

<b>FS – 12 / 15-16</b>
<b>Chemical Engineering</b>
<b>Paper – II</b>

*Time : 3 hours*

*Full Marks : 200*

*The figures in the right-hand margin indicate marks.*

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any **three** of the remaining questions, selecting at least **one** from each Section.*

*Neat sketches and block diagrams, wherever necessary, are to be drawn.*

**SECTION – A**

1. Answer any **two** of the following :      $20 \times 2 = 40$ 
  - (a) With block diagram differentiate between recycle and bypass streams. Why a purge stream is used in a process ?
  - (b) From the first law of thermodynamics, derive expressions for calculation of different

thermodynamic quantities in case of adiabatic reversible expansion of an ideal gas.

(c) Explain clearly the following terms with suitable examples wherever applicable :

(i) Limiting and excess reactants

(ii) Adiabatic flame temperature

(iii) Global rate concept

(iv) Gibbs free energy equation and its relevance in chemical equilibria

2. (a) Derive an expression for entropy changes of an ideal gas. By using this relation for an ideal gas undergoing a reversible adiabatic

process, prove that: 
$$\frac{T_2}{T_1} = \left( \frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}}$$

20

(b) Derive the expression for phase equilibria in terms of chemical potential and fugacity. 20

3. (a) What are the different reaction steps involved in the roasting of iron pyrites as represented by unreacted core model? 15

- (b) Write short notes on the following :  $5 \times 5 = 25$
- (i) Plug flow reactor
  - (ii) Arrhenius' equation
  - (iii) Homogeneous reaction kinetics
  - (iv) Performance of CSTR in series
  - (v) Reactor stability
4. (a) What is heat of reaction ? What is the effect of temperature on heat of reaction ? 10
- (b) Why excess air is used in the combustion of fuels ? What are the advantages and disadvantages of using excess air in combustion ? 10
- (c) Calculate the work done and exit temperature in case of adiabatic irreversible expansion of an ideal gas. 10
- (d) What are Maxwell's relations ? Give the mathematical expressions. 10

### SECTION – B

5. Answer any **two** of the following :  $20 \times 2 = 40$
- (a) What is the difference between high density and low density polyethylenes with respect

- to their properties and the process of manufacture ? How does this effect their ultimate use ?
- (b) Explain the principle of hazard rating by HAZOP and HAZAN analysis.
  - (c) What are the essential considerations for the selection of site for a chemical plant ?
6. (a) What are the important methods for the removal of particulates from the exit gas of a chemical plant ? Give details of any one of the proceses. 15
- (b) Name the important acts promulgated for the protection of the environment. 10
  - (c) What are the environmental hazards due to municipal solid wastes ? Suggest suitable methods for its safe disposal. 15
7. (a) What are the essential products obtained from the atmospheric distillation of petroleum crude ? Mention the secondary treatments to be adopted for making the products marketable through quality improvement. 25

(b) Why cracking and reforming are practised in a petroleum refinery ? Give the basic difference between these two processes.

15

8. Write notes on the following :  $8 \times 5 = 40$

- (a) Fixed and working capital
- (b) Pay back analysis
- (c) PERT and CPM
- (d) Depreciation
- (e) Break-even point analysis



