BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

UG

Name: …… Roll No.: ……..

Branch: …… Signature of Invigilator: ……

Semester: VIth Date: 25/04/2022 (MORNING)

Subject with Code: CL306 CHEMICAL REACTION ENGINEERING - II

Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.
2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**
3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.
4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.
5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.
6. Write on both side of the leaf and use pens with same ink.
7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.
8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.
9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.
10. Always maintain the highest level of integrity. Remember you are a BITian.
11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B.Tech **SEMESTER: VI**
BRANCH: Chemical/Chemical P&P **SESSION: SP/22**

SUBJECT: CL306 (Chemical Reaction Engineering-II)

TIME: 2 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 2 parts (Part-I carries 30 marks and Part-II carries 20 marks)
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data handbook/Graph paper etc. to be supplied to the candidates in the examination hall.

SET-A

PART-I

Q.1 Action of a catalyst follows its ability to change the **[1]**

(a) heat of reaction

(b) activation energy

(c) heat of formation of product

(d) equilibrium constant

Q.2 In catalytic reaction accelerators are used to **[1]**

(a) shift the equilibrium composition in a favourable direction

(b) change the temperature of reaction

(c) to decrease the formation of by product

(d) none of the above

Q.3 Catalyst deactivation may take place due to **[1]**

(a) gradual change of surface crystal structure

(b) formation of gas layer over the catalyst surface

(c) change of Entropy of the reaction products

(d) none of the above

Q.4 The classical theory of adsorption on solid catalyst surface follows **[1]**

(a) Mono-layer coverage hypothesis

(b) Principle of Beta decay

(c) Interaction between adsorbed molecules

(d) none of the above

Q.5 Which one of the following is not considered as mechanism for catalytic reaction **[1]**

(a) Transport of reactant to the catalyst surface

(b) Transport of reactant in the pores of catalyst particle

(c) Bounce back of molecules from the surface of catalyst

(d) Desorption of products

Q.6 The significance of Thiele modulus is **[1]**

(a) ratio of diameter of the catalyst particle to surface area of catalyst particle

(b) ratio of turbulent boundary layer to laminar boundary layer within pores

(c) relative effect of Diffusional resistance to Reaction resistance

(d) none of the above

Q.7 In solid catalysed reaction reactor design is generally performed based on **[1]**

(a) reaction rates with respect to unit surface area of reactor

(b) reaction rate with respect to unit mass of product

(c) reaction rate with respect to unit mass of catalyst

(d) none of the above

Q.8 If a solid gas non-catalytic reaction takes place at a very high temperature is the rate controlling step is **[1]**

(a) film diffusion

(b) chemical reaction

(c) pore diffusion

(d) none of the above

Q.9 When catalyst increases the rate of chemical reaction value of rate constant **[1]**

(a) remains unchanged

(b) increases

(c) decreases

(d) none of the above

Q.10 The rate of a reaction is influenced by **[1]**

(a) temperature

(b) concentration of reactants

(c) catalyst

(d) all of the above

Q.11 Physical adsorption is valuable to determine **[1]**

(a) catalyst surface area

(b) pore size distribution

(c) both (a) and (b)

(d) none of the above

Q.12 All in a gas solid reaction the phenomena of physical adsorption **[1]**

(a) occurs with all solid

(b) with all gases

(c) is reversible

(d) all of the above

Q.13 When reactants are associated with solid catalyst the important step in order to determine the global rate is **[1]**

(a) adsorption

(b) desorption

(c) intrinsic chemical step

(d) all of these

Q.14 For Heterogeneous reaction, which is not correct **[1]**

(a) the concentration of reactant molecules at active centers of catalyst becomes high due to adsorption

(b) intermediate complex is formed

(c) surface of catalyst does not play any important role

(d) all of these

Q.15 If the catalyst deactivation is fast due to physical blockage of surface it is called **[1]**

(a) Poisoning

(b) Fouling

(c) Complexing

(d) Surface breaking

Q.16 Enzymes are **[1]**

(a) used to increase the activation energy of reaction

(b) used to convert inorganic catalyst to organic catalyst

(c) used to change the product formation in a desired manner

(d) found in organism

Q.17 The catalyst activity of enzyme is due to their capacity to **[1]**

(a) increase the activation energy

(b) lower the potential energy

(c) increase the potential energy

(d) decrease the activation energy

Q.18 Which of the following is not pertinent to modelling of fluidized bed reactor **[1]**

(a) Mass transfer due to gas flow from bubble phase to cloud phase

(b) Transfer due to gas flow from cloud face to emulsion phase

(c) Mass transfer due to gas flow from emulsion phase to cloud phase

(d) Mass transfer due to gas flow from turbulent phase to laminar phase

Q.19 In a slurry reactor **[1]**

(a) catalyst particle and liquid reactant mixture is introduced in the gas phase

(b) gaseous reactant mixed with catalyst particle is introduced in the liquid phase

(c) gas is bubbled through liquid phase suspended with catalyst particle

(d) a mixture of solid, liquid, and gas is introduced in the reactor

Q.20 In trickle bed reactor **[1]**

(a) liquid and gas flows counter currently

(b) liquid and gas flow in a downward direction

(c) gas flows from the bottom through a pool of liquid and catalyst is fed from the top

(d) none of the above

Q.21 For shrinking core model which resistance is variable **[1]**

(a) Resistance offered by gas layer

(b) Resistance offered by ash layer

(c) Resistance of chemical reaction

(d) Resistance offered by turbulent gas-phase

Q.22 In which non-catalytic gas-solid reaction model fractional conversion of solid is proportional to reaction time **[1]**

(a) Ash layer control diffusion

(b) Chemical reaction control process

(c) Gas film-controlled diffusion

(d) None of the above

Q.23 Optimum temperature of progression in packed bed reactor may be obtained by **[1]**

(a) applying side feeding of reactant

(b) applying interstage cooling

(c) applying side withdrawal of product

(d) none of the above

Q.24 Higbie's penetration model assumes **[1]**

(a) variable gas liquid contact time

(b) variable film thickness

(c) variable eddy size

(d) constant surface age

Q.25 Danckewerts surface renewal model is similar to **[1]**

(a) film theory with variable age distribution

(b) film theory with variable film thickness

(c) penetration theory with random age distribution

(d) penetration theory with exponential age distribution

Q.26 A silica-alumina cracking catalyst has particle density of 0.962 g/cm^3 as determined by mercury displacement. The true density of the solid material is 2.37 g/cm^3. The surface area of the sample is 372 m^2/g. What will be the mean pore radius in Å? [2]

(a) 0.004

(b) 0.006

(c) 3.6

(d) 33

Q.27 In the homogeneous catalysis, the recovery of catalyst is [1]

(a) easier than heterogeneous catalysis

(b) difficult than heterogeneous catalysis

(c) in both catalysis recovery of catalysts is difficult

(d) in both catalysis recovery of catalysts is easier

Q.28 A gross measurements of a catalyst pellet are as below: [2]

Mass = 3.15 g, Diameter = 1 inch, Thickness = 0.25-inch, Volume = 3.22 cm^3. The macropore volume of the pellet is 0.645 cm^3. The micropore volume of the pellet is 0.40 cm^3/g. What will be the solid fraction?

(a) 0.2

(b) 0.205

(c) 0.391

(d) 0.409

PART-II

Q.29 Assume a cylindrical pore of length L in a catalyst pellet. Explain with diagram, how diffusion and reaction take place in the catalyst pore. Derive a differential equation for concentration distribution assuming a first order irreversible reaction. **[2]**

Q.30 Derive an expression for conversion with respect to time for gas-solid reaction with changing particle size. Assume gas film diffusion control process. **[2]**

Q.31 Write important design considerations for fixed bed catalytic reactor. Also Give the reasons for accounting Knudsen diffusion in design consideration. **[2]**

Q.32 Explain Michaelis-Menten kinetics curve for different total enzyme concentration. **[2]**

Q.33 With the help of suitable equations write the design procedure for mass transfer and reaction in a mixed-flow bubble contactor. **[3]**

Q.34 A gas phase second order reaction is carried out in a plug flow reactor packed with 2.0 kg of solid catalyst, with pure A entering the reactor at a rate of 6000 L/min at 4 atm and 160°C. The conversion obtained 70%. It is desired to treat 60,000 L/min of a 50% A and 50% inert in feed at 15 atm and 160°C. How much catalyst would be required for 90% conversion of A? **[4]**

Q.35 An 8.01 g sample of Glaucosil is studied with N_2 adsorption at -195.8°C. The following data were obtained: **[5]**

Pressure (mmHg)	25	140	230	285	320
Volume adsorbed, cm^3 (at 0°C and 1 atm)	127	170	197	215	230

The vapor pressure of N_2 at -195.8°C is 1 atm. The density of nitrogen at -195.8°C is 0.808 g/cm^3. Estimate the surface area of the sample in m^2/g.

:::::25/04/2022:::::