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

CLASS: IMSC. **SEMESTER : III**
BRANCH: FOOD TECHNOLOGY **SESSION : MO/19**

SUBJECT: FT202 INTRODUCTION TO FOOD ENGINEERING

TIME: 3 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
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 hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Define followings: (i) Buckingham pi theorem, (ii) System and surroundings. [2]

Q.1(b) Stefan-Boltzmann law states that the emissive power is proportional to the fourth power of absolute temperature. Stated mathematically, $E_b = \sigma T^4$, where E_b is the emissive power in BTU/(ft^2 h), σ is the Stefan-Boltzmann constant, and T is the temperature in °R. what is the value of σ in W/(m^2K^4), if its value in FPS units is 0.171×10^{-8} BTU/(ft^2 h°R^4)? [3]

Q.1(C) The heat capacity of carbon dioxide gas is given by [5]

$$C_P = 0.1978+1.059\times10^{-4}\ t - 2.395 \times 10^{-8}\ t^2$$

where C_P is in BTU/(lb-mol °F) and t is in °F. Change the equation into the form in which C_P is given in kJ/(kmol K) and temperature is in K.

Q.2(a) How many molecules are present in 691 g K_2CO_3? The atomic weights of potassium = 39.1, carbon = 12.0, oxygen = 16.0. [2]

Q.2(b) Soyabean seeds are extracted with hexane in a batch extractor. The flaked seeds contain 18.6% oil, 69.6% solid and 12.4% moisture. At the end of the process, cake (meal) is separated from hexane oil mixture. The cake analysis yields 0.8% oil, 87.7% solids and 11.5% moisture. Find the percentage recovery of oil. All percentages are by weight. [3]

Q.2(C) A gas analyzing CO_2 = 5.5%, CO = 25%, H_2 = 14%, CH_4 = 0.5% and N_2 = 55% (by volume) is burnt in furnace with air which is 10% excess over that required to burn CO, H_2, and CH_4 completely. Give the analysis of the product gas mixture, assuming all reactions proceed to completion. **[5]**

Q.3(a) The average molecular weight of a gas containing oxygen and other gases is 40. A student evaluated the average molecular weight as 36.8. He got the wrong result because he used an incorrect value of 16 as the molecular weight of oxygen in the calculation. What is the mole percentage of oxygen in the mixture? [2]

Q.3(b) n-heptane and toluene form an ideal solution. At 373 K their vapor pressures are 106 kPa and 74 kPa, respectively. Determine the composition of the liquid and the vapor in the equilibrium at 373 K and 101.3 kPa. [3]

Q.3(C) Estimate the molar volume of CO_2 at 500 K and 100 bar using the (i) ideal gas equation and (ii) the van der waals equation. The van der waals constants are 0.364 Nm^4/mol^2 and 4.267×10^{-5} m^3/mol. [5]

Q.4(a) The activation energy of a bimolecular reaction is about 9150 cal/mol. How much faster is this reaction takes place at 500 K than at 400 K. [2]

Q.4(b) In the case of first order reaction, show that time required for 75% conversion is double the time required for 50% conversion. [3]

Q.4(C) The rates of reaction at concentrations 0.15 mol/l and 0.05 mol/l are 2.7×10^{-3} and 0.3×10^{-3} mol/(l.min). Evaluate the order of reaction with respect to the reactant. [5]

Q.5(a) Expand the following function by partial-fraction and evaluate the coefficients. [2]

$$X(s) = 1/[(s+1)(s+2)(s+3)(s+4)]$$

Q.5(b) Derive the transfer function Y(s)/X(s) for mercury thermometer. [3]

Q.5(C) Define following terms for an underdamped system: (i) Overshoot, (ii) Rise time, (iii) Response time, (iv) Decay ratio, (v) Period of oscillation [5]

:::::27/11/2019:::::M