Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : 3   No. of Printed Pages : 7

M-SFS-II-2017 (12)

CHEMICAL ENGINEERING

(Optional Subject)

Second Paper

Time : 3 Hours]   [Total Marks : 200

Instructions to the candidates :

1. This question paper consists of **three** questions and all questions are compulsory.

2. Marks for each question have been indicated on the right hand margin.

3. There is no internal choice in Question No. 1, remaining questions carry internal choice.

4. The first question is of very short-answer type consisting of **15** compulsory questions. Each one is to be answered in one or two lines. Question No. 2 is short answer type, word limit is **100**. Question No. 3 is long answer/Essay type, word limit is **300**.

5. Wherever word limit has been given, it must be followed to.

6. Question should be answered exactly in the order same as mentioned in the question paper. Answer to the various parts of the same question should be written together compulsorily and no answer of the other question should be inserted between them.

1. Answer the questions in **one** or **two** lines :   **15 × 4 = 60**

   (A) Write the names of principle types of heads used to close the ends of a cylindrical vessel.

   (B) Write the names of the support which are used for vertical and horizontal vessels.

(C) Why mild steel is most commonly used engineering material ?

(D) Write the names of any 4 meters that are used to measure flow through a process line.

(E) Describe the principle on which resistance thermometer works.

(F) Write the names of any 4 types of disturbances used in control.

(G) Find the relation between two reaction rate constants (K_1 and K_2) at two different temperatures (T_1 and T_2) respectively by using Arrhenius equation.

(H) The reaction $A \rightarrow B$ is conducted in an isothermal batch reactor. If the conversion A increases linearly with holding time. Determine the order of the reaction.

(I) Determine the expansion factor of the following gaseous reaction $A \rightarrow B + C$.

(J) State any 4 sources of Air pollution.

(K) Write any 4 effects of ozone depletion.

(L) How volume reduction of solid waste is done prior to disposal ?

(M) Describe fixed and working capital.

(N) Define payback period.

(O) Explain straight line method for calculating depreciation.

2. Answer **10** questions. **10 × 8 = 80**

(A) What is Acid Rain ? Explain briefly its impact.

(B) Write short notes on Green house effect.

(C) A plant manufactures compressors at the rate of N units/day. The daily fixed charges are ₹ 20,000 = 00 and the variable cost per compressor is ₹ 500 + 0.2N$^{1.3}$. The selling price per compressor is ₹ 1000 = 00. Calculate the number of compressors to be manufactured to maximize the daily profit.

(D) Due to a 20% drop in the product selling price, the payback period of a new plant increased 1.5 times that estimated initially, the production cost and the production rate remaining unchanged. Find the ratio of production cost (C_p) and New selling price (C_s).

(E) A cylindrical pressure vessel of volume $6\pi m^3$ has to be designed to withstand a maximum internal pressure of 10 atm. The allowable design stress of the material is 125 N/mm^2 and corrosion allowance is 2 mm. Determine the thickness of the vessel for a length / diameter ratio of 3. Take joint factor 1.

M-SFS-II-2017 (12)

(F) Draw diagram to show the effect of rate of production on costs and profits and explain what is meant by breakeven point.

(G) For a second order liquid phase reaction A → Products, Occuring in an isothermal plug flow reactor, the conversion is 50% what will be the conversion if the plug flow reactor is replaced by a continuous stirred tank reactor of same volume.

(H) For an isothermal second order aqueous phase reaction A → B. Find the ratio of the time required for 90% conversion to time required for 45% conversion.

(I) Find out the expression for the conversion of reactant A(XA) for a second order irreversible reaction, constant volume, A $\xrightarrow{K_2}$ B in a batch reactor.

(J) The characteristic equation of a closed loop system using a proportional controller with gain K_c is –

$$12S^3 + 19S^2 + 8S + 1 + K_c = 0$$

Find the value of controller gain K_c at the onset of stability.

(K) A step change of magnitude 2 is introduced into a system having the transfer function $G(S) = \dfrac{2}{(S^2 + 2S + 4)}$. Calculate the percent overshoot, period of oscillation and decay ratio.

(L) Write short notes on Radiation Pyrometers.

3. Answer of any three questions. $3 \times 20 = 60$

(A) In a commercial batch plant, R is produced by liquid phase reaction, $A \rightarrow 2R$ at the rate of 10000 kg per 20 hr day. The molecular weight of R is 60 and reaction velocity constant is 0.00031 per second. Calculate number of batches and volume of each batch if the total time for charging, heating discharging and cleaning takes 0.5 hr. The reaction temperature is 80 °C and 98% conversion can be achieved in each batch. Initial concentration of A is 5 k mol/m^3.

(B) In a P – I – D controller having proportional gain $K_C = 4$, the reset rate $\tau_I = 60$ sec and $\tau_D = 30$ sec. Find the response equation of the controller if

(i) the controller is subjected to sinusoidal change

$\in(t) = 5 \sin 0.3\, t$

(ii) the error, $\in(t)$ is increased linearly at the rate of 5 °C/min.

(C) Discuss the salient features of pollution control acts and rules in India.

(D) From the following information about a project.

Activity	Immediate Predecessors	Estimated Duration
A	–	2 weeks
B	A	4 weeks
C	B	10 weeks
D	C	6 weeks
E	C	4 weeks
F	E	5 weeks
G	D	7 weeks
H	E, G	9 weeks
I	C	7 weeks
J	F, I	8 weeks
K	J	4 weeks
L	J	5 weeks
M	H	2 weeks
N	K, L	6 weeks

(i) Construct the project network for this project.

(ii) Find the earlist times for each activity.

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