PROCESS CALCULATIONS (SEMESTER - 4)

CS/B.Tech (CT)/SEM-4/CT-404/09

1. .....
Signature of Invigilator

2. .....
Signature of the Officer-in-Charge

Reg. No. | | | | | | | | | | | | | | |

Roll No. of the Candidate | | | | | | | | | | | | | | |

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CS/B.Tech (CT)/SEM-4/CT-404/09

ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

PROCESS CALCULATIONS (SEMESTER - 4)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. You have to answer the questions in the space provided marked 'Answer Sheet'. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

FOR OFFICE USE / EVALUATION ONLY

Marks Obtained

Question Number											*Total Marks*	*Examiner's Signature*
Marks Obtained												

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Head-Examiner/Co-Ordinator/Scrutineer

4719 (18/06)

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ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

PROCESS CALCULATIONS

SEMESTER - 4

Time : 3 Hours] [Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* of the following. 5 × 14 = 70

1. a) A pure hydrocarbon gas is burnt in a furnace giving a flue gas containing 10·8% CO_2, 3·8% O_2 and rest N_2 and inerts. Calculate the atomic ratio of H/C.

   b) A hydrocarbon gas burnt with 15% excess air. The flue gas cantain CO_2 – 11·6%, CO – 2·0%, H_2 – 1·6%, O_2 – 4·0% and the rest N_2. Calculate the actual amount of excess air. 7 + 7

2. a) The feed containing 60 mole% *A*, 30 mole % *B* and 10 mole % inerts enters a reactor. The product stream leaving the reaction is found to contain 2 mole % *A*. Reaction taking place is

   $2A + B \varnothing C$

   Find the % of original '*A*' getting converted *C*.

   b) A combustion reactor is fed with 50 kg mole of butane per hour and 2100 kg mol of air per hour. Calculate the % excess air.

   Reaction is : $C_4 H_{10} + \frac{13}{2} O_2 \varnothing 4CO_2 + 5H_2O$. 7 + 7

3. Pure CO_2 may be obtained as a by-product by reacting H_2SO_4 with limestone, the main product being $CaSO_4$. A limestone ore is treated with dilute H_2SO_4 containing 15% H_2SO_4 and the reactions are allowed to go to completion

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 \downarrow + H_2O + CO_2 \uparrow$$

$$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2 \uparrow .$$

and the CO_2 gas evolved at 1·1 bar, 40°C is stored. The solid residue is found to contain only $CaSO_4$ and the inerts, and the liquid contain $MgSO_4$ – 5·8%, H_2SO_4 – 1·1% and the rest water. Before filtration the free acid is neutralised with precipitated chalk ($CaCO_3$).

The filter cake composition expressed as the weight ratio of $CaSO_4$ to inerts is 18 : 1.

Calculate :

i) The composition of the limestone used

ii) The mole of CO_2 produced per kg. of limestone

iii) The quantity of chalk required to neutralize the excess acid per kg of the original limestone.

iv) The percentage excess of acid used. 14

4. In an experiment, methane is burned with the theoretical quantity of air for complete combustion. Because of faulty construction and operation of the equipment, the reaction does not proceed to completion. All the carbon which burn, however, goes to form carbon dioxide. If methane and air are originally at 300 K and the total products (including unburnt methane and unused O_2) leave at 670 K, what % of methane is burnt ? The water may be pressured to leave in the vapour form.

Data : $\Delta H_R = -0{\cdot}8028 \times 10^6$ J/mol for water in vapour form.

C_P for O_2 = 30·98 J/mol-K

C_P for N_2 = 29·68 J/mol-K

C_P for CH_4 = 45·55 J/mol-K

C_P for CO_2 = 43·87 J/mol-K

C_P for H_2O = 34·95 J/mol-K. 14

5. Calculate a glass batch composition to yield a glass of the following composition :

SiO_2 – 68%, Al_2O_3 – 2%, CaO – 13%, Na_2O – 11% & K_2O – 6% using the following raw materials :

Sand (SiO_2 – 99%) ; feldspar (SiO_2 – 65%, Al_2O_3 – 19% K_2O – 16%) ; limestone 98% pure & 2% SiO_2 ; K_2CO_3 (K_2O – 68%) & soda ash – 98% pure. 14

6. Calculate the batch composition of a glass with the oxide composition of SiO_2 – 71%, Na_2O – 15%, CaO – 10%, Al_2O_3 – 4% using the following raw materials :

Sand, feldspar, anhydrous soda ash and cullet (20%).

The cullet composition is SiO_2 – 75%, Na_2O – 15%, CaO – 95% & Al_2O_3 – 0·5%. 14

7. The formula of a glaze is

$$\left.\begin{matrix} 0{\cdot}081\ K_2O \\ 0{\cdot}028\ Na_2O \\ 0{\cdot}293\ CaO \\ 0{\cdot}598\ PbO \end{matrix}\right\} 0{\cdot}232\ Al_2O_3\ ;\ 4{\cdot}065\ SiO_2$$

Calculate the batch composition using the following raw materials :

Whiting, lead bisilicate, china clay, flint & stone. The stone has the molecular formula.

$$\left.\begin{matrix} 0{\cdot}412\ K_2O \\ 0{\cdot}143\ Na_2O \\ 0{\cdot}180\ CaO \end{matrix}\right\} 1{\cdot}0\ Al_2O_3\ ;\ 6{\cdot}1\ SiO_2$$ 14

8. The batch composition of a glaze is as fellows :

Mill batch	**(Parts by weight)**	**Lead frit**	**Borax frit**	
Lead frit	137·2	$PbO.\ 2SiO_2$	Borax	76·4
Borax frit	131·2		Whiting	20·0
Whiting	10·0		Feldspar	55·6
China clay	91·6		Flint	24·0
Flint	36·0			

Calculate the glaze formula. 14

END