

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

WINTER-12 EXAMINATION

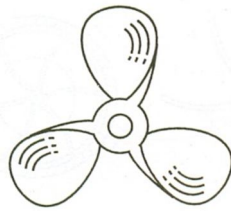
Model Answer

Subject code: Mechanical Operations(12080)

Page No: /

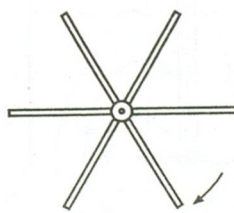
Q no:	Answer	Remark
1.	<b>Attempt any ten</b>	
a	Decantation,filtration,sedimentation,screening,flotation,mixing,size reduction(any four)	½ mark each
b.	Unit operations are classified as mechanical operations, fluid flow operations, mass transfer operations and heat transfer operations	½ mark each
c	Different electromechanical operations are magnetic separation, electrostatic separation, electro-dialysis,electro-osmosis,electrophoresis(any two)	1 mark each
d	Different size reduction operations are crushing, grinding, ultrafine grinding and cutting	½ mark each
e	Jaw crusher, gyratory crusher, crushing rolls.	2 marks
f	In <b>open circuit</b> grinding, the feed material is passed only once through the size reduction machine and no attempt is made to return the oversize material to it for further reduction whereas in <b>closed circuit</b> grinding, the partially ground material from the size reduction machine is sent to the size separation unit, from where undersize is withdrawn as product and oversize material is returned to the machine for regrinding.	2marks
g	Grinders- Hammer mill, rolling compression mill, attrition mill, tumbling mill(any two) Ultra fine grinders- Hammer mills with internal classification,fluid energy mill, agitated mills(any two)	½ mark each
h	An <b>ideal screen</b> is the one which sharply separates the feed mixture in such a way that the smallest particle in the overflow is just larger than the largest particle in the underflow whereas in <b>actual screen</b> the overflow will contain undersize particles and underflow will contain oversize particles	2marks
i.	Grizzlies, trommel, gyratory screen, shaking and vibrating screen	½ mark each
j.	<b>Classification</b> is the separation of particles into several size fractions based upon their terminal settling velocities. <b>Centrifugation</b> is the separation of solid particles from fluids using centrifugal force	1 mark each
k.	<b>Clarifiers</b> are equipments used for settling whereas <b>classifiers</b> are equipments working on the principle of classification	1 mark each

I.

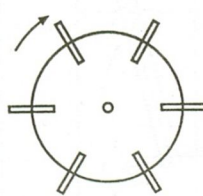


Propeller

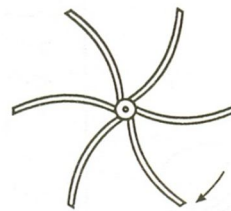
Any 2  
diagram.  
1 mark  
each



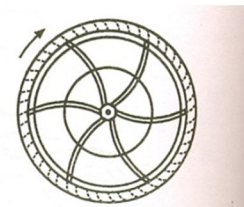
(a) Open  
straight blade



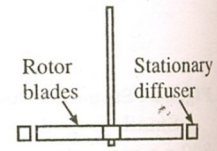
(b) Bladed disk/  
flat disk blade



(c) Vertical  
curved blade



(d) Shrouded curved  
blade with diffuser ring

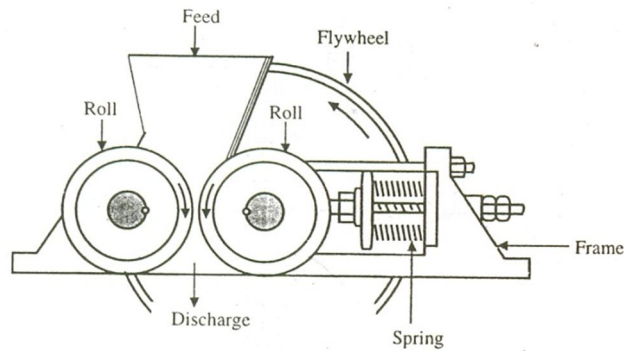


Turbine

OR

<p>2 a.</p>	<div data-bbox="482 235 646 449" data-label="Image"> </div> <p data-bbox="448 506 649 535">(a) Flat paddle</p> <div data-bbox="912 205 1162 459" data-label="Image"> </div> <p data-bbox="943 510 1089 539">(b) Anchor</p> <div data-bbox="331 575 583 823" data-label="Image"> </div> <p data-bbox="384 863 490 892">(c) Gate</p> <div data-bbox="893 579 1159 827" data-label="Image"> </div> <p data-bbox="760 865 1149 894">(d) Combined anchor and gate</p> <p data-bbox="323 942 518 976">Paddle(any one)</p> <p data-bbox="323 1050 535 1083"><b>Attempt any four</b></p> <div data-bbox="368 1121 927 1404" data-label="Diagram"> </div> <p data-bbox="323 1440 1321 1507">Electrodialysis is a form of dialysis in which an electric current aids the separation of substances that ionize in solution.</p> <p data-bbox="323 1514 1377 1686">Sea water can be desalted by this method on a large scale by placing it in the centre chamber of a three compartment container having two semi permeable membranes and a positive electrode in one end chamber and a negative electrode in the other. The ions migrate to their respective electrodes under a difference of potential, leaving the water salt free.</p>	<p data-bbox="1417 1190 1500 1220">1 mark</p> <p data-bbox="1417 1440 1511 1470">3 marks</p>
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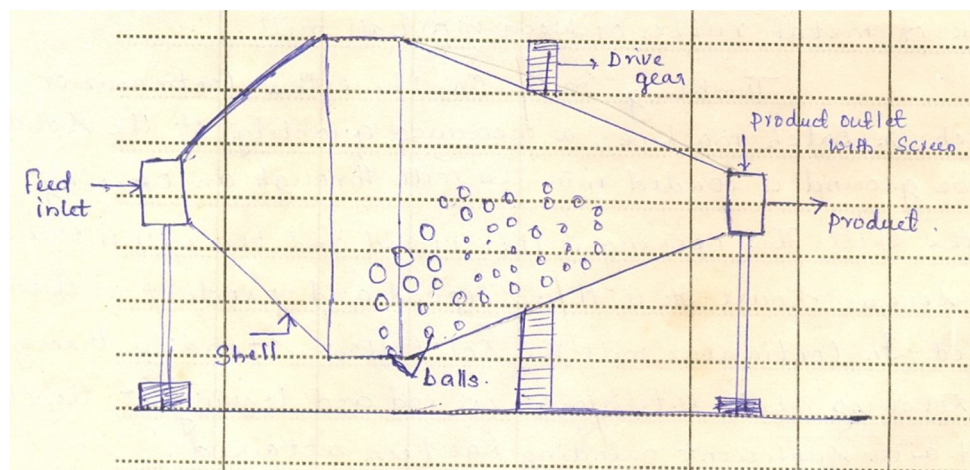
b



Smooth Roll Crusher

2marks  
For neat  
diagram  
2 marks  
for  
labelling

c



Ball Mill

2 marks

Working :

Ball mill works on the principle of impact and attrition. The material to be ground is fed from the left through a  $60^\circ$  cone and the product is discharged through a  $300^\circ$  cone to the right. When the mill is rotating, the balls are picked up by the mill wall and are carried near the top of the mill. The balls then break contact with the wall and drop to the bottom. In doing so, the solid particles are reduced in size by impact. During the upward movement of the balls, centrifugal force keeps the ball in contact with the wall and with each other. At low speeds of operation, the balls simply roll over each other, resulting into little grinding action. If the mill is operated at high speed, the balls will be carried further inside the mill and since the ball falls down from higher distance, greater will be the impact at the bottom. If the mill is operated at very high speed, the balls are carried right round in contact with the sides of the mill and the mill is said to be centrifuging. Little or no grinding takes place when the mill is centrifuging.

2marks

d

#### Differential Analysis

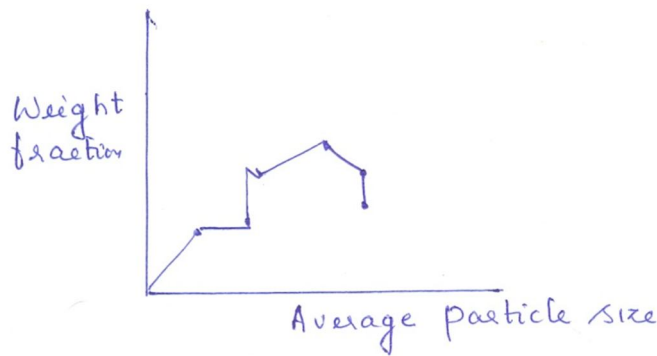
The results of a screen analysis can be reported in a tabular form to show the weight fraction of the material retained on each screen as a function of mesh size. The average

2marks

particle size of the material retained on any particular screen is calculated as the arithmetic mean of two screen openings used to obtain the fraction.

Mesh	Screen opening in microns	Average particle size	Weight fraction retained
6			
8			
10			
14			
48			
100			
120			
pan			

1 mark



1 mark

OR

#### Cumulative analysis

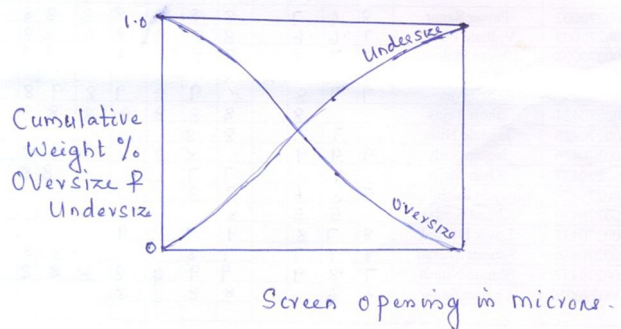
The cumulative analysis of fraction retained (oversize) is obtained by adding cumulatively, the individual weight fractions of material retained on each screen, starting with that retained on the largest mesh and tabulating or plotting the cumulative sums against the screen opening of the retaining screen.

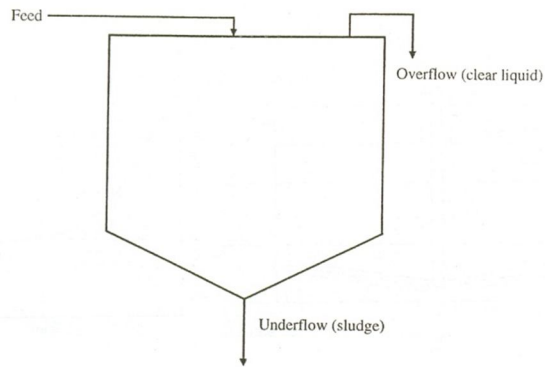
2 marks

$$\theta = \theta_1 + \theta_2 + \dots + \theta_{N_T} = \sum_{N=1}^{N_T} \theta_N$$

Where  $\theta_1, \theta_2, \dots$  are the weight fractions of material retained on screens 1, 2, ..., numbered serially from the top of the deck

The cumulative analysis is also reported for cumulative weight fraction passing through the screen (undersize)

		Mesh	Screen opening in microns	Weight fraction retained	Cumulative weight fraction oversize	Cumulative weight fraction undersize		1mark
		6		$\theta_1$	$\theta_1$	$1 - \theta_1$		
		8		$\theta_2$	$\theta_1 + \theta_2$	$1 - (\theta_1 + \theta_2)$		
		10		$\theta_3$	$\theta_1 + \theta_2 + \theta_3$	$1 - (\theta_1 + \theta_2 + \theta_3)$		
		14		.	.	.		
		48		.	.	.		
		100		.	.	.		
		120		.	.	.		
		pan		$\theta_{NT}$	$\theta_1 + \theta_2 + \theta_3 + \dots \theta_{NT}$	0		
								1mark
e		Cyclone separators are used for separating solids from fluids using centrifugal force.						1mark
		<p>The feed enters the cyclone tangentially from the top. Tangential entry gives a spinning motion to the feed stream, whereupon the gas and the suspended particles are thrown towards the wall of the chamber. The particles continue to descend down in a spiraling path, while the gas, free of solids moves upward in the central cone. At high tangential velocity, the centrifugal acceleration is many times greater than the acceleration due to gravity which makes cyclone a more effective separating device. Separation becomes ineffective as the tangential velocity is not enough to overcome the centripetal force of the rotating fluid</p>						3marks
f		<p>Industrially the sedimentation operation is carried out batch wise or continuously in equipment called thickener.</p> <p>A <u>batch thickener</u> usually consists of a cylindrical tank provided with inlet for feed slurry and outlet for product discharge. Bottom of the cylindrical tank is conical. The tank is filled with dilute slurry, and the slurry is allowed to settle. After sedimentation has proceeded for sufficient time, clear liquid is decanted and the thickened sludge is withdrawn from the bottom opening.</p>						3marks

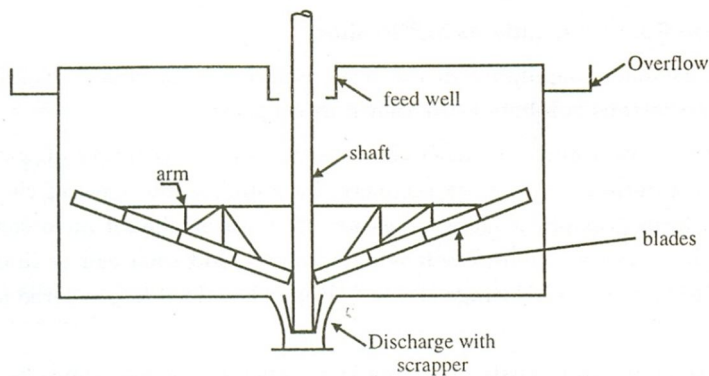


1 mark

OR

A continuous thickener (Dorr thickener) consists of a flat bottomed, large diameter shallow tank. It is provided with slow moving radial rakes driven from a central shaft for removing the sludge. The slurry is fed to the centre of the tank at a depth of 0.3 to 1m below the surface of the liquid, with as little disturbance as possible. The clarified liquid is continuously removed as overflow and the thickened liquid is continuously withdrawn from the bottom. The slowly revolving rakes scrape the sludge towards the centre. Thus the solids are continuously moving downwards to the sludge outlet and the liquid is moving upwards and then outwards.

2 marks



2 marks



3  
a

COURSE CODE:CH3E

SUBJECT: MECHANICAL OPERATIONS(12028)

**Q.3)a)Electrostatic precipitator/separator:**

Principle: method of separation of solid particles, based on differential attraction /repulsion of charged particles under influence of electric field.

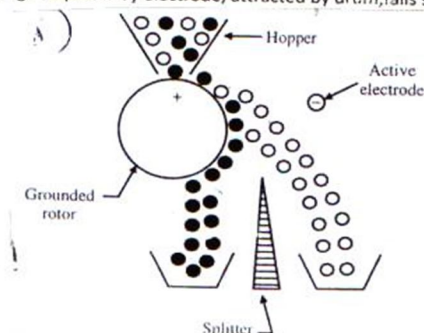
Construction: consists of rotating drum, a hopper for feed ,an active electrode & collecting bin. 1 mark

Working:1)charged/grounded solids are fed on drum from hopper. 1 mark

2)conductive particles assume potential of drum ,opposite to that of active electrode, hence attracted towards active electrode. 1 mark

3)non - conductive particles get repelled by electrode, attracted by drum,falls straight: in collecting bin due to gravity.

Diagram:



1 mark

**Electrostatic separator (separation by conductive**

**b)Rotary vacuum filter :**

Description

3 marks

used for continuous & large scale operations.

Filter drum is immersed in slurry ,vacuum applied to filter medium causes cake to deposit on outer surface of drum .drum is divided into segments ,each segment connected to rotating valve through which vacuum is applied & filtrate ,wash & air are removed.

Construction:1)rotating drum filter consists of a cylindrical sheet metal drum(dia.-50 to 400 cm,length -50 to 800cm)mounted horizontally.

2) outer surface of drum is formed of perforated plate.

3)filter medium(canvas cloth) covers drum which turns at 0.1 to 2 r/min in agitated slurry trough.

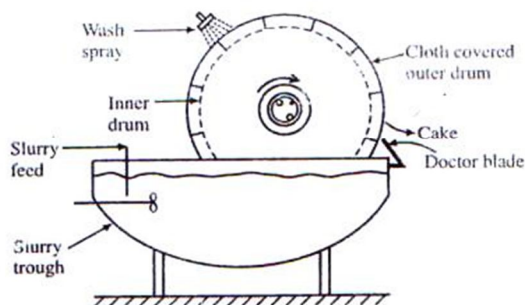
4) inside outer drum,a smaller drum with a solid surface.

5)annular space between 2 drums is divided into compartments by radial partitions& separate connection is made &rotating valve .

6)drum rotates ,vacuum &air are alternately applied to each compartment.

Diagram:

1 mark



**Fig. 5.9 : Rotary drum filter**

1



C

**c) Constant rate filtration:**

definition : "method in which pressure drop is varied from minimum at start of filtration to a maximum at end so that filtration is constant throughout run"

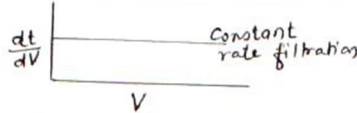
1 mark

Explanation:

3 marks

for Constant rate filtration, rate is maintained by starting at low inlet pressure & continuously increasing pressure to overcome resistance of cake, until maximum pressure is reached towards end of run.

By plotting a graph of reciprocal rate  $dt/dV$  as a function of filtrate volume, a straight line is observed with a certain intercept.



In Constant rate filtration maximum pressure is reached towards end of run, whole cycle is operated at less than maximum capacity.

d

**d) Batch sedimentation:**

*Description*

*2 marks*

the process is illustrated by suspending some fine solids in water in graduated cylinder & allowing the contents of cylinder to stand undisturbed.

At start, concentration of solids is uniform. all particles fall through fluid at maximum falling velocities under hindered settling. Various zones are observed.

Zone D: Zone of heavier faster settling particles settled at bottom.

Zone C: Region of variable size distribution & non-uniform concn.

Zone B: Zone of uniform concn as that of original slurry.

Zone A: Zone of clear liquid.

Boundary between C & D is obscure, marked by vertical channels.

Boundary between A & B is sharp if slurry is closed sized w.r.t. smallest particle.

As sedimentation proceeds, heights vary with time.

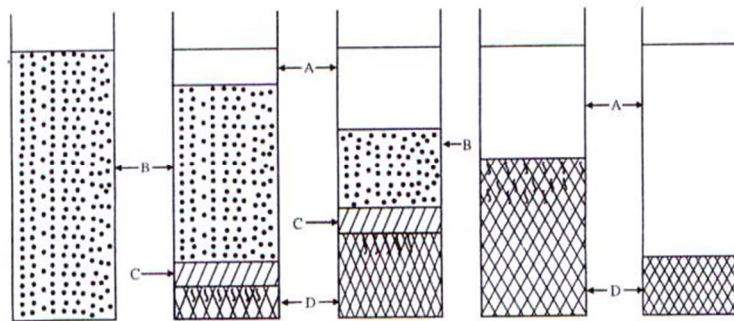
Heights of D & A – increase at expense of zone B

Height of C – remains constant.

Further settling, zones of B and C disappear.

All solids appear in zone D (may shrink due to compression.)

*Diagram → 2 marks*



**Fig. 5.15 : Laboratory Batch Settling test (Batch sedimentation)**

e

e) Ribbon blender:

used for mixing of solids with solids, effective for dry powder.

It mix solids by mechanical stuffing.

Description:

3 marks

Consists of a horizontal trough, held by central shaft & helical ribbon agitator.

Two counter acting ribbons mounted on same shaft, one ribbon moves slowly in one direction while other moves quickly in other direction.

Ribbons may be continuous / interrupted.

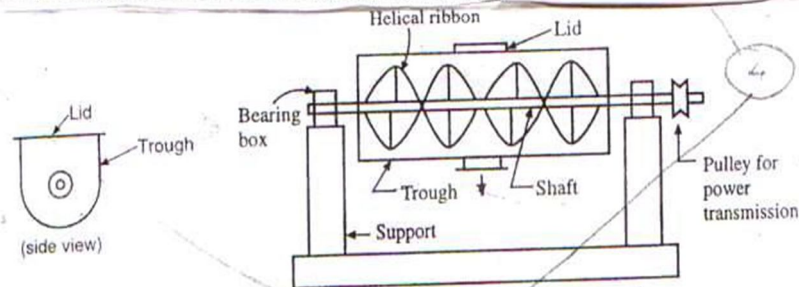
Mixing due to turbulence induced by counter acting ribbons.

Used for batch/continuous operation

In batch, Solids are charged & mixed until satisfactory & discharged from other end.

Continuously operated, solids fed from one end, discharged from other end.

Diagram



3marks

1mark

f

f) Rapid sand filters:

Construction: type of gravity filter, used for water treatment

2 marks

Consists of a open water tight tank (3 to 3.5 m deep) containing a filter bed, a large coarse sand (0.6 to 0.7 m thick)

Sand size 0.4 to 1 mm. sand bed supported by a layer of graded gravel (size range 1 to 50mm) 0.45 m thick.

Tank material of construction: wood, steel or other metals. but for water treatment it is of concrete.

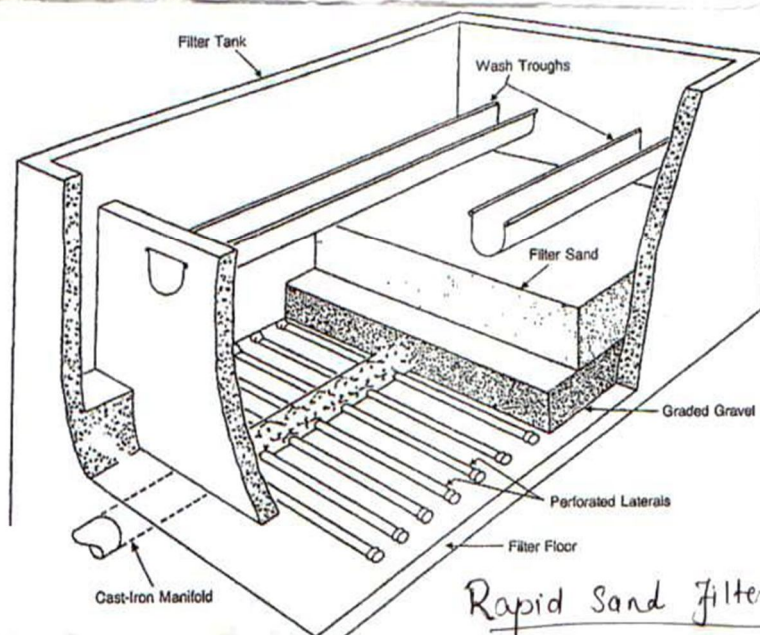
Ducts beneath perforated bottoms lead filtrate from bed. ducts having valves for back washing to remove accumulated solids by reversed flow.

Working: water to be filtered introduced from top, passes downward through filter bed.

1 mark

Suspended impurities trap inside bed & almost clear water leaves the filter from bottom.

Diagram



2 marks

1mark

1mark

4  
A

Q.4)

a) Power consumption in mixing :-

Power requirement of impeller to rotate at a given speed.

It is function of geometrical details of impeller, vessel, viscosity and density of fluid and rotation speed of impeller

$$P/(N^3 Da^5 \rho) = F((NDa^2 \rho / \mu), (N^2 Da / \rho))$$

$$Np = F(N_{Re}, N_{Fr})$$

Mixing index:- It is the measure of degree of uniformity of a mixed product it gives relative measure of mixing

$$I_p = ((N-1) \times \mu (1-\mu) / (\sum_{i=1}^N Vi^2 - \bar{V} \sum_{i=1}^N Vi))$$

$I_p$  = Mixing Index

$N$  = No. of spot samples

$\mu$  = overall average fraction of tracer in the mix

$V_i$  = fraction of tracer

$\bar{V}$  = Average value of measured concentration

Sample No.	$V_i$
1	0.1024
2	0.0930
3	0.0794
4	0.1024
5	0.1108
6	0.1003
7	0.1191
8	0.0972
9	0.0920
10	0.1076
11	0.1097
12	0.1015
	$\sum V_i = 1.2194$

$$\bar{V} = \sum V_i / N$$

$$\bar{V} = 1.2194 / 12$$

$$\bar{V} = 0.10167$$

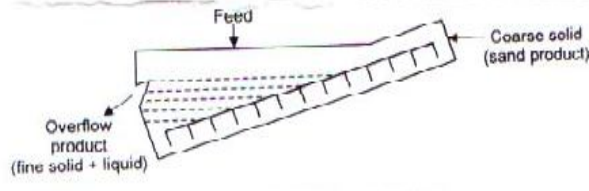
$$\sum Vi^2 = 0.1251028$$

$$I_p^2 = (12-1) \times 0.1 \times (1-0.1) / (0.1251028 - (0.10167 \times 1.2194))$$

$$I_p = 28.8$$

2marks

6marks

b	<p><b>(b) Rake Classifiers</b></p> <p>Classification:- Separation of materials into two or more fractions, depending upon rates of flow through fluid</p> <p>Construction 3 marks</p> <ol style="list-style-type: none"> <li>1. Consist of a settling rectangular tank, bottom inclined , with movable rakes</li> <li>2. Feed enters continuously through a feed launder</li> <li>3. Lower or fine discharge end provided with overflow lip</li> <li>4. Courser sinks to bottom where the rakes gently move it towards upper end</li> <li>5. Upper end of tank is open</li> </ol> <p>Working 3 marks</p> <ol style="list-style-type: none"> <li>1. At beginning of stroke rakes drop to bottom and slowly drawn to upper end</li> <li>2. After movement rakes are lifted clear of the floor move parallel to bottom towards discharge end</li> <li>3. After completion of this part of their travel rakes are drop and cycle is repeated</li> <li>4. Movement of rakes stirs up solids, the heavier particles collected at bottom</li> <li>5. Fine particles thrown above the rakes and travel in suspension toward the discharge end</li> </ol> <p>Diagram 2 marks</p> 	<p>3marks</p> <p>3 marks</p> <p>2 marks</p>
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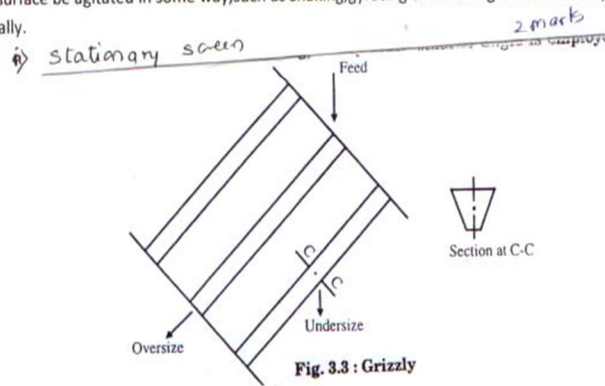
C

### c) Screening equipments:

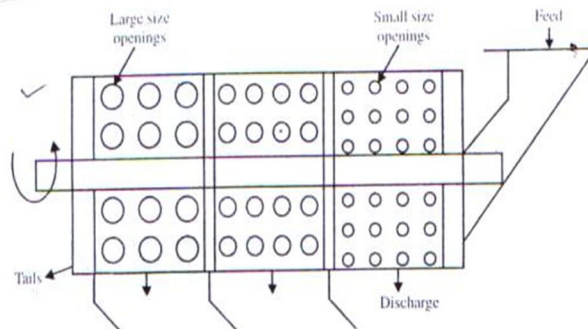
various Screening equipments are available for different purposes.

Particles drop thro openings by gravity, in few, they are pushed thro screen by a brush /centrifugal force.

Course particles drop easily thro large opening in a stationary surface ,but with the fine particles,the screen surface be agitated in some way,such as shaking,gyrating or vibrating it mechanically or electrically.



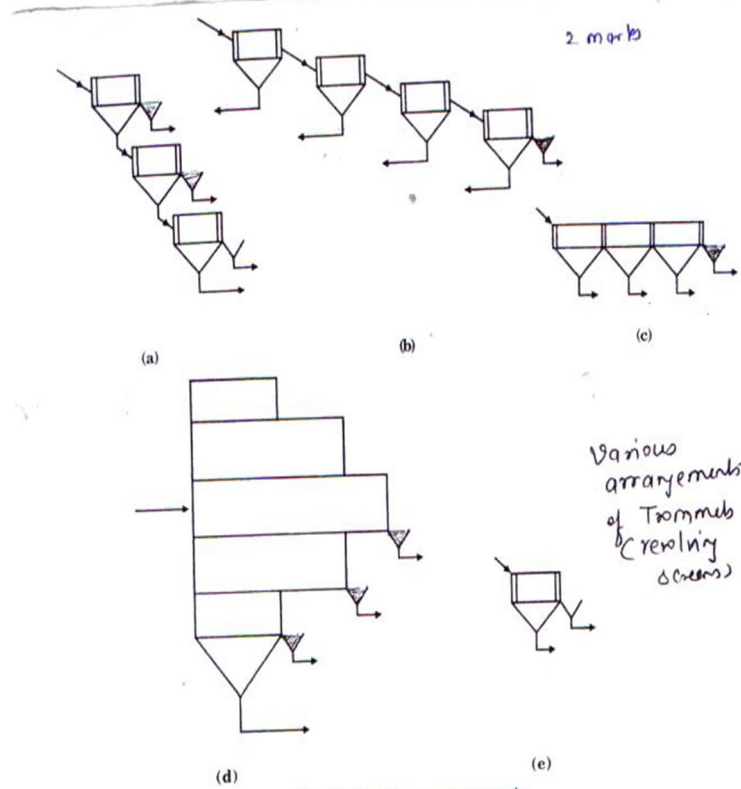
### ii) Revolving screens:-



**Fig. 3.4 : Trommel (with screens of different openings)**

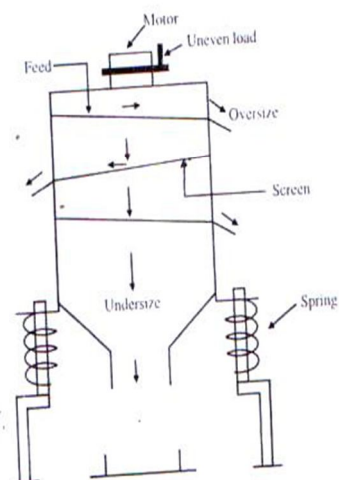
Working :-

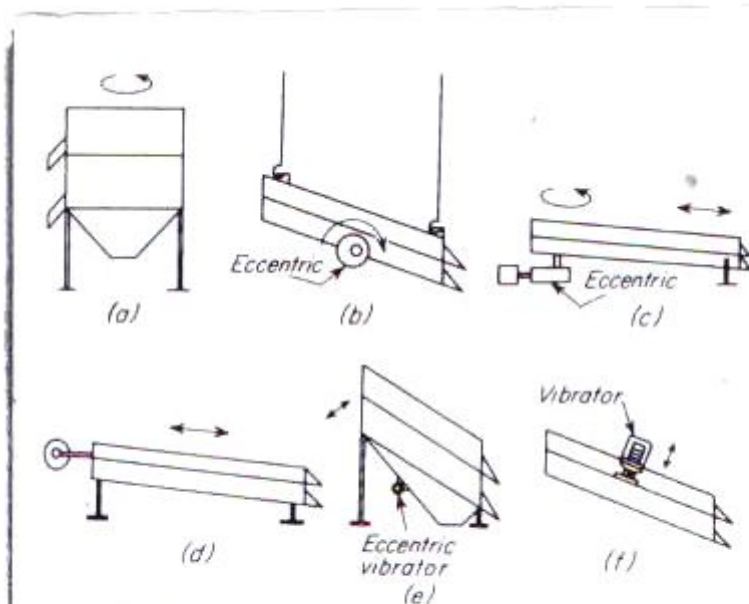




**Fig. 3.5 : Trommel arrangements**  
 (a) One-size screen to each trommel, coarsest trommel first; (b) One-size screen to each trommel, finest trommel-first; (c) Single trommel with different perforations; (d) Concentric trommels with one inside; (e) Trommel with single size perforations.

iii) Vibrating  
screen





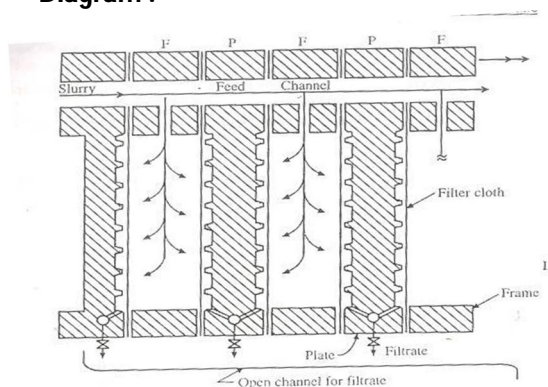
**FIGURE 30.1**

Motions of screens: (a) gyrations in horizontal plane; (b) gyrations in vertical plane; (c) gyrations at one end, shaking at other; (d) shaking; (e) mechanically vibrated; (f) electrically vibrated.

5 Attempt anyFour of the following

a **Plate and Frame Filter:**

• **Diagram :**



**Fig. 5.4 : Plate and frame filter press (sectional view)**

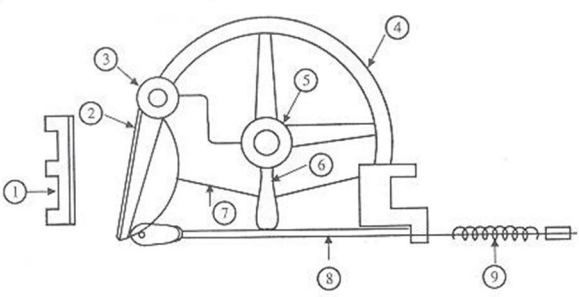
• **Construction:**

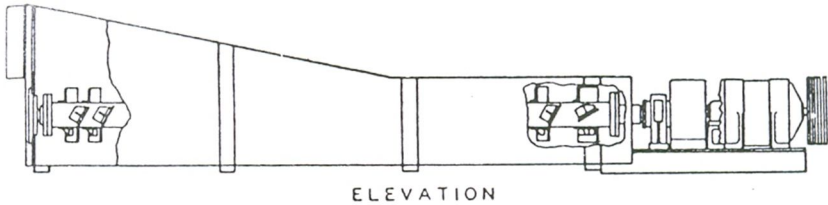
1. It consists of plates and frames arranged alternately and supported on a pair of rails.
2. The plate is a solid piece having a ribbed surface.
3. The frame is hollow and provides the space for the filter cake.
4. The plates and frames are square or rectangular in shape and can be made of cast iron, stainless steel, nickel etc.
5. Filter cloths are placed over each plate to cover the plate surface on both sides so

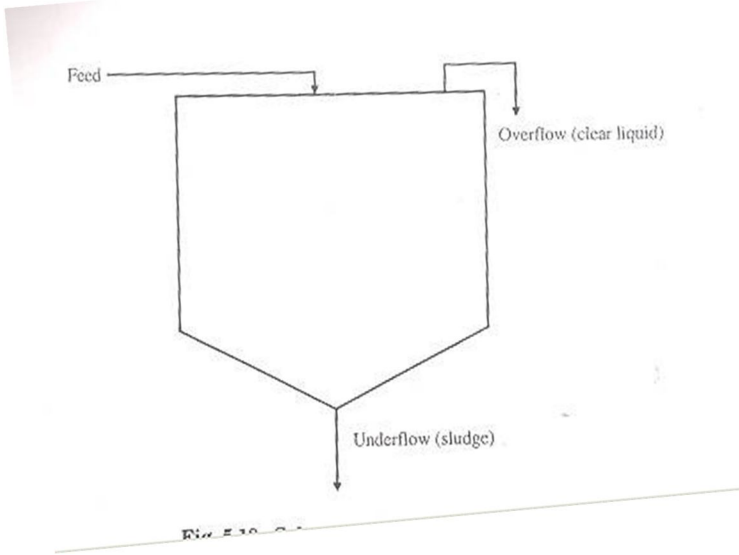
2 marks

01  
Mark

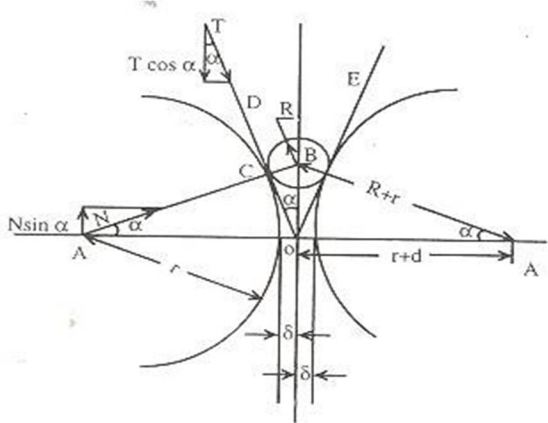


	<p>that hollow frame is separated from the plate by the filter cloth.</p> <p>6. The plates and frames have circular holes on the corners for feed and discharge.</p> <p>7. When the press is closed a continuous channel is formed along the whole length.</p> <p>8. At the bottom of the plate holes are cored which connect the face of the plates to the outlet.</p> <p>• <b>Working :</b></p> <ol style="list-style-type: none"> <li>1. Slurry to be filtered is pumped through the feed channel ,it runs into chamber formed and fills chamber completely.</li> <li>2. As feed pump continues to supply slurry to be filtered ,the pressure goes on increasing.</li> <li>3. Because of this, the filtrate passes through the filter cloth ,run down the faces of plates and finally leaves the filter through discharge.</li> <li>4. The solid are deposited on the filter cloth.</li> <li>5. The two cakes are formed simultaneously in each chamber and these join when frame is full.</li> <li>6. The press is then dismantled and cake of solid scrapped off from each plate.</li> </ol>	1 mark
(b)	<p><b>Diagram of Blake Jaw Crusher :</b></p>  <p>(1) Fixed jaw, (2) Movable jaw, (3) Shaft, (4) Fly wheel, (5) Eccentric, (6) Pitman, (7) Toggle, (8) Tie rod, (9) Spring</p>	<p>03 marks for neat diagram</p> <p>01 mark for labeling</p>
(c)	<p><b>Factor affecting Performance of Screen:</b></p> <ol style="list-style-type: none"> <li>1. <b>Method of Feeding :</b> In order to obtain maximum capacity and efficiency the screening equipment must be feed properly .The material should be spread evenly over the full width of the screening surface .It must be feed at as low a practical velocity as is possible.</li> <li>2. <b>Screening Surfaces:</b> Uses of single-deck screens in series results into most efficient as in case of multiple-deck screens lower decks are not feed so that their entire area is not use.</li> <li>3. <b>Screen Slope :</b> As screen slope increases, the rate of material travels over the screening surfaces increases, means increasing tonnage passing over the screen per unit time. However the slope cannot be increased beyond a certain value because material will travel down the screen much faster without getting screened .</li> <li>4. <b>Vibration amplitude and Frequency:</b> One has to select proper amplitude of vibration to prevent blinding of the screen and for long bearing life .The frequency</li> </ol>	<p>Any Four , 01 mark for each</p>

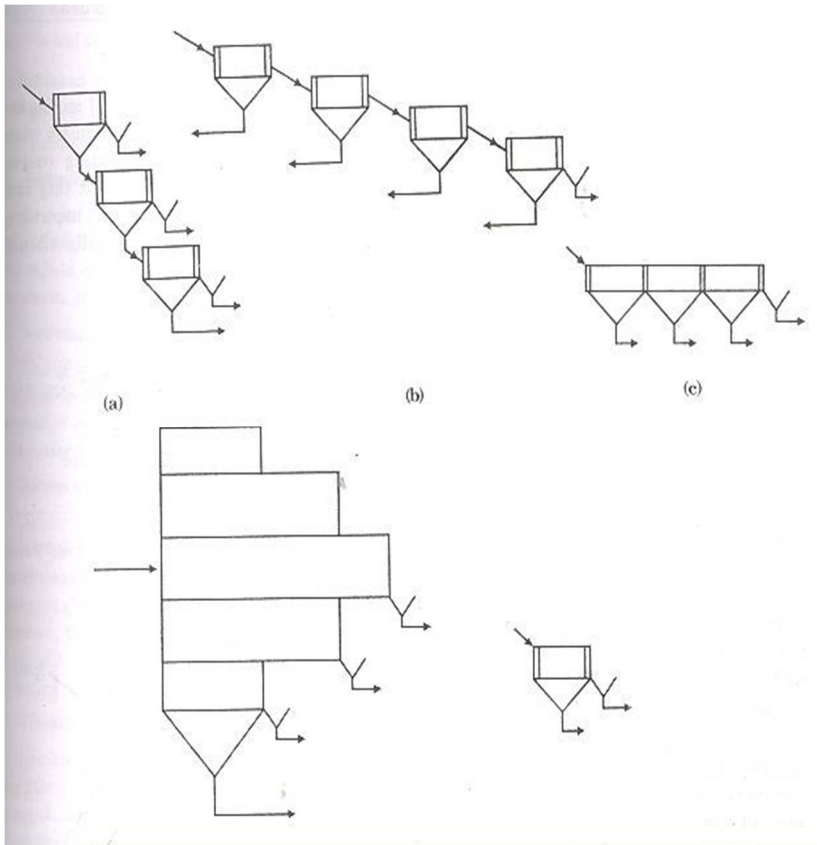
	<p>of vibration affects the capacity of screening equipment by regulating number of impact between the material and the screening surface.</p> <p><b>5. Moisture in Feed :</b> The moisture associated with the feed material adversely affects the screening operation and should be removed.</p>	
(d)	<p>1. <b>Pug Mill:</b> Pug mill are widely used for blending and homogenizing clay, mixing liquids with solid to form thick slurries</p> <p>• <b>Diagram:</b></p>  <p>• <b>Construction:</b></p> <ol style="list-style-type: none"> <li>1. A pug mill consists of a horizontal open trough or closed cylinder.</li> <li>2. One or two rotating shafts fitted with short heavy paddles or inclined blades are incorporated in the trough or cylinder.</li> <li>3. The rotating shafts are parallel to the trough length and are situated near the bottom.</li> <li>4. The paddles may or not intermesh and clearances are wide so that there is a considerable mass mixing.</li> <li>5. The mill may be jacketed for heating or cooling</li> </ol> <p>• <b>Working:</b></p> <ol style="list-style-type: none"> <li>1 The unmixed or partially mixed ingredients are continuously feed at one end of the mixing chamber and the product is discharged from the other end.</li> <li>2 In mixing chamber, the ingredients are cut, mixed and moved forwarded to be acted upon by each successive blade.</li> <li>3 The product may be discharged through one or two open ports or through extrusion nozzles which give roughly shaped ,continuous strip</li> </ol>	<p>01mark</p> <p>01 mark</p> <p>01 mark</p> <p>1 mark</p>

Question No.	Answers	Marks
(e)	<p><b>Gravity Thickener:</b> Sedimentation operation carried out batch wise or continuously in equipment called Gravity thickener</p> <p>• <b>Diagram:</b></p>  <p>•</p> <ol style="list-style-type: none"> <li>1. It consists of relatively shallow tank from the top of which clear liquid is taken off and thickened liquid is withdrawn from bottom.</li> <li>2. In majority cases, the concentration of suspension is high and hindered settling takesplace. the rate of sedimentation can be artificially increased.</li> <li>3. A batch thickener usually consists of a cylindrical tank provided with openings for a slurry feed and product discharge.</li> <li>4. The bottom of tank is conical.</li> <li>5. The tank is filled with dilute slurry and slurry is allowed to settle.</li> <li>6. After the sedimentation has proceeded for an adequate time, clear liquid is decanted until sludge appears in the draw-off and thickened liquid is withdrawn from the bottom opening.</li> </ol>	<p>02 mark</p> <p>02 marks</p>



Question No.	Answers	Marks
	<p>• <b>Working:</b></p> <ol style="list-style-type: none"> <li>1. Water is taken into the cell; material is feed to the cell.</li> <li>2. The promoters and frothers are added.</li> <li>3. Agitations are given and air is bubbled in the form of fine bubbles.</li> <li>4. Air-aid 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</li> <li>5. Hydrophilic particles will sink to the bottom and removed from the discharge for tailing</li> </ol>	01 mark
(b)	<p><b>Selection of Crushing Rolls:</b></p> <p>In selecting the rolls for a certain duty, it is necessary to know the size of the feed and the size of the product</p> <p>Consider a system as shown in figure</p>  <p>Wherein spherical particle B of a material is just being caught between the rolls.</p> <p>The vertical components of forces T and N are opposed. Force <math>N \sin \alpha</math> tends to expel the particle from the rolls and force <math>T \sin \alpha</math> tends to draw the particle between the rolls. If the particle is to be drawn between the rolls and crushed,</p> $T \sin \alpha \geq N \sin \alpha$ <p>T and N are related through,</p> $T = \mu N$ $\mu N \sin \alpha \geq N \sin \alpha$ $\mu \geq \tan \alpha$	01mark
		02marks

Question No.	Answers	Marks
(C)	<p>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 ABG, the angle BAG is <math>\alpha</math>, AG is r+d and AB is r+R. Then, from the simple geometry of figure</p> $\cos \alpha = \frac{r+d}{r+R}$ <p>Where, <math>\alpha</math>=angle of nip=0.961</p> <p><b>Critical Speed of Ball mill:</b> If the mill is operated at very high speed, the balls are carried right round in contact with the sides of mill and the mill is said to be centrifuging. The minimum speed at which centrifuging occurs is called the critical speed of the mill</p> <p><b>Trommels:</b> Trommels are revolving screens consisting of cylindrical frame surrounded by wire cloth used for size separation. Trommel is mechanically operated screen consisting of a slowly rotating perforated cylinder with its axis at a slight angle to the horizontal</p>	<p>01mark</p> <p>01mark</p>

Question No.	Answers	Marks
	<p><b>Trommel Arrangements:</b></p>  <p>The image contains three diagrams labeled (a), (b), and (c) illustrating different trommel arrangements. Diagram (a) shows a series arrangement where material passes through one trommel, and the undersize is removed while the oversize goes to the next trommel. Diagram (b) shows a parallel arrangement where material is fed into a single trommel that has multiple screens, allowing different size fractions to be removed at different points. Diagram (c) shows a parallel arrangement where material is fed into a single trommel, and the undersize is removed, while the oversize is then fed into a second parallel section of three trommels.</p> <p><b>Fig. a)</b> For separation of a given material into several size fractions, several trommels are operated in series. The first trommel of a series may have the coarsest perforations so that it produces the coarsest finished product which is delivered to the next trommel and so on.</p> <p><b>Fig.b)</b> When the first trommel of the series has the smallest perforations, the oversize material passes to the next trommel and so on. In such a case, it is most convenient to put the screens in line, end to end.</p>	02 marks



Question No.	Answers	Marks
(d)	<p><b>Fig d)</b> Several concentric cylinder. The innermost is the longest and has coarsest perforations. The outer ones are successively shorter and have finer perforations. In this arrangement ,maximum load is given to the strongest screen but the construction is complicated and expensive.</p> <p><b>Trommel Use:</b></p> <ol style="list-style-type: none"> <li>1.It is used for relatively coarser material(1/2 inch or over)</li> <li>2. It can be used for finer separations also provided the screen is covererd with fine wire or cloth</li> </ol>	01 marks
	<p><b>i) Decantation:</b> Decantation involves the separation of two immiscible liquids of differing densities from one another. Basically the difference between densities of two immiscible liquids is responsible for such a separation. Decanters utilize either gravitational force or centrifugal force to effect the separation.</p> <p><b>ii) Filtration:</b> Filtration is the operation of separating a solid from a liquid by means of a porous membrane. The porous membrane is usually a wire or fabric cloth. The separation is achieved by forcing the slurry feed through the porous medium. Solid particles are trapped within the pores of the membrane and build up as a layer on the surface of the membrane. The pressure difference set up across the membrane causes the flow of liquid through it.</p> <p><b>iii) Settling:</b> In these method separation methods, the solid particles are separated from the liquid by gravitational forces acting on solid particles of various sizes and densities. Settling is used for removal of solid from liquid sewage wastes, settling of crystals from mother liquor.</p> <p><b>iv) Screening:</b> Screening refers to the separation of solid materials on the basis of size alone. A mixture of solid particles of various sizes is feed onto a screening surface of known openings. Some of material passes through the screen openings while the other remains on the screen. Thus,a single screen gives two fractions which are more uniform in original material.</p>	01 marks each

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(f)	<p><b>Centrifuge:</b> Centrifuge is the device used for separating solids from slurry with the help of centrifugal force</p> <p>• <b>Diagram:</b></p> <p>Adjustable unloader knife Motor shaft Feed slurry Perforated basket Casing Filter cloth Solid cake Filtrate Removable valve plate Solid discharge</p>	01 mark  02 marks										

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	<ul style="list-style-type: none"> <li>• <b>Construction:</b> <ol style="list-style-type: none"> <li>1) It consists of a basket with perforated sides.</li> <li>2) The diameter of basket ranges from 750 to 1200 mm and depth from 450 to 750 mm.</li> <li>3) The basket rotates at speeds between 600 to 1800 r.p.m.</li> <li>4) The basket is held at lower end of a free swinging vertical shaft. Which is driven by electric motor.</li> <li>5) A filter medium is placed around the inside surface of the basket.</li> <li>6) The basket or other parts may be constructed of mild steel or Monel metal.</li> </ol> </li> <li>• <b>Working:</b> <ol style="list-style-type: none"> <li>1) Slurry to be filtered is feed to the rotating basket through an inlet pipe.</li> <li>2) It is forced against the basket sides by centrifugal force.</li> <li>3) The liquid passes the filter medium into the casing and out discharge pipe.</li> <li>4) The solid phase forms a filter cake against the filter medium.</li> <li>5) The cake is washed by spraying wash liquid to remove the soluble material.</li> <li>6) It leaves the centrifuge through the discharge pipe.</li> </ol> </li> </ul>	01 marks