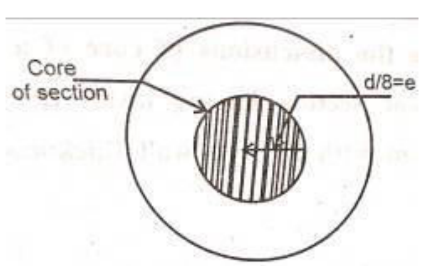
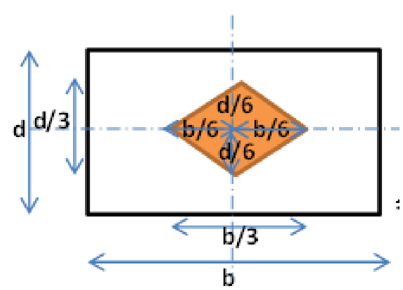
MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC -270001 – 2005 certified)

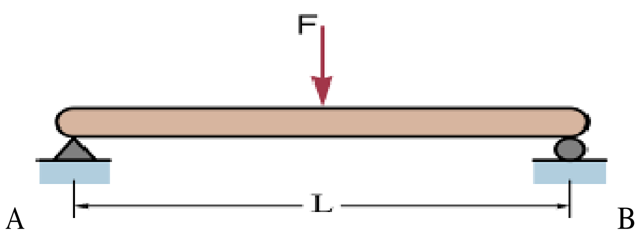
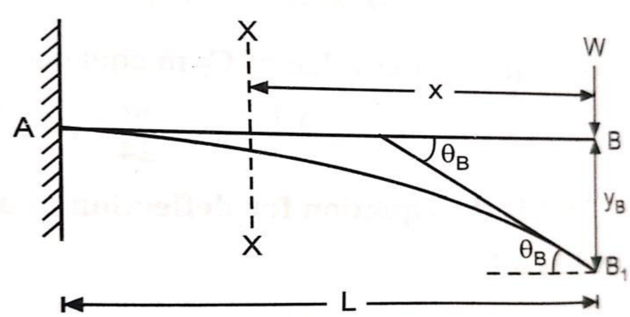
WINTER -2019 EXAMINATION **SUBJECT CODE: 22402**

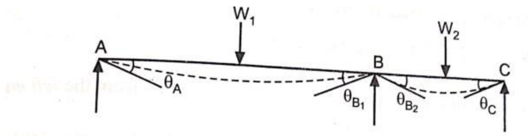
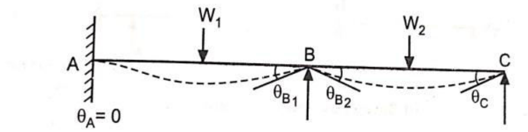
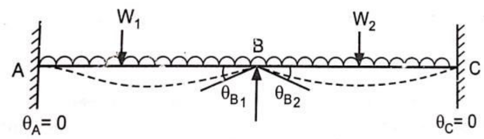
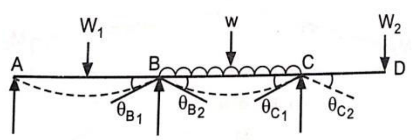
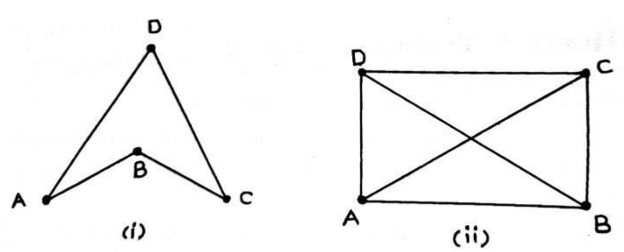
MODEL ANSWER

Important Instructions to examiners:

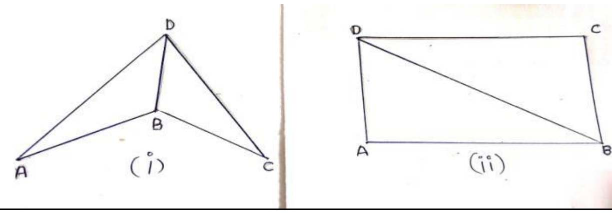
1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language error such as grammatical, spelling errors should not be given more importance.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure 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 the some cases, the assumed constants values may vary and there may be some difference in the candidate's answer and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.

Que. NO	Answer with question	Mark
Q. 1	**Attempt any FIVE of the following**	**10 M**
a)	**Define core of section.**	
Ans.	**Core of a section:** Core of the section is that portion around the centroid in within which the line of action of load must act, so as to produce only compressive stress is called as core of the section. It is also defined as the region or area within which if load is applied, produces only compressive resultant stress**.** If Compressive load is applied, the there is no tension anywhere in the section.	**01 M**
	emax = d/8 e = Core of section	
	 For Circular section  For rectangular section	**01 M**

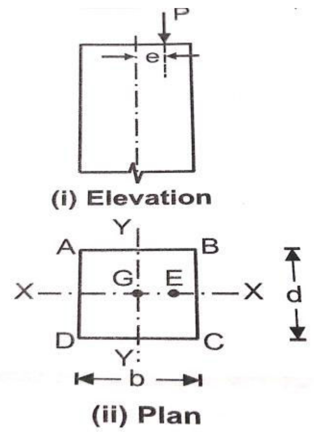
b)	**State the condition for no tension in the column section**	
Ans.	**Condition for no tension in the column section** σo = Direct stress and σ_b= Bending stress ,if $\sigma o > \sigma_b$ the resultant stress is compressive , If $\sigma o = \sigma_b$ the minimum stress is zero and the maximum stress is 2σo, the stress distribution is compressive . but $\sigma o < \sigma_b$ the stress is partly compressive and partly tensile. A small tensile stress at the base of a structure may develop tension cracks. Hence for no- tension condition, direct stress should be greater than or equal to bending stress. $\sigma o >= \sigma_b$ P / A = M/Z P / A = Pxe/Z , e = < Z/A Hence for no –tension condition, eccentricity should be less than Z/A	**01 M** **01 M**
c)	**State expression for deflection of simply supported beam carrying point load at midspan.**	
Ans.	**A simply supported beam of span L carrying a central point load F at midspan**  To find the maximum deflection at mid-span, we set x=L/2 in the equation and obtain ,maximum deflection = Yc $Yc = Y max = F L^3 / 48 EI$	**01 M** **01 M**
d)	**State the values of maximum slope and maximum deflection for a cantilever beam of span 'L' carrying a point load 'W' at the free end . EI = constant**	
Ans.	 Maximum slope = $\theta_B = dy/_{dx\ B} = WL^2/2EI$ Maximum deflection= $Y_B = - WL^3/ 3EI$	**01 M** **01 M**

e)	**Compare a simply supported beam and a continuous beam w.r.t deflected shape of a beam.**	
Ans.	The firm of a curve to which the longitudinal axis of the beam bends after loading is called elastic curve or deflected shape of the beam. In the figure shows the deflected shape for various types of continuous beam. The deflected shape is shown by a dotted curve. Deflected shape simply supported beam and continuous beam  (i) Continuous beam with simply supported ends  (ii) Continuous beam with one end fixed and other simply supportc  (iii) Continuous beam with both ends fixed  (iv) Continuous beam with end span overhanging	**01 M** **01 M** (Any one sketch)
f)	**Write the values of stiffness factor for beams.** **i) Simply supported at both ends** **ii)/fixed at one end simply supported at other end**	
Ans.	**i)** Stiffness factor for a beam Simply supported at both the ends = 3EI /L **ii)** Stiffness factor for a beam fixed at one end and simply supported at other end = 4EI/L	**01 M** **01 M**
g)	**Make the following truss perfect by adding or removing the members, if required as shown in fig. No.1**  **Fig. No. 1**	

<table>
<tr><td>Ans.</td><td>For i) n=5 ,j=4

2j-3 = 2 x 4 – 3 = 5 .since n = 2j-3 hence the frame is Perfect frame
iii) n= 5 ,j=4 , 2j-3 = 2 x 4 – 3 = since n =2j-3 hence the frame is Perfect frame


</td><td>01 M

01 M</td></tr>
<tr><td>Q. 2</td><td>Attempt any THREE of the following:</td><td>12 M</td></tr>
<tr><td>a)</td><td>Explain the effect of eccentric load with sketch w.r.t stresses developed</td><td></td></tr>
<tr><td>Ans.</td><td>Effect of eccentric load: A load whose line of action does not coincide with the axis of a member is called an eccentric load .The distance between the eccentric axis of the body and the point of loading is called an eccentric limit ‘e’. Due to effect of eccentricity axial load causes only direct stress whereas an eccentric load causes direct as well as bending stresses. Direct load is that force which acts at centroidal longitudinal axis of the member. Eccentric load is that force which act away from centroidal longitudinal axis of the member. Thus the resultant stresses due to direct as well as bending stresses in the member


Direct stress = $\sigma 0$, Bending stress = σb

$\sigma 0 = P / A$,$\sigma b = (M \times y) / I$ therefor $\sigma b = M/Z$ But, Resultant stresses =

$\sigma_{direct} + \sigma_{bending}$ $\sigma max = 60 + 6b$,

$\sigma min = 60 - 6b$</td><td>02 M

01 M

01 M</td></tr>
<tr><td>b)</td><td>Explain with expression four conditions of stability of dam.</td><td></td></tr>
<tr><td>Ans.</td><td>1. Condition to prevent Overturning of a dam Stability against Due to
Overturning (P.h/3) < W(b-X)</td><td>01 M</td></tr>
</table>

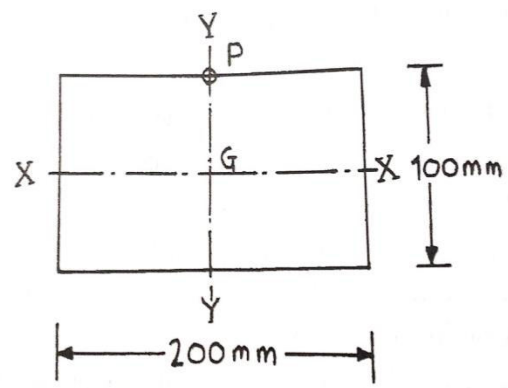
2. Condition to prevent sliding of a dam ,Stability against Due to Sliding P < F P < μ W factor of safety against sliding **01 M**

3. Compression or Crushing of masonry **01 M**

4. Condition to avoid tension in the masonry Stability against No Tension if e < (b/6) Where e = eccentricity **01 M**

P = Compressive Load h = Ht. of dam W =Wt of dam b = Base width of dam

c) **Calculate maximum and minimum stresses at base of a rectangular column as shown in Fig No.2 . It carries a load 200 KN at 'P' on the outer edge of a column. Draw stress distribution diagram.**



Ans.

Solution :-

Area =200 x 100 =

20000 mm^2 P = 200kN

e = 50 mm

M = P x e = 200 x 50 =10000 kN mm **01 M**

I =bd^3/12 = 200x100^3/12 = 16.66x10^6 = mm^4

y = 100/2 = 50 mm.

Where, Stresses

i) 6_0 = P / A = 200x 10^3/ 20000 = 10 N/ mm^2

ii) 6b = (M x y) / I

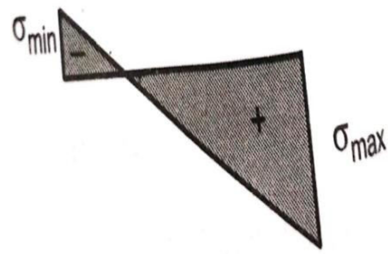
(10000 x 10^3) x 50 / 16.66 x 10^6 = 30.012 N/ mm^2 **01 M**

But, 6max = 60 + 6b , 6min = 60 - 6b

6max = 6_0 + 6b = 10 + 30.012 = 40.012 N/mm^2

6min = 6_0 - 6b = 10 - 30.012 = -20.012 N/mm^2 (Tension) **01 M**

stress distribution diagram as below — 01 M



Stress distribution diagram at base

d) **Calculate the values of direct stress and bending stress at the base of chimney. Write interpretation of obtained values of stresses.**
Use following data

i) External diameter = 3m

ii) Internal diameter = 2m

iii) Height of chimney = 44m

iv) Weight of masonry = 20 kN/m2

v) Co-efficient of wind resistance = 0.60

vi) Wind pressure = 1 kN/m2

Ans.

Solution :

Given = d1= 3m , d2=2m, height of chimney h =44

i) Area of the section = A = (π /4) x $(3^2 - 2^2)$ =3.926 m^2

I xx = I = π /64 $(3^4 - 2^4)$ = 51.05 mm^4

Wind pressure = Þ =1 kN/m^2 =1000 N/m^2

ii) Direct stress on the base σ_0 = W / A

= A x h x ρ = (3.926 x 44 x 20) / A

=880 kN/m^2 — 01 M

iii) section modulus Z = π /32 x $(3^4 - 2^4)/3$=2.127 m^3

iv) Total wind load P =C x Þ x projected area

= 0.6 x Þ x D x h =0.6 x1 x 3 x 44 = 79.2

v) Moment on the base M= P x h/2 =79.2 x 44 /2 =1742.40 kNm

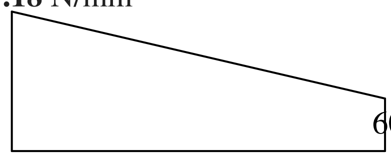
vi) Bending stress on the base section , σb = (M x y) / I

σb = ± M/Z =1742.40 /2.127 = ± 819.18 kN/m^2 — 01 M

σ max = σ0 + σb = 880 + 819.18 = 1699.18 kN/m^2 Comp — 01 M

σ min = σ0 - σb = 880 - 819.18 = 60.82 kN/m^2 Comp

1699.18 N/mm²



Stress distribution diagram at base — 01 M

3. **Attempt any THREE of the following** — **12 M**

a) **Calculate the deflection under point load of a simply supported beam as shown in figure No. 3 Take EI = constant. Use Macaulay's method.**

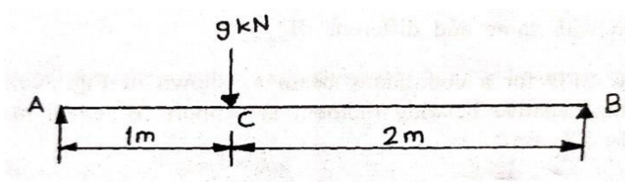
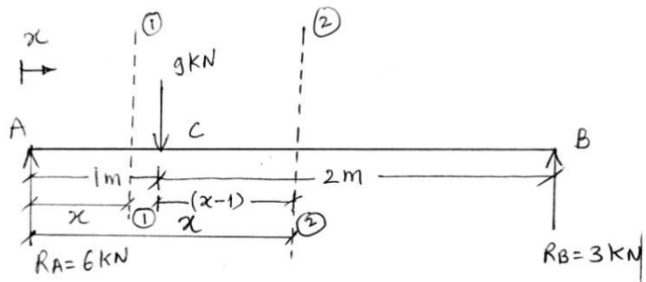


Figure 3

Ans:



1. Calculate support reactions:

Taking moment at B $\sum M_B = 0$

R_A x 3 – 9 x 2 = 0

R_A = 6 kN.   And R_B = 3 kN

Macaulay's method

$EI\frac{d^2y}{dx^2} = M$ --- Differential Equation

$EI\frac{d^2y}{dx^2} = 6x \Big|_{x=1} - 9(x-1)$ — **01 M**

Differentiating with respect to x

$EI\frac{dy}{dx} = \frac{6x^2}{2} + C_1 \Big| - \frac{9(x-1)^2}{2}$ ------------------- Slope Equation

$EIy = \frac{3x^3}{3} + C_1x + C_2 \Big| - \frac{9(x-1)^3}{6}$ ------------------- Deflection Equation

Calculate Constants of Integration C_1 and C_2

Consider boundary condition

1) At x=0, y= 0 putting in deflection equation

$EI\,(0) = 0 + C_1 \times 0 + C_2$

$\mathbf{C_2 = 0}$

2) At x = 3m, y= 0 putting in deflection equation

$EI\,(0) = 3^3 + 3\,C_1 + 0 - \frac{9}{6}(3-1)^3$ **01 M**

$\mathbf{C_1 = -5}$

Putting values of C_1 and C_2 in Slope and Deflection Equation.

$EI\,\frac{dy}{dx} = \frac{6x^2}{2} - 5 - \frac{9(x-1)^2}{2}$ ------------------- Final Slope Equation **01 M**

$EIy = \frac{3x^3}{3} - 5x - \frac{9(x-1)^3}{6}$ ------------------- Final Deflection Equation

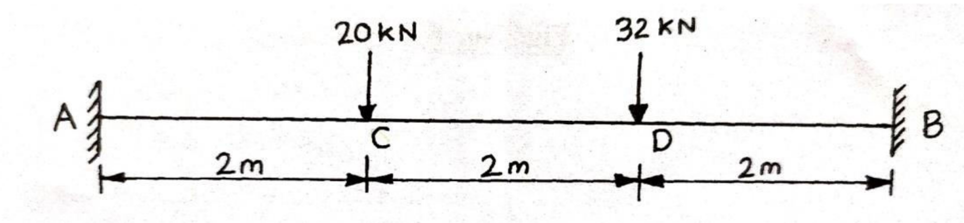
Calculate Deflection under point load

At x = 1m, y = y_c putting in deflection equation.

$EI\,y_c = \frac{3(1)^3}{3} - 5(1) - 9(0)$ **01 M**

$\mathbf{y_c = \frac{-4}{EI}}$

b) **Calculate fixed end moments and draw BMD for a fixed beam as shown in Fig.**



Ans:

Assume beam is simply supported beam and calculate support Reactions.

$\sum M_A = 0$ Clockwise moment positive and Anti clockwise moment Negative

$-R_B \times 6 + 20 \times 2 + 32 \times 4 = 0$

$R_B = 28$ kN

$R_A + R_B$ = Total load = 20+32 = 52

$R_A + 28 = 52$

$R_A = 24$ kN

Calculate BM at C and D for simply supported beam

$M_c = 24 \times 2 = 48$ kN.m and moment at D $M_D = 24 \times 4 - 20 \times 2 = 56$ kN.m **01 M**

Calculate Fixed End Moments

$M_A = M_{A1} + M_{A2} = -\frac{W_1 a_1 b_1^2}{L^2} - \frac{W_2 a_2 b_2^2}{L^2}$

$= -\frac{20x2x4^2}{6^2} - \frac{32x4x2^2}{6^2} = -17.78 - 14.22$ **01 M**

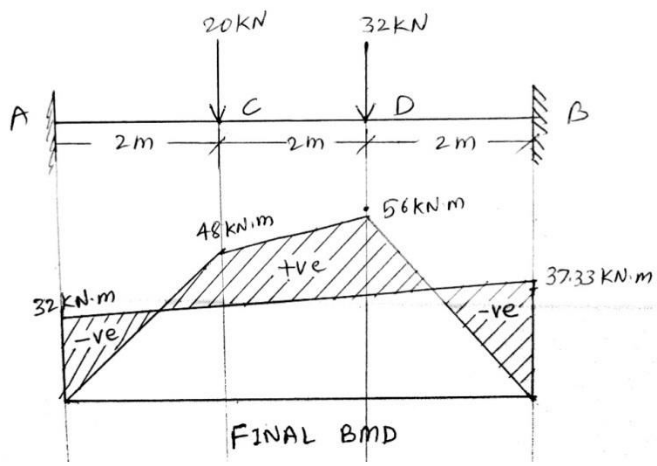
$M_A = -32.0$ kN.m

$M_B = M_{B1} + M_{B2} = -\frac{W_1 a_1^2 b_1}{L^2} - \frac{W_2 a_2^2 b_2}{L^2}$

$= -\frac{20x2^2x4}{6^2} - \frac{32x4^2x2}{6^2} = -8.89 - 28.44$ **01 M**

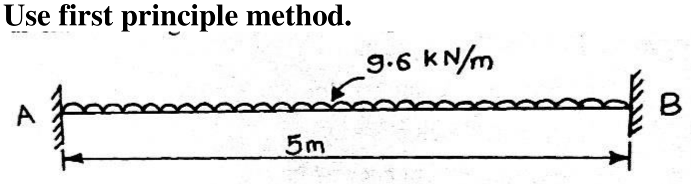
$M_B = -37.33$ kN.m

Draw final BMD for simply supported beam and fixed beam by overlapping each other



01 M

c) **Calculate fixed end moments and Draw BMD for a beam as shown in Fig. No. 5. Use first principle method.**



Ans:

1. Assume beam is simply supported beam and calculate simply supported BM.

Mmax = $M_{AB} = \frac{wL^2}{8} = \frac{9.6x5^2}{8} = 30.0 kN.m$ **01 M**

2. Calculate Fixed end Moments

   $M_A + M_B = \frac{-2a}{L}$

   a = Area of SS BM dia. = area of Parabola = 2/3 bh

   a = 2/3 x 5 x 30 = 100 kN.m

   $M_A + M_B = \frac{-2x100}{5} = -40$ --------------- (I) and $M_A + 2M_B = \frac{-6ax}{L^2}$

x = C.G. of SS BM = 5/2 = 2.5m

$M_A + 2M_B = \frac{-6x100x2.5}{5^2}$ = -60 --------------- (II) **01 M**

Solving Two Simultaneous Equations I and II **01 M**

M_A = -20 kN.m M_B = -20 kN.m

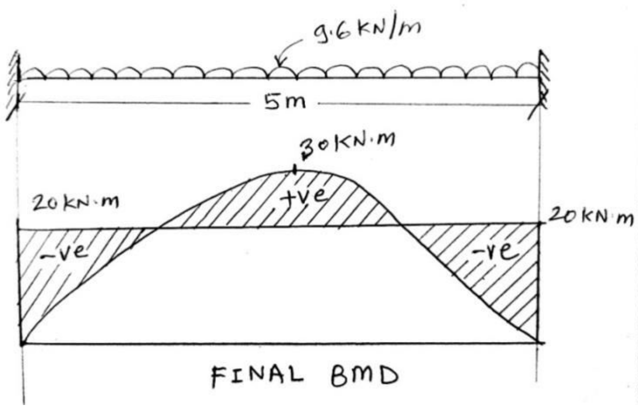
OR

Note: Fixed end moments can be calculated by using standard formula as formula is Derived using First Principle, hence if students solve problem using formula appropriate Marks shall be given

$$M_{AB} = -\frac{wL^2}{12} = -\frac{9.6x5^2}{12} = -20.0 kN.m$$

$$M_{BA} = \frac{wL^2}{12} = +\frac{9.6x5^2}{12} = +20.0 kN.m$$

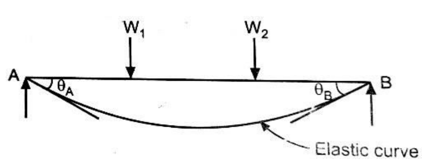
3. Draw Final BM diagram by overlapping simply supported BM and Fixed end BM.



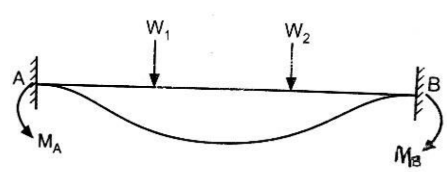
01 M

d) i) **Explain with sketch the effect of fixity on bending moment of a beam.**

Ans: If simply supported beam is considered subjected to any pattern of loading, beam bends and slopes will developed at the ends. If however, the ends of beam is firmly built in supports i.e. ends are fixed, slopes at the supports are zero. Fixity at ends induces end moments. Due to fixity, deflection of beam at center of beam is also reduced as compared to simply supported beam. **01 M**

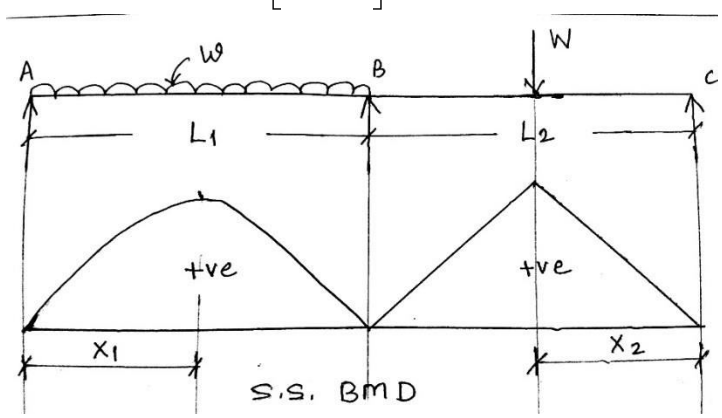


Simply supported beam

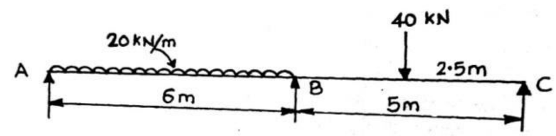


Fixed Beam

01 M

(ii)	**State two advantages of fixed beam over simply supported beam.**	
Ans:	1. End slopes of fixed beam are zero 2. A fixed beam is more stiff, strong and stable than a simply supported beam. 3. For the same span and loading, a fixed beam has lesser values of bending moments as compared to a simply supported beam. 4. For the same span and loading, a fixed beam has lesser values of deflections as compared to a simply supported beam.	**02 M for any 2**
Q.4.	**Attempt any THREE of the following**	**12**
a)	**State Clapeyron's theorem of three moments for continuous beam with same and different EI**	
Ans:	The claperon's theorm of three moment is applicable to two span continuous beams. It state that " For any two consecutive spans of continuous beam subjected to an external loading and having uniform moment of inertia, the support moments M_A, M_B and M_C at supports A,B and C respectively are given by following equation $M_A + 2M_B(L_1 + L_2) + M_C L_2 = -\left[\frac{6A_1X_1 -}{L_1}\right] - \left[\frac{6A_2X_2}{L_2}\right]$  If the moment of inertia is not constant then claperon's theorem can be stated in the form of following equation. $M_A \frac{L_1}{I_1} + 2M_B\left(\frac{L_1}{I_1} + \frac{L_2}{I_2}\right) + M_C \frac{L_2}{I_2} + M_C \frac{L_2}{I_2} = -\left[\frac{6A_1X_1}{L_1I_1} + \frac{6A_2X_2}{L_2I_2}\right]$ Where , L_1 and L_2 are length of span AB and BC respectively. I_1 and I_2 are moment of inertia of span AB and BC respectively. A_1 and A_2 are area of simply supported BMD of span AB and BC respectively. X_1 and X_2 are distances of centroid of simply supported BMD from A and C respectively.	**01 M** **01 M** **01 M** **01 M**

b) **Draw SFD or a continuous beam as shown in Fig. No. 6 having negative bending moment at support 'B' equal to 66.14 kN.m Fig. No. 6**



Ans: Calculate the support reactions

Clockwise moment positive and Anti clockwise moment Negative

Consider Span AB Taking moment at B $\sum M_B = 0$

R_A x 6 – 20 x 6 x 3 + 66.14 = 0

R_A = 48.976 kN.

Consider Span BC Taking moment at B $\sum M_B = 0$

-R_C x 5 + 40 x 2.5 - 66.14 = 0

R_C = 6.772 kN

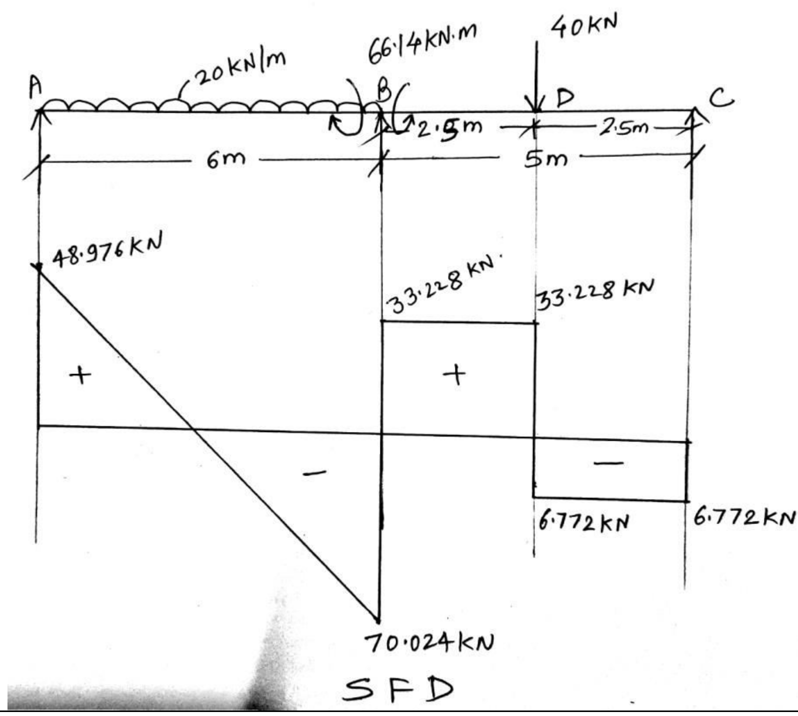
$\sum F_y = 0$

R_A+R_B+R_C -20x6 – 40 = 0

48.976+R_B+6.772 = 160

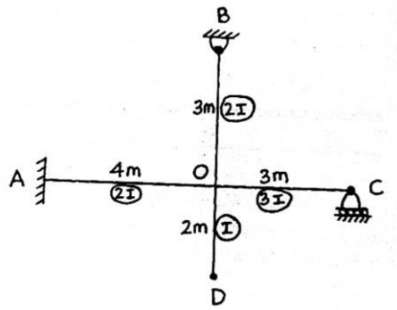
R_B = 104.252 kN **01 M**

1. **S.F. Calculations:**
   SF at A, just left =0 and Just Right = +48.976 kN.
   SF at B, just left = +48.976-20x6 = -71.024 kN.
   Just Right = -71.024 + 104.252 = + 33.228 kN **02 M**
   SF at D, just left =+ 33.228 kN Just Right = + 33.228 -40 = -6.772 kN
   SF at C, just left = -6.772 kN Just Right = -6.772 kN + 6.772 kN = 0



01M

c) **Calculate distribution factors for the members OA, OB, OC and OD for the joint 'O' as shown in Fig. No. 7.**



Ans:

Joint	Member	Stiffness Factor	Total stiffness	Distribution Factor	
O	OA	$K_{OA} = \frac{4EI}{L} = \frac{4E(2I)}{4} = 2EI$	$\sum K_O = 2EI + 2EI + 3EI = 7EI$	$DF_{OA} = \frac{2EI}{7EI}$ **DF_{OA}=0.286**	**01 M for each D.F.**
	OB	$K_{OB} = \frac{3EI}{L} = \frac{3E(2I)}{3} = 2EI$		$DF_{OB} = \frac{2EI}{7EI}$ **DF_{OB} = 0.286**	
	OC	$K_{OC} = \frac{3EI}{L} = \frac{3E(3I)}{3} = 3EI$		$DF_{OC} = \frac{3EI}{7EI}$ **DF_{OC}=0.428**	
	OD	K_{OD}= 0		**DF_{OD}=0**	

d) **Calculate support moments and Draw BMD of a beam as shown in Fig. No. 8. Use moment distribution Method.**

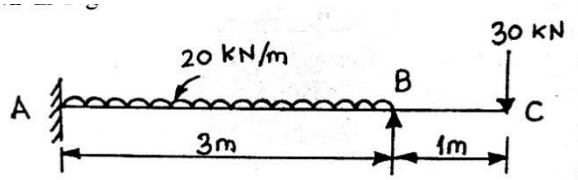


Fig. No. 8

Ans:

1. Calculate simply supported BM for span AB

$$m_{AB} = \frac{wL^2}{8} = \frac{20x3^2}{8} = 22.5kN.m$$

2. Calculate Fixed end Moment for span AB

$$M_{AB} = -\frac{wL^2}{12} = -\frac{20x3^2}{12} = -15kN.m$$

$$M_{BA} = \frac{wL^2}{12} = +\frac{20x3^2}{12} = +15kN.m$$

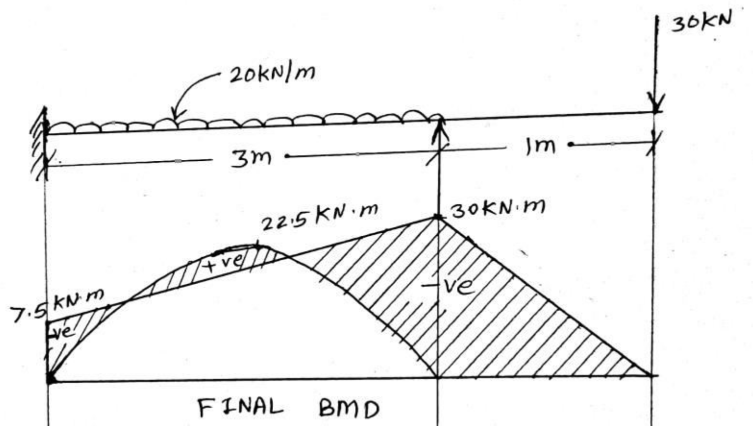
01 M

M_{BC} = - 30 x 1 = -30 kN.m

Distribution factor DF_{BA} = 1.0, DF_{BC} = 0 as it is overhang

A	B		C	Joint
AB	**BA**	**BC**	**CB**	Member
	1.0	**0**		Distribution factor
-15	+15	-30	0	Fixed end moments
	+15			Balancing at B
+7.5				Carryover to A
-7.5	**+30**	**-30**	**0**	Final Moments

Table 02 M

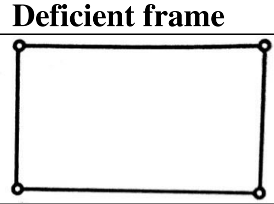


01 M

e) **Draw one Sketch of the following.**

(i) **Deficient frame**

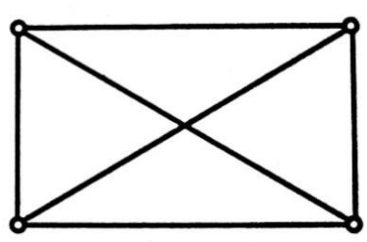
Ans:



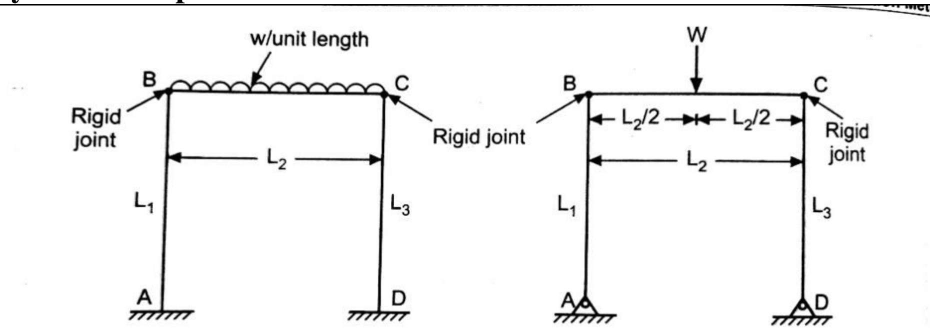
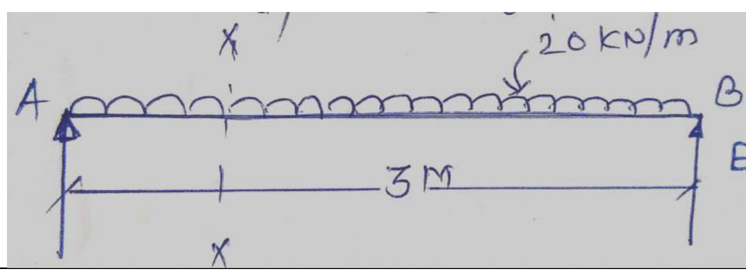
01M

(ii) **Redundant frame**

Ans:



01 M

(iii)	**Symmetrical portal frame**	
Ans:	 **(i) Symmetrical portal frame fixed at the base** **(ii) Symmetrical portal frame simply supported (hinged) at the base**	**Any 01 one mark**
(iv)	**Unsymmetrical portal frame**	
Ans:	 **(i) Unsymmetrical portal frame hinged at the base** **(ii) Unsymmetrical portal frame one end fixed, other hinged** **Note-** Other than these above sketches if any relevant sketch is drawn, the marks are given accordingly.	**Any 01 one mark**
Q.5.	**Attempt any TWO of the following**	**12 M**
a)	**Calculate Maximum Deflection of Simply Supported Beam as Shown In Fig no-9. take E=200gpa I=2x 10^8 Use Macaulay's Method.** 	
Ans:	Given :- E=200 GPA =200x10^3 =N/mm^2 E =200x10^3 =2x10^8 KN/m^2 I=2x10^8= mm^4 I=2x10^{-4} m^4 **1)Find support Reaction**	**01 M**

RA = RB=Wl/2 =20X3/2 =30KN

2)Find slope &deflection

EI d^2y/dx^2 = M -Differential equation

Taking moment at section X-X, and at distance x from A

$EI\, d^2y/dx^2 = 30x \;\Big|\; - 20x^2/2$

$EI\, d^2y/dx^2 = 30x \;\Big|\; -10x^2$

Integrating w. r to x

$EI\, dy/dx = 30\, x^2/2 + C1 \;\Big|\; -10x^3/3$

$EI\, dy/dx=15x^2+C1 \;\Big|\; -3.33x^3$ _______slope equation **01 M**

Again integrating w.r to x

$EIy=15x^3/3+C1x + C2 - 3.33\, x^4/4$

$EIy=5x^3+C1x + C2 -0.832\, x^4$ __________ Deflection equation **01 M**

To find C2

Boundary condition

x=0 Y=0 put in **Deflection Equations**.

E1(0) =5(0) +c1(0)+c2- 0.83(0)4

C2=0

To find C1

Boundary condition

At x=3 y=0 put in deflection equation

$0=05(3)3+c1x3+0 - 0.832^* 3^4$

3C1=67.608

C1= -22.53 **01 M**

Put this value in Deflection equation

$EIy= 5x^3-22.53\, x -0.832x^4$

To find Maximum Deflection

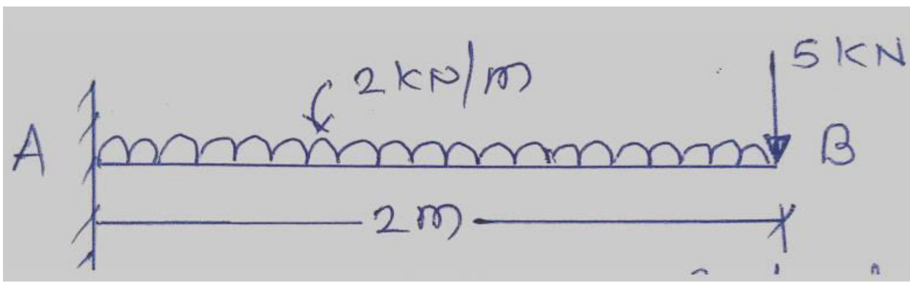
Put x=L/2 = 3/2 = 1.5 m

$EIY =5(1.5)^3-22.53 * 1.5 -0.832(1.5)^4$

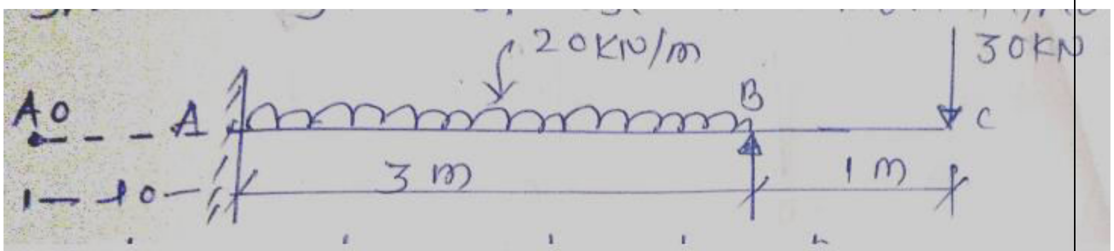
EIY= -21.132 **01 M**

E=200 GPA =200x10^3 =N/mm^2

E =200x10^3 =2x10^8 KN/m^2 (note:- W is in KN/m and L is in m.)

	$I=2x10^{8}=mm^{4}$ **$I=2x10^{-4}m^{4}$** Y= -21.132/EI $= 21.132/ (200x10^{-4} * 200x10^{8})$ **Y max = 0.0005288 m=0.000528m** **Y max=0.528 mm (- ve indicate downward deflection)**	**01 M**
b)	**Calculate Maximum Slope & Maximum Deflection Of A Cantilever Beam As Shown In Fig** 	
Ans:	Given :- $E=100\ GPA=100X10^{3}\ N/mm^{2}$ Width =100 mm ,depth=200mm $I=bd^{3}/12 =100*(200)^{3}/12 =66.66X10^{6}$ Maximum deflection =Deflection due to UDL+ deflection due to point load YB=yB1+yB2 $Yb1=-WL^{4} / 8EI = (-2X(2000)^{4}) / (8X100 * 10^{3} * 66.66X10^{6})$ **=-0.600 mm** $Yb2 = - WL^{4}/ 3EI = (-5000X(2000)^{3})/ (3*100*66.66*10^{6}*10^{3})$ **= -2.01 mm** YB = YB1+YB2 = -(0.6+2.01) = **-2.6 mm** maximum slope = slope due to UDL + slope due to point load $\theta = \theta 1+ \theta 2$ $\theta 1 = W L^{3} /6 EI = (2*2000^{3}/6*100*10^{3}* 66.66X10^{6})$ **=0.0004 Radian** $\theta 2 = W L^{2} /2 EI = (5000*2000^{2}/2*100X10^{3} * 66.66*10^{6})$ **=0.0015 Radian** θ = 0.0004+0.0015=**0.0019 Radian** **deflection Maximum =2.6mm (-ve indicates the downward deflection)** **Maximum slope =0.0019 Radian**	**1M** **1M** **1 M** **1M** **1M** **1 M**

c) **Calculate Support Moments For A Beam As Shown In Fig No-08 .**
Use Three Moment Theorem.



Ans: TO find support moments and reactions

B.M at mid span AB = $WL^2 / 8 = 20(3)^2 /8$

= **22.5 KN.M**

Consider the cantilever action point BC

MB = -30X1 **= -30KNm**

Since the end A is fixed assume as imaginary span A-AO at left of A — **01 M**

For span AO - A

6 ao* o / L0 = 0

Span AO A B

A1 = Area Of A Diagram =(2/3) * 3 * 22.5 **= 45**

X1= centroidal distance of a diagram =3/2 = **1.5m**

A1 X1 = 45*1.5 **= 67.5** — **01 M**

Applying clapeymn's theorem of three moment for span A Ao & AB we get

Mo L0+2MA (Lo+L1) +MBL1 =-[6a0X0/ Lo + 6a1x1 /L1] — **01 M**

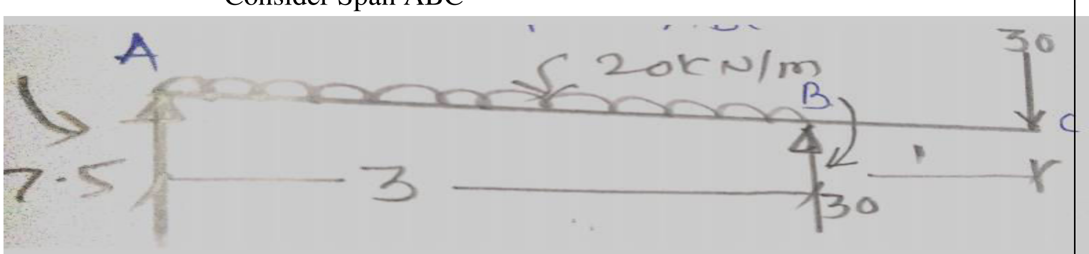
0+2MA (0+3) +(-30) (3) = [0+6X67.5/3]

6 MA -90 =-135

6 MA = -135+90=-45 — **01 M**

MA=-7.5 KN-m

Consider Span ABC



Take moment @ a

O=20*3*1.5+30+30*4 -RB*3 — **01 M**

RB*3 = 240 **RB=80KN**.

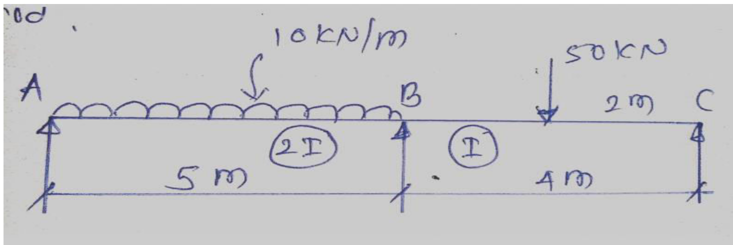
∑ fy = 0

0 =RA+RB-20X3-30

0=RA+80-60-30 — **01 M**

RA= 10KN

Q.6.	Attempt Any Two of the following	12 M
a)	calculate support moment for a spam as shown in fig no.11 Use moment distribution method	



Ans:

Solution :- Assume span AB & BC as a fixed beam and find fixed end moment

M AB = - $WL^2/12$ =-10(5)^2/12= -20.83 KN-m

M BA = $WL^2/12$ =10(5)^2/12= 20.83 KN-m

M BC = $-Wab^2/L^2$ = $50(2)(2)^2/4^2$ = -25 KN-m

M CB = + Wab^2/L^2 = $5*2*2^2/4^2$ = 25 KN-m **01 M**

To find the Stiffness factor at joint B

K BA = 3EI/L AB = 3E(2I)/5=6EI/5=**1.2 EI**

K BC = 3EI/LBC = 3EI/4 = **0.75 EI**

∑K=1.2EI+0.75EI=**1.95 EI**

Distribution Factor **01 M**

DFBA=KBA/∑K =1.2EI/1.95EI=**0.62**

DFBC = KBC/∑K =0.75EI/1.95EI =**0.38**

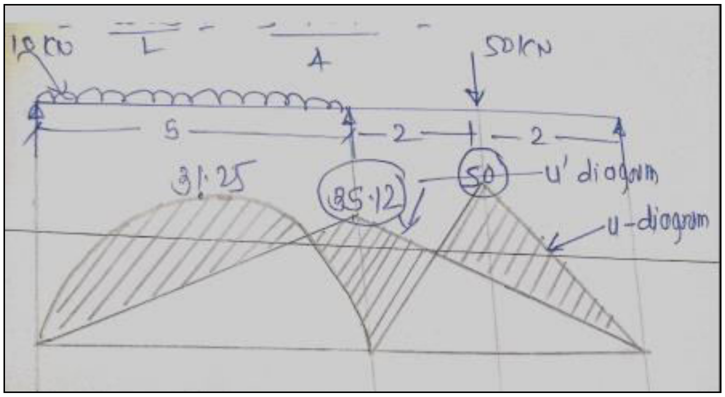
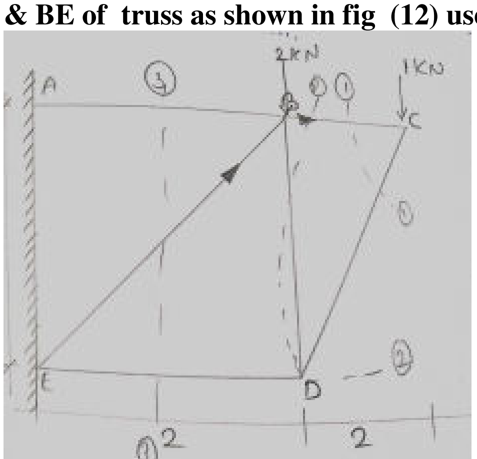
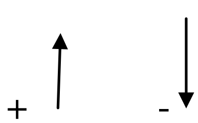
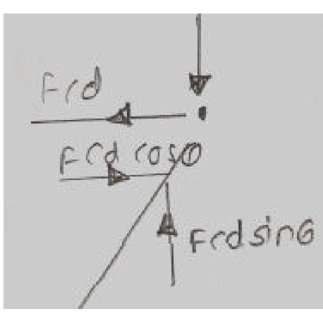
Point	A B	C
Member	AB BA	BC CB
Distribution factor	0.62	0.38
Fixed end moment	-20.83 20.83	-25 25
Release support A& C and then carry over from A to B from C to B	+20.83 → 10.415	-25 → -12.5
Initial moment	0 31.245	-37.5 0
Ist distribution C balance B	+3.87	+2.37
Final moment	+35.12	-35.12

02 M

Assume span AB and BC to be simply supported beam and find free BM.

For span AB L=5m W=10KN/m

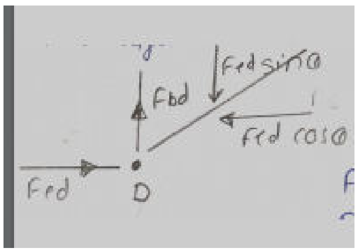
M max =$wl^2/8$ =$10*(5)^2/8$ =**31.25 KN.m**

	For span BC SPAN BC =4m ,a=2m b=2m w =50 kn = wab/L =50*2*2 /4 =**50kn-m** 	**02 M**
b)	**Calculate magnitude& state the nature of forces in the member AB,BC,CD,DE,BD & BE of truss as shown in fig (12) use method of section** 	
Ans:	Consider △ CBD tan θ =2/2 =45 θ **=45** Consider section (1)-(1) cut at BC & CD (joint C)   ∑FY=0 0 =-1+Fcd sin θ Fcd sin θ =1	

Fcd=1.41 KN (C)

∑FX=0
0= Fcd cos θ - Fcb
Fcb = Fcd cos θ
= 1.41 cos 45
=0.997
= *1KN(T)* **02 M**

Consider section (2)-(2) cut at CD,BC,ED
Consider right hand side

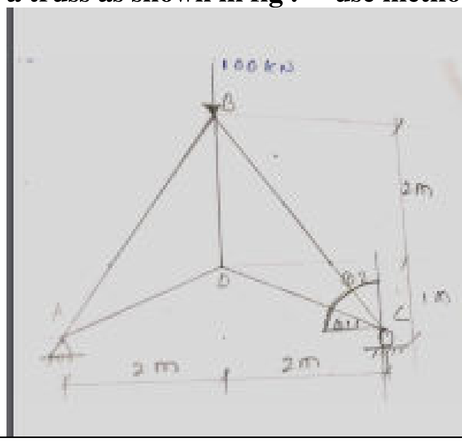
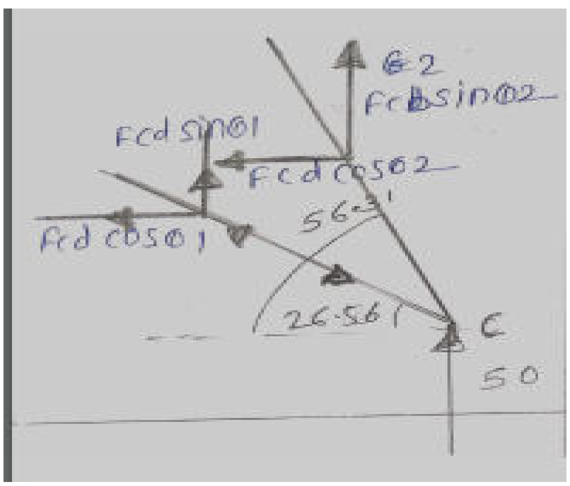


∑ fy=0 **02 M**
0=-1-Fcd sin θ +Fbd
Fbd=1+Fcd sin 45
Fbd=2(T)

∑fx=o
0= - Fcd cos θ +Fed
1.41 cos 45 =Fed
Fed =1.41 cos 45
Fed= 1 kN(c)

Consider section (3)-(3), take moment at @ A
0=Fbe cos 45 +Fed *2 +2*2+1*4
10 = 1.41 Fbe
F be =7.092 (-ve indicate compressive) **01 M**
∑fx=o
0= -fab+feb cos45 +fed
Fab =7.092X COS 45 +1
Fab =6.014 (T) **01 M**

MEMBER	FORCE (KN)	NATURE
AB	6.014	TENSION
BC	1	TENSION
CD	1.41	COMPRESSION
DE	1	COMPRESSION
BD	2	TENSION
BE	7.092	COMPRESSION

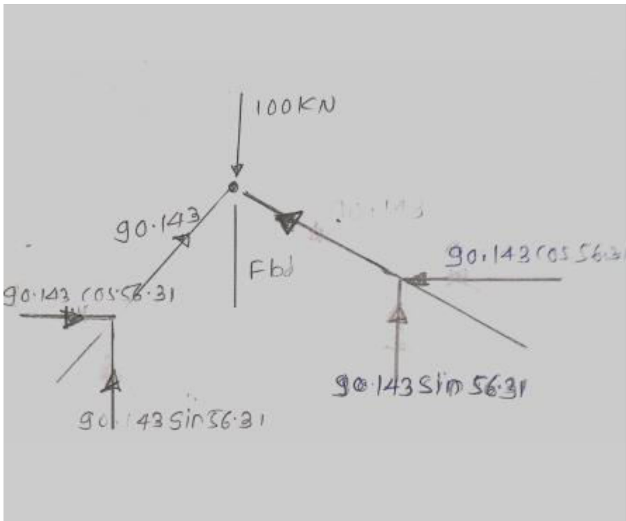
c)	**calculate magnitude &state the nature of forces in member AB,BC,CD,AD&BD Of a truss as shown in fig . use method of joints.**  	
Ans:	∑ fy =0 RA+RC =100, due to symmitricity RA=RC=W/2=100/2 = 50KN Consider joint C θ 1 = tan θ 1 =1/2 θ2=tan θ 2 =3/2 θ 1 =26. 56 θ2=56.31 **Consider Joint C**  ∑Fx= 0 fcd cos θ 1 +fcb cos θ 2= 0 0.8944 fcd +0.55fcb= 0 ____________________1 ∑ fy =0 0= 50+fcd sin θ1 + fcb sin θ2 -50= fcd sin θ1 + fcb sin θ2 -50=0.4471fcd+0.832 fcb ______________________2	**01 M**

Solving both equation 1& 2, We get

Fcd=   55.91 KN   (T)

Fcb = -90.143 KN   (C) **02 M**

Consider Joint B



02 M

∑FY =0

0= Fbd -100+90.143 sin 56.31+90.143sin56.31 **01 M**

Fbd= 50 KN

MEMBER	FORCE in KN	NATURE
AB	90.143	COMPRESSION
BC	90.143	COMPRESSION
CD	55.91	TENSION
AD	55.91	TENSION
BD	50.00	COMPRESSION