**BACHELOR OF CHEMICAL ENGINEERING SUPPLEMENTARY EXAM. 2018 (OLD)**
(3$^{rd}$ Year, 1$^{st}$ Semester)
Mechanical Operations
**Full Marks: 100**
Answer any _four (4)_
Assume any **missing** data

1. a) Through washing is more effective than simple washing in a plate and frame filter press. Explain the reason with a clear schematic diagram of filtration and washing stages in a plate and frame press.

    b) A slurry containing 0.2 kg of solid (specific gravity 3.0) per kilogram of water, is fed to a rotary drum filter 0.6m long and 0.6m diameter. The drum rotates at one revolution in 6 min and 20% of filtering surface is in contact with the slurry at any instant. If a filtrate is produced at the rate of 0.45 t/hr and cake has voidage of 0.5, what thickness of cake is produced when filtering with a pressure difference of 65 KN/m$^2$?
    The rotary filter breaks down and the operation has to be carried out temporarily in a plate and frame press with frames 0.3 m square. The press takes 2 min to dismantle and 2 min to reassemble and in addition 2 min is required to remove the cake from each frame. If filtration is to be carried out at same overall rate as before, with an operating pressure difference of 175 KN/m$^2$, what is the minimum no. of frames that needs to be used and what is the thickness of each? Assume cakes to be incompressible and neglect the resistance of filter media.

    5+20

2. a) Describe the working principle of Blake type jaw crusher.
   b) One method for preventing choke feeding is use of close-circuit grinding. Discuss.
   c) Show that for an unbaffled mixing tank, power number ($N_{PO}$) is function of vessel Reynolds Number ($N_{Re}$) and Froude Number ($N_{Fr}$).
   d) What are the factors on which the performance of ball mill depends?

    5+4+12+4

3. a) A mixture of an ore (specific gravity = 2.0) and the gangue (specific gravity = 7.0) has to be separated in a hydraulic free settling elutriator. If the mixture has the following size distribution (valid for both ore and gangue) and a relation $C_D = 18.5/ (N_{ReP}^{0.6})$ is valid for the flow zone under consideration, estimate the upward velocity of hydraulic water to be used in the elutriator so that the entire ore is collected in the overflow. Will the overflow be gangue-free?

   | Particle size (mm) | Mass fraction |
   | --- | --- |
   | -0.58+0.49 | 0.62 |
   | -0.49+0.40 | 0.21 |
   | -0.40+0.36 | 0.17 |

b) Discuss 'settling ratio' of the particles when the settling occurs either in laminar zone or in turbulent zone. Discuss the range of values of 'settling ratio' required for separation.

c) What are the needs of use draft tubes in an agitator and mixer?

d) Consider two spherical particles that have the same outer diameter but are made of different materials. The first one is a solid sphere but second one is a hollow sphere with inner shell diameter equal to half the outer diameter. If both spheres have the same terminal velocity in any fluid, then determine the ratio of their densities.

10+ 5 +3+7

4. a) When aqueous slurry is filtered in a plate and frame press, fitted with 50 mm thick frames each 150 mm square, operating with a pressure difference of 450 KN/m², the frames are filled in 3600 sec. The filtration unit has four plates. How long will it take to produce the same volume of filtrate as is obtained from a single cycle of plate & frame operation when using a centrifuge with a perforated basket, 300 mm diameter and 200 mm deep? The radius of inner surface of the slurry is maintained constant at 75 mm and speed of rotation is 65 Hz.

It may be assumed that the filter cake is incompressible, that the resistance of the cloth is equivalent to 3 mm of cake in both cases, and that the liquid in the slurry has the same density as water.

b) What are the basic differences between axial flow and radial flow impellers?

c) What are the advantages of cumulative screen analysis over differential screen analysis?

20+3+2

5. a) A centrifugal pump is situated 12.5 m vertically above the surface of liquid toluene in a tank which is open to atmosphere and at $30^0$ C. Show that even if primed, the pump could not lift liquid toluene from the tank under this condition.

If the minimum NPSH of the pump is 0.65 m of water under this condition and inside pipe diameter is 2.3 cm, calculate the maximum height at which the pump could be located above the toluene surface to deliver the liquid at 0.002 m³/sec after priming, without risk of cavitation and if the suction pipe just dipped into the toluene in the tank. The pipe may be considered smooth.

Saturated vapour pressure of toluene at $30^0$ C: 4.535 kPa

Density of toluene at $30^0$ C: 867 kg/m³· Viscosity of toluene at $30^0$ C: 5.26x10⁻⁴ kg/m-s

For turbulent flow in smooth pipe, $f = 0.0390 \times N_{Re}^{-0.25}$

b) Distinguish between
   i) Classification and jigging
   ii) Free settling and hindered settling
   iii) Frothers and collectors used in froth floatation cell

10+15