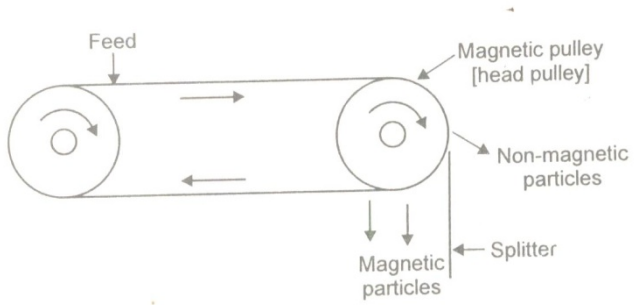
WINTER-15 EXAMINATION

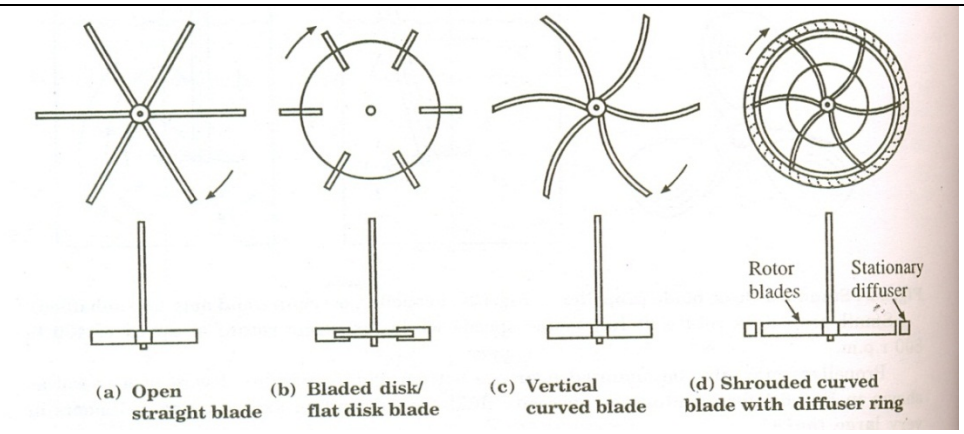
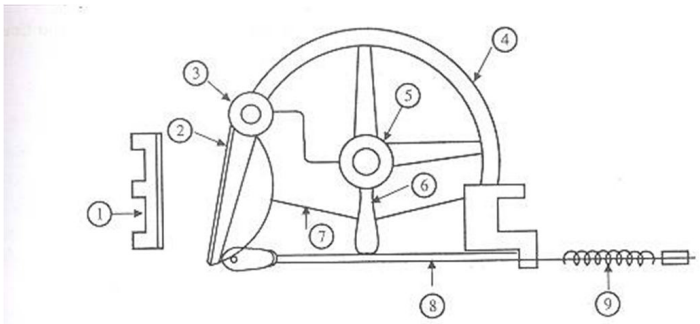
Model Answer

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

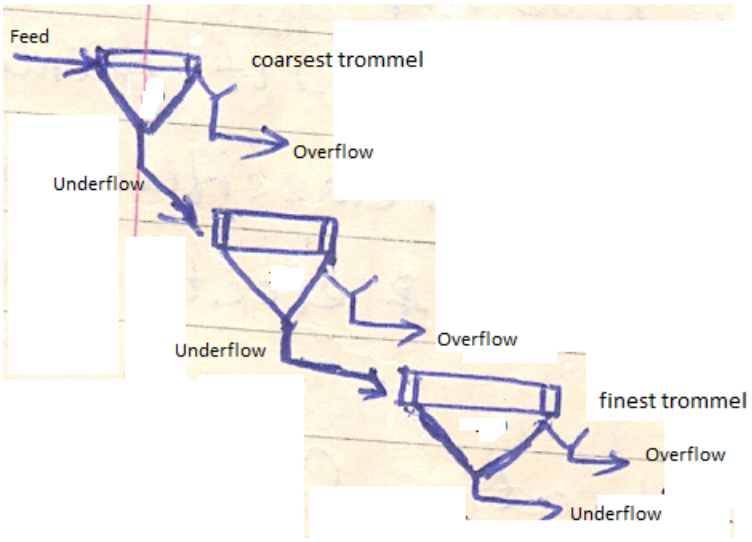
Q No.	Answer	marks	Total marks
1A	**Solve any SIX of the following**		**12**
1A-a	**Kick's law:** Kick's law states that the work required for crushing a given mass of material is the log of ratio of initial particle size to final particle size. $\frac{P}{\dot{m}} = K_k \ln \frac{\bar{D}_{sa}}{\bar{D}_{sb}}$	2	2
1A-b	**Work index** Work index is defined as the gross energy requirement in KWH/ ton of feed needed to reducevery large feed to such a size that 80% of the product passes a 100µm screen **Mathematical expression** $\frac{P}{\dot{m}} = 0.3162\ W_i \left(\frac{1}{\sqrt{\bar{D}_{pb}}} - \frac{1}{\sqrt{\bar{D}_{pa}}}\right)$ Where P is the power required in KW $\dot{m}$ is the mass flow rate in tons/ hr W_i is the work index $\bar{D}_{pb}$ and $\bar{D}_{pa}$ are the diameter of the product and feed Respectively in mm	1 1	
1A-c	**Mesh:** It is the number of openings per linear inch counting from the center of any wire to a point exactly one inch distant. **Screen aperture**: Minimum clear space between edges of openings in the screening surface is termed as screen aperture.	1 1	2
1A-d	**Classification of screens on the basis of performance:**	2	2

	On the basis of performance, screens are classified in to ideal screens and actual screens.		
1A-e	**Importance of mixing in process industries.** 1. To promote a chemical reaction . 2. To produce simple physical mixtures 3. To carry out physical change 4. To accomplish dispersion to produce two or more immiscible fluids or disperse one or more fluids with finely divided solids.	1 mark each for any two	2
1A-f	**Classification:** It is the separation of solid particles (from a slurry) into several fractions based on terminal settling velocities.	2	2
1A-g	**Diagram of magnetic head pulley.** 	2	2
1A-h	**Sketches of turbine impellers: (Any two)**	1 mark each	2

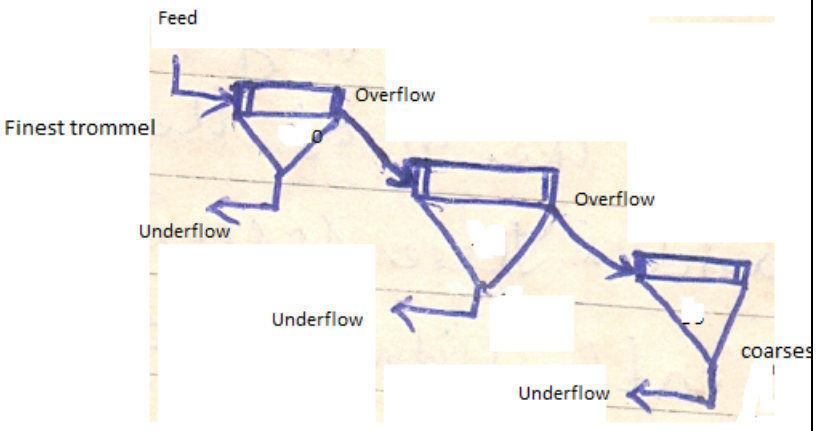
	 (a) Open straight blade (b) Bladed disk/ flat disk blade (c) Vertical curved blade (d) Shrouded curved blade with diffuser ring		
1B	**Solve any TWO of the following**		**8**
1B-a	**Jaw crusher:** **Diagram**  (1) Fixed jaw, (2) Movable jaw, (3) Shaft, (4) Fly wheel, (5) Eccentric, (6) Pitman, (7) Toggle, (8) Tie rod, (9) Spring **Construction:** It has a fixed & movable jaw pivoted at top.Both jaws form V- opening at the top.Movable jaw reciprocates horizontally, making angle of 20-30^0 with fixed jaw.Material of construction of the jaws are Manganese steel or other to withstand abrasion.Faces of jaws are corrugated to concentrate the pressure on small areas.Eccentric causes the pitman to oscillate in a vertical direction & this movement is communicated horizontally to movable jaw by the toggles. As crushing action is intermittent,the loading is uneven,therefore crusher has a	2 2	4

	heavy flywheel.One of the toggles is made weakest, by making it into two pieces, held together by bolts.If any hard material enters, the bolts shear through & allow the movable jaw to drop back far enough to discharge the obstacle.		
1B-b	Diameter of ball mill = 1000 mm = 1 m Diameter of ball = 80 mm = 0.080 m Cririal speed of ball mill (Nc) $Nc = \frac{1}{2\pi}\sqrt{\frac{g}{R-r}}$ $g = 9.81\ m/s^2$ R= 1 /2 m = 0.5 m r = 0.080 / 2 = 0.040 m $Nc = \frac{1}{2\pi}\sqrt{\frac{9.81}{0.5 - 0.040}}$ Nc =0.7353r.p.s.= 0.7353 x 60 = 44.12r.p.m. Assume operating speed is 50% of critical speed. Operating speed = 44.12 x 0.5 = **23.33 rpm** ***(Operating speed can be 50 -75% of critical speed. So due consideration should be given for proper assumption*)**	1 2 1	4
1B-c	**Factors affecting performance of screen.** 1)Method of feeding Particles should approach the screening surface in a direction parallel to the longitudinal axis (perpendicular) of the screen. Particles should be fed at as low velocity as possible. 2)Screen slope As the slope increases, the rate at which the materials travels over the screening	1 mark each for any 4 points	4

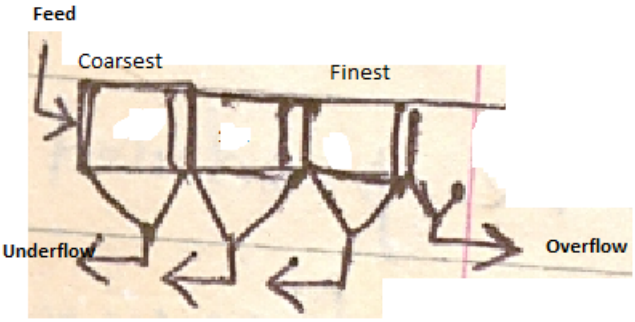
	surface increases thereby reducing bed thickness and allowing the fines to come in contact with the screening surface. But if the slope is increased too much, the material will travel down the screen very fast without getting properly screened 3)Screening Surface Material should be spread evenly on the full screening surface so that all particles will come in contact with the screening surface 4)Vibration amplitude &frequency Proper amplitude of vibration is selected to prevent binding of screen. 5) Moisture in the feed Moisture in the feed adversely affects screening operation & shouldbe removed.		
2	**Solve any FOUR of the following**		**16**
2-a	$\frac{P}{\dot{m}} = 0.3162\ W_i \left(\frac{1}{\sqrt{\bar{D}_{pb}}} - \frac{1}{\sqrt{\bar{D}_{pa}}}\right)$ P = 270 KW $\dot{m}$ = 150 tons/ hr $\bar{D}_{pa}$ = 50mm $\bar{D}_{pb}$ = 3mm $\frac{P}{\dot{m}} = 0.3162\ W_i \left(\frac{1}{\sqrt{\bar{D}_{pb}}} - \frac{1}{\sqrt{\bar{D}_{pa}}}\right)$ $\frac{270}{150} = 0.3162\ W_i \left(\frac{1}{\sqrt{3}} - \frac{1}{\sqrt{50}}\right)$ W_i = **13.06**	1 2 1	4
2-b	**Four arrangements of trommel** (a) Coarsest trommel first	1 mark each	4

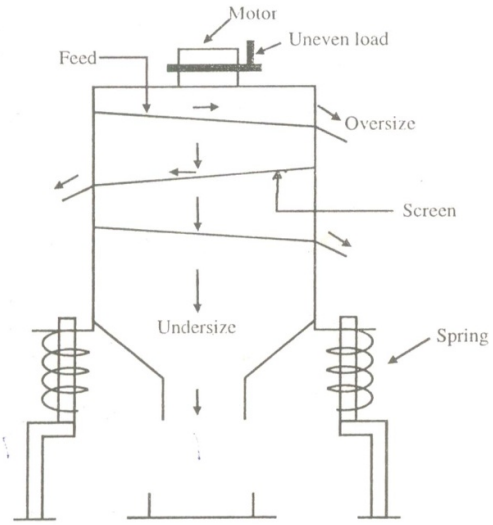
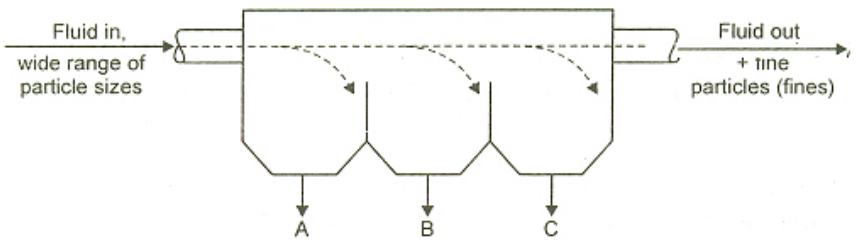


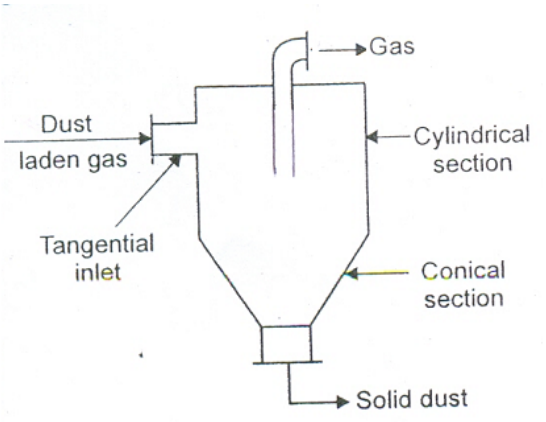
(b) Finest trommel first



(c) Single trommel with different perforations

	 d) Different size screen on concentric trommels. 		
2-c	**Vibrating screen** **Construction :**Generally the screens are provided with one deck, two & maximum three decks, with the coarsest screen at the top ,either horizontally or inclined up to 45^0 .Each screen is provided with a separate over flow. The undersize material from the last screen is collected from bottom. Due to inclination to screen,the oversize material travels along the screen.	2	4

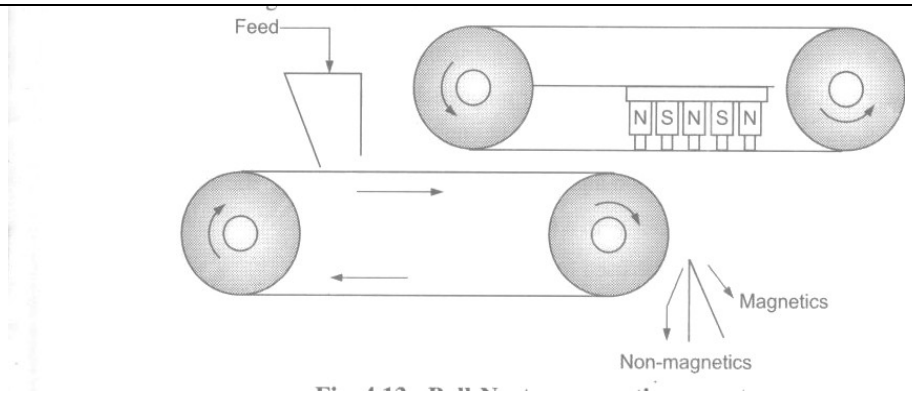
	 **Working:** The screens are vibrated mechanically or electrically with a frequency of 1800 to 3600 per minute.Mechanical vibrations are transmitted from the high speed eccentrics to casing & from there to screens so that the whole assembly is vibrated. In electrically vibrated screens, vibrations are transmitted from heavy duty solenoids directly to the screens.	2	
2-d	**Gravity settling tank**  A = Coarse particles B = Intermediate particles C = Small particles	.4	4

	It works on the principle of classification. It consists of a large tank with provisions for inlet and outlet. As soon as the slurry feed enters the tank through the inlet, its velocity decreases. The particle will settle under the influence of gravity. Large particles which have high terminal settling velocity settles first and they will be collected near the feed end. Intermediate particles will then settle and finally fine particles will settle. Very fine particles will be carried away by the flowing stream to the outlet.		
2-e	**Cyclone separator:** **Diagram**  **Construction:** It has a top cylindrical section and a lower conical section. Top vertical section is covered by a flat plate and has a tangential inlet at the top. A downward extending pipe is provided for the removal of fluids(gases). An outlet is provided at the bottom of the conical section for the removal of solids.	2 2	4
2-f	**Difference between constant rate filtration and constant pressure filtration** Constant rate filtration | Constant pressure filtration	1 mark each	4

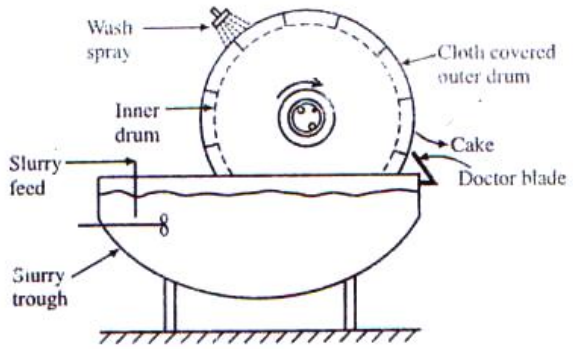
	1.Rate of filtration is maintained constant	1. Rate of filtration varies		
	2. pressure drop is varying	2. Pressure drop is constant		
	3.Starts with low inlet pressure and continuously increasing the pressure to overcome the resistance of the cake	3. High inlet pressure is applied which is maintained throughout.		
	4. The first particles filtered will not be compacted into a tight mass.	4. The first particles filtered will be compacted into a tight mass due to the high initial pressure applied.		
3	**Solve any FOUR of the following**			16
3-a	**Fluid energy mill**: Principle of operation: attrition It consists of a flat horizontal cylindrical chamber with tangentially arranged jet nozzles in the inner wall. The energy for grinding is supplied by a compressed air or nitrogen gas. The compressed air issuing through the nozzles forms a very high velocity tangential circle within the grinding chamber. The feed is fed into the same tangential circle through a venture feeder. The material gets rapidly accelerated, causing it to impact against itself, hence breaking of the particles to the micron range. The larger particles are held towards the outer periphery of the chamber by centrifugal force, while smaller particles travel in a spiral movement towards the central outlet for exit into a cyclone below for bottom discharge. It can handle powders having an initial size from 150 microns & can handle up to one micron. The materials that can be processed include food products,antibiotics,pigments,dyes & pigments.		4	4

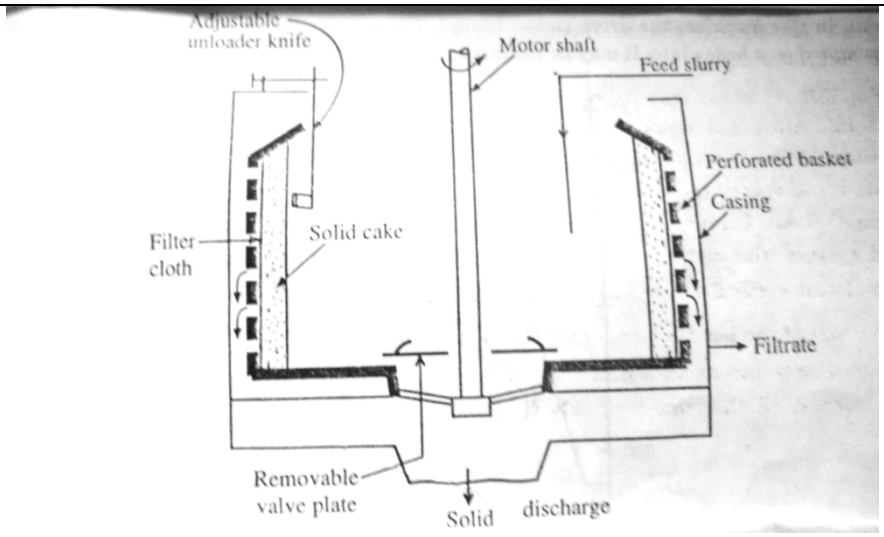
3-b	**Overall effectiveness of a screen:** Let feed consists of material A &Where A is the oversize & B is the undersize material. Let *F*, *D*, and *B* be the mass flow rates of feed, overflow, and underflow, respectively, and x_F, x_D, and x_B be the mass fractions of material A in the streams. The mass fractions of material B in the feed, overflow, and underflow are 1- x_F, 1- x_D, and 1- x_B. Overall material balance: Feed = Overflow + Underflow $F = D + B$ *eq. 1* *Material balance of A over a screen* $Fx_F = Dx_D + Bx_B$ *eq.2* *As F-B = D* *eq.3* *Putting value of D from eq.3 into eq.2,we get* $Fx_F = (F-B)x_D + Bx_B$ $Fx_F = Fx_D - Bx_D + Bx_B$ $(x_D - x_F)F = (x_D - x_B)B$ $\frac{B}{F} = \frac{x_D - x_F}{x_D - x_B}$ Elimination of *B* from the above equations gives $\frac{D}{F} = \frac{x_F - x_B}{x_D - x_B}$ Screen effectivenessbased on the oversize, E_A $E_A = \frac{Dx_D}{Fx_F}$ where is the screen effectiveness. Similarly, an effectiveness E_B based on the	1 1	4

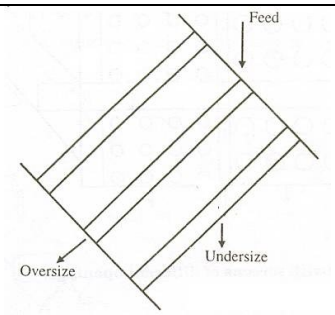
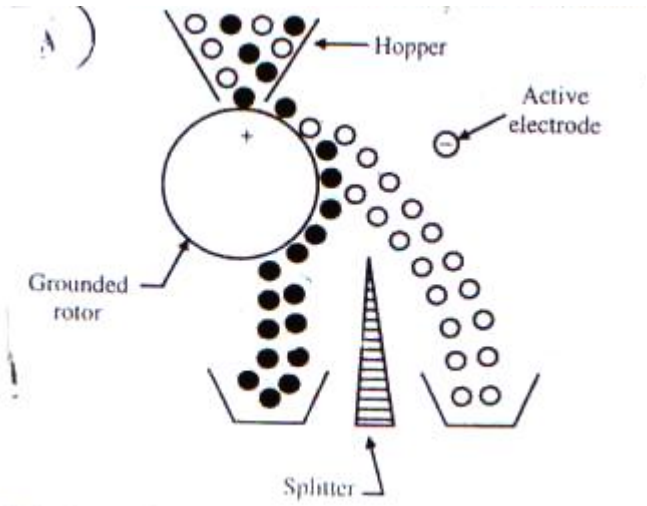
	Effectiveness E_B based on the undersize materials is given by $E_B = \frac{B(1-x_B)}{F(1-x_F)}$ A combined overall effectiveness can be defined as the product of the two individual ratios. $E = E_A E_B = \frac{(x_F - x_B)(x_D - x_F)x_D(1-x_B)}{(x_D - x_B)^2(1-x_F)x_F}$	1 1	
3-c	**Ball –Norton Machine**: It is used for separating magnetic ores from the associated mineral matter. **Construction:** It consists of two horizontally staggered belt conveyors running parallel, one above the other .A hopper is provided for feeding the feed to the lower belt & a stationary magnet assembly is incorporated in the upper belt conveyor near the discharge end. **Working:** The material to be separated is fed to the lower belt in the form of a thin sheet & is conveyed under the second belt where it is subjected to a magnetic field. The non-magnetic material is discharged in the normal manner, whereas the magnetic material adheres to the lower side of the upper belt & thus carried some distance away from the discharge point of nonmagnetic materials. It ultimately drops-off the belt in to the separate compartment when the belt loses the contact of magnet assembly.	2 2	4

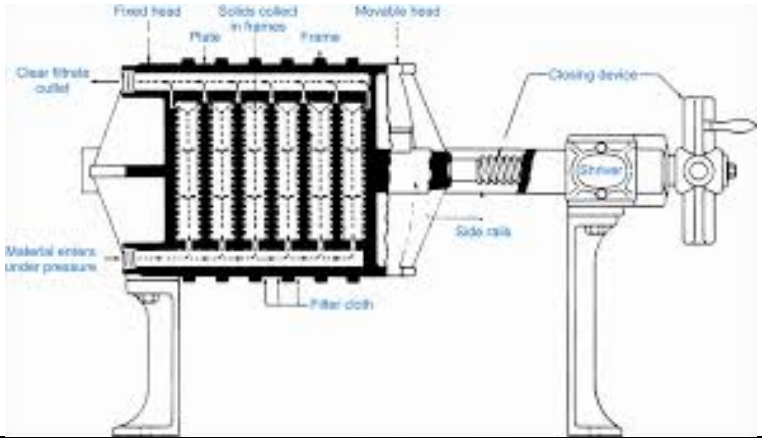
	 Ball –Norton Machine		
3-d	**Expression for batch filter for constant pressure filtration:** As the equation for overall pressure drop is ΔP = Pressure drops over filter medium & cake ΔP = ΔPc + ΔPm eq.I The differential rate of filtration per unit area of filtering surface (which is the ratio of pressure drop to the product of viscosity of filtrate & the sum of cake resistance & filter medium resistance) is as follows $\frac{dt}{dV} = \frac{\mu}{A.\Delta P}\left[\frac{c\alpha V}{A} + R_m\right]$ $eq.2$ Where $\alpha = specific\ cake\ resistance$ $\mu = viscosity\ of\ filtrate$ $A = Area\ of\ filter\ surface$ C =mass of particles deposited For constant pressure filtration :$\Delta P = 0$, V & t are variables. When t = 0 ,V = 0 &$\Delta P = \Delta Pm$ The eq.II can be written as $\frac{\mu R_m}{A.\Delta P} = \left(\frac{dt}{dV}\right)_0 = \frac{1}{q_0}$	1 1	4

	The eq.II can be rewritten as $$\frac{dt}{dV} = \frac{\mu\alpha cV}{A^2.\Delta P} + \frac{\mu R_m}{A.\Delta P}$$ $\frac{dt}{dV} = \frac{1}{q} = K_c . V + \frac{1}{q_0}$ eq 3 Where $K_c = \frac{\mu\alpha cV}{A^2.\Delta P}$ Integrating eq.III between limits t= 0 ,V= 0 and t=t , V = V $$\int_0^t dt = \int_0^V \left(K_c V + \frac{1}{q_0}\right) dV$$ $$t = \frac{K_c V^2}{2} + \frac{V}{q_0} \quad eq.4$$ Rearranging eq.4 $$\frac{t}{V} = \frac{K_c}{2} V + \frac{1}{q_0}$$	1 1	
3-e	**Rotary drum Filter**: **Working:** Filter drum is immersed in slurry, vacuum applied to filter medium causes cake to deposit on outer surface of drum. Cake is washed by spraying wash liquid; wash liquid is collected in a separate tank. Then cake enters into drying zone as drum rotates where cake is partially dried by sucking air through cake of solids. Then vacuum is cut off & cake removed with a doctor's knife. Air blown for removal of cake. **Diagram**	2	4

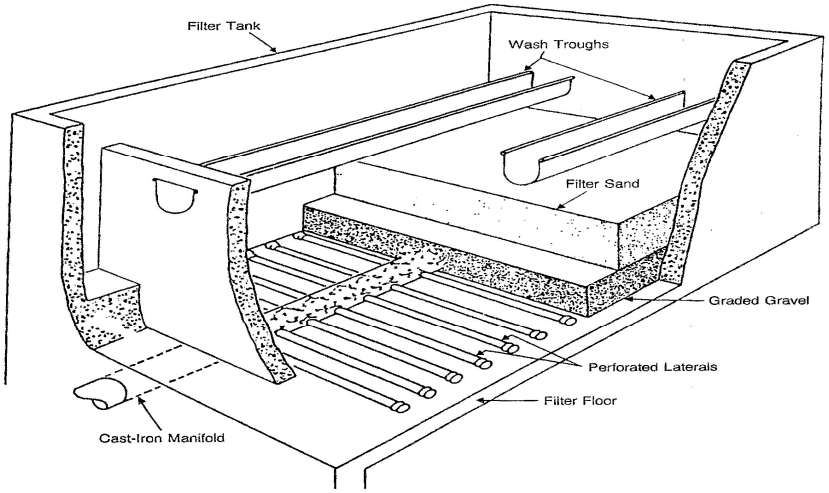
		2	
3-f	**Batch Centrifuge**: A centrifuge is any rotating machine in which centrifugal force is utilized for phase separation. **Construction** :the components of a centrifuge are| 1)a rotor or bowl in which centrifugal force is applied to the contents of bowl 2)a drive shaft 3) a drive mechanism(electric motor) 4) a frame for support 5) a casing It consists of a basket (dia.750 to 1200 mm, depth 450 to 750mm) with perforated sides. Basket rotates at speeds between 600 to 1800 rpm .basket is held at lower end of a free moving vertical shaft., driven by electric motor .A filter medium is placed around the inside surface of the basket sides .casing is provided around basket with a filtrate discharge connection at bottom. Material of construction is mild steel,monel, stainless steel,lined by lead,rubber.	2	4

		2	
4	**Solve any FOUR of the following**		**12**
4A-a	**Equipment for coarse Screening of large lumps :**Grizzly screen Construction: A grizzly is a grid of parallel metal bars set in an inclined stationary frame, with a slope of 30 to450 . The slope & path of the material is parallel to the length of the bars. The length of bar is up to 3 m & spacing between the bars is 50 to 200mm. The material of construction of the bars is Manganese steel to reduce wear. Usually the bar is shaped in such a way that its top is wider than the bottom, & hence the bars can be made fairly deep for strength without being choked by material passing through them. The course feed is fed at the upper end of the grizzly. Large chunks roll & slide to lower end ,while small lumps of small size less than the opening in the bar fall through the grid into a separate collector. If angle of inclination is more, more will be the output, but lower is the screen efficiency.	4	4

			
4A-b	**Electrostatic Separator**: Principle :It is the method of separation of solid particles based on differential attraction or repulsion of charged particles under the influence of an electric field. Construction: It consists of rotating drum, a hopper for feed, an active electrode & collecting bin Working: The charged particles fed on drum from hopper. Conductive particles assume potential of drum, opposite to that of active electrode, hence attracted towards active electrode.Non-conductive particles get repelled by electrode ,attracted by drum,falls straight in collecting bin due to gravity.  Electrostatic separator	2 2	4

4A-c	**Plate &frame filter press**: **Construction**:Alternate arrangement of plates &frames, supported on a pair of rail. Plate: solid piece with a ribbed surface. Frame: hollow from inside, provides space for cake. Alternate arrangement of plates & frames results in formation of chambers. Shapes of plates & frames: square or rectangular Material of construction: Stainless steel,nickel,aluminium,monel ,hard rubber or plastics(polypropylene).Coated materials (rubber or lead or epoxy resin covered) are also used. Filter cloths are placed over each plate to cover the plate surface on boyh sides so hollow frame is separated from plate by filter cloth.Theplates ,frames& filter cloths have circular holes on corners for feed &discharge. Filter cloths act as gaskets.When the press is closed,a continuous channel is formed along the whole length of the press out of the corner holes in the frames,plates&cloths.Frames have openings in interior from the corner holes so that slurry channels opens into interior of frame. At the bottom of the plates, holes are cored which connect the faces of plates to the outlet cocks.  	2 2	4

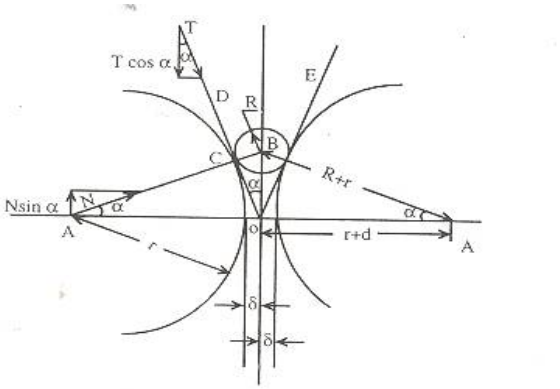
4A-d	**Classification of Industrial cake filters**: 1)Batch pressure filters : Eg.Plate& frame filter press,Pressure leaf filters 2) Continuous pressure filters: Eg.Pressure filter-thickener,Rotary pressure filters 3)Batch vacuum filters: Eg.Vacuumnutsches,Vacuum leaf filters 4) Continuous vacuum filters :Eg. Rotary drum filters,Vacuumprecoat filters 5) Centrifugal filters(Batch & Continuous) :Eg.Suspended basket centrifuge, Continuous filtering centrifugals	4	4
4A-e	**Rapid sand Filter**.: Water to be filtered is introduced from the top,it passes down ward through the filter bed.During the flow the suspended impurities get trapped in the bed & almost clean water leaves from the bottom. The filter bed is cleaned periodically by backwashing.During backwashing with water ,the upward flow carries deposited floc with it.Rapid sand filters use relatively coarse sand and other granular media to remove particles and impurities that have been trapped in a floc through the use of flocculation chemicals—typically salts of aluminium or iron. Advantages: • Much higher flow rate than a slow sand filter; about 150 to 200 million gallons of water per acre per day. • Requires relatively small land area. • Less sensitive to changes in raw water quality, e.g. turbidity. • Requires less quantity of sand.	4	4

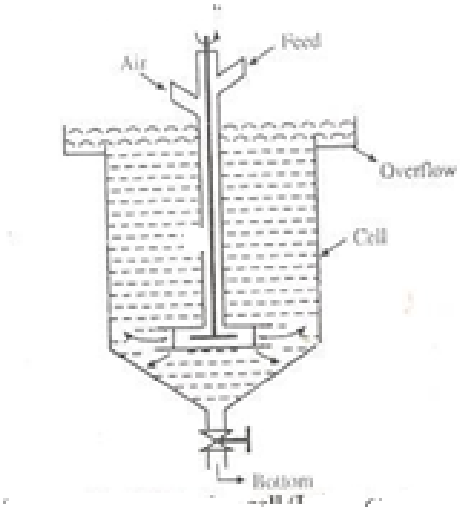


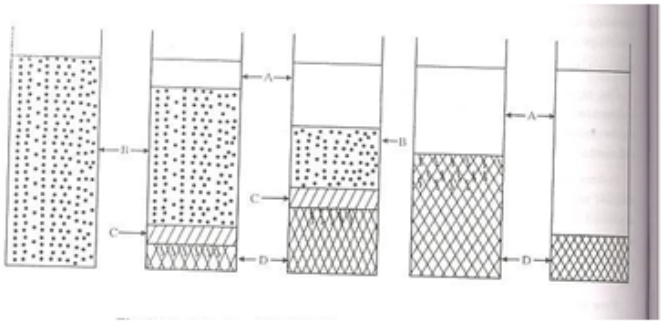
4A-f **Differentiation of Sedimentation & Centrifugation** — 1 mark each — 4

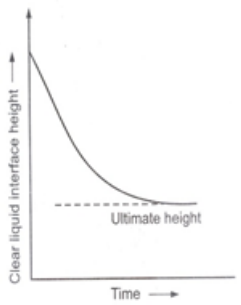
Basis	Sedimentation	Centrifugation
Principle	Separation of solids from suspension in liquids by gravity settling	Separation of immiscible liquids or solids from liquids by application of centrifugal force
Application	Water treatment	Sugar refining
Magnitude of driving force	Very less force of gravity & slow separation	very high centrifugal force & faster separation
Equipments used	Dorr thickener	Basket centrifuge

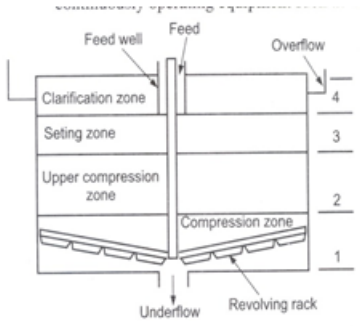
5 Solve any TWO of the following — **16**

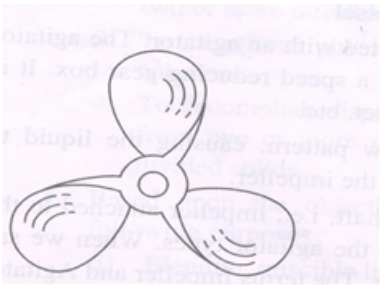
5-a	**Derivation for angle of nip:** Consider a feed particle B caught between the rolls as shown in figure  Let A and A□be the centre of the 2 rolls. C and C□ are the points where the particle is in contact with left hand roll and right hand roll respectively. Let the angle between line AB and AA□ be α. Line OD and OE are tangents to the rolls. Neglecting the force of gravity, the two forces acting at the point C are vertical component of tangential force and vertical component of radial force. Vertical component of tangential force = T cos α Vertical component of radial force = Nsin α. The vertical components of forces T and N are opposed. Force Nsinα tends to expel the particle from the rolls and force Tcosα tends to draw the particle between the rolls. If the particle is to be drawn between the rolls and crushed, Tcosα ≥ Nsinα T and N are related through T= μN μNcosα ≥ Nsinα μ ≥ tanα Let R be the radius of the feed particle, r the radius of the roll and 2d the distance between the rolls. Then in triangle ABO, the angle BAO is α,AO is	2 4	8

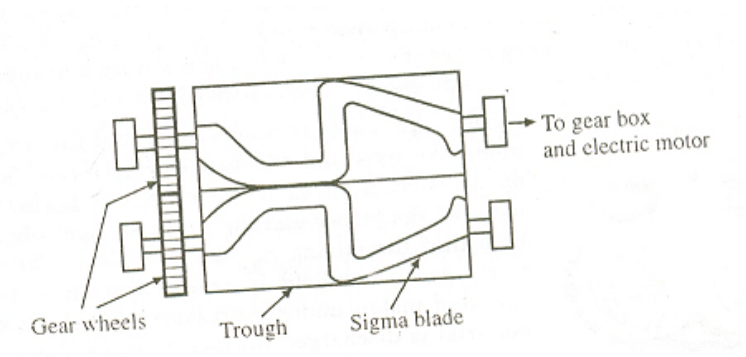
	r+dand AB is r+R.Then ,from the simple geometry of figure $\cos\alpha = \frac{r+d}{r+R}$ Where, α=angle of nip	2	
5-b	**Froth floatation** **Principle:** Floatation refers to an operation in which one solid is separated from another by floating one of them at or on the liquid surfaces. Separation of a mixture of solids using Froth flotation methods depends on the difference in surface properties of the materials involved. **Diagram:**  **Construction:** 1.The mechanically agitated cell consists of a tank having square or circular cross-section. 2.It is provided with an agitator which violently agitates the pulp.	2 2 2	8

	3.The air from a compressor is introduced into the system through a downpipe surrounding the impeller shaft. 4.The bottom of the tank is conical and is provided with a discharge for tailing. An overflow is provided at the top for mineralized froth removal. **Working:** 1. Water is taken into the cell; material is feed to the cell. 2. The promoters and frothers are added. 3. Agitations are given and air is bubbled in the form of fine bubbles. 4. Air-avid particles due to reduction in their effective density, will rise to the surface and be held in the froth before they are discharged from the overflow **5.** Hydrophilic particles will sink to the bottom and removed from the discharge for tailing.	2	
5-c	**Laboratory test for Batch Sedimentation:**  1.The mechanism of settling may be described by batch settling test in glass cylinder in laboratory. 2. As shown in figure, cylinder containing newly prepared slurry of a uniform concentration of uniform solid particles through. 3. As soon as the process starts, all the particles begin to settle and are believed	2	8

	to approach rapidly terminal settling velocities under hindered settling condition 4. Various zones of concentration then are established. The heavier faster settling particles settled at the bottom of glass cylinder are indicated by Zone D. 5. Above zone D forms another layer, called zone C ,a region of variable size distribution and non-uniform concentration. 6. The boundary between C and D is usually obscure and is marked by vertical channels through which fluid is rising from the lower zone D as it compresses. 7. Above zone C is zone B, which is a zone of uniform concentration of approximately the same concentration as that of original pulp. 8. Above the zone B is zone A, which is a zone of clear liquid. if original slurry is closed sized with respect to smallest particles, the boundary between A and B is Sharp.  **Graph showing the settling zones in a continuous thickener:**	4	

		2	
6	**Solve any FOUR of the following**		**16**
6-a	**Vacuum Filters:** **Advantages:** 1)These filters can be designed as effective continuous filters. 2) Low labourrequriment. 3) The filterating surface is easily accessible for inspection and repair as it can open to the atmosphere. 4) Low maintenance costs. **Disadvantages:** 1) We have to maintain a vacuum system. 2) Not maintain with filtrates that are volatile. 3) These units cannot handle difficulty filterable compressible solids. 4) Continuousevaccum filters are inflexible.	1 mark each for any two points 1 mark each for any two points	4
6-b	**Methods of avoiding vortex in agitated Vessel:** There are four methods of prevention of swirling and vortex formation a. Off-center mounting of the impeller. b. Use of Baffles c. Use of diffuser ring with turbines d. Angular entry of agitators.	1 mark each	4

6-c	**Importance of Propellers:** • A propeller is an axial flow,high speed impeller commonly used for low viscosity liquids. • A propeller is shaped with a tapering blade to minimize the effect of centrifugal force and produce maximum axial flow. • Propeller drives the liquid straight down to the bottom of the vessel,at the bottom the stream spreads radially in all directions towards the wall,then the liquid flows upward along the wall.These agitators are used in situation where strong vertical currents are desired. **Standard 3-blade Propeller:** 	1 mark each for any two points 2	4
6-d	**Mixing index:** It is a measure of the homogeneity of the mixture. ie the degree of uniformity of the mixture. **Formula to calculate mixing index:** **For granular solids** $I_S = \sqrt{\frac{(N-1)\mu(1-\mu)}{n\sum_1^N (x_{i-}\overline{x})^2}}$ Where $I_S$is the mixing index. N is the number of sample. μ is the weight fraction of desired solid in the feed.	2 2	4

	x_i is the weight fraction of desired solid in the sample/ $\bar{x}$ is the $\frac{\varepsilon X_i}{N}$ N is the number of particles in the sample. ***Formula to calculate mixing index for other types of mixtures should also be given consideration***.		
6-e	**Mixer used for mixing stiff masses.** Banbury mixer: It is an internal mixer. Here the agitators are in the form of interrupted spirals. Solids are charged in from above and held in the trough during mixing by an air operated piston under a pressure of 1 to 10 atm. Mixed material is discharged through a sliding door in the bottom of the trough. These mixers are used for compounding rubber, plastic solids, devulcanize rubber scrap etc. ***(Due consideration should be given for any other type of kneading machines)***	4	4
6-f	**Two –arm Kneader :** **Sigma Mixer:** **Diagram**  **Construction:** It consists of a short rectangular trough with saddle shaped bottom. Two counter rotating blades are incorporated in the trough. Blades are so placed and	2 2	4

	so shaped that the material turned up by one blade is immediately turned under adjacent one. The blades are driven by through a gear mechanism provided at either ends. The trough may be open or closed and may be jacketed for heating or cooling. The machine can be emptied through a bottom valve.		