



12 Pages

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.**

SURNAME: JONES

FORENAME(S): NATHAN

1	Student Number	P151484
2	Title of Examination Paper	Advanced Stress & FEA
3	Module Code	M6X00420
4	Date and Time of Examination	31/1/20 1:30pm
5	Examination Venue	1Q002
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	10 1/2
2	9
3	10
Total	29.5

(Gweler yr ochr arall am y fersiwn Cymraeg)

49.2%

Q1

a) Strain energy is the strain within a component due to loading.

b) $E = \frac{\sigma}{\epsilon}$ $\sigma = \frac{F}{A}$ $F = P$
 $\therefore P = \sigma A$

$$\epsilon = \frac{xL}{L}$$

$$E = \frac{F}{A} \div \frac{xL}{L}$$

$$E = \frac{FL}{A \times L}$$

$$L = ds$$

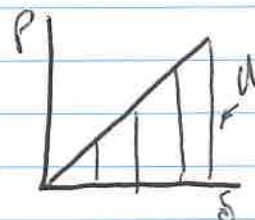
$$xL = \delta$$

$$F = P$$

$$\delta = \frac{Pds}{AE}$$

c) $U = \frac{P^2 L}{2AE}$

$$P^2 = \sigma^2 A^2$$



$$\delta = \frac{Pds}{AE}$$

$$U = \int_0^L \frac{P^2 ds}{2AE} \cdot ds$$

$$U = \frac{1}{2} \times P \times \delta$$

$$U = \left[\frac{P^2 ds}{2AE} \right]_0^L$$

$$U = \frac{1}{2} \times \frac{P^2 ds}{AE}$$

$$U = \left[\frac{P^2 L}{2AE} \right] - \left[\frac{P^2 0}{2AE} \right]$$

$$\therefore U = \frac{P^2 ds}{2AE}$$

$$\therefore U = \frac{P^2 L}{2AE}$$

d) Resilience is $\frac{U}{V}$ strain stress per unit volume. 1

e) $E = \frac{\sigma}{\epsilon}$ $\sigma = \frac{F}{A}$ $\epsilon = \frac{xL}{L}$

$$U = \frac{P^2 L}{2AE} \quad \therefore \frac{\sigma^2 A^2 L}{2AE}$$

$$U = \frac{\sigma^2 AL}{2E} \quad \therefore \frac{\sigma^2 V}{2E}$$

So $\frac{U}{V} = \frac{\sigma^2}{2E}$ 2

f) $L = 1m$
 $A = 0.015 \times 0.015 = 225 \times 10^{-6} m^2$
 $\sigma = 200 \times 10^6 Pa$

$$\sigma = \frac{F}{A} \quad \therefore F = \sigma A = 45 \times 10^3 Nm^2$$

$$E = \frac{xL}{L} \quad E = 200 \times 10^9 Pa$$

$$U = \frac{P^2 L}{2AE} \quad \therefore U = \frac{\sigma^2 A^2 L}{2AE}$$

$$U = \frac{(45 \times 10^3)^2 \times 1}{2 \times 225 \times 10^{-6} \times 200 \times 10^9}$$

$$U = \frac{(200 \times 10^6)^2 \times 225 \times 10^{-6} \times 1}{2 \times 200 \times 10^9}$$

~~$$U = 22.5 N$$~~

$$U = 22.5 N$$

$$U = 22.5 N$$

- g) If sudden applied loads are to be present it is important to ensure that the change in length won't effect the component as per the specification, this could cause elongation to components which would ~~also~~ result in unusable parts.

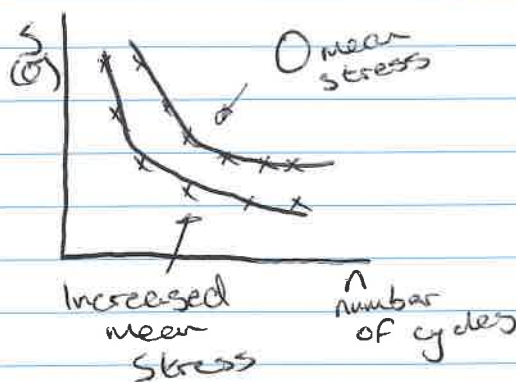
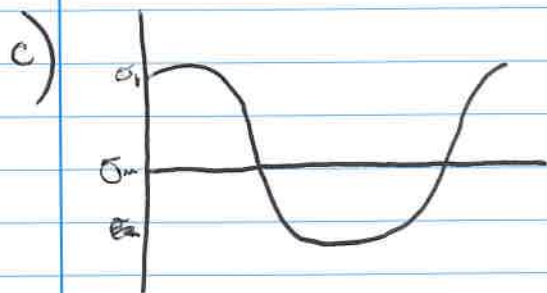
+

Q2

- a) A crack may be initiated by sharp edges, ^{sudden diameter change, or wall thickness} within a component which will lead to stress concentrations within the area. Because of this a fatigue failure may occur way below the yield strength of the material due to cyclic loading.
- b) Initiation ~~propagation~~ - Initial crack point
propagation - Due to cyclic loading
Crystalline area of failure or rupture.

2

3



By loading and unloading a component the number of cycles to failure can be calculated.

+

$$d) \frac{n_1}{N_1} + \frac{n_2}{N_2} + \frac{n_3}{N_3} = 1$$

$$\frac{100 \times 10^6}{1 \times 10^9} + \frac{200 \times 10^6}{1 \times 10^6} + \frac{150 \times 10^6}{x} = 1$$

$$1 - \left(\frac{100 \times 10^6}{1 \times 10^9} + \frac{200 \times 10^6}{1 \times 10^6} \right) = \frac{150 \times 10^6}{x}$$

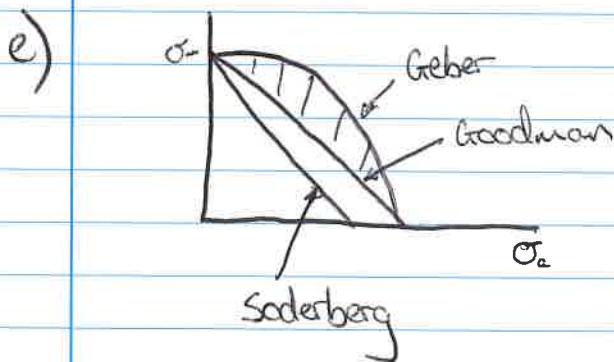
$$x =$$

$$\sigma_r^m N_f = k$$

$$150 \times 10^6 N_f = k$$

$$N_f = \frac{k}{150 \times 10^6}$$

X



These theories take mean stress to stress amplitude when mean stress equals 0.

Many failures tend to occur within the Geber - Goodman area, although Soderberg's theory is typically used as it is conservative allowing for safety, and

Q3

- a) When meshing a component it is important to ensure this is done ~~q~~ correctly to improve the reliability of your results. There is many different types of mesh which can be applied to a component whether that be 1D, 2D or 3D element meshes, each having a different amount of nodes and DOF. Additionally there is also Solid meshes and shell meshes, which can be either square shape or triangular, dependant on the component geometry a certain amount of both shapes may be used.

Mesh quality is important to ensure certain nodes aren't overlapping when not needed and to try have perfect shaped elements within the mesh, to improve accuracy ~~within~~ when performing analysis. If an element isn't fitted correctly the stress, strain or displacement values could be unreliable.

When nodes are overlapping could be due to a mirror/revolve feature being used in the modelling phase, and non-fitting elements could be due to mesh sizing, shape or component geometry, this can be rectified by adjusting the mesh within that area.

- b) To gain confidence in the model hand ~~calculations~~ calculations can be carried out to clarify if the values the model shows as correlates to what would be expected, this is especially important when using a linear solver as the model wouldn't show failure even when the stress within the component exceeds the yield strength of the material.

Question No.

Examiner On

Arholwr yn unig

nif y Cwestiwn

Question No.

Examiner On

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Y Cwestiwn

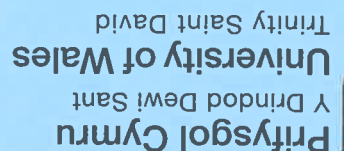
Question No.

Examiner On

Arholwr yn unig

hif y Cwestiwn





12 Tüdalen

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

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

4. Ysgriennwch 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, rhwymych hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyllyllwr/gwyllyr.

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 unithy w amgylchiadau.

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 Myfyrwr	

(See the other side for English version)

[illegible]

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: