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VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

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SCHOOL OF CHEMICAL ENGINEERING CONTINUOUS ASSESSMENT TEST -II FALL SEMESTER 2025-2026

Programme Name & Branch	: B.Tech. Chemical
Engineering Course Code	: BCHE203L
Course Name	: Chemical Process Calculations
Faculty Name(s)	: Dr. S.Velu (10386)
Class Number(s)	: VL2025260101206
Date of Examination	: 05-10-2025
Exam Duration	: 90 minutes

Q.No.	Answer ALL the questions. Marks 5×10=50	Max. Marks
1	You are provided with the following composition of a limestone sample (all values are by weight): Calcium carbonate ($CaCO_3$): 90%, Magnesium carbonate ($MgCO_3$): 7%, Insoluble materials: 3%.Using relevant chemical equations, molar masses, and any other necessary data from your notes or textbook, answer the following: i. Calculate the mass of calcium oxide (CaO) that can be obtained from 4 tonnes of this limestone. ii. Determine the mass of carbon dioxide (CO_2) released per kilogram of limestone during thermal decomposition. iii. If the goal is to produce 3 tonnes of lime (CaO), estimate the amount of limestone required, based on the given composition.	10
2	a) Ethylene (C_2H_4) is oxidized to produce ethylene oxide (C_2H_4O). 130 kmol of ethylene is fed to the reactor. The product contains 80 kmol of ethylene oxide and 9 kmol of carbon dioxide (CO_2).Using this information, answer the following: i. Calculate the percentage conversion of ethylene in the reactor. ii. Calculate the percentage yield of ethylene oxide (C_2H_4O) based on the ethylene fed. b) Ethylene oxide is manufactured by the oxidation of ethylene. 120kgmol of ethylene and 120 kgmol of oxygen are fed to the reactor. The conversion of ethylene is 75% and the percentage yield of C_2H_4O is 95. Calculate the composition of product stream leaving the reactor. The reactions taking place in reactor are: $C_2H_4 + \frac{1}{2} O_2 \longrightarrow C_2H_4O$ $C_2H_4{+}3O_2 \longrightarrow 2CO_2 + 2H_2O$	10

3	You are provided with the ultimate analysis (by weight) of a residual fuel oil (RFO) sample: Carbon (C): 88%, Hydrogen (H): 10%, Sulfur (S): 2%. This fuel is burned in a power-generating boiler using 30% excess air. Using relevant combustion principles, molar masses, and air composition data from your resources, calculate the following: i. The theoretical dry air requirement (in appropriate units) needed for complete combustion of the RFO. ii. The actual dry air supplied to the boiler, considering the 30% excess air. iii. The composition of the dry flue gas leaving the boiler.	10
4	The ultimate analysis of coal sample is given below: C= 62 %, H= 4%, S= 1%, Ash= 15%, N_2 = 2% And rest is oxygen. Calculate: i. Theoretical oxygen requirement per unit weight of coal. ii. The theoretical dry air requirement per unit weight of coal. iii. The flue gas composition. Assume that the coal is burnt with 90% excess air.	10
5	Butane (C_4H_{10}) is burned using 10% excess air. Using relevant chemical equations, molar masses, and gas laws from your reference materials, calculate the following: a) The air-to-fuel ratio by weight. b) The air-to-fuel ratio by volume. c) The weight of dry exhaust gases formed per unit weight of fuel burned. d) The moles of oxygen (O_2) present in the exhaust gases per unit weight of fuel. e) The moles of water vapour (H_2O) present in the exhaust gases per unit weight of fuel. f) The volume of the exhaust gases at 1 atm pressure and 260°C temperature per unit weight of fuel burned.	10