28. a. Derive the scalar equations of motion for restricted three-body problem. 10 1 3 1

(OR)

b. The geocentric position vectors of a space object at three successive times are 10 3 3 1

$$\vec{r_1} = -294.32\hat{i} + 4265.1\hat{j} + 5986.7\hat{k}(km)$$
$$\vec{r_2} = -1365.5\hat{i} + 3637.6\hat{j} + 6346.8\hat{k}(km)$$
$$\vec{r_3} = -2940.3\hat{i} + 2473.7\hat{j} + 6555.8\hat{k}(km)$$

Determine the velocity vector $\vec{V_3}$ using Gibbs method.

29. a.i. Explain orbit deviation due to injection errors. 5 2 4 1

ii. Describe the general aspects of satellite injection. 5 2 4 1

(OR)

b. Explain the types of space vehicle entry mechanics. 10 2 4 1

30. a. Estimate the radius of a planet's gravitational sphere of influence of three-body system. 10 3 5 1

(OR)

b. A spacecraft is launched on a mission to Mars starting from a 300 km circular parking orbit. 10 3 5 1

Calculate

(i) The delta-v required,

(ii) The location of perigee of the departure hyperbola, and

(iii) The amount of propellant required as a percentage of the spacecraft mass before the delta-v burn, assuming a specific impulse of 300 s.

* * * * *

Reg. No.															

B.Tech. DEGREE EXAMINATION, MAY 2022

Seventh Semester

18ASE304T – SPACE MISSION DESIGN AND ANALYSIS

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

$m_{Sun} = 1.989\times10^{30}$ 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, $\mu_{Earth} = 398600$ km^3 /s^2 and $R_{Earth} = 149.6\times10^6$ km

$m_{Mars} = 6.419\times10^{23}$ kg, r_{Mars} =3396 km, $\mu_{Mars} = 42828$ 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 40th minute.

(ii) **Part - B** should be answered in answer booklet.

Time: 2½ Hours Max. Marks: 75

PART – A (25 × 1 = 25 Marks)

Answer **ALL** Questions

Marks BL CO PO

1. At lower orbits a spacecraft will be bombarded by the atmosphere at orbital velocities on the order of 1 1 1 1

(A) 7 km/s (B) 8 km/s
(C) 9 km/s (D) 10 km/s

2. Which of the following events affects the Random-Access Memory (RAM) and microprocessors? 1 1 1 1

(A) Trapped radiation (B) Solar particle events
(C) Galactic cosmic rays (D) Magnetosphere

3. ________ are principal mission parameters or characteristics which influence performance, cost and schedule 1 1 1 1

(A) Mission architectures (B) System drivers
(C) Mission evaluation (D) Mission objectives

4. Which of the following are the principal design variable for constellation design? 1 1 1 1

(A) Inclination (B) Eccentricity
(C) Declination (D) Altitude

5. Which of the following is also called as ICO? 1 1 1 1

(A) LEO (B) MEO
(C) GEO (D) GSO

6. The attitude determination and control subsystem determine its attitude using 1 1 2 1

(A) Sensor (B) Actuator
(C) Controller (D) Amplifier

7. Which of the following are not function of telemetry, tracking and command subsystem? 1 1 2 1
(A) Receive (B) Oscillate
(C) Modulate (D) Transmit

8. A telemetry channel with information encoded as a resistance is called as 1 1 2 1
(A) High-level analog (B) Low-level analog
(C) Passive analog (D) Active analog

9. The spacecraft average density is 1 1 2 1
(A) 59 kg/m^3 (B) 69 kg/m^3
(C) 79 kg/m^3 (D) 89 kg/m^3

10. The ______________ isolates the transmitter from receiver. 1 1 2 1
(A) Actuator (B) Sensor
(C) Domain decomposer (D) Diplexer

11. Which of the following trajectory called as escape trajectory? 1 1 3 1
(A) Circular trajectory (B) Parabolic trajectory
(C) Elliptic trajectory (D) Hyperbolic trajectory

12. Which is the measure of energy required for interplanetary mission? 1 1 3 1
(A) Escape velocity (B) Parabolic excess speed
(C) Elliptic excess speed (D) Characteristic energy

13. The geocentric position vector is given as $\vec{r} = -294.32\hat{i} + 4265.1\hat{j} + 986.7\hat{k}(km)$. What is the corresponding magnitude? 1 3 3 1
(A) 7356.5 km (B) 7441.7 km
(C) 7456.8 km (D) 7556.9 km

14. In perifocal coordinate system, the unit vector $\hat{w}$ lies in the direction of ________. 1 1 3 1
(A) Eccentricity (B) Angular momentum
(C) Ture anomaly (D) Eccentric anomaly

15. __________ is called equilibrium or liberation point 1 1 3 1
(A) Lagrange point (B) Jacobi point
(C) Gaussian point (D) Euler point

16. Which of the following is the arithmetic sum of all the velocity changes required to perform a specified mission? 1 1 4 1
(A) Mission characteristic velocity (B) Launch vehicle characteristic velocity
(C) Mission azimuthal velocity (D) Launch vehicle azimuthal velocity

17. The time of separation is called as 1 1 4 1
(A) Injection parameter (B) Injection anomaly
(C) Injection epoch (D) Injection unit

18. Prandtl number for air at standard condition is _______. 1 2 4 1
(A) 0.70 (B) 0.71
(C) 0.80 (D) 0.81

19. The heat flux of the wall is proportional to ________. 1 1 4 1
(A) Local free steam temperature (B) Local stagnation temperature
(C) Local temperature gradient (D) Local velocity gradient

20. At hypersonic speeds, the total enthalpy depends on the 1 1 4 1
(A) Static enthalpy alone (B) Velocity alone
(C) Both static enthalpy and velocity (D) Both static enthalpy and pressure

21. Far manned mission, which one of the following orbital maneuver has a large period of heliocentric orbits? 1 1 5 1
(A) Hohmann maneuver (B) Simple impulse maneuver
(C) Phasing maneuver (D) Bi-elliptic Hohmann maneuver

22. Which of the following is the gravitational parameter for Mars? 1 2 5 1
(A) 1.327×10^{11}km^3/s^2 (B) 42828 km^3/s^2
(C) 22930 km^3/s^2 (D) 1.26686×10^8 km^3/s^2

23. In order to escape the gravitational pull of a planet, the spacecraft must travel in _______. 1 1 5 1
(A) Escape trajectory (B) Circular trajectory
(C) Elliptic trajectory (D) Hyperbolic trajectory

24. Which one of the following astronomical object has relatively large eccentricity? 1 1 5 1
(A) Jupiter (B) Venus
(C) Saturn (D) Pluto

25. Which of the following are the velocity of an orbiting satellite at an altitude of 600 km circular orbit? (μ_{Earth} – 398600 km^3/s^2 and R_{Earth} –6378 km) 1 3 5 1
(A) 7.5 km/s (B) 8.5 km/s
(C) 9.5 km/s (D) 10.5 km/s

PART – B (5 × 10 = 50 Marks)
Answer **ALL** Questions

Marks BL CO PO

26. a. Define space mission and explain the classifications of space mission. 10 1,2 1 1

(OR)

b. Explain the step by step procedure for orbit design. 10 2 1 1

27. a. Explain in detail about attitude determination and control subsystem. 10 2 2 2

(OR)

b. Describe in detail about electrical power subsystem. 10 2 2 1