



Complete, fold and seal
(see note 2 below)

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Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

1	Student Number	1701657
2	Title of Examination Paper	Mechanical Principles
3	Module Code	MSX02201
4	Date and Time of Examination	17/1/19
5	Examination Venue	Vivian Hall
6	Seat Number	G031
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	10
2	10
3	9
4	10.
5	10
Total	49 (98%)

Lovely! ☺
Mark agreed
23/01/19.



$$1 \quad \epsilon_x = 15 \times 10^{-6} \quad \epsilon_y = -18 \times 10^{-6} \quad \nu = 0.26 \quad E = 169 \times 10^9$$

$$\begin{aligned} \text{i) } \sigma_x &= \frac{E}{1-\nu^2} (\epsilon_x + \nu \epsilon_y) \\ &= \frac{169 \times 10^9}{1-0.26^2} (15 \times 10^{-6} + 0.26 \times -18 \times 10^{-6}) \\ &= \underline{1.87 \times 10^6 \text{ N/m}^2} \quad \text{Tensile.} \end{aligned}$$

$$\begin{aligned} \sigma_y &= \frac{E}{1-\nu^2} (\epsilon_y + \nu \epsilon_x) \\ &= \frac{169 \times 10^9}{1-0.26^2} (-18 \times 10^{-6} + 0.26 \times 15 \times 10^{-6}) \\ &= \underline{-2.56 \times 10^6 \text{ N/m}^2} \quad \text{Compressive} \end{aligned}$$

$$\text{ii) } \sigma_x = 65 \times 10^6 \quad \sigma_y = 10 \times 10^6 \quad \nu = 0.26 \quad E = 169 \times 10^9$$

$$\begin{aligned} \epsilon_x &= \frac{1}{E} (\sigma_x - \nu \sigma_y) \\ &= \frac{1}{169 \times 10^9} (65 \times 10^6 - 0.26 \times 10 \times 10^6) \\ &= 0.37 \times 10^{-3} \end{aligned}$$

$$\begin{aligned} \epsilon_y &= \frac{1}{E} (\sigma_y - \nu \sigma_x) \\ &= \frac{1}{169 \times 10^9} (10 \times 10^6 - 0.26 \times 65 \times 10^6) \\ &= -40.83 \times 10^{-6} \end{aligned}$$

- 2 i) $r = 0.025 \text{ m}$ $p = 20 \times 10^5$ $E = 163.2 \times 10^9$ $\nu = 0.3$.
Calc Bulk

$$K = \frac{E}{3(1-2\nu)} = \frac{163.2 \times 10^9}{3(1-2 \times 0.3)} = 1.36 \times 10^{11}$$

- ii) volumetric strain

$$K = \frac{-P}{\epsilon_v}$$

$$\epsilon_v = \frac{-P}{K} = \frac{-20 \times 10^5}{1.36 \times 10^{11}} = -14.71 \times 10^{-6}$$

- iii)

$$\epsilon_v = \frac{\Delta V}{V}$$

$$\Delta V = \epsilon_v V$$

$$V_{\text{sphere}} = \frac{4}{3} \pi r^3 = \frac{4}{3} \pi (0.025)^3 = 0.065 \times 10^{-3}$$

$$\Delta V = -14.71 \times 10^{-6} \times 0.065 \times 10^{-3} = -0.96 \times 10^{-9}$$

- iv) An Isotropic Material has the same material properties in all directions.

An example of a non-Isotropic material is a composite like carbon fibre.

3 $L=1.3$ $w=1500 \text{ N/m}$ $F=5000 \text{ N/m}$ $EI=2.2 \times 10^6$

i) UDL Def.

$$\frac{wL^4}{8EI} = \frac{-1500 \times 1.3^4}{8 \times 2.2 \times 10^6}$$

$$= -0.24 \times 10^{-3}$$

ii) PL Def

$$\frac{FL^3}{3EI} = \frac{-5000 \times 1.3^3}{3 \times 2.2 \times 10^6}$$

$$= -1.66 \times 10^{-3}$$

iii) Total

$$y = y_{UDL} + y_{PL}$$

$$= -0.24 \times 10^{-3} + -1.66 \times 10^{-3}$$

$$= -1.9 \times 10^{-3}$$

used

iv) $y' = y_{PL} + y_{UDL}$

$$3.5 \text{ mm} = y_{PL} + -0.24 \times 10^{-3}$$

$$y_{PL} = 3.5 \times 10^{-3} + 0.24 \times 10^{-3}$$

$$= 3.74 \times 10^{-3}$$

$$y' = \frac{FL^3}{3EI}$$

$$F = \frac{3EI y'}{L^3} = \frac{3 \times 2.2 \times 10^6 \times 3.74 \times 10^{-3}}{1.3^3}$$

$$F = -9.79 \times 10^3 \text{ N/m}$$

$\Delta F = ?$

Shame!

4 $d = 0.35$ $L = 0.8m$ $\eta l = 0.85$ $\eta c = 0.95$ $p_{max} = 20 \times 10^5$
 ~~$p = 175m$~~ $\sigma_{max} = 110 \times 10^6$ $t = ?$

$$\sigma_c = \frac{pD}{2t\eta l}$$

$$t = \frac{pD}{2\eta l \sigma_c}$$

$$= \frac{20 \times 10^5 \times 0.35}{2 \times 0.85 \times 110 \times 10^6}$$

$$= 3.74 \times 10^{-3} m$$

$$\sigma_L = \frac{pD}{4t\eta c}$$

$$t = \frac{pD}{4\eta c \sigma_L}$$

$$= \frac{20 \times 10^5 \times 0.35}{4 \times 0.95 \times 110 \times 10^6}$$

$$= 1.67 \times 10^{-3}$$

$$t_{min} = 3.74 \times 10^{-3} m$$

5 $d_o = 0.15m$ $d_i = 0.13m$ $p = 80 \times 10^5$
 $r_o = 0.075m$ $r_i = 0.065m$

①

$$\sigma_R = a - \frac{b}{r^2}$$

$$0 = a - \frac{b}{0.075^2}$$

$$(\times 0.075^2)$$

$$0 = 0.075^2 a - b$$

① - ②

$$0 - -33800 = 0.075^2 a - 0.065^2 a - b - -b$$

$$33800 = 0.075^2 a - 0.065^2 a$$

$$33800 = a(0.075^2 - 0.065^2)$$

~~$$a = \frac{33800}{(0.075^2 - 0.065^2)}$$~~

~~$$a = \frac{33800}{(0.075^2 - 0.065^2)}$$~~

$$a = \frac{33800}{(0.075^2 - 0.065^2)}$$

$$= 24.14 \times 10^6$$

in ①

$$b = 0.075^2 \times 24.14 \times 10^6$$

$$= 135.79 \times 10^3$$

$$\begin{aligned} 5 \quad \sigma_c &= a + \frac{b}{r^2} \quad \frac{135.79 \times 10^3}{r^2} \\ &= 24.14 \times 10^6 + 0.075^2 \\ &= \underline{48.28 \times 10^6} \text{ N/m} \end{aligned}$$

$$\begin{aligned} \sigma_c &= a + \frac{b}{r^2} \quad \frac{135.79 \times 10^3}{r^2} \\ &= 24.14 \times 10^6 + 0.065^2 \\ &= \underline{56.28 \times 10^6} \text{ N/m} \end{aligned}$$

Question No.

Examiner

Arholwr yn unig

Cwestiwn

Question No.

Examiner C

Arholwr yn unig

y Cwestiwn

Question No.

Examiner's

Arholwr yn unig

y Cwestiwn

Question No.

Examiner

Arholwr yn unig

Qwestiwn



Cyfarwyddiadau i Ymgeiswyr

1. Rhowch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhowch eich enw yn y lle a ddarparwyd ar y dde, plynwch ef at i sellio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

3. Rhaid i'r atebion fod mewn llawysgrifedd ddarllenadwy. Gall yr Arholwyr naill ai anwybyddu sgrifft annarllenadwy, neu drefnu iddi! gael ei theipio a chael yr ymgeisydd i dalu.

4. Ysgriptennwch eich atebion mewn inc.

5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw tras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.

6. Ni ddylid rhwygo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.

7. Os deŷyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwylliwyr/gwylwyr.

8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

7	Nifer y Llyfrau Atebion a gyflwynwyd	
6	Rhif Sedd	
5	Lleoliad yr Arholiad	
4	Dyddiad ac Amser yr Arholiad	
3	Cod y Modwl	
2	Teitl y Papur Arholiad	
1	Rhif Myfyrwr	

[illegible]

(See the other side for English version)

Llenwch, plygwrch a seliwrch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: