Subject:	Mechanics of Materials-I	**End Term Exam KEY**
Time Allowed: 2 hours	Max. Marks: 40	Session 2008
Name:_____	Reg.# 2008-EP-_____	Date: 09-01-2010

Note: Attempt all questions. E = 200 GPa For Steel.

1 (a) Determine moment of Inertia (I_y) along Y-Axis for the area shown in **Fig (1a)**.

The X-section can be considered as three composite
rectangular areas A, B & D as shown

Rectangle A & D:

$$I_y = \frac{1}{12}(300\text{ mm})(100\text{ mm})^3 + (100\text{ mm})(300\text{ mm})(250\text{ mm})^2$$
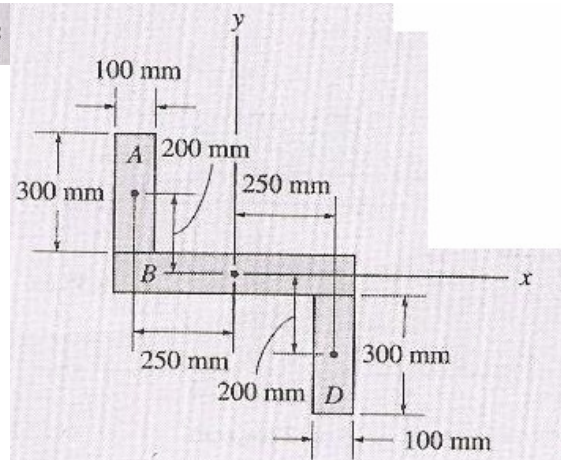
= **1.90 * 10^9 mm^4**

Rectangle B :

$$I_y = \frac{1}{12}(100\text{ mm})(600\text{ mm})^3$$

= **1.80 * 10^9 mm^4**

so,

$$I_y = 1.90(10^9) + 1.80(10^9) + 1.90(10^9)$$
$$= 5.60(10^9)\text{ mm}^4 \qquad \textbf{Ans.}$$

1 (b) If the magnitude of the couples required to bend the steel strip is 4.32 * 10^{-3} N. m
into a circle of 20 mm diameter without resulting permanent deformation, then find the
width "w" of the strip as shown in **Fig. (1b)**.

DATA:
M = 4.32* 10^{-3} N.m
d = 20 mm = 20 * 10^{-3} m OR r = 10 * 10^{-3} m
w =?
h = 0.12 mm OR 0.12 * 10^{-3} m
From Appendix: For steel E = 200 GPa.

Solution:
Flexure formula: M / I = E / r ------------- (1)
Since, I = wh^3 / 12
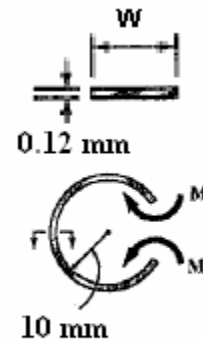
(1) ➔ 12M / wh^3 = E / r
  ➔ 12M r / E h^3 = w
  ➔ w = 12 *4.32* 10^{-3} N.m *10 * 10^{-3} m / 200 GPa * (0.12 * 10^{-3} m)^3
  ➔ **w = 0.15 m   Ans.**

Fig. (1b)

2 (a) from the table in appendix the column's
Area = A= 5890 mm ^{2}, I_x = 45.5 * 10 ^{6} mm ^{4}, I_y = 15.3 * 10 ^{6} mm ^{4}
By inspection buckling will occur about Y – Axis.
So, P_{cr} = π^2 EI / (ZL) ^{2} = 1887.6 KN
Now, σ_{cr} = P_{cr} / A = 320.5 MPa.
Since this stress exceeds the yield stress of steel (250 MPa), the load P is determined from simple compression.

250 MPa = P / 5890 mm ^{2}
➔ **P = 1472.5 KN.** **Ans.**

2 (b) Flexure Rigidity = E I = 80 * 10 ^{9} N-mm ^{2} = 80 * 10 ^{9} * (10 $^{-3}$) ^{2} N-m ^{2}
Y = 5 WL^4 / 384 E I = 5 * 2 * 4 ^{4} / 384 * 80 * 10 ^{9} (10 $^{-3}$) ^{2} = **83.3 *10 $^{-3}$ m**
Derivation: **AS in Class**.

Q#3 Draw shear force & bending moment diagrams for the beam shown in **Fig. (3)** & locate the point of maximum bending moment.
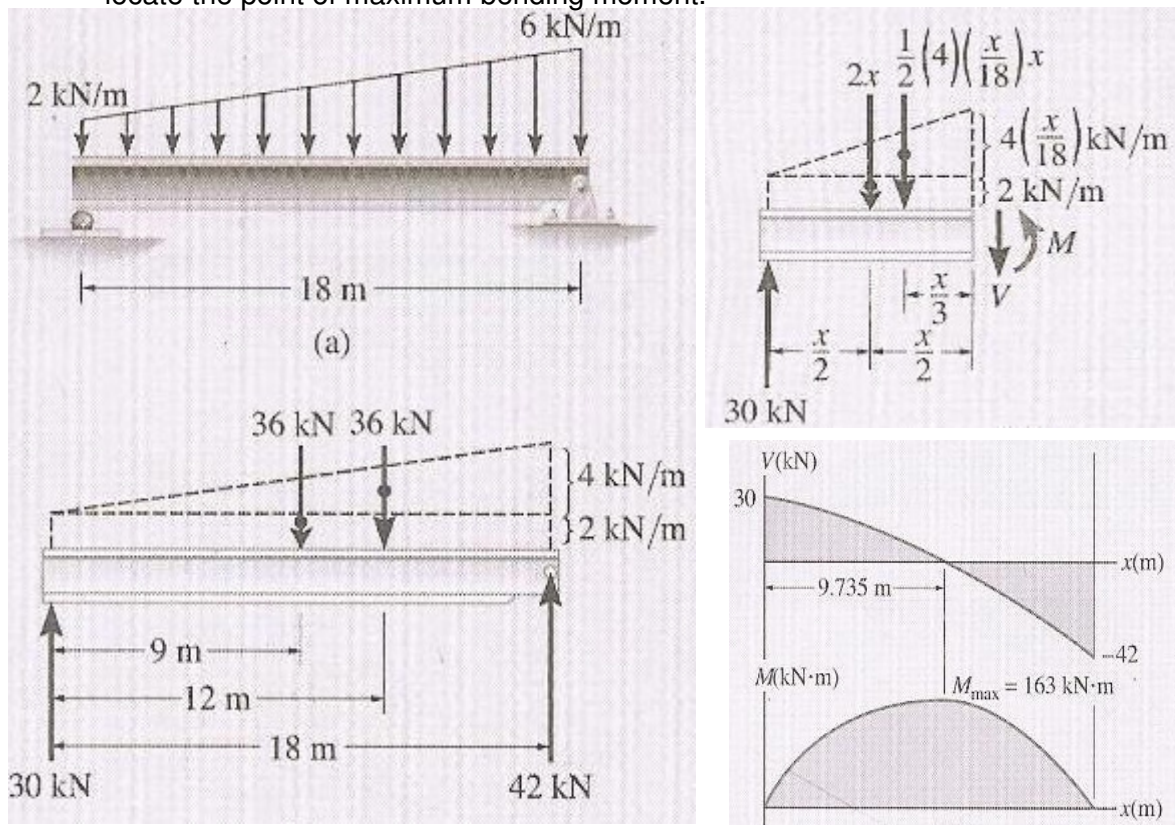
Q#4 **(a)** Derive the relation for crippling load using Euler's Theorem of Columns. Assuming that the column is pinned connected at its ends.
(b) Define**:** Perpendicular axis theorem, Bifurcation point, Section modulus & Deflection of beam.

AS IN CLASS LECTURE.