Name: BITS ID:

BITS Pilani, Pilani campus, First semester 2023-2024

MF F218 Transport phenomena in manufacturing

Mid-semester Examination

Date: 10/10/2023, 2:00 pm to 3:30 pm, Total marks: 50, and Weightage: 25%

Instructions

i. There are 4 questions printed on both sides of this paper. Please answer all of them.
ii. This is an open-book examination. However, the use of Textbook (Welty, Wicks, Wilson, Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th Edition, Wiley, 2010), class slides and handwritten notes are only permitted.
iii. State assumptions if any and assume any missing data.

Questions

1. Elaborate briefly on:

(a) Shear thinning and shear thickening fluids with an example for each. [3 marks]

(b) Molecular mechanism behind the heat conduction in metals, non-metals, liquids and gases. [4 marks]

(c) Lagrangian and Eulerian descriptions of flow field with an example for each. [3 marks]

2. (a) Using the fundamental law of fluid statics, derive equations for the hydrostatic pressure distribution under the sea with respect to the depth (y in m) from free surface. [2 marks]

(b) Further, derive an expression for atmospheric pressure variation with respect to the altitude (y in m) from sea level for the following two cases: (i) T(y)= constant and (ii) T(y)= A-By; where A and B are constants. [3+5= 8 marks]

(c) Comment on the nature of the equations derived in (a) and (b). [1 mark]

3. Consider a rectangular plane surface which is 4 m wide (w) and 6 m deep (d). For its various orientations described below, determine the pressure force and position of centre of pressure on the plane surface

(a) The plane is kept horizontal and 5 m below the free water surface. [2 marks]

(b) The plane is kept vertical such that its upper edge (the 4 mm side) is horizontal and 5 m below the free water surface. [4 marks]

(c) The plane is kept inclined with respect to the free surface by an angle of 30^o such that its upper edge (the 4 mm side) is horizontal and 5 m below the free water surface. [5 marks]

Take ρ= 1000 kg/m^3 and g= 9.81 m/s^2. For rectangular plane, the area moment of inertia about its centre, $I_{xx}= b*h^3/12$; b= breadth and h= height.

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4. Consider the following flow fields (i) u= 1 and v=1, (ii) u= x and v= -y, and (iii) u= x, and v= y(1+t).

(a) Examine the given flow fields and classify whether they are steady/unsteady and uniform/non-uniform. [3 marks]

(b) Estimate the magnitude of acceleration at point (1,1) for each flow field. [3 marks]

(c) Find the equations of (a) streamline (b) pathline of the particle and (c) streakline that passes through the point (1, 1) at time t= 0 in the xy plane for each flow fields. [9 marks]

(d) Compare the streamline, pathline and streak line equations and comment if they coincide in the above cases or not. [3 marks]