

- b) Crude oil of density 840 kg/m^3 is pumped at a rate of 3 l/s through a 52 mm inner diameter steel pipe under a pressure drops of 550 kPa over a length of 600 m . Calculate the Fanning friction factor using the Hagen-Poiseuille equation. 7 CO2 [K4]
23. a) Water is flowing at a rate of $500 \text{ cm}^3/\text{s}$ through an orifice of 25 mm diameter installed in a 75 mm diameter pipe. What will be the difference in the level on a mercury manometer connected across the meter? The coefficient of orifice meter is 0.65 . 7 CO3 [K4]
- b) Demonstrate the working principle of centrifugal pump with a neat diagram. 7 CO3 [K4]
24. a) A dolomite mixture having the following screen analysis is screened through a standard 100 mesh screen. Calculate the effectiveness of the screen and the mass ratios of overflow and underflow to feed. Work index of limestone = 12.74 . Screen analysis data below: 7 CO4 [K5]

Mesh	35	48	65	100	150	200	-200
Feed	7.07	16.60	14.02	11.82	9.07	7.62	33.80
Oversize	13.67	32.09	27.12	20.70	4.35	2.07	0.00
Undersize(wt%)	0.00	0.00	0.00	2.32	14.32	13.34	70.02

- b) What will be the power required to crush 150 tonnes per hour of limestone if 80 percent of the feed passes 50 mm screen and 80 percent of the product a 3.125 mm screen? 7 CO4 [K5]
25. a) A batch bioreactor is to be scaled up from 10 to 10000 liters. The diameter of the large bioreactor is 10 times that of the small bioreactor. The agitator speed in the small bioreactor is 450 rpm . Determine the agitator speed (rpm) of the large bioreactor with same impeller tip speed as that of the small bioreactor. 7 CO5 [K3]
- b) Explain the purposes of agitating of liquids and illustrate the classification of impeller types. 7 CO5 [K3]
26. a) What is the terminal velocity in m/s , calculated from Stokes law, for a particle of diameter $0.1 \times 10^{-3} \text{ m}$, density 21800 kg/m^3 settling in water of density 1000 kg/m^3 and viscosity 10^{-3} kg/m s ? (Assume $g = 10 \text{ m/s}^2$). 7 CO6 [K3]
- b) Volumetric flow rate during constant pressure filtration is 7 CO6 [K5]

$$\frac{dV}{dt} = \frac{1}{K_c V + 1/q_0}$$

Where V is the total volume of filtrate collected in time t , q_0 and K_c are constants.

Given $V = 1.0$ litre at $t = 41.3 \text{ s}$ and $V = 2.0$ litre at $t = 108.3 \text{ s}$, Integrate the above equation and evaluate K_c and q_0 .
