Ministry of Higher Education
Giza Higher Institute of Engineering & Technology
Civil Engineering Department
Course Name: **Theory of Structures (1)B**
Course Code : **CIV 121** Date : **17 / 3 / 2018**

Academic Year : **2017/2018**
Semester : **Second**
Level : **1st Civil**
Time : 1 **Hour**
Examiner: ***Dr. Maha Nazeef***
Dr. M. Abdel-Kader

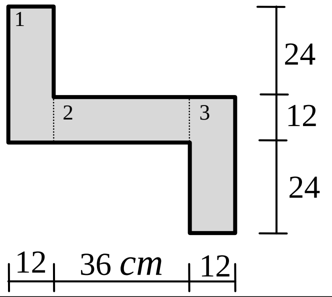
Answer of Mid-Term Exam

Total Marks: **30** No. of Questions:**2** (Attempt all questions)

Student Name: Code:

Question (1): (15 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.



Solution:

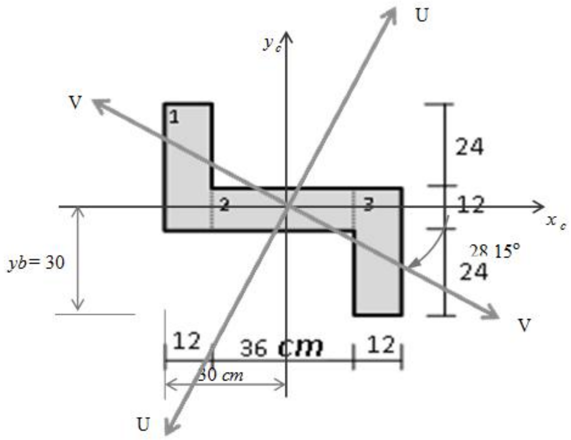
Element	A	x	y	Ax	Ay	x-xb	y-yb	I_x	$A(y-yb)^2$	I_y	$A(x-xb)^2$	I_{xcyc}	I_{xy}
1	432.00	6.00	42.00	2592.00	18144.00	-24.00	12.00	46656.00	62208.00	5184.00	248832.00	0.00	-124416.00
2	432.00	30.00	30.00	12960.00	12960.00	0.00	0.00	5184.00	0.00	46656.00	0.00	0.00	0.00
3	432.00	54.00	18.00	23328.00	7776.00	24.00	-12.00	46656.00	62208.00	5184.00	248832.00	0.00	-124416.00
	1296.00			38880.00	38880.00			98496.00	124416.00	57024.00	497664.00		-248832.00

$xb =$ 30.00 cm
$yb =$ 30.00 cm

$I_x =$ 222912.00 cm^4
$I_y =$ 554688.00 cm^4

$I_u =$ 687858.84 cm^4
$I_v =$ 89741.16 cm^4

tan (2 Theta) = -1.5
2 Theta = -56.31
Theta = -28.15



Please turn over

Question (2): (15 Marks)

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

(a) Determine the maximum safe value of $\boldsymbol{P_{Safe}}$.

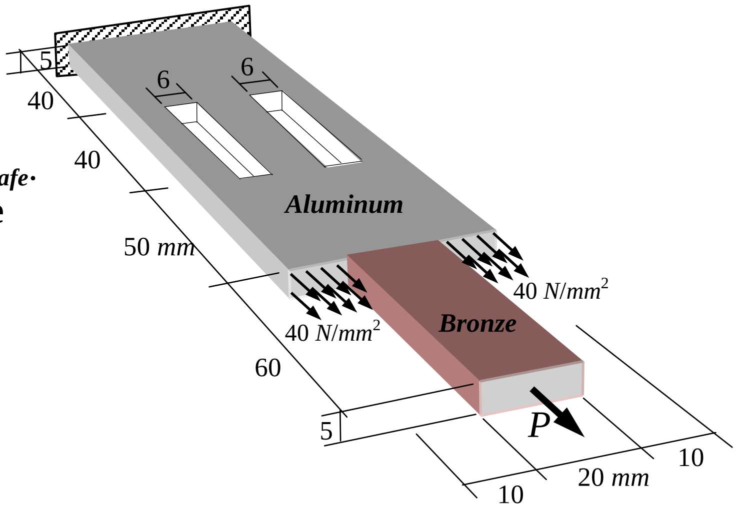
(b) Determine the deformation of the **Bronze** part **only** due to $\boldsymbol{P_{Safe}}$ calculated in (a)

Given Data:

Allowable stress for bronze = 100 *MPa*

Allowable stress for aluminum = 90 *MPa*

E =2.58 *GPa*



Solution:

(a)

For bronze:

$$\sigma_{bronze} = \frac{P_{bronze}}{A_{bronze}} \le 100\ N/mm^2 \rightarrow \frac{P}{20 \times 5} \le 100 \qquad \therefore\ P \le 10000\ N \ \ldots(1)$$

For aluminum (solid part):

$$\sigma_{alum} = \frac{P_{alum}}{A_{alum}} \le 90\, N/mm^2 \rightarrow \frac{P + 2(10 \times 5) \times 40}{40 \times 5} \le 90 \qquad \therefore\ P \le 14000\ N \ \ldots(2)$$

For aluminum (hollow part):

$$\sigma_{alum} = \frac{P_{alum}}{A_{alum}} \le 90\, N/mm^2 \rightarrow \frac{P + 2(10 \times 5) \times 40}{(40 - 2 \times 6) \times 5} \le 90 \qquad \therefore\ P \le 8600\ N \ \ldots(3)$$

Form (1), (2) and (3), the maximum safe value of axial load $\boldsymbol{P}$ = 8600 *N* = 8.6 *kN*

$$\boxed{P_{Safe} = 8.6\ kN}$$

(b)

$E = 2.58\ GPa = 2.58{\times}10^3\ MPa = 2.58{\times}10^3\ N/mm^2$

$$\Delta = \frac{P_{safe} L}{EA} = \frac{8600 \times 60}{2580 \times (20 \times 5)} = 2\ \ mm$$

The deformation of the **Bronze** part **only** due to $\boldsymbol{P_{Safe}}$ = 2 mm

$$\boxed{\Delta = 2\ mm}$$

With best wishes

Dr. Maha Nazeef

Dr. M. Abdel-Kader