Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE SEM-VI Examination-Nov/Dec-2011

Subject code: 161906 **Date: 02/12/2011**
Subject Name: Heat and Mass Transfer
Time: 10.30 am -1.00 pm **Total marks: 70**

Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What is the difference between the natural and forced convection? **03**

(b) Explain the following terms **04**
1.Radiation
2.Thermal resistance
3.Thermal diffusivity
4.Thermal conductivity

(c) A gas turbine blade made of stainless steel (k =32 W/m°C) is 70 mm long ,500 mm^2 cross sectional area and 120 mm perimeter .The temperature of the root of blade is 500°C and it is exposed to the combustion product of the fuel passing from turbine at 830°C.If the film coefficient between the blade and the combustion gases is 300 W/m^{2}°C, **07**
Determine: (1) The temperature at the middle of blade
(2)The rate of heat flow from the blade

Q.2 **(a)** Derive general heat conduction equation in spherical co-ordinates **07**

(b) A furnace wall is made up of three layers of thickness 250 mm,100mm and 150mm with thermal conductivity of 1.65,k and 9.2 W/m°C respectively .The inside is exposed to gases at 1250°C with a convection coefficient of 25 W/m^{2}°C and the inside surface is at 1100°C,the outside surface is exposed to air at 25°C with convection coefficient of **07**
12 W/m^{2}°C.Determine:-
(1)The unknown thermal conductivity k
(2)The overall heat transfer coefficient
(3)All Surface temperatures

OR

(b) Derive an expression for heat dissipation in Rectangular Fin of uniform cross section which is insulated at tip . **07**

Q.3 **(a)** Derive momentum equation for hydrodynamic boundary layer over a flat plate **07**

(b) Enumerate the factors on which the rate of emission of radiation by body depends. **03**

(c) Differentiate between pool boiling and forced convection boiling **04**

OR

Q.3 **(a)** Define Nusselt number and Prandtle number. **04**

(b) What is black body? How does it differ from gray body? Give examples of each. **03**

(c) A steam pipe 8 cm in diameter is covered with 3 cm thick layer of insulation which has a surface emissivity of 0.9.The surface temperature of the insulation is 80°C and the pipe is placed in atmospheric air at 24°C.Considering heat loss by both radiation and natural convection calculate: **07**

(1)The heat loss from the 7 m length of pipe.

(2)The overall heat transfer coefficient and the heat transfer coefficient due to radiation alone.

The thermo physical properties of air at mean film temperature of 52°C are as following:

ϱ=1.092 kg/m^3,c_p=1.007kj/kg°C,μ=19.57×10^{-6}kg/ms,

k=27.81×10^{-3}W/m°C (where the notations have their usual meaning.)

use empirical correlation for horizontal cylinders as $Nu=053(Gr.Pr)^{.25}$

Q.4 **(a)** Derive the relationship between the effectiveness and number of transfer units for a counter flow heat exchangers. **07**

(b) A heat exchanger is to be designed to condense 8 kg/sec of an organic liquid (t_{sat}=80°C,h_{fg}=600 Kj/kg)with cooling water available at 15°C and at a flow rate of 60kg/sec.The overall heat transfer coefficient is 480 W/m^2°C calculate: **07**

(a)the number of tube required .The tubes are to be of 25 mm outer diameter ,2 mm thickness and 4.85 m length

(b)The number of tube passes. The velocity of the cooling water is not to exceed 2m/sec.

OR

Q.4 **(a)** Sketch a shell and tube type heat exchanger **04**

(b) Discuss the importance of heat exchangers for industrial use. **03**

(c) Water at the rate of 4 kg/sec is heated from 40°C to 55°C in a shell and tube type heat exchanger. The water is to flow inside tubes of 2 cm diameter with an average velocity of 35cm/sec.Hot water is available at 100°C and at the rate of 2kg/sec.which is used as the heating medium in shell side. If the length of the tube is of 2m calculate the number of tube passes, the number of tube per pass and the length of the tubes for one shell pass, assuming U_o=1500 W/m^{2}K **07**

Q.5 **(a)** Define the Fick's first law and second law for diffusion **04**

(b) Define convective mass transfer coefficient and what are its units **03**

(c) The air pressure in a tyre tube of surface area 0.5 m^2 and wall thickness of 0.01m is approximated to drop from 2 bar to 1.98 bar in period of 6 days. The solubility of air in rubber is 0.07 m^{3}of air/ m^3 of rubber at 1 bar. Estimate the diffusivity of air in rubber at operating temperature of 300K if the volume of air in tube is 0.026m^3. **07**

OR

Q.5 **(a)** Enumerate the applications of mass transfer **04**

(b) Define absorptivity,reflectivity and transmissivity with respect to radiation heat transfer **03**

(c) Explain the following in detail: (draw neat sketch if required) **07**

1.Film wise and drop wise condensation

2.Fouling factors and over all heat transfer coefficient

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