MGM University

Jawaharlal Nehru Engineering College, Aurangabad

End Semester Examination Paper

Course: S.Y.B.Tech Chemical — Sem: IV

Subject Name: **Chemical and Allied Industries** — Subject Code: **20UCH401D**

Max Marks: 60 — Date: — Duration:- 3 Hr.

- Instructions: Solve Total Six Questions
- Solve any Two Questions from the Each

QN	Questions	CO	BL	Marks
1(a)	Explain the Examples of Unit processes.	CO1	L3	5
1(b)	Justify How does the chemical industry contribute to an economy?	CO1	L3	5
1(c)	Give the reactions involved in the Solvay process for the manufacture of soda ash(Na_2CO_3).	CO1	L3	5
2(a)	Explain the following engineering problems related to urea synthesis:- i) Autoclave variable ii) Carbamate decomposition and recycle.	CO1	L2	5
2(b)	Describe manufacture of single super phosphate with chemical reactions involved in it. What are the by products generated?	CO1	L3	5
2(c)	Develop flow sheet for ammonium nitrate manufacturing.	CO1	L3	5
3(a)	List chemical reactions involved in sulphuric acid manufacture.	CO2	L2	5
3(b)	Discuss Elemental sulfur mining by Frasch process.	CO2	L2	5
3 (c)	Discuss economy in soap manufacturing process ?	CO2	L2	5
4(a)	Describe the Major Engineering Problems Extraction of Sucrose from Sugar cane.	CO3	L2	5
4(b)	Develop a flow sheet for Production of food Proteins from Petroleum.	CO3	L2	5
4(C)	Why last effect evaporator is maintained at 63cm vacuum in sugar manufacturing?	CO3	L2	5
5(a)	Classify the Types of paper Products.	CO3	L3	5
5(b)	Explain the paper manufacture process.	CO3	L2	5
5(c)	Mention the merits and demerits of Emulsion Polymerization w.r.t. other polymerization processes.	CO3	L3	5
6(a)	What is cracking reforming?	CO4	L3	5
6(b)	Develop a flow sheet and explain fluidized Bed type Catalytic cracking process	CO4	L3	5
6(C)	Explain thermal pyrolysis mechanisms	CO4	L3	5

MGM University
Aurangabad-431003
Second Term Exam A.Y. 2021-22

Program :Chemical Engineering — Sem –IV
Course : Chemical Engineering Thermodynamics-I — Marks : 60
Course Code : 20UCH402D

Instructions to the students
1. Each question carries 10 marks.
2 All questions are compulsory
3. Illustrate your answers with neat sketches , diagram etc wherever necessary
4. If some part or parameter is noticed to be missing ,you may appropriately assume it and should mention it clearly

Marks

Q1. Solve any two

a) Distinguish between open and closed system with examples. (5)

b) What is enthalpy of a system? How it is related to the internal energy? (5)

c) Prove that heat supplied is equal to the change in eternal energy for a constant volume process and the change in enthalpy a constant pressure process? (5)

Q2. Solve any two

a) Explain the P-V-T behaviour of pure fluids with pressure verses volume diagram. (5)

b) Van der Waals equation results when the ideal gas equation is corrected to include the effect of the molecular interaction and the volume of molecules. What are these correction terms? (5)

c) Calculate the molar volume of gaseous methane at 300 K and 600 bar by the following methods:

1. Using the ideal gas equation
2. Using the Van der Waals equation given that a= 0.2285 N m^4/mol^2, b= 4.27 x 10^{-5} m^3/ mol. (5)

Q3. Solve any two

a) Define: (a) The standard heat of reaction, (b) The standard heat of formation, (c) The standard heat of combustion. (5)

b) How is the Hess law of constant heat summation useful in thermo chemical calculations? (5)

c) If the standard heat of reaction at one temperature is known, how would you evaluate the standard heat of reaction at any other temperature? (5)

Q4. Solve any two

a) Give the mathematical definition of entropy and explain the terms involved. (5)

b) State the third law of thermodynamics. How does it follow from the statistical explanation for entropy? (5)

c) Ten Kilograms of water at 375 K is mixed adiabatically with 30 Kg water at 275 K. What is the change in entropy? Assume that specific heat of water is 4.2 kJ/kg and is independent of temperature.

Q5. Solve any two

a) Define Gibbs free energy, and show that at constant temperature and pressure the decrease in the Gibbs free energy measures the maximum net work available from a given change of state. (5)

b) Define fugacity, and show that the fugacity and pressure are identical for ideal gas? What is the standard state of fugacity for real gas? (5)

c) What are the fundamental differential equations for the energy properties? List canonical variables for U, H, A and G. (5)

Q6. Solve any two

a) Explain the working principle of heat pump. (5)

b) What is COP of a refrigerator? What do you know about the work required per ton of refrigeration by a Carnot refrigerating unit in comparison with other cycle? (5)

c) What are the desirable properties of refrigerant?. (5)

End of paper

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MGM University
Aurangabad-431003
Second Term Exam A.Y. 2021-22

Program: Chemical Engineering Sem –IV
Course: Process Instrumentation and Control
Marks: 60
Course Code: 20UCH405D

Instructions to the students
1. Each question carries 10 marks.
2 All questions are compulsory
3. Illustrate your answers with neat sketches, diagram etc wherever necessary
4. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly

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		Marks
Q1.	Answer any two of the following	
a.	Describe the following function of an instruments with example i. Transmitting ii. Signaling: iii. Registering: iv. Indicating	(5)
b.	Explain the functional elements of the measurement systems with schematic diagram	(5)
c.	What is meant by measurement? Give its purpose and application.	(5)
Q2.	Answer any two of the following	
a.	Explain working principle and construction of alcohol bulb thermometer with schematic diagram	(5)
b.	Explain working principle and construction of gas filled pressure spring thermometer with schematic diagram	(5)
c.	What is working principal of RTD thermometer? What are its advantages and advantages	(5)
Q3.	Answer any two of the following	
a.	Explain working principle and construction of diaphragm pressure gauge with schematic diagram	(5)
b.	Explain working principle and construction of u tube manometers with schematic diagram	(5)
c.	What is 300 k Pa when expressed as pressure head of water? given that g = 9.8 m/s^2 and ρ_{water} = 1000 kg/m^3	(5)
Q4.	Answer any two of the following	
a.	Why venturimeter is called head flow meters? Explain working principle and construction of venturimeter with schematic diagram.	(5)
b	Explain working principle and construction of area flow meter with schematic	(5)

PTO

c. How discharge through a pipe is measured using flow nozzle? (5)

Q5. Answer any two of the following

a. How sight glass is used to measure level? Explain with diagram. (5)

b. Explain working principle and construction of float and shaft liquid level gauge with schematic diagram (5)

c. What is dipstick? Explain ordinary dipstick method. (5)

Q6. Answer any two of the following

a. Explain any four input functions mainly observed in chemical industry (5)

b. Develop transfer function equation for interacting system (5)

c. Derive the response equation for mercury bulb thermometer system. (5)

End

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MGM University Aurangabad-431003
First Term Exam A.Y. 2021-22

Program : Chemical Engineering — Sem –III
Course : Chemical Process Calculations — Marks : 60
Course Code : 20UCH303D — Time : 03Hr.

Instructions to the students

1. Each question carries 10 marks.
2. All questions are compulsory.
3. Illustrate your answers with neat sketches, diagram etc wherever necessary.
4. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly.

Q. 1. Solve any two — Marks

a) Define and explain with suitable example equivalent mass, weight fraction and mass fraction. (5)

b) Calculate the available nitrogen content of solution having 30% urea (NH_2CONH_2), 20% ammonium sulphate and 20% ammonium nitrate. (5)

c) A solution containing 55 % benzene, 28 % toluene and 17% xylene by weight is in contact with its vapour at 373 K (100^0 C). Calculate the total pressure and molar composition of the liquid and vapour. Data Vapour pressure data at 373 K (100^0 C) benzene = 178.60 KPa, toluene = 74.60 KPa and xylene = 28 KPa (5)

Q. 2. Solve any two

a) A fuel gas saturated with water vapour at 300 K and 100 kPa has a heating value of 25000 kJ/m^3 of the total gas. What will be the heating value in kJ/m^3 of the gas at 295 K and 105 kPa if its relative saturation is only 50%? The vapour pressure of water at 300 K and 295 K are respectively 3.5 kPa and 2.6 kPa. (5)

b) A mixture of acetone vapour and nitrogen gas at 101.3 kPa and 310 K contains acetone vapour to the extent that it exerts a partial pressure of 15 kPa. The vapour pressure of acetone is given by the Antoine equation (5)

$$\ln P^S = 14.5463 - \frac{2940.46}{T - 49.19}$$

where the pressure is in kPa and temperature is in K. Determine the following:
(a) The mole fraction of acetone in the mixture.
(b) The weight fraction of acetone in the mixture.
(c) The molal humidity.
(d) The absolute humidity.
(e) The molal saturation humidity.
(f) The absolute saturation humidity.
(g) The mass of acetone in 100 m^3 of the mixture.

c) Air at a temperature of 20°C and 750 mm Hg has a relative humidity of 80%. Calculate the molal humidity of the air the molal humidity of this air if its temperature is reduced to 10°C and pressure increased to 2000 mm Hg condensing out some of the water. and weight of water condensed from 1000 litres of the original wet air in cooling and compressing to the conditions of part (ii).Vapor pressure of water at 20°C = 17.5 mm Hg Vapor pressure of water at 10°C = 9.2 mm Hg. (5)

Q. 3. Solve any two

a) A mixed acid containing 65% H_2SO_4, 20% HNO_3 and 15% H_2O on a weight basis is to be prepared by blending spent acid (60% H_2SO_4, 10% HNO_3, and 30% H_2O), concentrated nitric acid (90% HNO_3 and 10% H_2O) and concentrated sulphuric acid (96% H_2SO_4 and 4% H_2O). How many kilograms each should be used to obtain 1000 kg of the mixed acid? (5)

b) In a process for producing caustic (NaOH), 4000 kg/hr of a solution containing (5)

10 wt% NaOH is evaporated in the first evaporator, giving a 20% NaOH solution. This is then fed into a second evaporator, which gives a product of 50% NaOH. Calculate the following:

(a) The amount of water removed from each evaporator

(b) The feed to the second evaporator, kg/hr

(c) The amount of product, kg/hr

c) A distillation column is charged with aqueous solution of ethanol containing 35% ethanol by weight. The concentrated alcohol is withdrawn as the distillate containing 85% alcohol. The bottom product contains 5% ethanol. Determine the following: (5)

(a) The mass of distillate per 100 kg of feed

(b) The ratio of the mass of the distillate to mass of the residue

Q. 4. Solve any two

a) A fuel oil containing 70% carbon by weight and the rest combustible hydrogen and moisture is burned with excess air. The flue gas analyzed 9% CO_2, 2% CO, 3% O_2 and 86% N_2. Determine the following: (5)

(a) The percentage of excess air

(b) The ratio of carbon to combustible hydrogen in the fuel on a weight basis

(c) The ratio of carbon to total hydrogen in the fuel on a weight basis

(d) The percentages of combustible hydrogen and moisture in the fuel

(e) The mass of moisture present in the flue gas per kg of oil burned

b) Limestone mixed with coke is being burnt in a kiln. An average analysis of the limestone is $CaCO_3$ = 84.5%, $MgCO_3$ = 11.5% and the rest inerts. The coke contains 76.0% carbon, 21% ash and 3% moisture. The calcinations of $CaCO_3$ is only 95% complete and that of $MgCO_3$ is 90%. The carbon in the coke is completely burnt to CO_2. The kiln is fed with one kg of coke per 5 kg of limestone. Calculate the weight percent of CaO in the product leaving the kiln. Assume that the moisture in the feed is completely vaporized. (5)

c) Formaldehyde is made by the oxidation of methanol with air. The analysis of the exit gas from the reactor shows 64.49% N_2, 13.88% O_2, 5.31% H_2O, 11.02% CH_3OH, 4.08% HCHO and 1.22% HCOOH. Calculate the following: (5)

(a) The percent conversion of formaldehyde

(b) The ratio of air to methanol in the feed

Q. 5. Solve any two

a) Fresh air containing 0.01 kg of water per kg of dry air is mixed with recycled air containing 0.15 kg of water per kg of dry air and is blown over a wet solid in a drier. In a certain operation the wet solid contains 15% (weight) moisture and it is to be dried to a final moisture content of 5% by evaporating moisture into the air blown over it. The fresh air and recycled air are mixed in such proportions that the air blown over the solid contains 0.03 kg of moisture per kg of dry air. A part of the air leaving the drier which contains 0.15 kg water is recycled. For 100 kg of wet material charged, determine the following: (5)

(a) The ratio of dry air in the recycled air to that in the fresh air

(b) The quantity of dry air in the fresh air feed

(c) The amount of dry air recycled

b) In a process producing KNO_3 salt, 1000 kg/hr of a feed solution containing 10% KNO_3 is fed to an evaporator which evaporates some water to produce a 50% KNO_3 solution. This is then fed to a crystallizer, where crystals containing 95% KNO_3 are removed. The saturated solution containing 35% KNO_3 is recycled to the evaporator. Calculate the following: (5)

(a) The amount of recycle stream, kg/hr

(b) The amount of crystals, kg/hr

(c) The quantity of water evaporated, kg/hr

c) Air at 320 K saturated with water vapour is dehumidified by cooling to 285 K and by consequent condensation of water vapour. Air leaving the dehumidifier, (5)

saturated at 285 K is mixed with a part of the original air which is bypassed. The resulting air stream is reheated to 320 K. It is desired that the final air contains water vapour not more than 0.03 kg per kg of dry air. Calculate:

(a) The mass of dry air (in kilograms) bypassed per each kg of dry air sent through the dehumidifier

(b) The mass of water vapour (in kilograms) condensed in the dehumidifier per 100 cubic metres of air sent through it

(c) The volume of final air obtained per 100 cubic metres of air passed through the dehumidifier.

The total pressure is atmospheric and the vapour pressures of water are 1.4 kPa at 285 K and 10.6 kPa at 320 K.

Q. 6. Solve any two

a) A fuel oil containing 70% carbon by weight and the rest combustible hydrogen and moisture is burned with excess air. The flue gas analyzed 9% CO_2, 2% CO, 3% O_2 and 86% N_2. Determine the following: (5)

(a) The percentage of excess air

(b) The ratio of carbon to combustible hydrogen in the fuel on a weight basis

(c) The ratio of carbon to total hydrogen in the fuel on a weight basis

(d) The percentages of combustible hydrogen and moisture in the fuel

(e) The mass of moisture present in the flue gas per kg of oil burned

b) Find the Orsat analysis of the burner gas when pure sulphur is burned with 20% excess air. After the sulphur burned, 5% is converted to SO3 and the rest to SO2. (5)

c) Propane is burned with excess air to ensure complete combustion. If 55 kg of CO_2 and 15 kg of CO are obtained when propane is completely burned with 500 kg air, determine the following: (5)

(a) The mass of propane burnt (in kilograms)

(b) The percent excess air

(c) The composition of flue gas

End of paper

MGM University
Aurangabad-431003
First Term Exam A.Y. 2021-22

Program: Chemical Engineering Sem –III
Course: **HTO** (A)
Marks: 60
Course Code: **20UCH403D**

Instructions to the students
1. Each question carries 10 marks.
2 All questions are compulsory
3. Illustrate your answers with neat sketches. diagram etc wherever necessary
4. If some part or parameter is noticed to be missing. you may appropriately assume it and should mention it clearly

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Marks

Q1. Solve following.

a) What is Fourier's law of Conduction? State also assumptions on which this law is based (5)

b) Derive expressions for temperature distributions under one dimensional steady state heat Conduction for Hollow sphere. (5)

OR

c) A exterior wall of a house may be approximated by a 0.1 m layer of common brick (k=0.7 W/m ^{0}C) followed by a 0.04 m layer of gypsm plaster (k=0.48 W/m ^{0}C). What thickness of loosely packed rock wool insulation (k=0.065W/m ^{0}C) should be added to reduce the heat loss or gain through the wall by 80%. (10)

Q2. Solve any two

a) Derive expressions for temperature distributions in a straight rectangular for infinitely long fin. (5)

b) Write down critical thickness of insulation. (5)

c) Explain heat transfer through Semi-infinite solids. (5)

Q3. Solve any two

a) Derive Momentum equation for hydrodynamic boundary layer over flat pate. (5)

b) Define Prandtl Number and Write down its physical significance. (5)

c) Write down Colburn equation. (5)

Q4. Solve any two

a) Describe Boiling curve for water. (5)

b) Illustrate Characteristics parameter in free convection. (5)

c) Write down Reynolds Analogy. (5)

Q5. Solve any two

a) What is Black body? How does it differ from a gray body? (5)

b) State and prove Kirchhoff's law of Radiation. (5)

c) Derive radiation exchange between Black bodies by a non absorbing medium. (5)

Q6. Solve

a) How are heat exchanger classified. (5)

b) What is evaporation? (5)

OR

c) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 Kg/s and 0.5 Kg/s. The inlet temperatures on the hot and cold sides are 75 ^{0}C and 20 ^{0}C. The exit temperature of the hot water is 45^{0}C. If the individual heat transfer coefficients on both sides are 650 W/m^{2} ^{0}C, calculate the area of the heat exchanger. (10)

End of paper

MGM University
Aurangabad-431003
First Term Exam A.Y. 2021-22

Program: Chemical Engineering Sem –III

Course: **Fluid flow Operation**

Marks: 60

Course Code: **20UCH306D**

Time: 03hrs

Instructions to the students

1. Each question carries 10 marks.
2 All questions are compulsory
3. Illustrate your answers with neat sketches, diagram etc wherever necessary
4. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly

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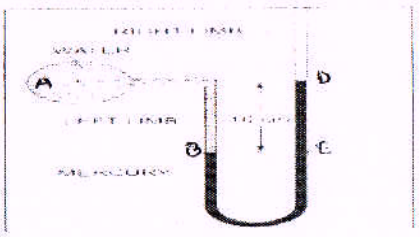
Marks

Q1. Solve any two

a) State Newton's law of viscosity and its applications (5)

b) Derive law of hydrostatic Equilibrium (5)

c) A U tube manometer is used to measure pressure of water in pipeline which is in excess of atmospheric pressure. The right limb of manometer is containing mercury and is open to atmosphere. The contact between water and mercury is in left limb. The determine pressure of water in main line. If the difference in level of mercury in the limb of U tube is 10 cm and free surface of mercury is in the level of with centre of pipe. (5)



Q2. Solve any two

a) Prove that $\frac{p_a}{\rho} + \frac{gZ_a}{g_c} + \frac{u_a^2}{2g_c} = \frac{p_b}{\rho} + \frac{gZ_b}{g_c} + \frac{u_b^2}{2g_c}$ (5)

b) Write down various types of Fluid flow. (5)

c) Explain Average velocity in detail. (5)

Q3. Solve any two

a) What is a venturimeter? Derive an expression for discharge through venturimeter. (5)

b) What is Pitot tube? How will you determine velocity at any point with the help of Pitot tube? (5)

c) An Orifice meter with Orifice diameter 10 cm inserted in the pipe of 20 cm diameter. The Pressure gauges is fitted upstream and downstream of the orifice meter gives reading of 19.62 N/cm^2 and 9.81 N/ cm^2. Coefficient of discharge for the orifice meter is given as 0.6. Find the discharge of water through pipe. (5)

Q4. Solve any two

a) Derive Hagen Poiseuille equation (5)

b) Illustrate Friction loss from sudden contraction of Cross section. (5)

c) Define friction factor and its relation between skin friction parameter. (5)

Q5. Solve any two

a) Describe concept of drag Coefficients. (5)

b) Derive Kozeny Carman equation. (5)

c) Explain Minimum Fluidization Velocity in detail. (5)

Q6. Solve any two

a) Write down construction and working of Centrifugal pump. (5)

b) What are types of valves? Explain any one in detail. (5)

c) State Developed head, Power requirement of Pump. (5)

End of paper