b) Explain the procedure used to achieve desired performance in a satellite on-board transponder. [8+8]

4. (a) Explain the effects of deceleration on the trajectory of a re-entry space vehicle. Indicate the deceleration profiles for various re-entry velocities and re-entry flight path angles, in a graphical form.
   (b) Write a short note on 'Ablation' as a thermal protection system. [10+6]

5. Suppose NASA wants to send a space-craft from its circular orbit at 150 km altitude (28^0 inclination) to a circular orbit at 20,000 km altitude (inclination of 45^0).
   (a) What is the energy of the transfer orbit?
   (b) What is the velocity change (ΔV_1) needed to go from the initial circular orbit to the transfer orbit?
   (c) What is the ΔV needed for combined plane change at the apogee of the transfer orbit to go from the transfer orbit to the final circular orbit and to change the inclination? [16]

6. Explain about gravity gradient torque on satellite. [16]

7. (a) A satellite is launched into Earth's orbit when its launch vehicle burns out at an altitude of 250 km. At this instant, the satellite's velocity is 7,900 m/s with ϕ (flight path angle, the angle between the local horizontal and the velocity vector) equal to two degrees. Calculate the satellite's altitude at perigee and at apogee.

(b) Calculate the eccentricity of the orbit for the satellite in the above problem. [10+6]

8. Consider a spacecraft in an elliptical orbit around the Earth with a perigee altitude of 300 km and an apogee altitude of 1,000 km. Assuming the rocket exhaust velocity as 3,000 ms^{-1}, estimate the magnitude of the change in velocity (ΔV) required for orbit circularization. How much fuel, expressed as a fraction of the spacecraft mass, is required to achieve this? [16]

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1. Explain various modes of satellite communication. [16]

2. What are methods are used to determine Attitude? Explain briefly. [16]

3. (a) Explain the effects of heating on the trajectory of a re-entry space vehicle. Indicate the heating rate profiles for launch vehicles having various ballistic coefficient values, in a graphical form.
   (b) Write a short note on 'the three competing re-entry requirements'. [8+8]

4. Considering the Earth to be flat, obtain an expression for dispersion sensitivity factor in drag free (vacuum) conditions. [16]

5. Describe the danger to our planet Earth due to the impact of Meteors, and Meteorites. [16]

6. A tracking station reports that an approaching object has a velocity of 10,000 m/s at an altitude of 98,000 km and that the velocity vector makes an angle of 20^0 with r (the position vector). Will the object hit the Earth? If not, what is the altitude and velocity at the closest passage? [16]

7. While piloting a spacecraft you received a report of your position and velocity in the geo - centric equatorial frame as
   $\overline{R}$ = 7000 i + 0 j + 0 k km
   $\overline{V}$ = 0 i - 0.763 j + 0 k km/s
   (a) Sketch the spacecraft position vector and velocity vector relative to the Earth.
   (b) What is the specific angular momentum? Draw this vector on the sketch.
   (c) What does this angular momentum vector tell you about the orientation of your orbit ?
   (d) What is the specific mechanical energy of the satellite?
   (e) What is the shape of the trajectory? How can you tell? [16]

8. (a) How does a liquid propellant rocket differ from a solid propellant rocket? Explain which of the two will be useful for a sounding rocket of diameter 10 cm and length 1.5 m.
   (b) A missile, a single stage rocket, carries a war head of 50 kg. It has a structural mass of 250 kg, and propellant mass of 2,700 kg. If the specific impulse is 300 seconds, calculate the burnout velocity. [8+8]

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Code No: 07A62106 **R07** **Set No. 1**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Write a short note on the following aspects related to liquid propellants:
   (a) Insulation cooling
   (b) Regenerative cooling
   (c) Transpiration cooling
   (d) Boundary layer cooling. [4+4+4+4]

2. What do you mean by attitude determination? What is the importance of attitude determination? [16]

3. Write short notes on the following:
   (a) Effects of charged particles on the satellite
   (b) Shielding to the space vehicle against charged particle radiation
   (c) Effect of static charge accumulation on the performance of electronic components of a space vehicle. [6+6+4]

4. (a) Write a brief note on plane changes of an orbit.
   (b) A communication satellite is in a 322 km circular parking orbit but not in a desired plane. Find the ΔV required to shift the plane by 10^0, without changing the radius.
   (c) Rather than making the plane change while in the LEO, it is decided to make the plane change after the satellite has been placed into a circular GEO. Find the ΔV required and compare with the above problem. [6+4+6]

5. (a) Write the important features of a satellite in geostationary orbit.
   (b) The Virginia Tech earth station is located at 80.438^0 longitude and 37.229^0 N latitude. Calculate the look angles (azimuth and elevation angles) to a geosynchronous satellite whose sub-satellite point is located at 121^0 W longitude.
   (c) Why do signal losses occur in the earth's atmosphere for satellite communication? Write a note on ionospheric effects.
   [6+6+4]

6. You are the engineer in charge of launching a satellite of 11,500 kg mass. The satellite will be placed in a circular sun - synchronous orbit, at an altitude of 800 km. What is the kinetic energy of the satellite? Compare this to the kinetic energy of a 400 kg lorry traveling on a straight road at 100 km/hour. Explain clearly whether the comparison is realistic. [16]

7. Calculate the approximate burnout velocity (ignoring the effects of burn time) and the maximum altitude achieved for a sounding rocket with characteristics shown in the following table. The rocket carries a payload of 250 kg. Consider motion in free space.

Stage, k	Specific Impulse, I_{sp}	Propellant Mass, m_p	Stuctural Mass, M_s
1	282 $_s$	1,167 kg	113 kg
2	282 $_s$	415 kg	41 kg
Payload	-	-	250 kg

Suppose the second sage is allowed to coast to its maximum altitude and then ignited, instead of immediate ignition, calculate the maximum altitude achieved by the payload for this burn-coast-burn-coast strategy. Provide necessary reasons for the large differences obtained in both the cases. [16]

8. What do you understand by Hohmann braking ellipses in the case of reerntry? Obtain equations of motion for the down range trajectory as well as the altitude in terms of the flight path angle as an independent variable. [16]

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Code No: 07A62106 **R07** **Set No. 3**

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Time: 3 hours **Max Marks: 80**

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1. Explain, using neat sketches, about the mechanism to despin a satellite. [16]

2. (a) How many sets of initial conditions can we make use of for solving the two - body equation of motion? Give an example of one set of these.
   (b) A remote sensing satellite is in a circular orbit of 7,500 km. What is its inclination? [8+8]

3. (a) Explain the reasons for a rocket designer to choose the multi-staging concept rather than a single-stage design.
   (b) Define the terms 'mass ratio', 'pay load ratio', 'propellant ratio', and 'structural efficiency' in case of multi-stage rocket assembly.
   (c) Obtain an expression for the ideal velocity of a multi-stage rocket of N stages traveling in a free space. [2+8+6]

4. The Hubble space telescope (HST) was placed in a circular orbit at an altitude of 600 km. Find the orbital characteristics to include the specific kinetic energy, the specific potential energy, the total specific energy, the period, the semilatus rectum p, the eccentricity, the orbital velocity, and the angular momentem H. [16]

5. If the re-entry velocity of a spacecraft is 7.4 km s^{-1} and the re-entry flight path angle is 10^0, find out the maximum deceleration experienced by the vehicle and the altitude at which it occurs. The Ballistic Coefficient of the vehicle is 1,000 kg m^{-2}. [16]

6. (a) Define the following quantities in rocket propulsion:
      i. Mass Ratio,
      ii. Propellant Mass Fraction,
      iii. Velocity Loss due to gravity, and
      iv. Altitude loss due to gravity.
   (b) A rocket has the following data:
      Propellant flow rate = 5 kg/s
      Nozzle exit diameter = 11 cm
      Nozzle exit pressure = 1.02 bar
      Ambient pressure = 1.013 bar
      Thrust = 7 kN
      Determine the effective exhaust jet velocity, actual exhaust jet velocity and specific impulse. [8+8]

7. Explain the various parts of Telecommunication equipement in a satilite and their functions. [16]

8. Write a detailed note on radiation effects to both manned and unmanned spacecrafts.
   [16]

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