Reg. No															

B.Tech. DEGREE EXAMINATION, JUNE 2023

Seventh Semester

18ASE304T - SPACE MISSION DESIGN AND ANALYSIS

(For the candidates admitted during the academic year 2018-2019 to 2021-2022)

$m_{Sun} = 1.989\times10^{30}$ kg, r_{Sun} =696000 km, $\mu_{Sun} = 1.327\times10^{11}$ km^3/s^2 and $R_{Sun} = 57.91\times10^6$ km
$m_{Earth} = 5.974\times10^{24}$ kg, r_{Earth} =6378 km, μ_{Earth} = 398600 km^3/s^2 and $R_{Earth} = 149.6\times10^6$ km
$m_{Mars} = 6.419\times10^{23}$ kg, r_{Mars} =3396 km, μ_{Mars} = 42828 km^3/s^2 and $R_{Mars} = 227.9\times10^6$ km
$m_{Mercury} = 3.302\times10^{23}$ kg, $r_{Mercury}$ =2440 km, $\mu_{Mercury}$ = 22930 km^3/s^2 and $R_{Mercury} = 57.91\times10^6$ km
$m_{Jupiter} = 1.899\times10^{27}$ kg, $r_{Jupiter}$ =71490 km, $\mu_{Jupiter} = 1.26686\times10^8$ km^3/s^2 and $R_{Jupiter} = 778.6\times10^6$ km

Note:

i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40 minutes.
ii. **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours **Max. Marks: 100**

Part - A (20 × 1 Marks = 20 Marks)

Answer **All** Questions

	Question	Marks	BL	CO
1.	________ are principal mission parameters or characteristics which influence performance, cost and schedule (A) Mission architectures (B) System drivers (C) Mission evaluation (D) Mission objectives	1	2	1
2.	Which of the following events affects the Random-Access Memory (RAM) and microprocessors (A) Trapped radiation (B) Solar particle events (C) Galactic cosmic rays (D) Magnetosphere	1	1	1
3.	Which of the following is the principal design variable for constellation design (A) Inclination (B) Eccentricity (C) Declination (D) Altitude	1	1	1
4.	At lower orbits a spacecraft will be bombarded by the atmosphere at orbital velocities on the order of _______ (A) 7 km/s (B) 8 km/s (C) 9 km/s (D) 10 km/s	1	1	1
5.	The attitude determination and control subsystem determine the attitude using (A) Sensor (B) Actuator (C) Controller (D) Amplifier	1	1	2
6.	Which of the following is not function of telemetry, tracking and command subsystem. (A) Receive (B) Oscillate (C) Modulate (D) Transmit	1	1	2
7.	A telemetry channel with information encoded as a resistance is called as (A) High-level analog (B) Low-level analog (C) Passive analog (D) Active analog	1	1	2
8.	The spacecraft average density is (A) 59 kg/m^3 (B) 69 kg/m^3 (C) 79 kg/m^3 (D) 89 kg/m^3	1	2	2
9.	Which of the following trajectory is called as escape trajectory (A) Circular trajectory (B) Parabolic trajectory (C) Elliptic trajectory (D) Hyperbolic trajectory	1	2	3

	Question	Marks	BL	CO
10.	Which is the measure of energy required for interplanetary mission (A) Escape velocity (B) Parabolic excess speed (C) Elliptic excess speed (D) Characteristic energy	1	1	3
11.	Which of the following is the arithmetic sum of all the velocity changes required to perform a specified mission (A) Mission characteristic velocity (B) Launch vehicle characteristic velocity (C) Mission azimuthal velocity (D) Launch vehicle azimuthal velocity	1	2	3
12.	The time of separation is called as (A) Injection parameter (B) Injection anomaly (C) Injection epoch (D) Injection unit	1	1	4
13.	The heat flux of the wall is proportional to ________ (A) Local free steam temperature (B) Local stagnation temperature (C) Local temperature gradient (D) Local velocity gradient	1	1	4
14.	The ratio of momentum diffusion to thermal diffusion is called as (A) Prandtl number (B) Nusselt number (C) Péclet number (D) Stanton number	1	1	4
15.	Which one of the following astronomical objects has relatively large eccentricity (A) Jupiter (B) Venus (C) Saturn (D) Pluto	1	2	5
16.	For manned mission which one of the following orbital maneuver has a large period of heliocentric orbits (A) Hohmann maneuver (B) Simple impulse maneuver (C) Phasing maneuver (D) Bi-elliptic Hohmann maneuver	1	2	4
17.	Which of the following is the gravitational parameter for Mars (A) $1.327\times10^{11} km^3/s^2$ (B) $42828 km^3/s^2$ (C) $22930 km^3/s^2$ (D) $1.26686\times10^8 km^3/s^2$	1	2	5
18.	In order to escape the gravitational pull of a planet, the spacecraft must travel in. (A) Escape trajectory (B) Circular trajectory (C) Elliptic trajectory (D) Hyperbolic trajectory	1	1	5
19.	The geocentric position vector is given as $r = -294.32\hat{\imath} + 4265.1\hat{\jmath} + 5986.7\hat{k}\,(km)$. ____________ is the corresponding magnitude. (A) 7356.5 km (B) 7441.7 km (C) 7456.8 km (D) 7556.9 km	1	3	3
20.	In perifocal coordinate system, the unit vector $\hat{w}$ lies in the direction of (A) Eccentricity (B) Angular momentum (C) Ture anomaly (D) Eccentric anomaly	1	2	3

Part - B (5 × 4 Marks = 20 Marks)
Answer **any 5** Questions

	Question	Marks	BL	CO
21.	Explain the phases of life cycle of a space mission.	4	2	1
22.	Explain spacecraft charging.	4	2	1
23.	What is command decoder? Explain the types of command output.	4	2	2
24.	Describe the term energy storage in electrical power subsystem.	4	2	2
25.	Define C3 and explain the importance of the C3	4	2	3

	Question	Marks	BL	CO
26.	Explain aerodynamic heating	4	2	4
27.	Calculate the radius of the spheres of influence of Mercury and Jupiter	4	3	5

Part - C (5 × 12 Marks = 60 Marks)
Answer **All** Questions

	Question	Marks	BL	CO
28.	a. Define space mission and explain the classifications of space mission. (OR) b. Explain the step by step procedure for orbit design.	12	2	1
29.	a. Explain in detail about attitude determination and control subsystem. (OR) b. Describe in detail about electrical power subsystem.	12	2	2
30.	a. Derive the scalar equations of motion for restricted three-body problem. (OR) b. Find the orbital elements of a geocentric satellite whose inertial position and velocity vectors in a geocentric equatorial frame are $\vec{r} = 2615\hat{i} + 15881\hat{j} + 3980\hat{k}(km)$ and $\vec{v} = -2.767\hat{i} - 0.7905\hat{j} + 4.980\hat{k}(km/s)$.	12	3	2
31.	a. i) Explain orbit deviation due to injection errors. ii) Describe the general aspects of satellite injection. (OR) b. Explain the types of space vehicle entry mechanics.	12	2	4
32.	a. Estimate the radius of a planet's gravitational sphere of influence of three-body system. (OR) b. A spacecraft is launched on a mission to Mars starting from a 300 km circular parking orbit. Calculate (a) the delta-V required, (b) the location of perigee of the departure hyperbola, and (c) the amount of propellant required as a percentage of the spacecraft mass before the delta-V burn, assuming a specific impulse of 300 s.	12	3	3

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