



Complete, fold and seal
(see note 2 below)

SURNAME: Cummings

FORENAME(S): Kyle James

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	1700852
2	Title of Examination Paper	CAE + Stress Analysis
3	Module Code	MSX02064
4	Date and Time of Examination	9/5/19 12:00
5	Examination Venue	IQ 310
6	Seat Number	G017
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	~~9~~ 9
2	3
3	~~12~~ 12
Total	24

(Gweler yr ochr arall am y fersiwn Cymraeg)

40%

2a) Principle Stress - Maximum and minimum stresses applied onto an object in a plane. ($\sigma_{x/2}$) ✓

Principle plane - the plane in which these stresses are applied. ✓ (3)

2b) i) $\sigma_{\theta} = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta$

~~$\frac{d\sigma_{\theta}}{d\theta} = 0$~~

~~$\frac{d\sigma_{\theta}}{d\theta} = 0$~~
 $y = \cos 2\theta$
 $\frac{dy}{d\theta} = -2\sin 2\theta$

ii) $\tau_{\theta} = \frac{1}{2}(\sigma_x - \sigma_y)\sin 2\theta$

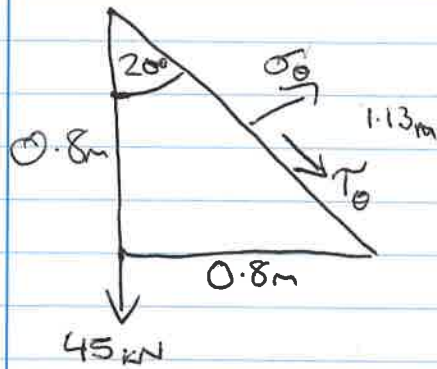
~~$\frac{d\tau_{\theta}}{d\theta} = 0$~~

$y = \sin 2\theta$
 $\frac{dy}{d\theta} = 2\cos 2\theta$

$\tau_{\theta} = -\frac{1}{2}\tau_{xy} \times 2\cos 2\theta$
 $= -\tau_{xy} \cos 2\theta$

✓

2c)



$$\sigma_{\theta} = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta$$

$$= \tau_{xy} \sin 2\theta$$

$$\tau_{\theta} = \frac{1}{2}(\sigma_x - \sigma_y)\sin 2\theta = -\tau_{xy} \cos 2\theta$$

$$800 \text{ mm}^2 = 0.8 \text{ m}^2$$

$$\sqrt{0.8^2 + 0.8^2} = 1.13 \text{ m}$$

$$\tau_{\theta} = -\tau_{xy} \cos 2\theta$$

$$= -45000 \cos(40)$$

$$= -34472 \text{ N/m}^2$$

$$\sigma_{\theta} = \tau_{xy} \sin 2\theta$$

$$= 45000 \sin 40$$

$$= -28925.4 \text{ N/m}^2$$

X

$$1a) \sigma_H = \frac{Pd}{2t}$$

$$\text{Pressure} \times \text{expected area} = PdL$$

$$\sigma_H 2tL = PdL$$

$$\sigma_H 2t = Pd$$

$$\sigma_H = \frac{Pd}{2t}$$

✓ (4)

$$1b) i) \sigma_H \leq 200 \text{ MPa}$$

$$\text{diameter} = 3.5 \text{ m}$$

$$t = 0.5 \text{ mm} = 0.5 \times 10^{-3} \text{ m}$$

$$\text{At sea level}$$

$$101 \text{ kPa}$$

$$P = \rho gh$$

$$P = \frac{2\sigma_H t}{d} = \rho gh$$

$$P = \frac{2 \times 200 \times 10^6 \times 0.5 \times 10^{-3}}{3.5}$$

$$= 57142.85714 \text{ Pa}$$

$$(57.142 \text{ kPa})$$

✓ (2)

$$P = \rho gh$$

$$101 \times 10^3 = (1.167 \times 9.81)h$$

$$h = \frac{101 \times 10^3}{1.167 \times 9.81} = 8822.293674$$

$$57142.85714 = (1.167 \times 9.81)h$$

$$h = \frac{57142.85714}{1.167 \times 9.81} = 4991.396704$$

At this altitude it can fly at:

ii)

$$\sigma_H = \frac{101 \times 10^3 \times 3.5}{2 \times 0.5 \times 10^{-3}} = 353.5 \text{ MPa}$$

Too high for plane to fly at 8822.3 m, therefore as it is limited by the hoop stress.

∴ The plane can fly at 15000 feet.

✗

ii) Pressurised as if at 8000 ft (75.3 kPa)

$$\sigma_H @ 75.3 \text{ kPa} = \frac{75.3 \times 10^3 \times 3.5}{2 \times 0.5 \times 10^{-3}} = \frac{263.55 \text{ MPa}}{263.55 \text{ MPa}}$$

Therefore this is again too high to fly at the height shown below due to hoop stress limitations.

$$75.3 \times 10^3 = (1.167 \times 9.81)h$$

$$h = \frac{75.3 \times 10^3}{1.167 \times 9.81} = 6577.413007 \text{ m}$$

∴ Due to hoop stress limitations the plane may only fly at up to 15000 feet.

1c) If the hoop stress is not so limited, the pressurising of cabins is a good idea as the pressure from sea level puts a bit of hoop stress on the material, however at the ~~low~~ lower pressure at 8000 ft it puts less hoop stress on the material. BUT WHY?

1d) $\sigma_H t d$

$$\begin{aligned} \text{pressure} \times \text{expected area} \\ = P \times \frac{\pi d^2}{4} \end{aligned}$$

$$\sigma_H t d = \frac{P d^2}{4}$$

$$\sigma_H = \frac{P d}{4t}$$

1e) Depending on the pressures involved in containing the oil, different hoop stresses can be imposed on the material involved. In a spherical container, the smaller the wall thickness puts a larger hoop stress on the ~~the~~ material the container is made from whereas if you need to keep under a maximum hoop stress ^{at a set pressure}, you can put a bigger wall thickness on a cylindrical container according to the equations.

3a) A design problem can be solved in many different ways with multiple different solutions due to new ideas from a multitude of people whereas an analysis problem will usually only have one solution. A design problem process is cyclical or iterative as it can be continued on and improved whereas an analysis problem is sequential as you move through the steps to find the final solution and it cannot be repeated.

/3

3b) A design problem is usually iterative due to its cyclical nature as a solution can always be evaluated and improved. This can take place during the testing section as something may have been picked up that isn't quite right, at which point you go back to the beginning to assess what can be done to fix it. This could also be as a result of a new company releasing their own solution competing with the product created ~~and what it would solve~~ and what it would solve, at this point you return to the beginning to see what the next step could be and to analyse their solution.

In an analysis solution this is not the case as steps are followed until the end is reached and there will usually only be one answer. Once this answer to the problem is realised it can be confirmed and the analysis problem is solved and complete end so this is the complete opposite to a design problem that can keep continuing forever, always being improved.

A design problem has 5 main points, defining the problem, gathering relevant information, producing solution ideas, analysing ideas and testing and ~~evaluation~~ evaluation. These 5 points go round in a cyclical nature and if something is found to be in the analysis or evaluation sections, the next step is to go back to defining the problem that was found.

/5

3c) The design process has 5 main points. ~~Defining~~
~~the problem~~

- 1- Defining the problem
 - What issue needs to be resolved
 - Determine clear outline of the issue
- 2- Gathering relevant information
 - Existing solutions
 - Who makes existing solutions
 - Customer needs
 - Funds required to conduct ~~pro~~ solution creation
- 3- Create solution ideas
 - Involve multiple people from different areas
 - Brainstorm ideas
 - Allow design team creative freedom.
- 4- Testing and analyse ideas
 - Confirm final design idea
 - Test prototypes created
- 5- Evaluate
 - Does it meet standards
 - What needs to be changed to improve
 - Does it match expected results.

1/10
4

Question No.

Examiner O

Arholwr yn unig

ff y Cwestiwn

Question No.

Examiner Or

Arholwr yn unig

hif y Cwestiwn

Question No.

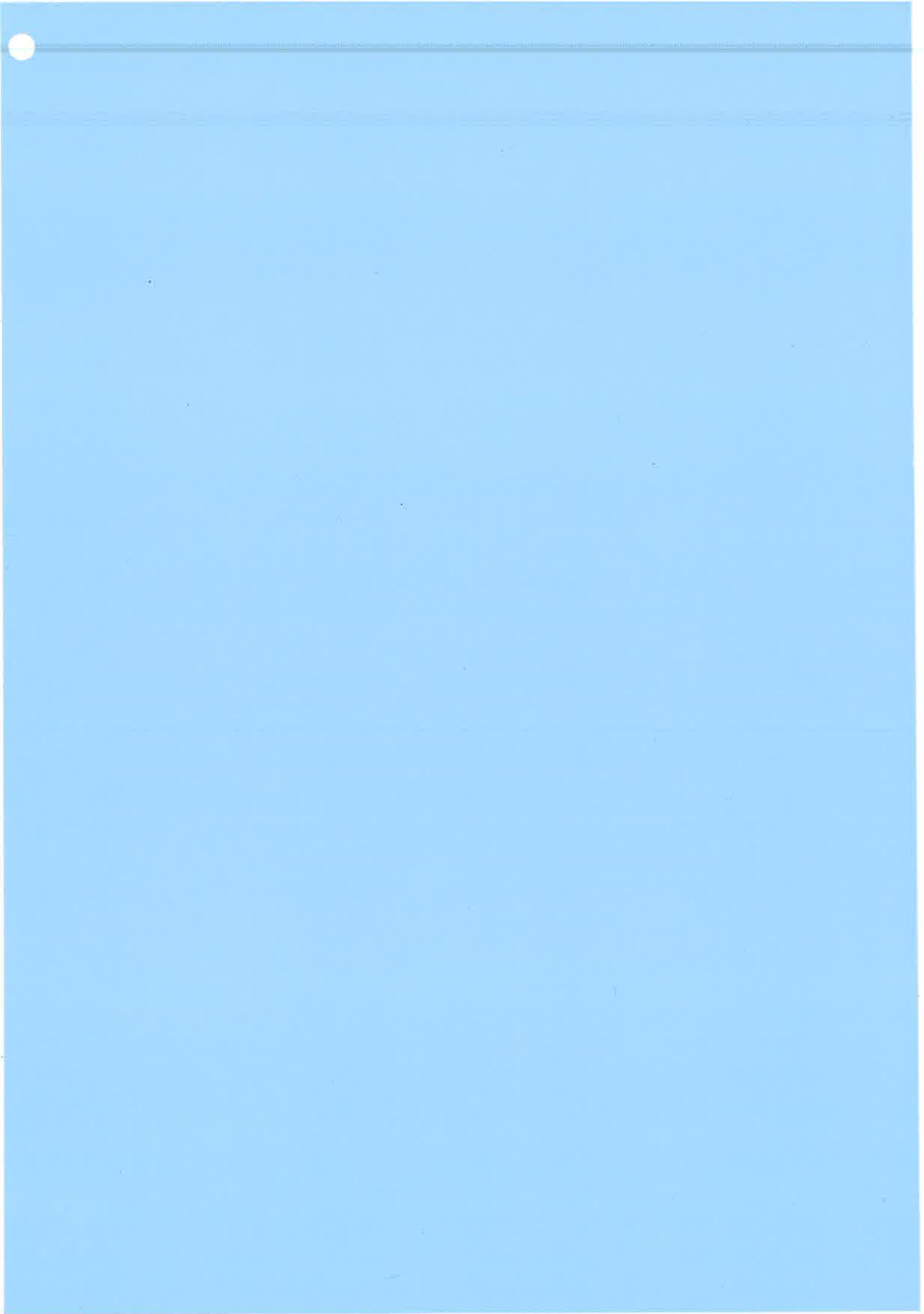
Examiner Only

Question No.

Examiner O

Arholwr yn unig

ff y Cwestiwn



Llyfr Atebion Arholiadau

12 Tüdalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, plygch ef a'i sello i lawr (gan ddefnyddio'r label a ddarparwyd) i 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. Ysgrifennwch 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 rhwngo 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 gwyllwyr/gwylwyr.
8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, aillan o'r lleoliad arholi o dan unrhyw amgylchiad.

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

Rhestrwch nïau'r cwestiynau a ymgeistwyd genych	
At Ddibenion y Swyddra	

(See the other side for English version)

Llenwch, plygwrch a seliwrch
(gweler nodyn 2 isod)

CYFENW:

ENW(AU) CYNTAF: