Registration no: | | | | | | | | | | |

Total Number of Pages: 03 **B.Tech**

PCCH4301

5th Semester Back Examination 2017-18

Heat Transfer

BRANCH: CHEM

Time: 3 Hours

Max Marks: 70

Q.CODE: B212

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** **(2 x 10)**

a) What is a black body?

b) What is emissivity?

c) If the viscosity of air is 24.5 $x10^{-6}$ N-s/m^2, specific heat capacity is 1kJ/kg K and thermal conductivity 0.12 W/mK, Calculate the prandtl number and thermal diffusivity.

d) What is Peclet number?

e) What is the physical significance of the Nusselt number? How is it defined?

f) Explain Wien's displacement law.

g) What is the difference between pool boiling and flow boiling?

h) In a counter flow heat exchanger, the heat capacity rate of both hot and cold fluids are equal. If NTU is 0.5, calculate the effectiveness of heat exchanger.

i) What is transient heat conduction?

j) What is Biot number?

Q2 **a)** Calculate the rate of heat loss for a red brick wall of length 5m, height 4m, and thickness 0.25 m. The temperature of the inner surface is 110^oC and that of the outer surface is 40^oC. The termal conductivity of red brick, *K*=0.70W/mK. Calculate also the temperature at an interior point of the wall, 20 cm distant from the inner wall. **(5)**

b) Derive an expression for critical insulation thickness for a cylindrical body. **(5)**

Q3 **a)** A carbon steel rod (*K*=55W/m-deg) has been attached to a plane wall which is maintained at a temperature of 350^{o}C. The rod is 8 cm long and has the cross-section of an equilateral triangle with each side 5 mm. Determine the heat dissipation from the rod if it is exposed to a convection environment at 25^{o}C with convection heat transfer coefficient 100 W/m^2.deg. Consider end surface loss to be negligible. **(5)**

b) One end of a very long aluminium rod is connected to a wall at 140^{o}C, while the other end protrudes into a room whose air temperature is 15^{o}C. The rod is 3 mm in diameter and the heat transfer coefficient between the rod surface and environment is 300 W/m^{2}K. Estimate the total heat dissipated by the rod taking its thermal conductivity as 150W/mK. **(5)**

Q4 **a)** A flat plate, 50 cm long x 75 cm wide and at 90^{o}C is located in water stream having a free stream velocity of 5 m/s and at 30^{o}C. The transition from laminar to turbulent boundary layer flow occurs at Reynolds number equal to 4x10^5. If flow is parallel to 50 cm side, calculate Nusselt number for the plate and thickness of thermal boundary layer at a distance of 20 cm from the leading edge. At the mean temperature 0f of 60^{o}C, the themophysical properties of water are **(5)**

$\rho = 1000$ kg/m^3, $C_p = 4.2$ kJ/kg K; Pr=13.7

K=0.55W/m-deg and μ=1780 x 10^{-6} kg/ms

b) Define Grashof number. Write its physical significance. **(5)**

Q5 **a)** Determine heat loss by radiation per meter length of 80 mm diameter pipe at 300^{o}C, if **(5)**

(i)Located in a large room with red brick walls at a temperature of 27^{o}C;

(ii) Enclosed in a 160 mm diameter red brick conduit at a temperature of 27^{o}C.

Take ε=0.79, and ε = (brick conduit)=0.93.

b) Describe briefly the various regimes in boiling heat transfer. **(5)**

Q6 **a)** What is Stefan-Boltzmann law? Explain the concept of total emissive power of a surface. **(5)**

b) A heat exchanger is to be designed to condense 8 kg/s of an orgnanic fluid (T_{sat}=80^{o}C; h_{fg}=600kJ/kg) with cooling water available at 15^{o}C and at a flow rate of 60 kg/s. The overall heat transfer coefficient is 480W/m^2-deg. Calculate: **(5)**

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

Q7 A counter-flow concentric heat exchanger is used to cool the lubricating oil of a large industrial gas turbine engine. The oil flows through the tube at 0.19 kg/s (C_p=2.18kJ/kgK), and the coolant water flows in the annulus in the opposite direction at a rate of 0.15 kg/s (C_p=4.18kJ/kg K). The oil enters the coolant at 425 K and leaves at 345 K while the coolant enters at 285 K. How long must the tube be made to perform this duty if the heat transfer coefficient from oil to tube surface is 2250 W/m^{2}K and from tube surface to water is 5650 W/m^{2}K? The tube has a mean diameter of 12.5 mm and its wall presents negligible resistance to heat transfer. **(10)**

Q8 **Write short answer on any TWO:** **(5 x 2)**

a) LMTD

b) Radiation shields

c) Planck's relation for monochromatic emissive power of a black body

d) Critical Reynolds number