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Question Paper Code:R3C05

B.E./B.Tech. DEGREE EXAMINATION, NOV 2025

Third Semester

R21UBT305 – FLUID MECHANICS AND HEAT TRANSFER OPERATIONS

Biotechnology

(Regulations R2021)

Duration: Three hours   Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1. List out the properties of fluid   CO1 - U

2. Differentiate fluid statics and fluid dynamics   CO3 -App

3. Write advantages and disadvantages of fluidisation   CO1 -U

4. Calculate the friction factor when the Reynolds number is 1600 for flow of   CO3 -App
    fluid through the pipe.

5. Calculate the rate of heat loss Q, through a wall of red brick[k = 0.70   CO3 -App
    W/(m·K)] 5 m in length, 4 m in height and 250 mm in thickness, if the wall
    surfacesare maintained at 373 K (100°C) and 303 K (30°C) respectively.

6. Define Thermal Conductivity   CO2 -U

7. State Nusselt number and its significance   CO2 -U

8. Write the relationship between U and hi, ho, xw/k and Rd   CO2 -U

9. Give examples of radiation heat transfer.   CO2 -U

10. Calculate the loss of heat per unit area from a steam pipe to the surrounding CO3 -App
    air by radiation mode. Take emissivity of 0.90.

PART – B (5 x 16= 80 Marks)

11. (a) In a water distribution plant, accurate measurement of fluid flow   CO3 - App   (16)
        is critical to monitor supply across different sectors. The facility
        currently uses expensive and complex electronic flow meters,
        which are difficult to maintain in harsh field conditions. As a
        mechanical or fluid mechanics consultant, you are asked to
        suggest a simpler, cost-effective alternative. Recommend the use
        of an orifice meter for this application. Examine a neat sketch of
        the orifice meter and explain its construction, working principle,
        advantages and disadvantages.

Or

(b) i. Derive the Bernoulli equation of cross sectional pipeline fluid flow with suitable sketch . CO3 - App (8)
(8)

ii. Water is flowing at a rate of 500 cm^3/s through an orifice of 25 mm diameter installed in a 75 mm diameter pipe. What will be the difference in the level on a mercury manometer connected across the meter? The coefficient of orifice meter is 0.65.

12. (a) In a hydraulic press manufacturing unit, precise and high-pressure fluid delivery is required to operate the pressing cylinders. The engineers currently using centrifugal pumps face issues with inconsistent pressure and lack of control over fluid delivery. As a fluid machinery consultant, recommend a suitable alternative. Suggest the use of a reciprocating pump for this application. Outline its construction, working principle, advantages, and limitations. Support your answer with a neat and labeled sketch. CO3 - App (16)

Or

(b) Water is flowing at a velocity of 2.5 m/s through 25 mm internal diameter pipe. Find out the friction factor ' f '. CO3 – App (16)
Data : Density of water = 1000 kg/m^3
Viscosity of water = 0.0008 (N.s)/m^2

13. (a) 88 mm O.D. pipe is insulated with a 50 mm thickness of an insulation having a mean thermal conductivity of 0.087 W/(m·K) and 30 mm thickness of an insulation, having mean thermal conductivity of 0.064 W/(m·K). If the temperature of the outer surface of the pipe is 623 K (350 ^{o}C) and the temperature of the outer surface of insulation is 313 K (40 ^{o}C), calculate the heat loss per meter of pipe. CO5 – Ana (16)

Or

(b) Establish an expression for heat flow through a thick walled cylinder by conduction. Take r_1 and r_2 as the inner and outer radii of cylinder, k as a mean thermal conductivity. Assume T_1 as the inside temperature and T_2 as the outside temperature. CO5 – App (16)

14. (a) Give the Sieder-Tate equation used to calculate the film   CO4 – App (16)
       coefficient in case of laminar flow.

                                    Or

    (b) Derive unsteady state heat conduction equation for cylindrical CO4 – App (16)
        coordinates.

15. (a) An oil cooler consists of straight tube of 20 mm outer diameter   CO5 - Ana (16)
        and 15 mm inner diameter r enclosed within a pipe and
        concentric with it. The external pipe is well insulated. The oil
        flows through the tube at 0.05 kg/s($Cp = 2$ kJ/kg ^oC) and
        cooling fluid flows in the annulus in opposite direction at the rate
        of 0.1 kg/s ($Cp=4$kJ/kg ^oC). The oil enters the cooler at 180^oC
        and leaves at 80 ^oC while cooling liquid enters the cooler at 30
        ^oC. Calculate the length of the pipe required if heat transfer
        coefficient from oil to tube surface is 1720 W/m^{2o}C and from
        metal surface to coolant is 3450 W/m^{2o}C. Neglect the resistance
        of the tube wall.

                                    Or

    (b) (i) Arrive at the equation to find out the radiation heat transfer CO5 - Ana (16)
        between the two black surfaces.
        (ii) Briefly explain black body concept.
        (iii) The effective temperature of a body having an area of 0.12
        m^2 is 630^oC. Calculate the total rate of energy emission, the
        intensity of normal radiation and wavelength of maximum
        monochromatic emissive power.

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