BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

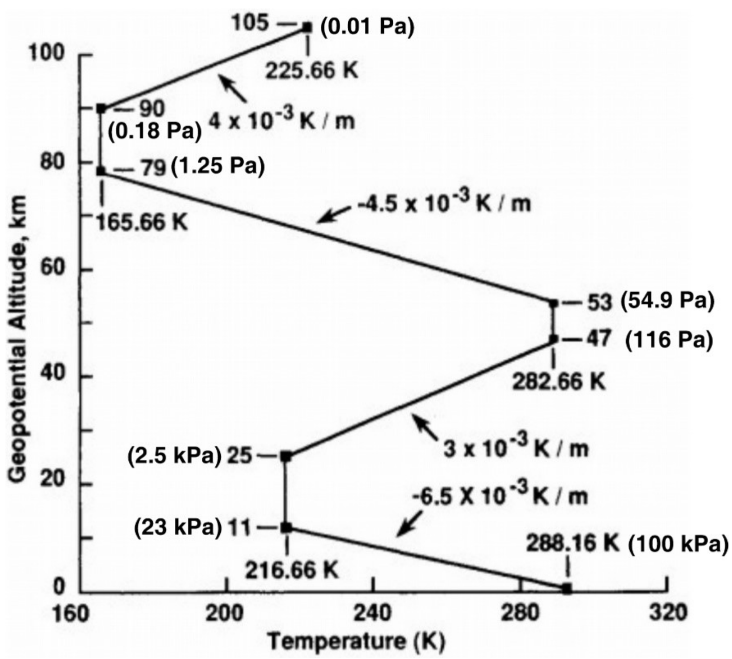
CLASS: MTECH **SEMESTER : I**
BRANCH: SPACE ENGINEERING AND ROCKETRY **SESSION : MO/2024**

SUBJECT: SR503 SPACE ENGINEERING AND SPACE DYNAMICS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1	Weather balloons and sounding rockets have provided following graphical form of the standard atmosphere. Obtain a mathematical model of atmospheric density using appropriate assumptions. If required, use the graph paper supplied to you.	[10]	4	4



Q.2(a)	State and analyze the main features of the Goddard problem and provide physical arguments for solution of the problem.	[5]	3	3
Q.2(b)	Provide a mathematical model of rocket motion in straight-line inclined trajectory in free-space and solve the model for initial conditions corresponding to the launch pad. Explicitly state your assumptions.	[5]	2,3	4
Q.3(a)	Explain the 'b-plane' and the targeting method using b-plane.	[2]	1	2
Q.3(b)	In the equation, $a = \mu r \times \left(2\mu - rV^2\right)^{-1}$, identify the orbital element(s) and injection condition(s) and provide expression(s) to estimate the deviation(s) in the identified element(s) due to error(s) in the identified condition(s).	[3]	3,4	3

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Q.3(c)	For an elliptic Keplerian orbit, given $V_\theta = \frac{2\pi(1+e\cos\theta)}{p\sqrt{1-e^2}}$ and $V_r = \frac{2\pi ae\sin\theta}{p\sqrt{1-e^2}}$, show that $V = \mu\left(\frac{2}{r}-\frac{1}{a}\right)$. Use the square-cube law and polar equation of an elliptic conic.	[5]	3,4	4
Q.4	Briefly define ballistic and gliding entry. Obtain limiting solutions of inertial velocity (V) of a vehicle for the ballistic entry and gliding entry problems using the starting differential equations given below. Symbols have usual meaning. $\frac{d}{d\rho}\left(\frac{V^2}{gR}\right) = \frac{SC_D}{m}\frac{1}{\beta}\sin\gamma\frac{V^2}{gR} + \frac{2}{\rho\beta R}$ $\frac{d}{d\rho}(\cos\gamma) = \frac{1}{2\beta}\frac{SC_D}{m}\frac{L}{D} - \left(\frac{gR}{V^2}-1\right)\frac{\cos\gamma}{\rho\beta R}$	[10]	3	3
Q.5(a)	Draw a sketch showing the usable region for power sources used in space.	[5]	4,5	2
Q.5(b)	Explain how the power requirements of a small satellite could be satisfied during the eclipse and sudden overload events. Suggest a useful method for the same and provide a performance criterion.	[5]	4,5	4

::::::21/11/2024::::::E