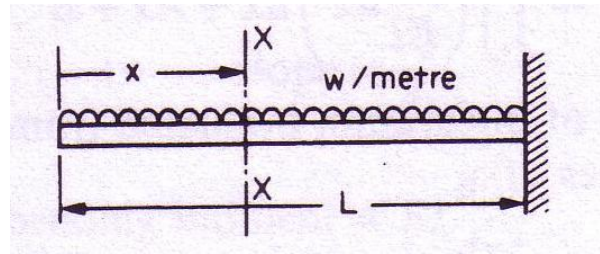


3)



a) Given the above diagram, and using the relationship, $M = EI \frac{d^2y}{dx^2}$, show that the deflection, y , at any point on the beam is given by;

$$y = \frac{1}{EI} \left[-\frac{Wx^4}{24} + \frac{WL^3x}{6} - \frac{WL^4}{8} \right]$$

[10 marks]

b)

i)

A 5m long cantilever beam carries a uniformly distributed load of 0.2 kN/m. What is the minimum flexural stiffness required to limit the central deflection to 2mm neglecting the weight of the beam?

[5 marks]

ii)

If the beam were to be made out of Aluminium ($E=69\text{GPa}$) what would the minimum second moment of area be?

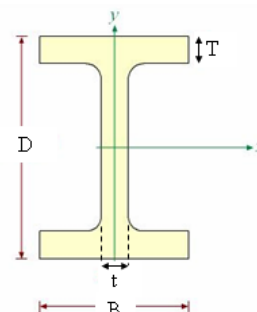
[1 mark]

iii)

Hence choose the lightest suitable beam from the below table assuming the beam is loaded about the x axis. What would the weight of this beam be over the length required?

[4 marks]

Size D x B (mm)	Mass per metre (kg)	Thickness		I_{xx} (cm^4)	I_{yy} (cm^4)
		Web, t (mm)	Flange, T (mm)		
910.3 x 304.1	222	15.9	23.9	375924	11223
840.7 x 292.4	194	14.7	21.7	279450	9069
762 x 266.7	173	14.3	21.6	205177	6846
677.9 x 253.0	125	11.7	16.2	118003	4379
617.5 x 307.0	113	14.1	23.6	151631	11412
533.1 x 209.3	92	10.2	15.6	55353	2392
467.4 x 192.8	98	11.4	19.6	45717	2343
457.2 x 151.9	67	9.1	15	28577	878
402.3 x 142.4	46	6.9	11.2	15647	539
364 x 173.2	67	9.1	15.7	19522	1362
352.8 x 126.0	39	6.5	10.7	10087	357
310.9 x 166.8	54	7.7	13.7	11710	1061
312.7 x 102.4	33	6.6	10.8	6487	193
254 x 101.6	22	5.8	6.8	2867	120
203.2 x 133.4	25	5.8	7.8	2356	310



4)

a)

In the context of complex stress, explain what is meant by the terms 'Principal Stress' and 'Principal Plane'?

[3 marks]

b)

At a given section a shaft is subjected to a bending stress of 10MPa and a shear stress of 30MPa.

i) Using the graph paper provided Draw Mohrs circle to represent the above condition.

[5 marks]

Hence determine;
ii) The principal stresses and the position of the planes on which these act.

[4 marks]

iii) The maximum shear stress and the plane on which this acts

[2 marks]

iv) Determine the tensile stress, which acting alone would produce the same maximum shear stress.

[3 marks]

v) Determine the shear stress, which acting alone would produce the same maximum principal stress.

[3 marks]

[REMEMBER TO ATTACH ANY GRAPH PAPER USED TO YOUR ANSWER BOOKLET]

Graph paper for question 4,b,i

