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

CLASS: B.TECH **SEMESTER: V**
BRANCH: ME **SESSION: MO/2022**

SUBJECT: ME331 THERMO FLUID ENGINEERING

TIME: 2 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

				CO	BL
Q1	(a)	Expand $\left(\vec{V}.\nabla\right)\vec{V}$ in rectangular coordinates by direct substitution of the velocity vector to obtain the convective acceleration of a fluid particle.	[2]	CO2	2
Q1	(b)	Define timeline, streakline and streamline in a flow field?	[3]	CO1	1
Q2	(a)	In steady-state flow, at downstream the density is 1 kg/m^3, the velocity is 1000 m/sec, and the area is 0.1 m^2. Upstream, the velocity is 1500 m/sec, and the area is 0.25 m^2. Calculate the density at upstream?	[2]	CO5	3
Q2	(b)	A tank of 0.4 m^3 volume contains compressed air. A valve is opened and air escapes with a velocity of 250 m/s through an opening of 100 mm^2 area. Air temperature passing through the opening is -20°C and the absolute pressure is 300 kPa. Find the rate of change of density of the air in the tank at this moment.	[3]	CO3	3
Q3	(a)	The stream function of a flow field is $\psi = Ax^2y - By^3$, where A = 1 m^{-1}s^{-1}, B = 0.33 m^{-1}s^{-1}. Find an expression for the velocity potential.	[2]	CO5	3
Q3	(b)	An incompressible frictionless flow field is given by $\vec{V} = (Ax + By)\,\hat{i} + (Bx - Ay)\,\hat{j}$, where A=2 s^{-1} and B=2 s^{-1}, and the coordinates are measured in meters. Find the magnitude of the acceleration of a fluid particle at point (x, y) = (2, 2). Find the pressure gradient at the same point, if $\vec{g} = -g\,\hat{j}$ and the fluid is water with density 1000 kg/m^3.	[3]	CO5	3
Q4	(a)	A flow field is represented by the stream function $\psi = x^5 - 10x^3y^2 + 5xy^4$. Check whether the flow is rotational or irrotational.	[2]	CO5	2
Q4	(b)	Consider frictionless, incompressible flow of air over the wing of an airplane flying at 200 km/hr. The air approaching the wing is at 65 kPa and -10°C. At a certain point in the flow, the pressure is 60 kPa. Calculate the speed of the air relative to the wing at this point and the absolute air speed. Consider air as an ideal gas and R = 286.9 J/kg.K.	[3]	CO1	3
Q5	(a)	Assume the liquid film over horizontal plane and the flow is driven by a constant shear stress on the top surface i.e at y = h, τ_{yx} = C. Assume that the liquid film is thin enough and flat and that the flow is fully developed with zero net flow rate (flow rate Q = 0). Determine the velocity profile u(y).	[2]	CO2	3
Q5	(b)	Determine the pressure gradient dp/dx	[3]	CO2	3

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