

- Note: i) Q.No 1 is compulsory.
 ii) Answer any three of the remaining five questions.
 iii) Assume suitable data where ever necessary.

- Q.1 a) Calculate the density of chlorine gas at 503 K and 15.2 MPa using Ideal gas law. 05
 b) Wet pulp is found to contain 71% water. After drying it is found that 60% of the original water has been removed. Calculate the mass of water removed per kg dry pulp. 05
 c) Prove Pressure% = Mole% = Volume%
- Q.2 a) A gas mixture has the following composition by volume, SO₂ = 8.5%, O₂ = 10%, N₂ = 81.5%. Find (i) Density of gas mixture at 473K and 202.65 Kpa.g (ii) Composition by weight 10
 b) A multiple effect evaporator system has a capacity of processing 1000 kg per day of caustic soda. When it concentrates weak liquor from 4% to 25% (wt basis), when the same plant is fed with 10% weak liquor and concentrated to 50%. Find the capacity of the plant in terms of solid caustic soda, assuming water evaporation capacity will be same in both the cases. 10
- Q.3 a) In synthesis of methanol, fresh feed containing 32% CO, 64% H₂ and 4% Inerts (by volume) is mixed with recycle feed. Mixed feed entering the reactor results in 20% per pass conversion of CO, the product stream from reactor is fed to condenser where all methanol formed gets condensed and the gases from the condenser are recycled. In order to prevent build-up of Inerts in recycle loop, a small portion of gases leaving the condenser is continuously purged. If mixed feed contains 15 mol% Inerts. Calculate (i) Recycle ratio (ii) purge ratio 20
- Q.4 a) A furnace is fired with fuel oil. The orsat analysis of flue gases by volume is as given below: CO₂ = 10.6%, O₂ = 6%, N₂ = 83.4%. Calculate (i) % excess air (ii) C:H ratio in the fuel oil, assuming fuel doesn't contain nitrogen. 10
 b) What is steady state material balance and unsteady state material balance? Explain with one example each. 10
- Q.5 a) Write down general energy balance procedure. 10
 b) Define (i) limiting reactant and excess reactant (ii) Hess's law (iii) Adiabatic reaction temperature (iv) Heat of reaction (v) Henry's law 10
- Q.6 a) Define (i) yield (ii) Degree of reduction 04
 b) Aerobic growth of *S. Cerevisiae* on ethanol is simply described by the following overall reaction: 16

$$C_2H_5OH + aO_2 + bNH_3 \longrightarrow cCH_{1.704}N_{0.149}O_{0.408} + dCO_2 + eH_2O$$

 (i) Determine the coefficients a, b, c, d and e where R.Q = 0.66
 (ii) Determine the biomass yield coefficient and oxygen yield coefficient