**Name:**

**Enrolment No:**

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, December 2020**

**Course: Chemical Eng I (Thermodynamics & Measuring A. Inst.) – HSFS2001** **Semester: III**
**Programme: BTech (FSE)**
**Time: 03 hrs.** **Max. Marks: 100**

**Instructions:**
**(i) All Questions in Section A are compulsory. Section B has 5 Questions with Q11 having an internal choice. Section C has 1 questions with an internal choice.**
**(ii) Answer all the questions sequentially.**

**SECTION A (Maximum marks 30)**

| S. No. | | Marks | COs |
|---|---|---|---|
| Q 1 | The drinking water needs of an office are met by cooling tab water in a refrigerated water fountain from 23 to 6°C at an average rate of 10 kg/h. If the COP of this refrigerator is 3.1, the required power input to this refrigerator is<br>(*a*) 197 W<br>(*b*) 612 W<br>(*c*) 64 W<br>(*d*) 109 W<br>(*e*) 403 W<br>(Hint: Specific Heat capacity (*Cp*) of water is 4.18 KJ/Kg-C) | **5** | **CO3** |
| Q2 | The pressure of a fluid always decreases during an adiabatic throttling process. Is this also the case for the temperature? Explain briefly. | **5** | **CO1** |
| Q3 | True or False<br>(a) As per 1st Law of Thermodynamics - there is no restriction on direction of conversion of energy.<br>(b) Dip Stick and Float type level measurement devices give direct measurement of level.<br>(c) In an adiabatic process heat flows from a system to the surrounding.<br>(d) For an open system energy can travel through the boundaries of a system in the form of heat and work but mass is not allowed to cross the boundaries of a system.<br>(e) Joule Thomson coefficient is a measure of the change in temperature with pressure during a constant enthalpy process. | **5** | **CO1** |
| Q4 | Propane ($C_3H_8$) is burned with 150 percent theoretical air. Calculate the air–fuel mass ratio for this combustion process. | **5** | **CO2** |
| Q5 | Is it possible to have a real heat engine with thermal efficiency more than that of a Carnot heat engine operating between same temperature source and sink? Explain. | **5** | **CO3** |
| Q6 | (a) What is Offset in a controller?<br>(b) What is Offshoot in a controller?<br>(c) Which controller is best suited for a process with frequent startups and shutdowns? | **2+2+1 =5** | **CO4** |

## SECTION B (Maximum marks 50)

| | | | |
|---|---|---|---|
| Q7 | Describe the working of any two instruments used for indirect level measurement. | **10** | **CO1** |
| Q8 | Determine the theoretical density for Barium with following properties:<br>crystal structure = BCC<br>atomic weight = 137.33 g/mol (1 amu = 1 g/mol)<br>atomic radius R = 0.217 nm (1 nm = $10^{-7}$ cm) | **10** | **CO5** |
| Q9 | Explain the working of mass spectroscopy with the help of a diagram. | **10** | **CO5** |
| Q10 | (a) Define the coefficient of performance of a refrigerator in words. Can it be greater than unity?<br>(b) A food department is kept at -12°C by a refrigerator in an environment at 30°C. The total heat gain to the food department is estimated to be 3300 kJ/h and the heat rejection in the condenser is 4800 kJ/h. Determine the power input to the compressor, in kW and the COP of the refrigerator. | **10** | **CO3** |
| Q11 | Write Bernoulli's equation and derive the expression for velocity of fluid flowing out from the bottom of water tank filled to a height of *h* meters. Explain all the assumptions made in the derivation.<br><br>**OR**<br><br>A rigid tank contains a hot fluid that is cooled while being stirred by a paddle wheel. Initially, the internal energy of the fluid is 800 kJ. During the cooling process, the fluid loses 500 kJ of heat, and the paddle wheel does 100 kJ of work on the fluid. Determine the final internal energy of the fluid. Neglect the energy stored in the paddle wheel. Clearly explain all the assumptions made in solving the problem. | **10** | **CO1** |

## SECTION-C (Maximum marks 20)

Q12 — **20** — **CO5**

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 | 50 |
| 3 | 20 |
| 4 | 80 |
| 2 | 20 |
| 1 | 80 |

**OR**

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.