

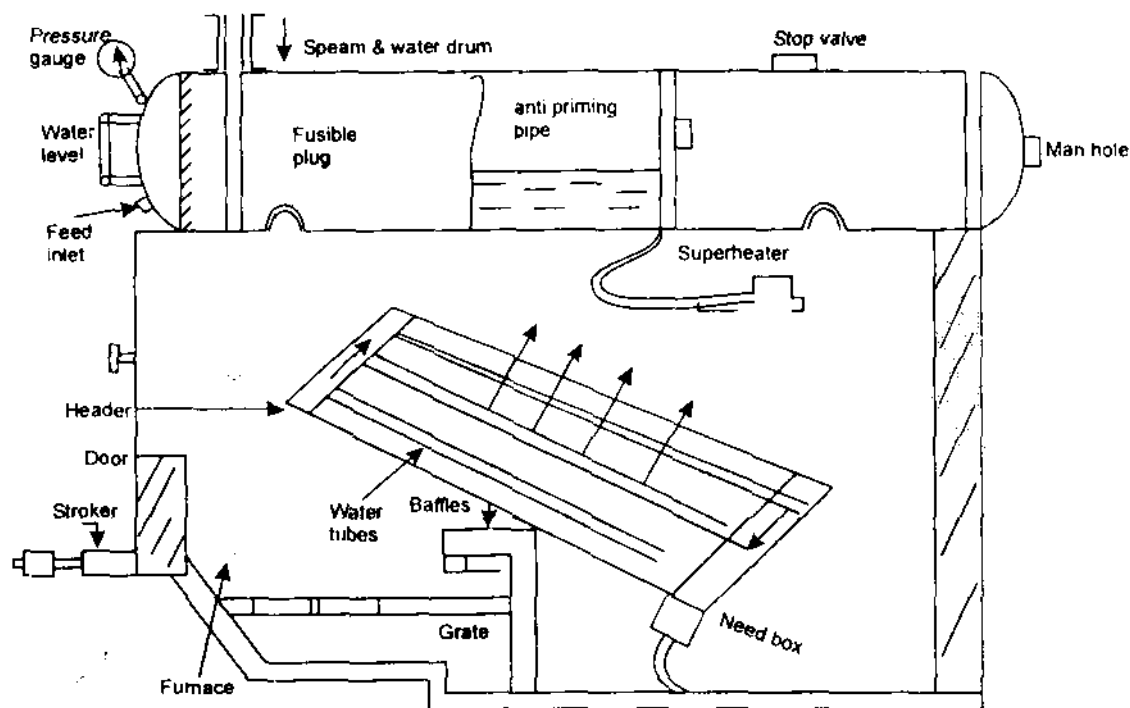
B.Tech.
First Semester Examination
Basics of Mechanical Engineering (ME-101F)

Note : Attempt any five questions. All questions carry equal marks.

Q. 1. (a) Explain with neat sketch, the construction and working of Babcock Wilcox boiler.

Ans. Babcock Wilcox Boiler : This is horizontal, externally fired, water tube, natural circulation type stationary boiler.

Construction : It consists of a welded steel high pressure drum mounted at the top. From each end of drum, connections are made with the uptake header & a downtake header. The headers are joined to each other by a large no. of water tubes which are kept inclined at an angle of about 15° to the horizontal. The water tubes are straight, solid down steel tubes about 10 cm in diameter.



Babcock & Wilcox boiler

Working : The circulation of water is manipulated by convective currents. The hottest water & steam rise from the tubes to the uptake header & then through riser enter the boiler drum. The steam vapours escape through water to the upper half of the drum. The cold water flows from the drum to the rear header & thus the cycle is completed.

Q. 1. (b) Explain boiler mountings and accessories.

Ans. Boiler Mountings & Accessories :

Mountings :

- (i) 2 safety valves
- (ii) 2 water level indicators
- (iii) Pressure gauge
- (iv) Fusible Plug
- (v) Steam stop valve
- (vi) Feed check valve
- (vii) Blow off
- (viii) Man & Mud holes

Boiler Accessories :

- (i) Air preheater
- (ii) Economiser
- (iii) Super heater
- (iv) Feed pump
- (v) Injector

Detail :

Safety Valves : Permits the steam in the boiler to escape to atm when pressure in the steam space exceeds a certain specified limit.

Water Level Indicator : Indicator ascertain constantly & exactly the level of water in the boiler shell.

Fusible Plug : Extinguishes the fire in the event of water level in the boiler shell falling below a certain specified limit.

Pressure Gauge : Records the pressure at which the steam is being generated in the boiler.

Blow off Cock : Serves to drain out the water from the boiler periodically for any one reasons like

- (i) to discharge mud.
- (ii) to empty boiler.
- (iii) to lower water level rapidly.

Q. 2. (a) What do you mean by compounding of turbine ? Explain pressure compounding.

Ans. Compounding of Turbine : The one wheel turbine is not useful. development of steam turbine led to the emergence of compounding whereby speed of rotation is reduced and at the same time, full use is made of the energy in the steam. This allows production of turbines of larger size & high power output.

Pressure Compounding : Here a no. of simple impulse turbines are arranged in series. The pressure compounding arrangement is also called Rateall compounding.

Main Features :

- (i) In the nozzles only a small pressure drop is provided, giving limited increase of KE.
- (ii) There are rotating rows of blades & fixed rows of blades, all stages being keyed to the shaft in series.
- (iii) The rotating blades have symmetrical shape of impulse turbine.
- (iv) For all rotating blades, the velocity diagrams & power output may be same.

(v) Since pressure gradually goes down, volume will increase & therefore the blade height has to be increased towards the low pressure side.

Q. 2. (b) Explain surface in detail.

Ans. Surface Condensers : The heat is convectively transferred through a wall-interposed between steam & water. The steam is drawn across a nest of tubes which are arranged in certain pattern & are maintained at a temperature lower than that of steam by flow of cooling water through them.

All the marine installations are equipped with surface.

The surface may be classified A/to:

- (i) direction of flow of condensate & arrangement of tubing.
- (ii) number of passes of water.
- (iii) shape of shell which may be circular, oval or .

The two pass arrangement of surface condensor arrangement is compact, more efficient in the process of heat exchange & is to be preferred when the supply of cooling water is limited.

In the central flow, type surface, the air extraction pump is placed in the centre of the tube.

Q. 3. (a) Difference between petrol and diesel engine.

Ans. (i) Petrol engine works on otto cycle whereas diesel engine works on diesel cycle.

(ii) Petrol engine is a light oil engine & uses gasoline or petrol as fuel. Diesel engine is a heavy oil engine & uses diesel as fuel.

(iii) The efficiency of a diesel engine is low than petrol engine.

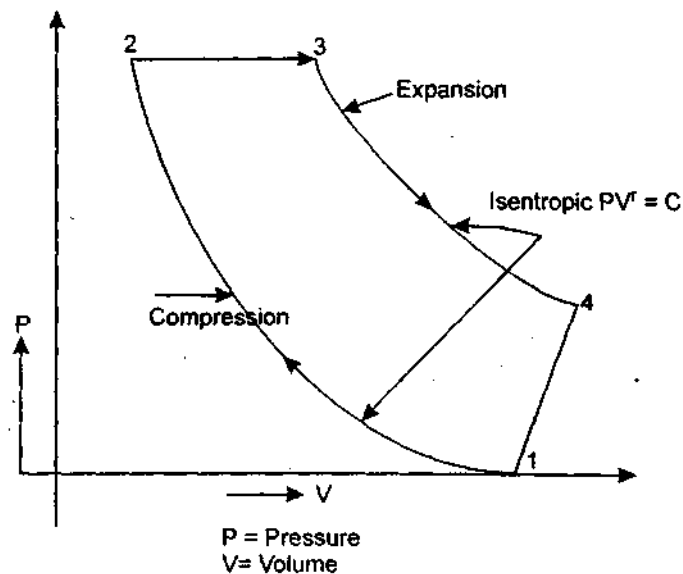
(iv) Petrol engine uses a spark plug to ignite the charge after it has been compressed. The combustion of fuel in diesel engines is due to high temperature of compressed air.

(v) Fire risk is minimized in diesel engines owing to the higher ignition point of fuel used.

(vi) Petrol engines are used in cars, scooters & motor cycles. Diesel engines are used in heavy duty vehicles like trucks, buses & locomotive engines.

Q. 3. (b) Calculate efficiency of diesel cycle.

Ans. Efficiency of Diesel Cycle :



Work done = heat supplied - heat rejected

$$= C_p (T_3 - T_2) - C_v (T_4 - T_1)$$

$$\eta = \frac{\text{Work done}}{\text{Heat Supplied}}$$

$$\eta = \frac{C_p (T_3 - T_2) - C_v (T_4 - T_1)}{C_p (T_3 - T_2)}$$

$$= 1 - \frac{1}{r} \left[\frac{(T_4 - T_1)}{T_3 - T_2} \right]$$

At point 2

$$V_2 = \frac{V_1}{r}$$

$$p_2 = p_1 \left(\frac{V_1}{V_2} \right)^\gamma = p_1 r^\gamma$$

$$\sqrt{2} = \sqrt{1} \left(\frac{V_1}{V_2} \right)^{\gamma-1} = \sqrt{1} r^{\gamma-1}$$

At point 3,

$$p_3 = p_2 = p_1^\gamma$$

$$V_3 = V_2 \rho$$

Where, ρ = cut off ratio

$$\sqrt{3} = V_2 \rho = \sqrt{2} \rho = T_1 r^{\gamma-1} \rho$$

At point 4,

$$V_4 = V_1$$

$$p_4 = p_3 \left(\frac{V_3}{V_4} \right)^\gamma = p_3 \left(\frac{V_3}{V_1} \right)^\gamma = p_3 \left(\frac{V_3 / V_2}{V_1 / V_2} \right)^\gamma$$

$$= p_3 (\rho / r)^\gamma$$

$$T_4 = T_3 (V_3 / V_4)^{\gamma-1} = T_3 (\rho / r)^{\gamma-1}$$

$$= T_1 \frac{r^{\gamma-1} \rho^{\gamma-1}}{r^{\gamma-1}} = T_1 \rho^\gamma$$

Hence

$$\eta = 1 - \frac{1}{r} \frac{T_1 \rho^\gamma - T_1}{T_1 r^{\gamma-1} \rho - T_1 r^{\gamma-1}}$$

$$= 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^{\gamma-1}}{(\rho-1)} \right] \quad \text{is required expression.}$$

Q. 4. (a) Explain construction and working of Pelton turbine.

Ans. Pelton Turbine :

Construction : With Operation :

There is a penstock :

Large sized conduct which conveys water from the high level reservoir to the turbine.

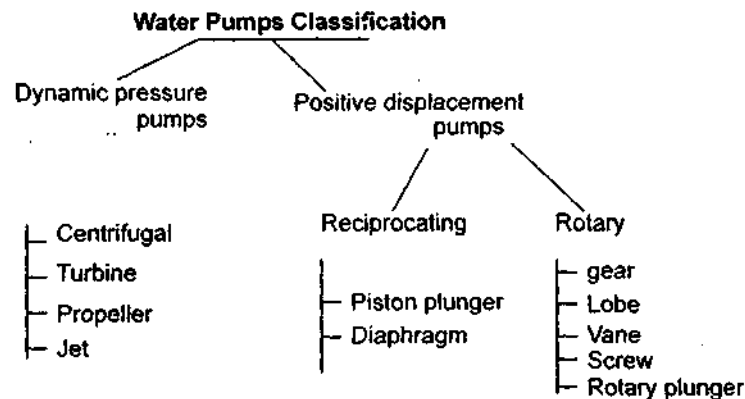
Spear & Nozzle : At its downstream end, the penstock is fitted with an efficient nozzle that converts the whole of hydraulic energy into a high speed jet. To regulate the water flow through the nozzle & to obtain a good jet of water at all loads, a spear/needle is so arranged that it can move forward or backward.

Runner & Buckets : The turbine rotor, called the runner, is a circular disk carrying a number of cupshaped buckets which are arranged equidistantly around the periphery of the disk. The inner surface of the buckets is perished to reduce frictional resistance of water jet.

Casing : Out flow from the runner buckets is in the form of a strong splash which scatters in all directions. To prevent this & to guide the H_2O to the tail race, a casing is provided at the runner.

Q. 4. (b) How water pumps are classified ? Explain one.

Ans.



Explanation :

Centrifugal Pumps : Centrifugal pumps belong to the category of dynamic pressure pumps wherein the pumping of liquids or generation of head is affected by rotary motion of one or more rotating wheels called impellers.

Main Elements :

Rotating Element : Consisting of shaft & a vaned rotor called impeller. The vanes are curved, cylindrical & have more complex surfaces. The unit has a finite no. of vanes.

Stationary Element : Consisting of casing, stuffing box & bearing. The casing is an airtight chamber surrounding the pump impeller; it collects liquid from the impeller & leads it away under high pressure to the delivery side.

Suction Pipe, Strainer & Foot Valve : Suction pipe connects the centre (eye) of impeller to the pump from which the liquid is to be lifted. The pipe is airtight so that there is no possibility of formation of air pockets.

Q. 5. (a) What is reversible machine ?

Ans. Reversible Machine : The work done by the machine is in reverse direction & the load falls. The machine is thus called reversible machine. A pulley used to draw water from a well with the help of bucket is reversible machine because the bucket falls back when the effort to pull it up is removed.

$$\begin{aligned}\text{Frictional work} &= \text{input} - \text{output} \\ &= P_y - W_x\end{aligned}$$

If $(Py - Wx) > Wx$

$$Py > 2Wx$$

$$\frac{Wx}{Py} < \frac{1}{2}$$

But

$$\frac{Wx}{Py} = \eta$$

If $\eta < \frac{1}{2}$ or 50%

This condition for self working of machine is that the flow efficiency of machine should be less than 50%.

Q. 5. (b) Calculate M.A., V.R., efficiency of double, purchase winch crab.

Ans. Double Purchase Winch Crab :

MA = Mechanical advantage

VR = Velocity Ratio

The revolutions made by the intermediate axle are

$$= 1 \times \frac{T_1}{T_2}$$

The revolutions made by the load axle & the drum mounted on it are

$$= 1 \times \frac{T_1}{T_2} \times \frac{T_3}{T_4}$$

Distance moved by the load

$$= \pi d \times \left(1 \times \frac{T_1}{T_2} \times \frac{T_3}{T_4} \right)$$

$$= \pi d \frac{T_1}{T_2} \times \frac{T_3}{T_4}$$

$$VR = \frac{\text{displacement of effort}}{\text{displacement of load}}$$

$$= \frac{2\pi l}{\pi d \frac{T_1}{T_2} \times \frac{T_3}{T_4}}$$

$$= \frac{2l}{d} \times \frac{T_2}{T_1} \times \frac{T_4}{T_3}$$

$$VR = \frac{2l T_2 T_4}{d T_1 T_3}$$

Neglecting loss of energy due to friction, the mechanical advantage equals the velocity ratio.

That is $MA = \frac{2l T_2 T_4}{d T_1 T_3}$

$$MA = \frac{2l}{d} \frac{T_2}{T_1} \frac{T_4}{T_3} \times \eta$$

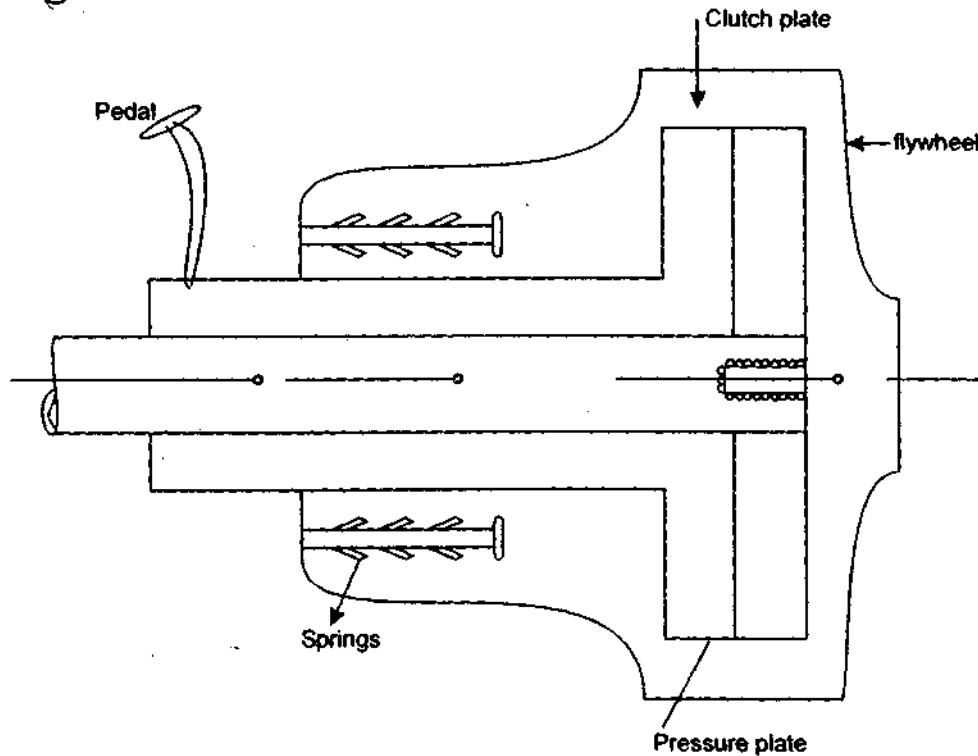
If loss of energy due to friction is taken into account where,

η = efficiency of system.

Q. 6. (a) Explain with diagram clutch.

Ans.

Multiplate Clutch



Multiplate Clutch

Explanation : The clutch is disengaged or withdrawn by forcing the pressure plate against the springs. This is achieved by depressing the pedal whilst the flywheel & pressure plate are rotating the clutch plate is stationary.

There is no contact between clutch plate & pressure plate. When the clutch is engaged, the pedal is released, so allowing the springs to force the pressure plate against the clutch plate, which in turn is squeezed against the flywheel.

Q. 6. (b) Explain principle, construction and working of Hydraulic brake.

Ans. Hydraulic Brake :

Principle : Hydraulic brake works on the principle of application of smaller effort as possible to lift heavy loads.

Construction & Working Operation : The unit consists of :

(i) A large cylinder C_1 inside which slides a ram of cross-sectional area A . The ram carries a platform upon which is placed the load W which is to be lifted.

(ii) A small cylinder C_2 inside which moves a plunger of area a , the plunger moves downwards under the influence of force.

Quite often mechanical advantage of hydraulic brake is increased by applying force by means of lever.

Taking moment about the fulcrum of lever.

$$F \times l = P \times L$$

$$F = PL/l$$

$$W/P = \frac{A}{a} \times \frac{L}{l}$$

The ratio L/l is called leverage of press & factor $\frac{AL}{al}$ is called the velocity ratio.

$$VR = \frac{AL}{al}$$

Hydraulic brakes are widely used in onto repair shops & wave houses.

Q. 7. (a) Find relation-ship between elastic const.

Ans. Relation between E , C & K

$$E = 2C(1 + \mu)$$

$$= 3K(1 - 2\mu)$$

To eliminate μ from these 2 expressions, we have

$$\mu = \frac{E}{2C} - 1 \quad \&$$

$$E = 3K \left[1 - 2 \left(\frac{E}{2C} - 1 \right) \right]$$

or

$$E = 3K \left[1 - \left(\frac{E}{C} - 2 \right) \right]$$

$$E = 3K \left[3 - \frac{E}{C} \right] = 9K - \frac{3KE}{C}$$

or

$$E + \frac{3KE}{C} = 9K;$$

$$E \left(\frac{C + 3K}{C} \right) = 9K$$

$$E = \frac{9KC}{C + 3K}$$

Accordingly,

$$E = 2C(1 + \mu)$$

$$E = 3K(1 - 2\mu)$$

$$E = \frac{9KC}{C + 3K}$$

Hence

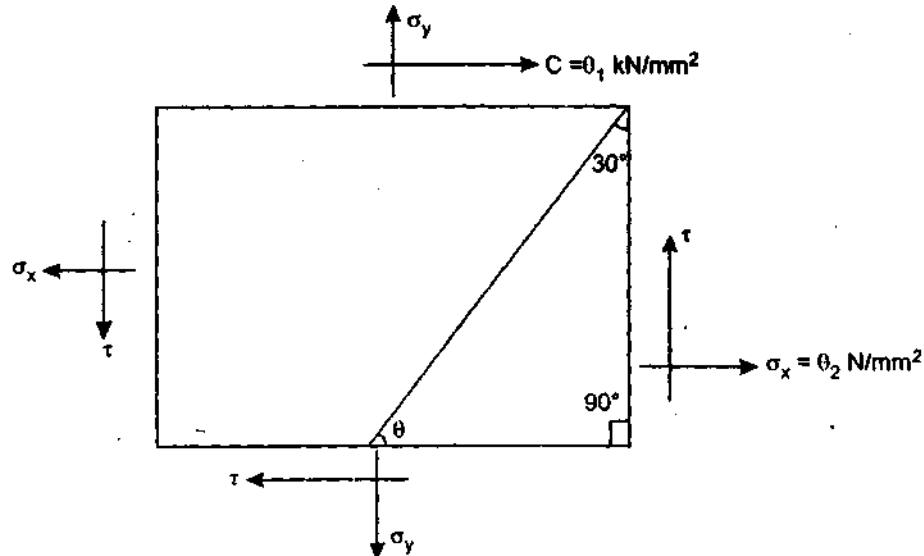
$$E = \frac{9KC}{C + 3K}$$

is required relation.

Q. 7. (b) A point in a strained material is subjected to two mutually perpendicular tensile stress of 02 kN/mm^2 and 01 kN/mm^2 . Determine the intensities of normal and resultant stresses on a plane inclined at 30° to the axis of minor stress. Solve with Mohr's Circle.

Ans. The inclination of the plane with the direction of stress S_x is

$$\theta = 90^\circ - 30^\circ = 60^\circ$$



$$\begin{aligned}\sigma_n &= \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2} \cos 2\theta - \tau \sin 2\theta \\ &= \frac{40 + 20}{2} - \frac{40 - 20}{2} \cos 120^\circ - 10 \sin 120^\circ \\ &= 30 + 5 - 8.66 \\ &= 26.34 \text{ N/mm}^2\end{aligned}$$

&

$$\begin{aligned}\sigma_t &= \frac{\sigma_x - \sigma_y}{2} \sin 2\theta - \tau \cos 2\theta \\ &= \frac{40 - 20}{2} \sin 120^\circ - 10 \cos 120^\circ \\ &= 8.66 + 5 \\ &= 13.66 \text{ N/mm}^2\end{aligned}$$

Resultant stress

$$\begin{aligned}\sigma_r &= \sqrt{\sigma_n^2 + \sigma_t^2} \\ &= \sqrt{(26.34)^2 + (13.66)^2} \\ &= 29.67 \text{ N/mm}^2\end{aligned}$$

$$\begin{aligned}\tan \phi &= \frac{\sigma_t}{\sigma_n} = \frac{13.66}{26.34} \\ &= 0.5186\end{aligned}$$

$$\phi = 27.41^\circ$$

Graphical Method :

Mohr's Circle

$$OA = \sigma_x = 40 \text{ N/mm}^2$$

$$OB = \sigma_y = 20 \text{ N/mm}^2$$

$$AE = BF = \tau = 10 \text{ N/mm}^2$$

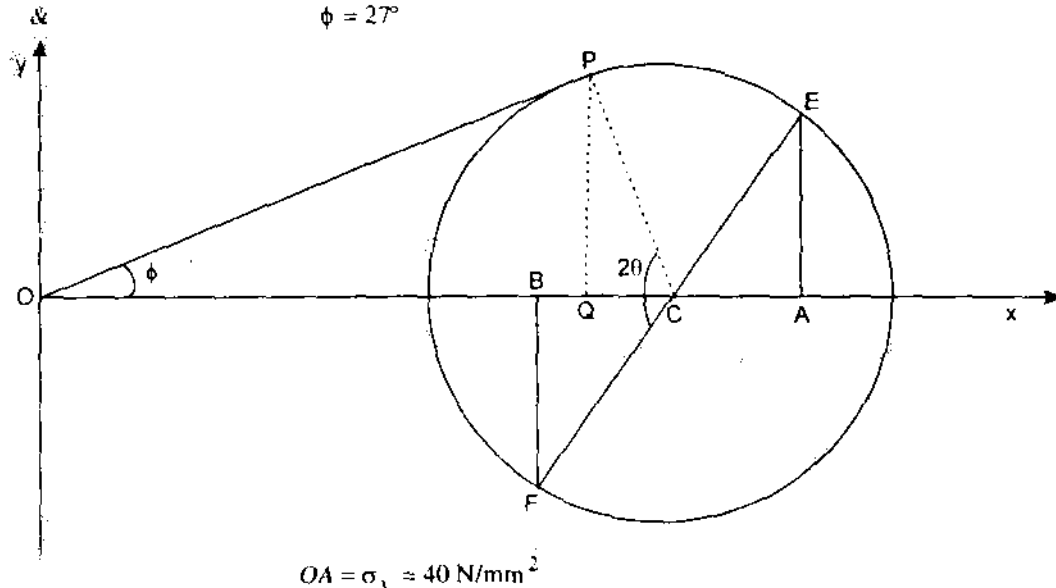
$$2\theta = 120^\circ$$

From measurement $\sigma_n = OQ = 27 \text{ N/mm}^2$

$$\sigma_t = PQ = 13.5 \text{ N/mm}^2$$

$$\sigma_r = OP = 30 \text{ N/mm}^2$$

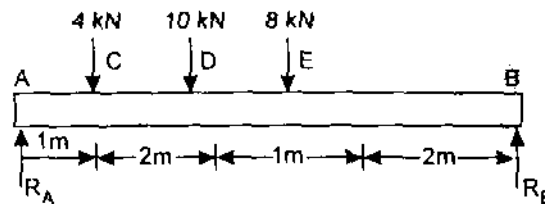
$$\phi = 27^\circ$$



$$OA = \sigma_x = 40 \text{ N/mm}^2$$

These results compare very well with the analytical results calculated above.

Q. 8. A simply supported beam is carrying point loads as shown in fig. Draw SFD and BMD for the beam.



Ans. Simply supported beam carrying point loads

SF Calculations

At $x = 0$, $SF = -5 \text{ kN}$

At $x = 1 \text{ m}$, $SF = -5 \text{ kN}$

At $x = 2 \text{ m}$, $SF = -9 \text{ kN}$

BM Calculations :

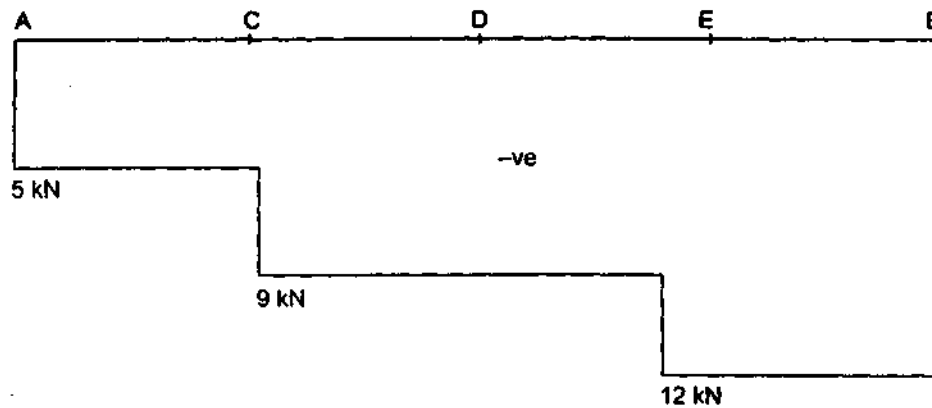
Portion AC $M_x = -5x$

At $x = 0$, $M_a = 0$
 At $x = 1$ m, $M_b = -5 \times 1 = -5$ kNm

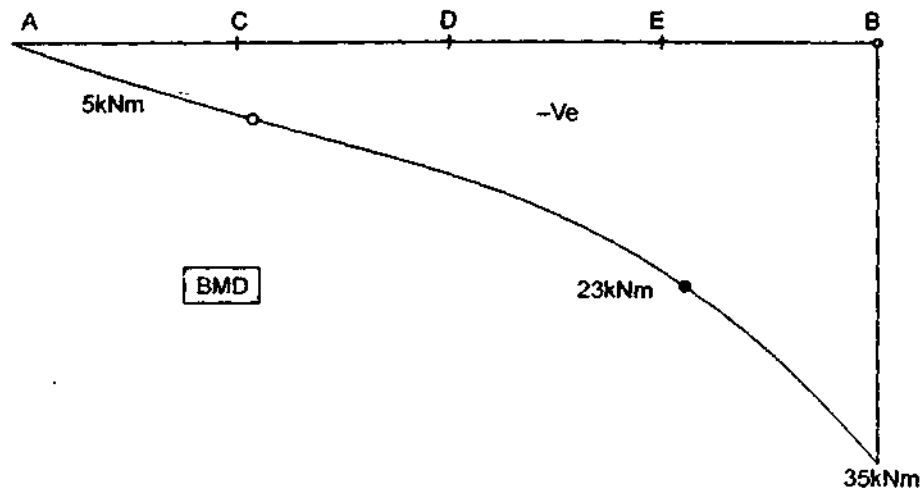
Portion CD : $M_x = -5x - 4(x-1)$
 $M_b = -5 \times 1 - (1-1) = -5$ kNm
 $M_c = -5 \times 3 - 4(3-1) = -23$ kNm

Portion EB : $M_x = -5x - 4(x-1) - 3(x-3)$
 $M_b = -5 \times 3 - 4(3-1) - 3(3-3) = -23$ kNm
 $M_d = -5 \times 4 - 4(4-1) - 3(4-3) = -35$ kNm

For SFD & BMD.



SFD



BMD