Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: **Theory of Structures (2)**
Course Code : **CIV 202**

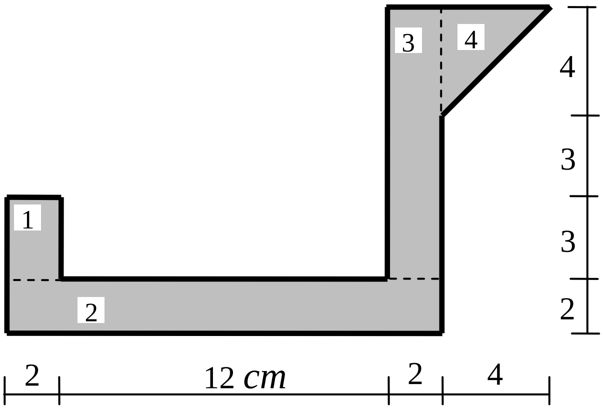
Academic Year : **2016-2017**
Semester : **Second**
Level : **2nd**
Time : **1½ Hours**
Date : **25 / 3 / 2017**
Examiner: ***Dr. M. Abdel-Kader***

Answer of Mid-Term Exam

- The Exam consists of **2** questions in **1** page.

Question (1): (10 Marks)

For the shown cross-section, determine the following:
(a) The location of the centroid.
(b) The moments of inertia about the centroidal axes.
(c) The direction of the principal axes.
(d) The principal moments of inertia.
(e) The polar moment of inertia.
(f) The radius of gyration about the centroidal *x*-axis.



Answer:

Element	*b*	*h*	*A*	*x*	*y*	*A x*	*A y*	*x-xb*	*y-yb*	I_x	$A(y\text{-}yb)^2$	I_y	$A(x\text{-}xb)^2$	*Ixcyc*	I_{xy}
1	2	3	6.00	1.00	3.50	6.00	21.00	-9.62	-0.72	4.50	3.09	2.00	554.82	0.00	41.38
2	16	2	32.00	8.00	1.00	256.00	32.00	-2.62	-3.22	10.67	331.21	682.67	219.02	0.00	269.33
3	2	10	20.00	15.00	7.00	300.00	140.00	4.38	2.78	166.67	154.88	6.67	384.36	0.00	243.99
4	4	4	8.00	17.33	10.67	138.67	85.33	6.72	6.45	7.11	332.77	7.11	360.96	3.56	350.13
			66.00			700.67	278.33			188.94	821.94	698.44	1519.16		904.84

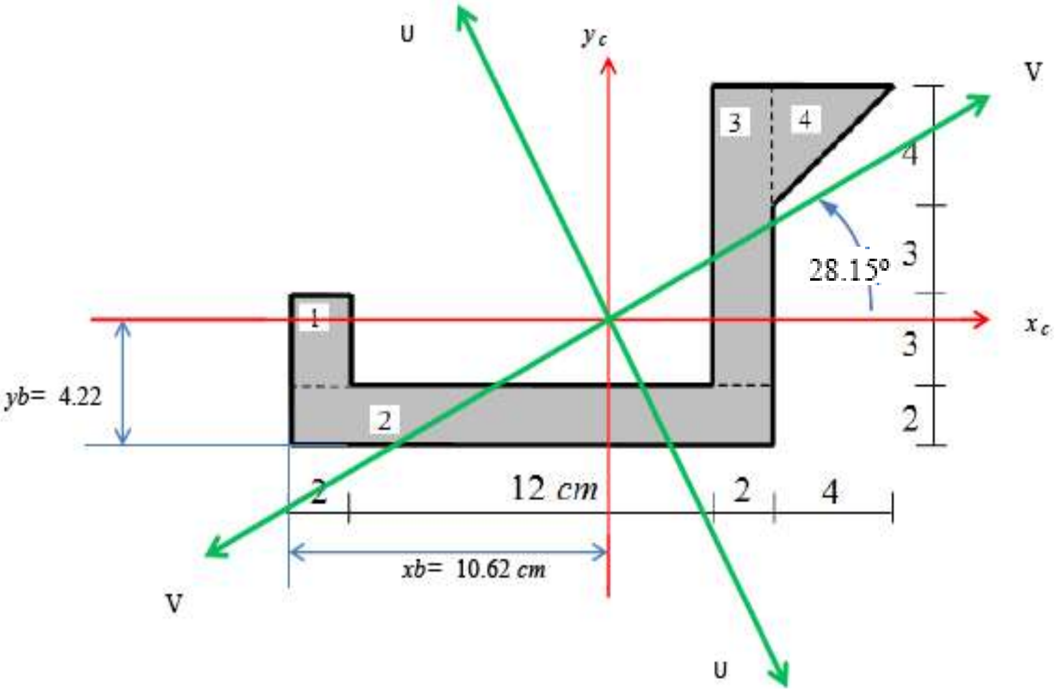
a) $xb=$ 10.62 *cm*
$yb=$ 4.22 *cm*

b) $I_x=$ 1010.89 cm^4
$I_y=$ 2217.61 cm^4

c) tan (2 Theta 1.499658
2 Theta = 56.30
Theta = 28.15

d) $I_u=$ 2701.80 cm^4
$I_v=$ 526.70 cm^4

e) The polar moment of inertia = I_x+I_y = 3228.50 cm^4
f) Radius of gyration i_x = $\sqrt{I_x / A}$ = 3.91 *cm*
Radius of gyration i_y = $\sqrt{I_y / A}$ = 5.80 *cm*



With my best wishes
Dr. M. Abdel-Kader

Question (2): (10 Marks)

A bar of variable cross-section is subjected to axial loads as shown.

(a) Determine the maximum safe value of ***P***.

(b) Determine the deformation of the **Bronze** part **only** due to ***P*** calculated in (a).

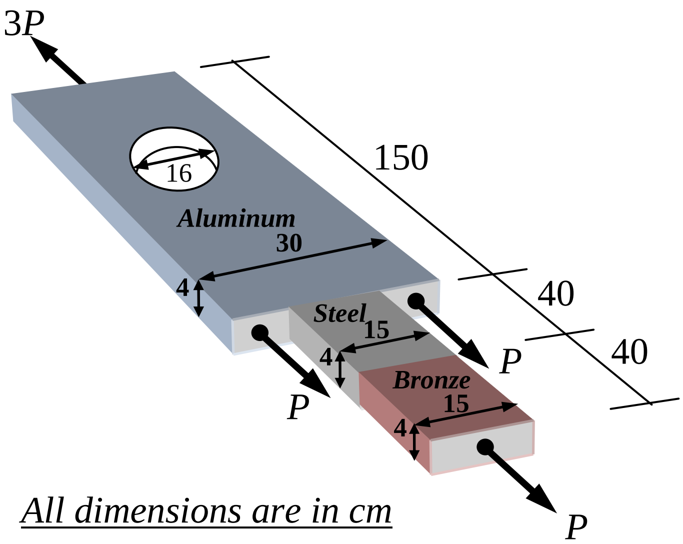
Given Data:

Allowable stress for bronze = 100 *MPa*

Allowable stress for steel = 140 *MPa*

Allowable stress for aluminum = 90 *MPa*

E =11.2 *GPa*



All dimensions are in cm

Answer:

(a)

For bronze:

$$\sigma_{bronze} = \frac{P_{bronze}}{A_{bronze}} \leq 100\ N/mm^2 \rightarrow \frac{P}{150\times 40} \leq 100 \qquad \therefore\ P \leq 600000\ N \quad \ldots(1)$$

For steel:

$$\sigma_{alum} = \frac{P_{alum}}{A_{alum}} \leq 140\,N/mm^2 \rightarrow \frac{P}{150\times 40} \leq 140 \qquad \therefore\ P \leq 840000\ N \quad \ldots(2)$$

For aluminum:

$$\sigma_{steel} = \frac{P_{steel}}{A_{steel}} \leq 90\,N/mm^2 \rightarrow \frac{3P}{(300-160)\times 40} \leq 90 \qquad \therefore\ P \leq 168000\ N \quad \ldots(3)$$

Form (1), (2) and (3), the maximum safe value of axial load ***P*** = 168000 *N* = 168 *kN*

$$\boxed{P_{Safe} = 168\ kN}$$

(b)

E = 11.2 *GPa* = 11.2×10^3 *MPa* = 11.2×10^3 *N/mm*^{2}

$$\Delta = \frac{PL}{EA} = \frac{168000\times 400}{11.2\times 10^3\times(150\times 40)} = 1\ mm$$

$$\boxed{\Delta = 1\ mm}$$

With my best wishes

Dr. M. Abdel-Kader