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ABP/CCM-10/XIV

2015

CHEMICAL ENGINEERING

SECOND PAPER

Full Marks : 200

Time : 3 Hours

The figures in the margin indicate full marks for the questions

Answer any ten questions.

1. (a) What are the static and dynamic characteristics of an instrument ? Classify these characteristics with respect to desirable and undesirable qualities. 5+5=10
- (b) What do you mean by "Order" of an instrument ? Derive the response equation of a first order instrument with a linear input type. 2+8=10
2. (a) Explain the various principles of temperature measurement with examples. 10

Contd.

- (b) Define the following terms : $5 \times 2 = 10$
- (i) Overshoot
 - (ii) Decay ratio
 - (iii) Rise time
 - (iv) Period oscillation
 - (v) Response time
3. (a) What are the characteristics of a first order system ? What is the transfer function of a purely capacitive process ? $5+5=10$
- (b) What is the dynamic response of a pure capacitive process ? 10
4. (a) What are servo problem and regulator problem ? $5+5=10$
- (b) Describe the Routh-Hurwitz criteria for stability. 10
5. (a) What is black body radiation intensity ? 5
- (b) What is Kirchoff's Law ? 5
- (c) What is 'view factor' ? Derive the expression defining the view factor between two elemental surfaces. $2+8=10$

- (b) What is activation energy? How is it related to the possibility, the rate and the energy demands of a reaction? Which famous equation highlights activation energy? $4+4+2=10$
- (c) A second-order reaction carried out in a single CSTR results in 80% conversion. It is proposed to arrange another similar CSTR in series with the first one. How will this addition affect the conversion of reactants? Explain. 10
- (d) Mention two equipments that can be used for separation of solids from gas. Explain the working principle of any one of them. 10
5. (a) What are the different methods for determining rate expressions? Write their merits and demerits. 10
- (b) "Screen analysis provides us with vital information on physical properties of a mixture or variable size materials." Explain this statement. Mention the most important uses of screening. What are the differences between differential analysis and cumulative screen analysis? $5+5=10$

(c) How does thermal conductivity of liquid vary with temperature? Calculate the heat flow 'Q' through a slab of thickness 0.18m; whose surfaces at $x=0$ and $x=0.1m$ are maintained at $T_0=500K$ and $T=300K$ respectively. The thermal conductivity of the slab material varies with temperature as $K(T)=K_0(1+\beta T)$, where $K_0=0.2W/m^\circ C$ and $\beta=2\times 10^{-3} K^{-1}$, consider $A=1m^2$.
2+4=6

9. (a) What is crystallization? How is it different from other thermal processes? Mention its application in process industries.
2+2+2=6

(b) How does molecular diffusion differ from Eddy diversion? Give two empirical expression of diffusion coefficient 'D' for gases. Explain the nomenclature used.
2+8=10

(c) Write in brief what do you mean by thermal diffusion.
4

10. (a) Show that the average heat transfer coefficient (h_m) is twice the local heat transfer coefficient (h_n) for laminar flow over a flat plate.
12

(b) Give the physical significance of the following dimensionless groups—

(i) Stanton number

(ii) Peclet number

(iii) Grashof number

(iv) Nusselt number

2×4=8

11. (a) Prepare a neat sketch to show the different moisture types with necessary legends. 10

(b) What do you mean by extraction? With the help of a diagram of an open tank, describe the extraction process. 2+8=10

12. (a) Describe the boundary layer concept, using a neat sketch of the boundary layer over a flat plate. 10

(b) Show the material balance for a counter-current operation and find the equation for the operating line. 5

(c) What do you mean by 'packings'? Write your answer with respect to the use of packings and the properties desired. 5

13. (a) Explain with diagram *any one* type of dryer. Mention *one* particular use of the dryer in industrial processes. 10

- (b) A commercial dryer needed 7 hours to dry a moist material from 33% moisture content to 9% moisture content on bone dry basis. The critical and equilibrium moisture content were 16% and 5% on bone dry basis. Determine the time needed to dry the material from a moisture content of 37% to 7% on bone dry basis if drying conditions remain unchanged. 10
14. (a) Describe Flash distillation and differential distillation. 5+5=10
- (b) What is optimum reflux ratio ? Explain with a neat sketch. 10
15. (a) Mention the properties that are to be considered for selecting a solvent for absorption. 5
- (b) Find the equation of the operating line for counter current flow in absorption. 5
- (c) How is the minimum liquid gas ratio for absorber obtained ? 10

