Total No. of Questions : 8]

SEAT No. :

PF5023

[Total No. of Pages : 3

[6626]-161

T. E. (Mechanical/Mechanical-Sandwich)

HEAT & MASS TRANSFER

(2019 Pattern) (Semester - V) (302042)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Solve Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q7 or Q.8.***
2) ***Draw neat diagram wherever necessary.***
3) ***Use of scientific calculator is allowed.***
4) ***Assume suitable data if necessary.***
5) ***Figures to the right indicate full marks.***

Q1) a) Explain significance of following number **[8]**

i) Reynolds number

ii) Grashof's Number

iii) Prandtl number

iv) Nusselt number

b) A rectangular plate of length 7 cm and width 4 cm maintained at 115ºC. It is exposed to still air at 25ºC on both sides. Calculate convective heat transfer rate if smaller side of the plate is held vertical. Use Correlation $Nu = 0.59 (Gr.Pr)^{0.25}$. For air at 70ºC, K = 0.03 W/mK; Pr = 0.697; kinematic viscosity $v = 2.076 \times 10^{-6}$ m^2/s. **[10]**

OR

Q2) a) Air at 20ºC is flowing along a heated plate at 134ºC with a velocity of 3 m/s. The plate is 2m long. Heat transferred from first 40cm from the leading edge is 1.45 kW. Determine the width of the plate.

Properties of air at 77ºC: $\rho = 0.998 kg/m^3$, $\vartheta = 20.76 \times 10^{-6}$ m^2/s, Cp = 1.009kJ/kgK; k = 0.03 W/mK

Use the following correlation:

$Nu_x = 0.332\ Re^{0.5}\ Pr^{0.33}$. **[8]**

b) Explain pool boiling curve with different regions. **[6]**

c) Differentiate between Thermal Boundary layer and Hydrodynamic boundary layer. **[4]**

P.T.O.

SPPUQuestionPapers.com CEGP019671 103.157.122.163 22/06/2026 09:34:19 in-pnq-static-163-122-157-103

Q3) a) Write the statements and mathematical expression of the following laws in radiation heat transfer. **[10]**

i) Plank's law

ii) Wien's law

iii) Kirchoff's law

iv) Lambert's cosine rule

v) Stefan's Boltzmann's law

b) The radiation shape factor of the circular surface of a thin hollow cylinder of 10 cm diameter and 15 cm length is 0.165. What is the shape factor of the curved surface of the cylinder with respect to itself. **[7]**

OR

Q4) a) Two large parallel steel plates of emissivity's 0.8 and 0.4 are held at temperatures 1100 K and 500 K respectively. If a thin radiation shield of emissivity 0.09 is introduced between two plates, determine radiation heat exchange in W/m^2 with and without radiation shield. Use $\sigma = 5.67\times10^{-8} W/m^2K^4$. **[10]**

b) Derive an expression for the shape factor in case of radiation exchange between two surfaces. **[7]**

Q5) a) Write any four examples each of mass transfer in industry and day-to-day life. **[4]**

b) Derive the general mass transfer equation in Cartesian coordinate. **[6]**

c) Explain following Terminology **[8]**

i) Mass Diffusion velocity

ii) Molar Diffusion velocity

iii) Mass Diffusion Flux

iv) Molar Diffusion Flux

OR

Q6) a) Hydrogen stored in a vessel diffuses through the steel wall of 20 mm thickness. The molar concentration at the inner surface is 2 kg mol/m^3. At the other surface it is zero. Assuming plane wall condition and diffusion coefficient $D_{AB} = 0.26 \times 10^{-12}$ m^2/sec (a into b), determine the mass of hydrogen diffused per m^2. **[8]**

b) Explain ficks law of diffusion. **[5]**

c) Draw Phase Diagram and explain different phases. **[5]**

SPPU Question Papers.com CEGP019671 103.157.122.163 22/06/2026 09:34:19 in-pnq-static-163-122-157-103

Q7) a) Classify heat exchanger. Explain shell and tube heat exchanger with neat sketch. **[6]**

b) Prove that in counter flow heat exchanger $\text{LMTD} = \dfrac{\theta_1 - \theta_2}{\ln\left(\dfrac{\theta_1}{\theta_2}\right)}$ and mention assumptions considered for derivations. **[8]**

c) Explain TEMA standards for heat exchanger. **[3]**

OR

Q8) a) A counter flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500 kg/hr. The steam enters the heat exchanger at 180ºC and leaves at 130ºC. The inlet and exit temperatures of water are 30ºC and 80ºC respectively. If the overall heat transfer coefficient from steam to water is 814 W/m^2 ºC. Calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel. **[12]**

b) Explain working of heat pipe with neat sketch. **[5]**

ⓘⓘⓘⓘ

SPPUQuestionPaper.com
CEGP019671
103.157.122.163 22/06/2026 09:34:19 in-pnq-static-163-122-157-103