

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2023

Subject Code:3142507**Date:11-07-2023****Subject Name:Fluid Mechanics and Heat Transfer****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

- Q.1**
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|------------|---|-----------|
| (a) | Define Density , Surface tension, and compressibility | 03 |
| (b) | State and prove Pascal's law. | 04 |
| (c) | A circular plate 4.0 m diameter is immersed in water in such a way that their greatest and least depths below the free surface of are 4 m and 2 m respectively. Determine the total the total pressure on one face of the plate and position of the centre of pressure. | 07 |
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- Q.2**
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|------------|---|-----------|
| (a) | Define steady flow, Non-uniform flow, and three dimensional flows. | 03 |
| (b) | Explain stability of floating body | 04 |
| (c) | Using Buckingham's π -theorem , show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\phi \left[\frac{D}{H}, \frac{\mu}{\rho V H} \right]$
Where H is the head causing flow, D is the diameter of orifice, μ is co-efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. | 07 |
- OR**
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|------------|--|-----------|
| (c) | Derive an expression for the discharge through venturimeter. | 07 |
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- Q.3**
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|------------|---|-----------|
| (a) | Define the conduction, convection and radiation modes of heat transfer with suitable example. | 03 |
| (b) | An electronic semiconductor device generates 0.16 kJ/ hr of heat. To keep the surface temperature at the upper safe limit of 75°C, it is desired that the generated heat should be dissipated to the surrounding environment which is at 30°C. The task is accomplished by attaching aluminum fins, 0.5 mm ² square and 10 mm to the surface. Work out the number of fins if thermal conductivity of fin material is 690 kJ/m-hr-deg and the heat transfer coefficient is 45 kJ/m ² -hr-deg. Neglecting the loss from the tip of the fin. | 04 |
| (c) | Derive general heat conduction equation in Cartesian coordinate system. Reduce the equation (i) Laplace equation, and (ii) Fourier equation. | 07 |
- OR**
- Q.3**
- | | | |
|------------|--|-----------|
| (a) | Define :
1) Critical thickness of insulation for cylinder
2) Thermal diffusivity
3) Thermal resistance | 03 |
| (b) | Explain the following : a) Fin Efficiency, b) Fin Effectiveness, | 04 |
| (c) | Saturated steam at 110°C flows inside a copper pipe (thermal conductivity 450 W/mK) having an internal diameter of 10 cm and a diameter of 12cm. the surface resistance on the steam side is 12000 W/m ² K and that on the outside surface of pipe is 18 W/m ² K. Determine the heat loss from the pipe if it is located in space at 25°C. How this heat loss would be affected if the | 07 |

pipe is lagged with 5 cm thick insulation of thermal conductivity 0.22 W/m K? Take length of pipe is unity(1 m).

- Q.4** (a) Define fouling factor in case of heat exchanger? List the causes of fouling. **03**
 (b) What are dimensionless numbers? Explain physical significance of Nusselt Number and Prandtl Number. **04**
 (c) Using dimensional analysis, obtain a general form of equation for forced convective heat transfer. **07**

OR

- Q.4** (a) Define Grashof number. Explain its significance in natural convection heat transfer. **03**
 (b) Explain the concept of thermal boundary layers. **04**
 (c) Superheated steam at 330°C is flowing at 20m/s velocity ($h = 110 \text{ W/m}^2\text{K}$) through a pipe 120 mm in diameter. The temperature of steam is to be measured by putting a pocket in the pipe of 15mm ID and 1mm thickness. Pocket material thermal conductivity is $50 \text{ W/m}^2\text{K}$. **07**
 1) Determine length of insertion so that error in the thermometer is 0.5%.
 2) If pipe wall is maintained at temperature of 40°C, find temperature measured by thermometer.

- Q.5** (a) Define the terms: Absorptivity, Reflectivity, Transmittivity. **03**
 (b) State and prove Kirchoff's law of radiation. **04**
 (c) Define radiation shield. Prove that if radiation shields of the emissivity same as the emissivity of two parallel plate is inserted between two parallel plates net heat transfer rate due to radiation is reduced to half as compared to without shield. **07**

OR

- Q.5** (a) Explain meaning of following as applied to heat exchangers: **03**
 (1) Heat capacity ratio,
 (2) Effectiveness and
 (3) Number of Transfer Units.
 (b) State and explain Wein's displacement law. **04**
 (c) A furnace emitted radiation at 2000K. Treating it as a black body radiation, calculate the **07**
 1) Monochromatic radiant flux density at $1\mu\text{m}$ wavelength.
 2) Wavelength at which emission is maximum and the corresponding radiant flux density
 3) Total emissive power, and
 4) Wavelength λ such that emission from 0 to λ is equal to the emission from λ to ∞
 Take $C_1 = 0.374 \times 10^{-5} \text{ Jm}^2/\text{s}$ and $C_2 = 1.4388 \times 10^{-2} \text{ mK}$
