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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: BTech (FSE)

Subject (Course): Chemical Eng I (T&M Ana. Inst.)

Course Code : CHEG236

No. of page/s:

Semester – III

Max. Marks : 100

Duration : 3 Hrs

Section A (10 × 2 marks = 20 marks)

All questions are compulsory (All questions carry equal marks)

Q1. Strain gauge is a device which is used to measure:

- a) Temperature
- b) Stress
- c) Weight
- d) Mass

Q2. Bimetal thermostats is made up of two metallic strips with different _____

- a) Melting point temperature
- b) Coefficient of thermal expansion
- c) Cross sectional areas
- d) Density

Q3. Hot objects emit _____ radiations as a function of their surface temperature.

- a) IR and visible
- b) UV and visible
- c) IR and gamma
- d) Visible and alpha

Q4. Displacers used for level sensing work on _____

- a) Bernoulli's principle
- b) Archimede's principle
- c) Newton's 1st law
- d) Newton's 2nd law

Q5. The risk of working with a batch reactor are much higher than that of working with a continuous reactor (**More than one option may be correct**).

- a) True
- b) False
- c) It does not depend on the mode of operation
- d) It depends on the size of operation

Q6. Rates of most reactions are very sensitive to temperature. A mere rise of 10°C can lead to _____ the reaction rate (**More than one option may be correct**).

- a) Decrease in
- b) Doubling of

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- c) Exponential rise in
- d) Unpredictable rise in

Q7. The main advantage of the _____ control mode is that the controller output continues to reposition the final control element until the error is reduced to zero.

- a) Proportional
- b) Feedback
- c) Integral
- d) Feedforward

Q8. IR spectrophotometer uses electromagnetic radiations in the range of

- a) 185 – 400 nm
- b) 400 – 700 nm
- c) 700 – 15000 nm
- d) 900 – 12000 nm

Q9. Ionic bonding requires _____ (Choose all the options, applicable)

- a) Transfer of electrons
- b) Sharing of electrons
- c) Large difference in electronegativity's
- d) Large number of lone pair electrons

Q10. Polymers made from identical unit of monomers is called _____

- a) Copolymer
- b) Homopolymer
- c) Multipolymer
- d) Unipolymer

Section B (5 × 8 marks = 40 marks)

All questions are compulsory (All questions carry equal marks)

Q11. For the following reaction given by equation $aA + bB \rightarrow cC + dD$

- i) Write the generic rate equation.
- ii) Units of rate equation.
- iii) What is the relationship of stoichiometric coefficients with the order of reaction?
- iv) What effect order of reaction has on overall rate of reaction?

Q12. What are controllers and what is the role of controllers in chemical process industry? Explain the various modes of control. Of the various types of controllers which one is the easiest to implement and why?

Q13. Explain the principle behind the working of a strain gauge. How is the resistance in a metal related to the applied force? What instrument is used to measure the change in resistance? Explain its working.

Q14. Explain the working of a mass spectroscope with the help of a diagram.

Q15 Explain inversion line, inversion temperature and maximum inversion temperature in context with Joule-Thompson coefficient. Which part of refrigeration cycle exploits Joule-Thompson effect and how?

Section C (2 × 20 marks = 40 marks)

Answer any two questions (all questions carry equal marks)

Q16. The importance of temperature measurement and control cannot be understated. Many gadgets of day to day use as well as sophisticated equipment used in industry require monitoring and control of temperature.

- i) Which law of thermodynamics describes the absolute temperature scale?
- ii) What are the various temperature measurement techniques? Describe the working principle of each of the temperature measurement techniques.
- iii) Write advantage and disadvantage of various temperature measurement techniques.

Q17. Discovery of synthetic polymers resulted in the age of plastic fantastic.

- i) What are polymers? Explain the molecular structure of polymers with the help of diagrams and comment on relative strength of various polymer structures.
- ii) How is molecular weight of a polymer calculated?
- iii) Calculate the molecular weight for a polymer with number and mass of monomer given as below:

Number of monomer units	Mass of monomer units(Kg)
1	100
3	150
4	120
2	180
1	260

Q18. Explain photo spectrometry with the help of Beer-Lambert Law. Describe the effects of electromagnetic radiation on molecules with the help of a chart. What are the various instrument used for the determination of structure of chemicals? What is the principle on which XRD is based?

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Semester – **III**

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Section A (5 × 4 marks = 20 marks)

All questions are compulsory (All questions carry equal marks)

- Q1. How does the difference in electronegativity of elements in periodic table determines the type of binding?
- Q2. Bimetal thermostats is made up of two metallic strips with different _____
- e) Melting point temperature
 - f) Coefficient of thermal expansion
 - g) Cross sectional areas
 - h) Density
- Q3. Calculate the atomic packing factor for a body centered molecular structure
- Q4. Strain gauge is a device which is used to measure:
- a) Temperature
 - b) Stress
 - c) Weight
 - d) Mass
- Q5. The risk of working with a batch reactor are much higher than that of working with a continuous reactor (**More than one option may be correct**).
- e) True
 - f) False
 - g) It does not depend on the mode of operation
 - h) It depends on the size of operation
- Q6. Hot objects emit _____ radiations as a function of their surface temperature.
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- e) Decrease in
- f) Doubling of
- g) Exponential rise in
- h) Unpredictable rise in

Q9. The main advantage of the _____ control mode is that the controller output continues to reposition the final control element until the error is reduced to zero.

- e) Proportional
- f) Feedback
- g) Integral
- h) Feedforward

Q10. Polymers made from identical unit of monomers is called _____

- e) Copolymer
- f) Homopolymer
- g) Multipolymer
- h) Unipolymer

Section B (5 × 8 marks = 40 marks)

All questions are compulsory (All questions carry equal marks)

Q11. What are chemical reactors? Give the classification of chemical reactors.

Q12 Determine the theoretical density for Barium with following properties:

crystal structure = BCC

atomic weight = 137.33 g/mol (1 amu = 1 g/mol)

atomic radius R = 0.217 nm (1 nm = 10⁻⁷ cm)

Q13. A Carnot heat engine receives 500 kJ of heat per cycle from a high temperature reservoir at 650 °C and rejects the heat to a low temperature sink at 30 °C. Determine:

- i) The thermal efficiency of this Carnot engine,
- ii) The amount of heat rejected to the sink per cycle, and
- iii) Can we further increase the efficiency of this heat engine? If yes, list the possible way that would help increase its efficiency.

Q14. Describe the effect of electromagnetic radiation on molecules with the help of a chart. What are the various instrument used for the determination of structure of chemicals?

Q15. Describe, with reason, the type of bonding that exists between:

- i) Na-Cl
- ii) CH₄
- iii) Al-Al

Section C (20 × 2 = 40 marks)

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Answer any two questions (all questions carry equal marks)

Q16. Knowing kinetics of a chemical reaction is crucial for design of a chemical reactor.

- What are the various methods used for the determination of rate equations?
- Using the initial rate and chemical data given in the table below. Determine a) rate equation and b) the rate constant.



Initial rate (mol dm ⁻³ s ⁻¹)	Initial concentration (mol dm ⁻³)		
	[I ₂ (aq)]	[CH ₃ COCH ₃ (aq)]	[H ⁺ (aq)]
3.5 × 10 ⁻⁵	2.5 × 10 ⁻⁴	2.0 × 10 ⁻¹	5.0 × 10 ⁻³
3.5 × 10 ⁻⁵	1.5 × 10 ⁻⁴	2.0 × 10 ⁻¹	5.0 × 10 ⁻³
1.4 × 10 ⁻⁴	2.5 × 10 ⁻⁴	4.0 × 10 ⁻¹	1.0 × 10 ⁻²
7.0 × 10 ⁻⁵	2.5 × 10 ⁻⁴	4.0 × 10 ⁻¹	5.0 × 10 ⁻³

Q17. Discovery of synthetic polymers resulted in the age of plastic fantastic.

- What are polymers? Explain the molecular structure of polymers with the help of diagrams and comment on relative strength of various polymer structures.
- How is molecular weight of a polymer calculated?
- Calculate the molecular weights for a polymer with number and mass of constituent units given below:

Number of monomer units	Mass of monomer units(Kg)
1	110
3	130
4	190
2	200
1	280

Q18. Temperature measurement and regulation is crucial for operation and efficiency of many day to day processes.

- What is temperature?
- What are the various temperature measurement techniques? Describe in working principle in detail with help of proper diagram.
- Write advantage and disadvantage of various temperature measurement techniques.