MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

Reg. No.									

DEPARTMENT OF CHEMICAL ENGINEERING

III Semester B.Tech. Chemical Engineering

End-Semester Examination – January 2022 (Proctored Online Examination)

CHE 2152: Chemical Process Calculations

PART B

DATE: 27/01/2022 **TIME: 75 + 10 MINUTES** **MAX. MARKS: 20**

Note: Answer ALL questions. Missing data may be suitably assumed.

Q.1A) A solution containing 25% benzene, 35% toluene and rest xylene is in equilibrium with its vapour at 373 K. All percentages are on a weight basis. Determine the following:

(a) The total pressure

(b) The composition of the vapour

(c) The average molecular weight of the liquid and vapour

(Note: The vapour pressures at 373 K are: benzene = 178.7 kPa, toluene = 74.7 kPa and xylene = 28 kPa. Molecular weight of Benzene is 78.04, toluene is 92.06 and xylene is 106.08 g/mol). **[3]**

Q.1B) At 298 K and 101.3 kPa, air-water vapor mixture has 60% relative humidity. It is then cooled to a temperature of 280 K and compressed to a pressure so that 95% of the water vapour is condensed. The vapor pressure of water at 298 K is 3.1 kPa and at 280 K is 0.964 kPa. Calculate the following: **[4]**

(a) The final pressure of the air,

(b) The volume of final air per cubic meter of original air, and

(c) Amount of water condensed after cooling the air at 280 K.

Q.1C) Tannin is extracted from certain wood bark which contains 6% moisture, 11% tannin, 8 % soluble non-tannin materials and the rest insoluble lignin. After tannin is extracted, the solid residue analyses 1% tannin and 0.25% soluble non-tannin on a dry basis. What is the percent extraction of tannin? **[3]**

Q.2A) A hydrocarbon fuel oil is burnt in furnace. The Orsat analysis of the flue gas obtain after combustion contain CO_2 = 11.2%, O_2 = 5.8%, N_2 = 83%. All percentages are by mole. Calculate the (a) wt% of carbon and hydrogen in fuel, and (b) % excess air used for the combustion. Assume that the fuel oil doesn't contain nitrogen. **[3]**

Q.2B) A 1:3 nitrogen-hydrogen mixture is fed to a converter resulting in 20% conversion to ammonia. After the complete separation of ammonia, the remaining unconverted gases are recycled to the converter. The initial reaction mixture contains 0.2% argon by volume. If the limit of argon in the reactor is 5% (by volume) of the N_2–H_2 mixture in the reactor, estimate the following: **[4]**

(a) The fraction of the recycle that is purged,
(b) The moles of ammonia produced per 100 moles of feed, and
(c) The overall conversion of ammonia

Q.2C) A natural gas has the following composition on mole basis CH_4 = 83%, C_2H_6 = 15% and N_2 = 2%. Calculate the heat to be added to raise the temperature from 300 K to 520 K using heat capacity data given below: **[3]**

$C_P = a + bT + cT^2$ kJ/ (kmol. K)

Component	**a**	**b x 10^3**	**c x 10^6**
CH_4 (g)	19.26	52.12	11.98
C_2H_6 (g)	5.41	178.09	– 67.38
N_2 (g)	29.6	5.15	13.19