Q. No. CHC - 401 87 ND/B.Tech./Even

Reg./2022-23

2022-23

HEAT TRANSFER

CHC - 401

Full Marks : 25 Time : Ninety Minutes

The figures in the margin indicate full marks.

Graph paper shall be supplied, if required.

Answer any *three* questions.

If any data is missing, assume it.

Group - A

1. Briefly discuss the modes of heat transfer. Give a note on Thermal conductivity. 4 [CO1]

2. Define unsteady state and steady state heat conduction. Develop a mathematical equation for steady-state heat conduction. Use general symbols for the property of the material and process parameters. Give general steady-state solutions for spherical geometry having inner and outer radii r and R respectively. 4 [CO2]

3. A furnace wall is constructed of fireclay brick, insulating bricks and chrome bricks each of 10 cm thick. The inside and outside temperatures of furnace wall are 900°C and 40°C respectively. The thermal conductivity of FB, IB and

P.T.O.

CB are 1, 0.07 and 0.6 Kcal/hr.m.°C, respectively. Find the steady rate of heat loss through 50 m^2 of furnace wall. If a thermocouple were placed at the center of the insulating brick, what temperature would it indicate. 4 [CO3]

4. Heat is being transferred under steady state conditions through a cylindrical fire clay pipe whose thermal conductivity varies linearly from 0.86 1.52 Kcal. hr.m.°C over the temperature range 100°C to 1400°C. Inside of the pipe (ID. 60cm and O.D. 200 cm) is maintained at temperature of 1220°C and the outside surface is maintained at 120°C, Calculate the rate of heat transfer per linear meter of the pipe. 4 [CO3]

5. A pipe 145 mm inside diameter and 156 mm outside diameter is covered with a layer of heat insulating material of thicken 60 mm. The thermal conductivity of the pipe is 60W/m°C and that of insulating material 0.9 W/m°C. The temperature of the inside surface of the pipe is 450°C, and the outside surface of the insulating layer is 60°C. Calculate the rate of heat loss per meter of pipe length. 4 [CO3]

Group - B

Answer *all* questions.

If any data is missing, assume it.

6. What is the difference between spectral emissive power and spectral radiation intensity ? 2 [CO1]

7. Consider two large parallel plates one at t_1=727 °C with emissivity ε_1= 0.8 and other at t_2=227 °C with emissivity ε_2= 0.4. An aluminium radiation shield with an emissivity,

ε_s= 0.05 on both sides is placed between the plates. Calculate the percentage reduction in heat transfer rate between the two plates as a result of the shield. 4 [CO3]

8. A Black body at 3000 K emits radiation. Calculate the following : 4 [CO3]

   (i) Monochromatic emissive power at 7 μm wave length.

   (ii) Wave length at which emission is maximum.

   (iii) Total emissive power.

   (iv) Calculate the total emissive of the furnace if it is assumed as a real surface having emissivity equal to 0.85. Given : Surface temperature T=3000 K.

9. A small sphere (outside diameter = 60 mm) with a surface temperature of 300 °C is located at the geometric centre of a large sphere (inside diameter = 360 mm) with an inner surface temperature of 15 °C. Calculate how much of emission from the inner surface of the large sphere is incident upon the outer surface of the small sphere ; assume that both sides approach black body behavior. 3 [CO3]

Course Outcomes :

CO1 : Illustrate principles of heat transfer of different heat exchanging phenomena

P.T.O.

CO2 : Apply laws of heat transfer for energy balance of chemical processes

CO3 : Solve heat transfer problems of different difficulty levels

CO4 : Design and analyze heat transfer equipment

Q. No. CHC - 402

ND/B.Tech./Even

Reg./2022-23

2022-23

MECHANICAL OPERATION

CHC - 402

Full Marks : 25 Time : Ninety Minutes

The figures in the margin indicate full marks.

Answer *all* the questions.

Graph paper shall be supplied, if required.

1. (a) Classify the screening equipment.

   (b) With proper diagram discuss the screening operation using Grizzly. 5 [CO1, CO2, CO4]

2. Compare the Coarse Crushers for hard materials as used in industry based on their structure, operating principle, forces employed, application, special feature, relative advantages and disadvantages [Use Table to compare]. 5 [CO3, CO4]

3. (a) 'The accuracy of results of screening depends on several factors' — Justify the statements.

   (b) 'Effectiveness of industrial screen is a numerical expression for the effect of all these factors' — Derive suitable equation with proper notation to justify the statement 10 [CO2]

P.T.O.

4. Crushed dolomite is screened through 14 mesh screen. As per the screen analysis as shown below, find the effectiveness of the screen. (No need of using graph paper) 5 [CO2]

Tyler Mesh	Feed to screen (%)	Undersize (%)	Oversize (%)
4 on	14.3	---	20.0
8 on	20.0	---	28.0
14 on	20.0	0.0	28.0
28 on	28.5	40.0	24.0
48 on	8.6	30.0	0.0
100 on	5.74	20.0	---
100 through	2.86	10.0	---
	100	**100**	**100**

Course Outcomes :

CO1 : Identify principles of separation of liquid-solid, gas-solid, and solid-solid

CO2 : Design and analyze mechanical operation equipment

CO3 : Compare performances and select type of size separation, solid-liquid separation and size reduction equipment

CO4 : Learn industrial applications of size separation, solid-liquid separation, size reduction equipment

Q. No. CHC - 403 84 ND/B.Tech./Even

Reg/2022-23

2022-23

MASS TRANSFER I

CHC - 403

Full Marks : 25 Time : Ninety Minutes

The figures in the margin indicate full marks.

Answer *all* the questions.

Graph paper shall be supplied, if required.

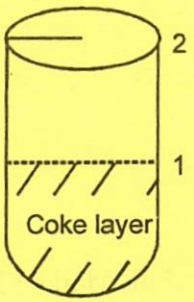
1. Differentiate the diffusive flux, convective flux and total molar flux. Give suitable equations and figures.

   Two kmole of gas mixture at a total pressure of 250 kPa and 303 K contains 10% CH_4, 40% N_2, and rest H_2 by mass. The absolute velocities of each species are – 10 m/s, – 5 m/s, and 15 m/s, respectively, all in the direction of the x-axis.

   Determine the molar average velocity. Hence calculate the molar flux of each components with respect to molar average velocity. 12 [CO1]

P.T.O.

2. A layer of porous coke is packed inside a cylindrical reactor up to the height of z_1, with total working height z. The reactor is flushed with oxygen from the top by sending the gentle stream of oxygen CO mixture over the upper opening. At steady state it is found that the mole fraction of Oxygen at location 2 and 1 are 0.6 and 0.1 respectively.



The reaction is represented as $C + \frac{1}{2} O_2 \rightarrow CO$

Derive the expression of steady state molar flux of CO and O_2. Show all the derivation steps. Assume any missing data with suitable notation and its unit. Refer the fig. 13 [CO2]

Course Outcomes :

- CO1 : Principles of mass transfer for chemical processes
- CO2 : Various laws of mass transfer and mass balance of chemical processes

22.02.2023

Q. No. CHC - 431 074

ND/B.Tech./Even

Reg/2022-23

2022-23

UNIT OPERATIONS OF CHEMICAL ENGINEERING I

CHC - 431

Full Marks : 25 Time : Ninety Minutes

The figures in the margin indicate full marks.

Answer *all* the questions.

Graph paper shall be supplied, if required.

Group - A

1. Define mesh. How to arrange screen for the separation of solid mixture? Explain about Indian standard screen. What do mean of –14 + 20 in screen operation? Calculate the sphericity for a cylindrical particle having diameter and height are equal. Derive an expression for finding the effectiveness when the mass fraction of the desired material in the feed, product and reject are known. 7.5 [CO4]

2. Mention the objectives of crushing & grinding process. How moisture content of a material effects on crushing & grinding. Describe the working principle of revolving screen with neat sketch. 5 [CO4]

P.T.O.

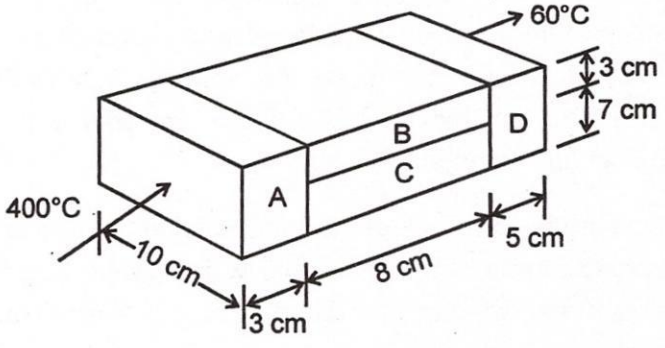
Group - B

3. Define fin effectiveness and fin efficiency and how they are related? 4 [CO2]

4. A wire of 6.5 mm diameter at a temperature of 60°C is to be insulated by a material having k = 0.174 W/m°C. Convection heat transfer (h_0) = 8.722 W/m^2°C. The ambient temperature is 20 °C. For maximum heat loss, what is the minimum thickness of insulation and heat loss per metre length? 4 [CO2]

5. Find the heat flow rate through the composite wall as shown in Fig. 1. Assume one dimensional flow. 4.5 [CO2]

   Data Given : k_A = 150 W/m°C, k_B = 30 W/m°.C, k_c = 65 W/m°.C, and k_D = 50 W/m°.C



Course Outcomes :

CO1 : To Understand fundamentals of fluid dynamics and mechanics

CO2 : Understanding the fundamentals of heat transfer operations

CO3 : To learn design of heat transfer equipment and calculations

CO4 : To develop knowledge of different mechanical operations and their applications

CO5 : To solve related problems of different difficulty levels through tutorials

Q. No. CHC 601/ 84

B.TECH/EVEN
REG/(22-23)

Even Semester Mid-term Examination, 2022-23

TRANSPORT PHENOMENA

CHC 601

Full Marks : 25 *Time* : 90 Minutes

The figures in the margin indicate full marks.

Graph paper shall be supplied, if required.

Answer *all* the questions.

Question No.	Body of the Question	Marks	Mapped CO

1. Answer the following: 2×3=6 CO1

(i) What is the universal approach of Transport Phenomena? Explain with mathematical expression.

(ii) What is the difference between total and substantial time derivative?

(iii) Define $\tau_{rz}, \tau_{xz}, \tau_{xx}$

Or

The following data are available on the viscosity of mixtures of hydrogen and Freon-12(CCl_2F_2) at 25°C and 1 atm. Find out the viscosity of the gas mixture (25:75 by volume of hydrogen and Freon-12 respectively).

Given 6 CO1

X1	μ X10^6
(mole fraction of H_2)	(Poise)
0.00	124.0
1.00	88.4

$$\mu_{mix} = \sum(X_i \mu_i) / \sum X_j \varphi_{ij}$$

where, $\varphi_{ij=}(1/\sqrt{8})(1+M_i/M_j)^{-0.5}[1+(\mu_i/\mu_j)^{0.5}(M_j/M_i)^{0.25}]^2$

2. Using shell balance technique derive the expression of momentum flux, velocity profile, average velocity and relation between average & maximum velocity for flow through cylinder. (State all the constraints) 7 CO2, CO4

3. A Stormer viscometer consists essentially of two concentric cylinders, the inner of which rotates while the other is held stationary. Viscosity is determined by measuring the rate of rotation of the inner cylinder under the application of a known torque. Develop the expression for the velocity distribution in this kind of apparatus, as a function of applied torque, for laminar flow of a Newtonian fluid using ***Navier-Stokes*** equation (NSE). Neglect the end effects. Need to mention the evaluation of associated terms. 12 CO3, CO4

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Q. No. CHC 602/ 83

B.TECH/EVEN
REG/(22-23)

Even Semester End Sem Examination, 2022-23

PETROLEUM REFINING AND PETROCHEMICALS

CHC 602

Full Marks : 25 *Time* : 90 Minutes

The figures in the margin indicate full marks.

Answer *all* questions for Group A and Group B

Question No.	Body of the Question	Marks	Mapped CO

GROUP A

1. Suggest four techno-management issues of Petroleum refining industry in India that need to be addressed towards sustainable business in this sector. 4.5 CO2, CO3

2. Define pour point of crude petroleum and explain its impact on crude oil transport during winter months. How will you overcome pumping difficulty in such case? 4.5 CO1, CO2

3. Why distillation of reduced crude is done under vacuum? With a schematic diagram show the products from petroleum vacuum distillation tower. How is vacuum maintained? What is top-tray refluxing? 4.5 CO1, CO2

GROUP B

4. What is petroleum? Mention the types of hydrocarbon present by wt. in the crude oil. What is the basic need of crude assay? What do you mean by oil spill? 4 CO1, CO3

5. What do you mean by kerogen? How it is related with origin of petroleum. Define cetane number and its importance in the petroleum industry.

4 CO1, CO2

6. Define API gravity. How crude oil is classified based on API. Discuss about benefits of Crude Oil Desalting. Briefly explain about desalting process.

4 CO2, CO3

COURSE OUTCOMES

CO1: Understanding correlation of petroleum properties with system design and operation

CO2: Understanding design and safe operation of complex refinery units for various petroleum products

CO3: Understanding technical, economic, environmental and international market issues in petroleum refining business

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