Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

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SECOND SEMESTER M.TECH. (AEROSPACE ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL/MAY 2017

SUBJECT: SPACECRAFT ENGINEERING [ICE 5241]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A.	Briefly explain the process of photon interactions in the radiation environment.	**4**
1B.	The following measurements were made in a sea level test of a solid propellant rocket motor: Burn duration=40 s, Initial mass before test=1210 kg, Mass of rocket motor after test=215 kg, Average thrust=62,250 N, Chamber pressure=7 MPa, Nozzle exit pressure=0.070 MPa, Nozzle throat diameter=0.0855 m, Nozzle exit diameter=0.2703 m. Determine mass flow rate, exhaust velocity, characteristic velocity, exit velocity and specific impulse at 1000 m altitude and 25,000 km altitude. (At 1000 km Pa=0.0898 MPa and at 25,000 km, Pa=0.00255 MPa)	**3**
1C.	A two-stage booster had a payload of 10,000 kg, a second-stage Isp=420 s with ε2=0.15, and a first-stage Isp=330 s with ε1=0.10. With total Δv=9000 m/s, Δv1 is to be 2Δv2. Find the stage mass ratios and total mass.	**3**
2A.	What burn time or pulse width is required to precess a spacecraft spin axis by 3 deg (0.05236 rad) under the following conditions: Thrust = 10 N, Moment arm = 1.5 m, Spacecraft spin rate = 2 rpm (0.2094 rad/s), Moment of inertia = 1100 N-m^2, Specific impulse = 185 s? Calculate the amount of propellant consumed for this precession.	**2**
2B.	Describe the types of electric propulsion techniques used in spacecrafts.	**5**
2C.	Classify the sensors used for attitude determination of a spacecraft.	**3**
3A.	Briefly explain the steps involved in attitude determination and estimation.	**4**
3B.	Illustrate the operation of a fuel cell with a diagram.	**3**
3C.	Briefly explain the constraints in the arrangement of a spacecraft structure.	**3**
4A.	What solar-array area is required to provide 1500 W, measured after the Diode for the following conditions: Po = 276 mW/cell at 1150C, packing factor =732	**2**

cells/m^2, utilization factor = 0.97, assembly factor = 0.96, diode loss = 3%. Assume all other factors are unity.

4B. Briefly explain the spacecraft thermal environment and its effects on a spacecraft. What happens if the spacecraft is not in thermal balance? **4**

4C. Illustrate the operation of a transponder in the communication system of a spacecraft with a diagram. **4**

5A. Consider a spacecraft transmitting system operating at a frequency of 8.4 GHz. The antenna system and the part of the power supply related to the telecommunication system is allocated a total weight of 150 lb. It is desired to achieve a maximum EIRP within this weight limit. The spacecraft antenna is a parabolic reftector. An analysis of the weight W_a of this type of antenna yields the following relation: $W_a = C_a + 2D^2$ where C_a is a constant, D is the diameter of the antenna in feet and W_a is the antenna weight in pounds. Similarly, the power supply weight W_p can be approximated as $W_p = C_p + 0.5P_t$, where C_p is a constant and P_t is transmitted power in watts. The sum of C_a and C_p is 40 lb and the efficiency of the antenna is 65%. Find the maximum EIRP and the corresponding antenna diameter and transmitted power (dBm). **3**

5B. Illustrate the process of sending a packet telecommand from the ground station to the spacecraft subsystem through different layers. **4**

5C. Briefly explain different types of spacecraft mechanisms. **3**

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