



Complete, fold and seal
(see note 2 below)

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FORENAME(S): RICHARD

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 the book in half and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners cannot read handwritten answers. You may not use a typewriter or have it typed and the expense of typing will be 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	1704921
2	Title of Examination Paper	MECHANICAL PRINCIPLES
3	Module Code	M5X02201
4	Date and Time of Examination	17.01.19 9am
5	Examination Venue	VIVIAN HALL
6	Seat Number	G022
7	Number of Answer Books handed in	1

[illegible]

← Shame

Mark agreed
23/01/19



1 i)

$$\epsilon_x = 15 \times 10^{-6}$$

$$\epsilon_y = -18 \times 10^{-6}$$

$$\nu = 0.26$$

$$E = 169 \times 10^9$$

$$\sigma_x = \frac{E}{1-\nu^2} (\epsilon_x + \nu \epsilon_y)$$

$$\sigma_x = \frac{169 \times 10^9}{1-(0.26)^2} (15 \times 10^{-6} + (0.26 \times -18 \times 10^{-6}))$$

$$15 \times 10^{-6} + -4.68 \times 10^{-6}$$

-12.724

$$\sigma_x = 1.87 \times 10^6$$

TENSILE

~~1.87 \times 10^6~~

$$\sigma_y = \frac{E}{1-\nu^2} (\epsilon_y + \nu \epsilon_x)$$

$$\sigma_y = \frac{169 \times 10^9}{1-(0.26)^2} (-18 \times 10^{-6} + (0.26 \times 15 \times 10^{-6}))$$

$$\sigma_y = -2.55 \times 10^6$$

COMPRESSIVE

ii)

$$P = 20 \times 10^3$$

$$\sigma_x = 65 \times 10^6$$

$$\sigma_y = 10 \times 10^6$$

$$\nu = 0.26$$

$$E = 169 \times 10^9$$

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu \sigma_y)$$

$$\epsilon_x = \frac{1}{169 \times 10^9} (65 \times 10^6 - (0.26 \times 10 \times 10^6))$$

$$\epsilon_x = 369.23 \times 10^{-6}$$

$$\epsilon_y = \frac{1}{E} (\sigma_y - \nu \sigma_x)$$

$$\epsilon_y = \frac{1}{169 \times 10^9} (10 \times 10^6 - (0.26 \times 65 \times 10^6))$$

$$\epsilon_y = -40.83 \times 10^{-6}$$

10

Nice.

$$2i) r = 25 \times 10^{-3}$$

$$P = 20 \times 10^5 \Rightarrow -P = -20 \times 10^5$$

$$E = 163.2 \times 10^9$$

$$\nu = 0.3$$

$$K = \frac{\sigma}{\epsilon_v} = \frac{E}{3(1-2\nu)}$$

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

$$K = \frac{163.2 \times 10^9}{3(1-0.6)} = K = \frac{163.2 \times 10^9}{3 \times 0.4}$$

$$K = -136 \times 10^9$$

$$ii) r = 25 \times 10^{-3} \Rightarrow D = 50 \times 10^{-3}$$

$$\epsilon_v = \frac{\sigma_x + \sigma_y + \sigma_z}{E} (1-2\nu)$$

$$\epsilon_v = \frac{-20 \times 10^5}{163.2 \times 10^9} (1-(2 \times 0.3))$$

$$\epsilon_v = -0.0049 \times 10^{-3} \Rightarrow -0.0049 \text{ mm}$$

2.iii) $E = 163.2 \times 10^9$
 $V = 0.3$
 $r = 25 \times 10^{-3}$
 $P = 20 \times 10^5 \Rightarrow -P = -20 \times 10^5$

$$V_{\text{SPHERE}} = \frac{4}{3} \pi r^3$$

$$V_{\text{SPHERE}} = \frac{4}{3} \times \pi \times (25 \times 10^{-3})^3$$

$$\frac{4}{3} \times \pi \times 1.5625 \times 10^{-5} = 6.54 \times 10^{-5}$$

$$V_{\text{SPHERE}} = 6.54 \times 10^{-5}$$

$$V \times \epsilon_v = \delta V$$

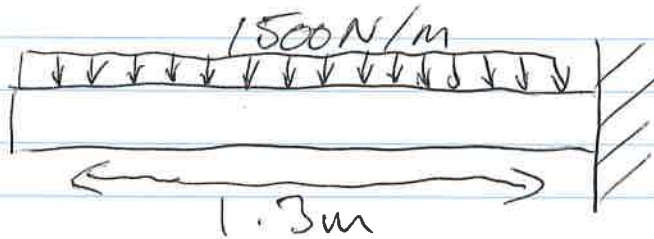
~~$6.54 \times 10^{-5} \times 0.0049 \times 10^{-3}$~~

$$6.54 \times 10^{-5} \times 0.0049 \times 10^{-3}$$

$$\delta V = -0.00000032 \times 10^{-3} \Rightarrow 0.00000032 \text{ mm}$$

iv)

3.i)



$$EI = 2.2 \times 10^6 \text{ Nm}^2$$

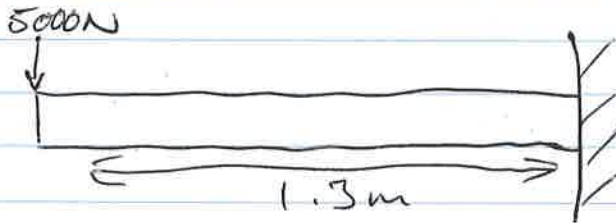
$$L = 1.3 \text{ m}$$

$$W = 1500 \text{ N/m}$$

$$\text{MAX DEFLECTION} = \frac{WL^4}{8EI} = \frac{1500 \times 1.3^4}{8 \times 2.2 \times 10^6}$$

$$\text{MAX DEFLECTION} = -2.43 \times 10^{-4} \text{ mm}$$

ii)



$$EI = 2.2 \times 10^6 \text{ Nm}^2$$

$$L = 1.3 \text{ m}$$

$$F = 5000 \text{ N}$$

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

$$\text{DEFLECTION} = -1.66 \times 10^{-3} \text{ mm}$$

iii)

$$\text{UDL DEFLECTION} = -2.43 \times 10^{-4} \text{ mm}$$

$$\text{POINT LOAD DEFLECTION} = -1.66 \times 10^{-3} \text{ mm}$$

$$-2.43 \times 10^{-4} + -1.66 \times 10^{-3}$$

$$\text{TOTAL DEFLECTION} = -1.903 \times 10^{-3} \text{ mm}$$

. iv)

$$MD = \frac{FL^3}{3EI}$$

~~MD = \frac{FL^3}{3EI}~~ $F = \frac{MD 3EI}{L^3}$ ✓

$$F = 10514.34 \text{ N}$$
 ✗

t)

$$D = 0.35 \text{ m}$$

$$L = 0.8 \text{ m}$$

$$\eta_L = 0.85$$
 ✓

$$\eta_c = 0.95$$

$$\eta_t = ?$$

$$P = 20 \times 10^5 \Rightarrow -20 \times 10^5 (-P)$$

$$\sigma_{\text{MAX}} = 110 \times 10^6$$

CIRCUMFERENTIAL

$$\sigma_c = \frac{PD}{2t\eta_L}$$
 ✓

$$\frac{\sigma_c 2\eta_L}{PD} = t$$

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

$$t = \frac{PD}{\sigma_c 2\eta_L} = \frac{20 \times 10^5 \times 0.35}{110 \times 10^6 \times 2 \times 0.85}$$
 ✓

$$t = 3.74 \times 10^{-3} \Rightarrow 3.74 \text{ mm}$$
 ✓

LONGITUDINAL

$$\sigma_L = \frac{PD}{4t\eta_c}$$
 ✓

$$t = \frac{PD}{\sigma_L 4\eta_c}$$
 ✓

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

$$t = 1.67 \times 10^{-3} \Rightarrow 1.67 \text{ mm}$$
 ✓

Minimum Thickness = 3.74

 ✓

$$5) \quad P = 80 \times 10^5 \Rightarrow -P = -80 \times 10^5$$

$$D_o = 150 \times 10^{-3} = r_o = 75 \times 10^{-3}$$

$$D_i = 130 \times 10^{-3} = r_i = 65 \times 10^{-3}$$

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

$$r_o^2 = 5.625 \times 10^{-3}$$

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

$$\sigma_r = a - \frac{b}{(75 \times 10^{-3})^2}$$

$$\sigma_r = (75 \times 10^{-3})^2 - b$$

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

Question No.

Examiner O

Arholwr yn unig

f y Cwestiwn

Question No.

Examiner's On

Arholwr yn unig

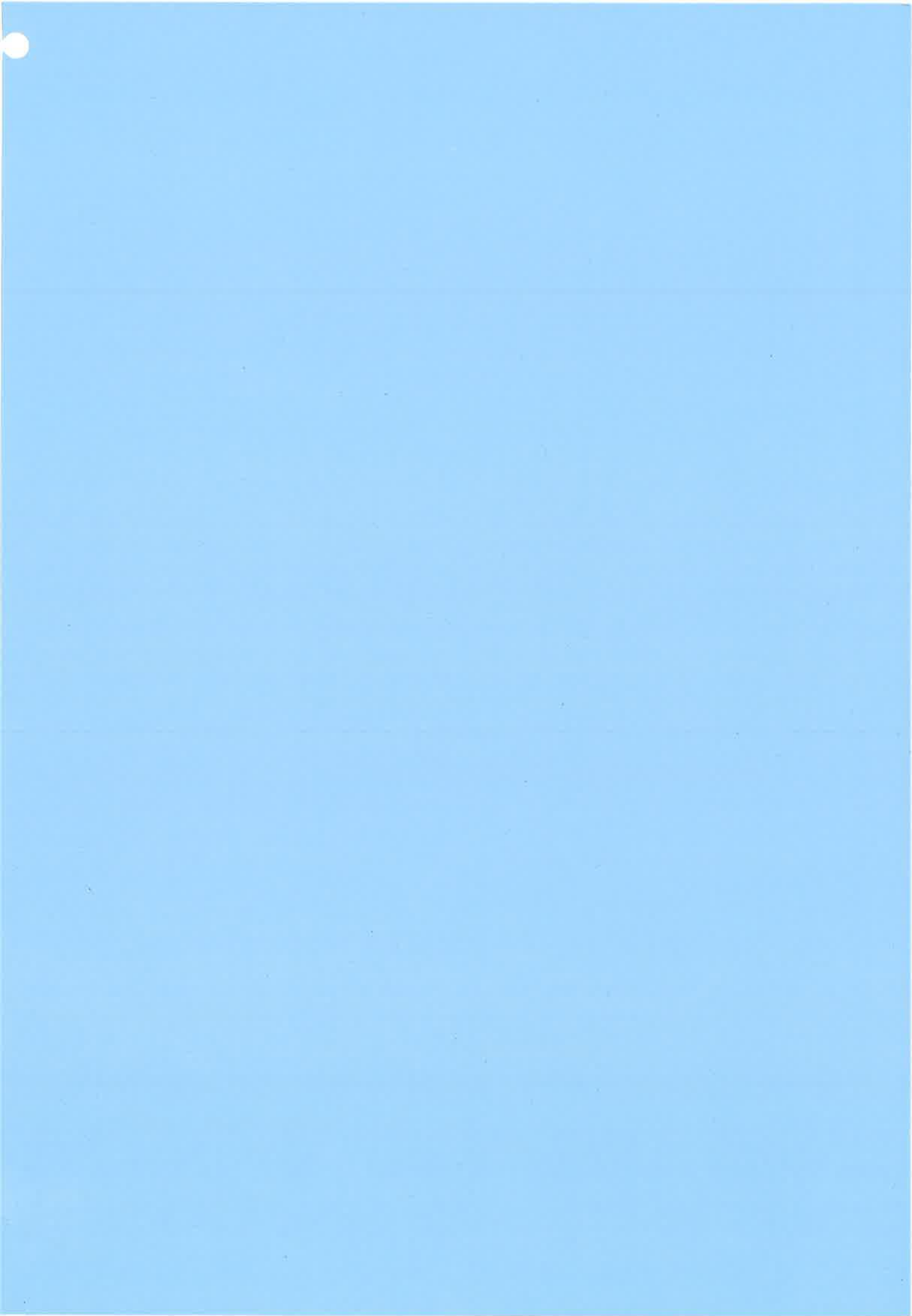
Y Cwestiwn

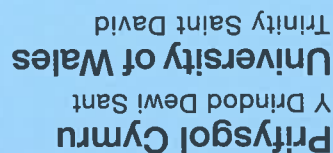
Question No.

Examiner O

Arholwr yn unig

y Cwestiwn





12 Tudalen

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.

2. Rhwch eich enw yn lle a ddarparwyd ar y dde, plygwch ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) !

guddio'ch enw.

3. Rhaid i'r atebion fod mewn llawysgriften ddarlennadwy. Gall yr Arholwyr naill ai anwybyddu sgript annarllennadwy, 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 fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.

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

7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwylwlr/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, plygwch a selwch
(gweler nodyn 2 isod)

CYFENW:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: