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

CLASS: B.Tech. **SEMESTER: IV**
BRANCH: Mechanical **SESSION: SP/2023**

SUBJECT: ME213 THERMO-FLUID ENGINEERING

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

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and a total of 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 handbook/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	In the setup shown in Fig. 1, the fluid mass is initially stationary (as in (A)), and after the bottom plate is removed (immediately), gravity causes the liquid in the tube to accelerate downward (as in (B)). In the first few moments after the flow starts, the liquid may be assumed to have a nearly spatially uniform velocity $\boldsymbol{u} = -U(t)\mathbf{k}$. Clearly describe the acceleration of the fluid from this velocity field.	[5]	1	1
Q.1(b)	A spherical tank of volume 0.05 m^3 contains air at p=800 kPa (absolute), T=15°C. At t=0, air escapes through the valve. Air leaves with speed v=311 m/s and density ρ=6.13 kg/m^3 through area A=65 mm^2. Find the change of air density in the tank at t=0.	[5]	3	2

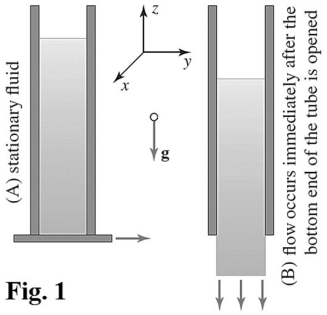

Fig. 1

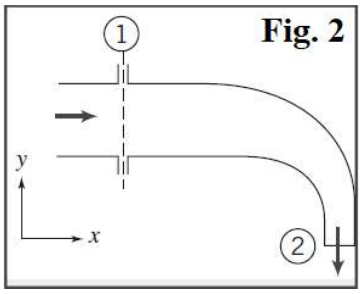

Fig. 2

Q.2(a)	A Newtonian flow field has the following velocity field: $\boldsymbol{V}=x^2y\mathbf{i}+2xy^2z\mathbf{j}-yz^3\mathbf{k}$. Calculate the normal and shearing rates of strain at x=-2, y=-1, and z=2. Also determine if the fluid is rotating at that location, and about what axis.	[5]	2	3
Q.2(b)	Consider a one-dimensional radial flow in the r-θ plane, given by $v_r=f(r)$ and $v_\theta=0$. Determine the conditions on $f(r)$ required for the flow to be incompressible.	[5]	2	4
Q.3	Water flows steadily through the 90° reducing elbow shown in Fig. 2. At the inlet to the elbow, the absolute pressure is 220 kPa and the cross-sectional area is 0.01 m^2. At the outlet, the cross-sectional area is 0.0025 m^2 and the velocity is 16 m/s. The elbow discharges to the atmosphere. Determine the force required to hold the elbow in place.	[10]	5	4
Q.4(a)	Prove that the speed of sound, $c=\sqrt{(kRT)}$	[5]	2	2
Q.4(b)	Discuss with a neat sketch the effect of moving source of sound at the speed of sound through the air.	[5]	1	2
Q.5(a)	Derive an expression for the availability in a steady flow process.	[5]	4	7
Q.5(b)	Calculate the decrease in the available energy when 25 kg of water at 95°C mix with 35 kg of water at 35°C, the pressure is taken as constant and the temperature of the surroundings is 15°C (C_p for water = 4.2 kJ/kgK).	[5]	5	6

::::::27/04/2023::::::M