



**GENERAL INSTRUCTIONS TO THE CANDIDATES**

- Candidates are instructed to answer the questions as per Bloom's Taxonomy knowledge level (K<sub>1</sub> to K<sub>6</sub>)
- Candidates are strictly instructed not to write anything in the question paper other than their roll number.
- Candidates should search their pockets, desks and benches and handover to the Hall Superintendent/ Invigilator if any paper, book or note which they may find therein as soon as they enter the examination hall.
- Candidates are not permitted to bring electronic watches with memory, laptop computers, personal systems, walkie-talkie sets, paging devices, mobile phones, cameras, recording systems or any other gadget / device /object that would be of unfair assistance to him / her.
- Corrective measures as per KCT examination policies will be imposed for malpractice in the hall like copying from any papers, books or notes and attempting to elicit the answer from neighbours.

**B.TECH. DEGREE EXAMINATIONS: DEC 2015**

(Regulation 2014)

Third Semester

**BIOTECHNOLOGY**

U14BTT304: Biochemical Process Calculations

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions**

**PART A (10 x 1 = 10 Marks)**

- What is the mass of 20.0 mL solution if its density is 1.84 g/mL? CO1 [K<sub>3</sub>]  
 a) 10.8 g b) 10.9 g  
 c) 21.8 g d) 36.8 g
- Express 0.000840 in scientific notation CO1 [K<sub>2</sub>]  
 a)  $8.40 \times 10^{-3}$  b)  $8.40 \times 10^4$   
 c)  $8.40 \times 10^{-4}$  d)  $8.4 \times 10^4$
- Items to be represented in flow charts are CO2 [K<sub>4</sub>]  
 1. Input to the process  
 2. Output from the process  
 3. Process steps  
 4. By products  
 5. Recycle  
 What was the CORRECT sequence of their occurrence?  
 a) 1-2-3-4-5 b) 1-3-4-5-2  
 c) 1-3-2-4-5 d) 1-4-3-5-2
- Consider the following statements. CO2 [K<sub>4</sub>]  
 1. Material balances are important first step when designing a new process.  
 2. Material balances are nothing more than the application of the law of conservation of mass.  
 3. Material balances are fundamental to the control of processing and particularly in the control of yields of the products.



9. **Assertion (A):** Stoichiometric equations are used to represent growth of microorganisms provided a 'molecular formula' for the cells is available. CO5 [K<sub>4</sub>]

**Reason (R):** The molecular formula for biomass is obtained by measuring the amounts of C, N, H, O and other elements in cells.

a) Both (A) and (R) are true and (R) is the correct reason for (A)      b) Both (A) and (R) are true and (R) is not the correct reason for (A)

c) (A) is false but (R) is true      d) (A) is true but (R) is false

10. Match the elements in column I with the appropriate valance given in column II CO5 [K<sub>4</sub>]

Column I	Column II
A. Carbon	[i] -2
B. Hydrogen	[ii] 6
C. Oxygen	[iii] 1
D. Sulphur	[iv] 4

a) A - i, B - ii, C - iv, D - iii

b) A - ii, B - i, C - iii, D - iv

c) A - iii, B - iv, C - ii, D - i

d) A - iv, B - iii, C - i, D - ii

### PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11. What is the conversion factor to change kilograms to pounds? CO1 [K<sub>4</sub>]

12. Write any two dimensional number. CO1 [K<sub>4</sub>]

13. Write a short note on three general methods of solving material balance problems. CO2 [K<sub>3</sub>]

14. Compare purging, recycle and bypass. CO2 [K<sub>2</sub>]

15. In production of sulphur trioxide (SO<sub>3</sub>) 100 k mol of SO<sub>2</sub> and 200 k mol of O<sub>2</sub> are fed to the reactor. The product stream is found to contain 80 k mol of SO<sub>3</sub>. Find the percent conversion of SO<sub>2</sub>. CO3 [K<sub>5</sub>]

16. Define yield and selectivity. CO3 [K<sub>1</sub>]

17. State Hess's law. CO4 [K<sub>1</sub>]

18. When 20.0 g of titanium is heated from 10.0°C to 20.0°C, 25.0 cal of heat is absorbed. What is the specific heat of titanium? CO4 [K<sub>3</sub>]

19. What do you understand about degree of reduction in the elemental balance? CO5 [K<sub>1</sub>]

20. What is meant by maintenance coefficient? CO5 [K<sub>2</sub>]

### Answer any FIVE Questions

### PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

#### Q.No. 21 is Compulsory

21. A gas containing 60% H<sub>2</sub> and 40% NH<sub>3</sub> (by mole) is cooled from 500°C to 40°C at 1 atmosphere pressure absolute. Calculate the heat in kcal/kg mole with the following data. CO4 [K<sub>4</sub>]

For H<sub>2</sub>:  $C_p = 6.947 - 0.2 \times 10^{-3}T + 0.481 \times 10^{-6}T^2$

For NH<sub>3</sub>:  $C_p = 6.086 + 8.812 \times 10^{-3}T - 1.506 \times 10^{-6}T^2$

Where  $C_p$  values is in kcal/kg mole °K and T is in °K

22. A solution of common salt in water is prepared by adding 20 kg of salt to 100 kg of water, to make a liquid of density 1323 kg/m<sup>3</sup>. Calculate the concentration of salt in this solution as a CO1 [K<sub>4</sub>]
- (i) Weight fraction (3)
- (ii) Weight / volume fraction (4)
- (iii) Mole fraction (3)
- (iv) Molal concentration. (4)

23. A mixture containing 45% benzene (B) and 55% toluene (T) by mass is fed to a distillation column. An overhead stream of 95 wt% B is produced and 8% of the benzene fed to the column leaves in the bottom stream. The feed rate is 2000 kg/h. Determine the overhead flow rate and the mass flow rates of benzene and toluene in the bottom stream. CO2 [K<sub>4</sub>]

24. In the production of chlorine gas by oxidation of hydrochloric acid gas, air is used 30% in excess of that theoretically required. Based on 4 k mol HCl. CO3 [K<sub>5</sub>]
- Calculate
- i) The weight ratio of air to hydrochloric acid gas in feed. (7)
- ii) If the oxidation is 80% complete, find the composition of the product stream on mole basis. (7)

25. Ammonia is synthesized according to the following reaction: CO4 [K<sub>5</sub>]
- $$\frac{1}{2} \text{N}_2 + \frac{3}{2} \text{H}_2 \rightarrow \text{NH}_3 \quad \Delta H_{298}^0 = -46.191 \text{ kJ}$$
- The specific heats are represented by
- $C_p = \alpha + \beta T + \gamma T^2$  where  $C_p$  is in J/mol K and  $\alpha$ ,  $\beta$  and  $\gamma$  are:

Compounds	$\alpha$	$\beta$	$\gamma$
N <sub>2</sub>	27.31	$5.2335 \times 10^{-3}$	$-4.1868 \times 10^{-9}$
H <sub>2</sub>	29.09	$-8.374 \times 10^{-4}$	$2.0139 \times 10^{-6}$
NH <sub>3</sub>	25.48	$36.89 \times 10^{-3}$	$-6.305 \times 10^{-6}$

Determine the heat of the reaction at 700 K.

26. Calculate the stoichiometric coefficients and yield coefficients  $Y_{X/S}$  (g dw cell/ g substrate) for the following biological reaction. CO5 [K<sub>5</sub>]
- $$\text{C}_{16}\text{H}_{34} + a \text{O}_2 + b \text{NH}_3 \rightarrow c (\text{C}_{4.4} \text{H}_{7.3} \text{N}_{0.86} \text{O}_{1.2}) + d \text{H}_2\text{O} + e \text{CO}_2$$
- Assume that experimental measurements for a certain organism have shown that cells can convert two-third (wt/wt) of the substrate carbon to biomass.

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