

CHEMICAL ENGINEERING

Paper - I

Time Allowed : Three Hours

Maximum Marks : 200

INSTRUCTIONS

Candidates should attempt questions 1 and 5 which are compulsory, and any THREE of the remaining questions, selecting at least ONE question from each Section.

All questions carry equal marks.

Marks allotted to each part of a question are indicated against each.

Answers must be written in ENGLISH only.

Assume suitable data if considered necessary and indicate the same clearly in your answer.

Neat sketches may be drawn, wherever required.

IMPORTANT NOTE :

All parts/sub-parts of a question must be answered contiguously. That is, where a question is being attempted on the answer-book, all its constituent parts/sub-parts must be attempted before moving on to the next question.

Pages left blank in the answer-book(s), if any, must be clearly struck out. Answers that follow pages left blank may not be given credit.

SECTION A

1. Answer the following, keeping your answers brief and to the point : 8×5=40
- (a) (i) How is the friction factor defined and what are the parameters on which it depends ? 4
- (ii) What are the different types of conveyers available for bulk solid transportation ? 4
- (b) Distinguish between "Adiabatic Saturation Temperature" and "Wet Bulb Temperature". Explain why both these are same for air-water system.
- (c) Discuss caking of crystals and its prevention.
- (d) Distinguish between series resistance and parallel resistance through which heat is being conducted under steady - state conduction. Explain using electrical analogy.
- (e) Differentiate between nucleate boiling, pool boiling and sub-cooled boiling.
2. (a) How do you use shear stress - shear rate relationship to explain the rheological classification of fluids ? Explain with examples. 8
- (b) (i) Derive the continuity equation. State the assumptions made. 5
- (ii) Explain the terms, drag and drag coefficients. 4

- (c) (i) Describe a Rotary Drum Filter with its advantages and disadvantages. 5
- (ii) State the two laws of crushing and grinding, and write suitable mathematical relationships for them. 5
- (d) (i) Explain the basis for the selection of mixing impellers. 4
- (ii) Briefly explain the mechanism of fluidization. 4
- (e) Explain with a neat sketch the principle and working of a leaf filter. 5
3. (a) (i) Bring out clearly the concept of film transfer coefficient in mass transfer. 5
- (ii) Explain briefly the diffusivity of gases and liquids. 5
- (b) (i) Discuss the resistances in wetted column. 5
- (ii) What are bubble cap and valve trays used in distillation columns? 4
- (c) With a neat drying rate curve, explain different zones. 8
- (d) What are the limitations of McCabe - Thiele method? How are these overcome in Ponchon - Savarit method? 8
- (e) Derive the expression for critical speed of a ball mill used for grinding solid material. State clearly the assumptions made. 5

4. (a) (i) Discuss flooding and loading phenomena in packed towers. 4
- (ii) Obtain the relationship between individual and overall heat transfer coefficients. 5
- (b) (i) Distinguish between bound and unbound moisture. 4
- (ii) Write a note on the absorption of radiation by opaque solids. 5
- (c) (i) What is the influence of boiling point elevation on the evaporator performance? 4
- (ii) Describe different methods of creating vacuum in Multiple Effect Evaporators. 5
- (d) Write the design procedure for a double pipe heat exchanger. 8
- (e) Compare and contrast fans and blowers. 5

SECTION B

5. Answer the following, keeping your answers brief and to the point : 8×5=40
- (a) Explain the principle of reverse osmosis. What are its limitations and applications ?
 - (b) Giving examples, distinguish between second order “under damped” and “over damped” systems.
 - (c) Name the different supports used for process vessels mentioning their advantages and disadvantages.
 - (d) Explain with sketches the working principle, installation and applications of thermocouples for temperature measurement.
 - (e) Explain the working of a PID control system. Draw a pneumatic control circuit for this system and explain the characteristics.
6. (a) Explain the principle of ultrafiltration and list out its industrial applications. 10
- (b) What are the advantages and disadvantages of ion exchange process over membrane processes ? 10

- (c) Explain any two methods for separating a binary liquid mixture. List out the assumptions made. 10
- (d) Explain the working of an instrument based on electro dialysis. 10
7. (a) Explain the design equations for calculating the thickness of cylindrical and spherical shells, subjected to internal pressure. How will you select a standard plate for fabricating the shell ? 10
- (b) Write down the stepwise procedure for the design of an elliptical head, of a cylindrical pressure vessel. 10
- (c) Name the different stresses acting on a tall vessel which is to be installed in a seismic zone. 10
- (d) Mention any five industrially important alloys of Nickel and Copper. Give their approximate compositions and applications. 10
8. (a) With a neat diagram, describe the radioactive vacuum gauge method for measuring pressure in a process industry. 10

(b) Sketch the following function

$$f(t) = 3t u(t) - 3u(t - 1) - u(t - 2)$$

and obtain the Laplace transformation. 10

(c) (i) Explain in practical terms, how one tunes a feedback controller for an existing process in a chemical plant. 5

(ii) Define phase margin and gain margin and show how you can compute them from Bode Plot. 5

(d) Develop a transfer function between the pressure drop and the manometer reading "h" for a mercury manometer. List the assumptions made. 10