



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.**

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FORENAME(S): PAUL JAMES

1	Student Number	1708327
2	Title of Examination Paper	Advanced Structures & FEA
3	Module Code	MGX00420
4	Date and Time of Examination	31/01/20 13:30 PM
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	7
2	11½
3	19
Total	37½

(Gweler yr ochr arall am y fersiwn Cymraeg)

62.5%

①
a)

Strain energy is the linear relationship between stress and strain. This is demonstrated in Fig 1.3, where P signifies the stress or load and U represents the strain energy proportional to any extension of a bar.

X

d)

Resilience = Strain per unit volume therefore the effect of stress is directly proportional to Strain. This is due to

/1

$$\sigma = \frac{F}{A} \quad \text{or} \quad P = \sigma A$$

e)

$$\text{Resilience} = \frac{\sigma^2}{2E}$$

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

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

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

$$\frac{U}{AL} = \text{Resilience or Strain per unit volume}$$

/

2

f

$$\square = 15 \text{ mm} \times 15 \text{ mm} \\ = 0.015 \times 0.015 \text{ m} = 0.03 \text{ m}^2$$

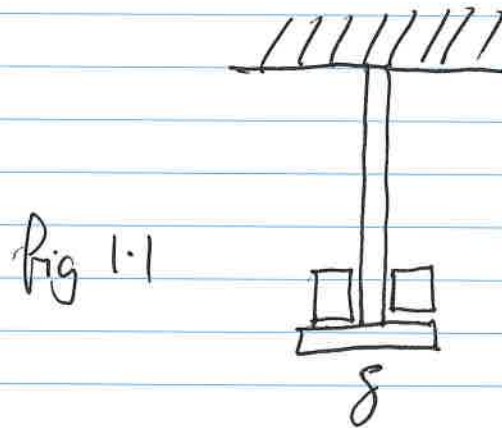
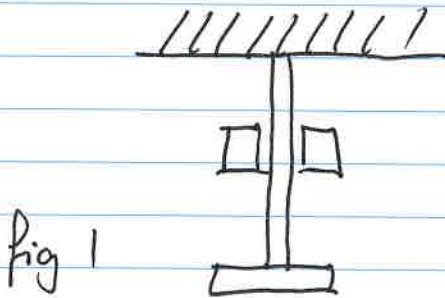
$$L = 1 \text{ m} \\ E = 200 \times 10^9 \\ \sigma = 200 \times 10^6 \text{ N}$$

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

$$U = \frac{((200 \times 10^6) \times 0.03^2)^2 \times 1}{2 \times 0.03 \times 200 \times 10^9} \\ = 3000 \text{ J}$$

X 2

g



One must be taken to consider the effect of sudden applied loads. This is due to its effect on part elongation. This can be seen in Fig 1 and 1.1. This diagram displays the effect of the sudden applied load on the elongation. This relationship is also demonstrated in Fig 1.3 on the exam paper. This sudden applied load creates a non-linear reaction, as the load is dependent on time and is no longer a static relationship as shown in Fig 1.3 on exam paper.

X 1

②
a)

- Porosity
- Geometry - i.e sharp corners
- Fatigue - cyclic loading - causes failure below yield
- Corrosion - surface flaws

3

b)

Initiation location - could potentially be at the site of one of the examples in question a)

Fault propagation lines - where the stress increases and spreads from the initiation site before failure

Crystalline failure location - where part component is unable to withstand the stress and fails affecting materials internal structure.

c)

$$\sigma_r^2 Nf = K$$

$$Nf = 10^9$$

$$\sigma_a = 100 \times 10^6 \text{ N}$$

$$Nf = 10^6$$

$$\sigma_r = 200 \times 10^6 \text{ N}$$

X

~~$$\frac{100}{10^9} + \frac{200}{10^6} + \frac{150}{x}$$~~

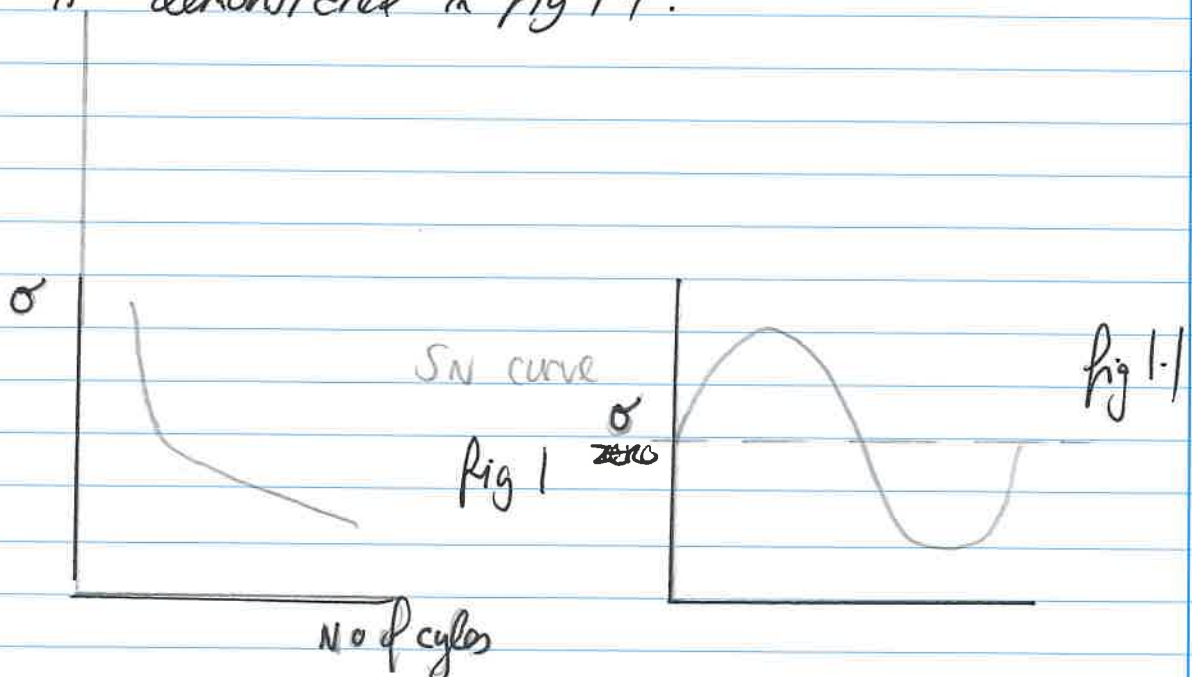
~~$$x \neq$$~~

~~$$\text{if } 100 \times 10^9 + 200 \times 10^6 + 150x$$~~

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

~~$$x =$$~~

- c) A wöhler machine simulates the effect of zero mean stress by cycling a load on and off repeatedly until failure. Continued testing of different materials and loading conditions can be used to produce SN curves for differing scenarios. The wöhler machine does this via a controlled and repeatable process. The resulting SN curve is shown in Fig 1 and the cycling loading is demonstrated in Fig 1.1.



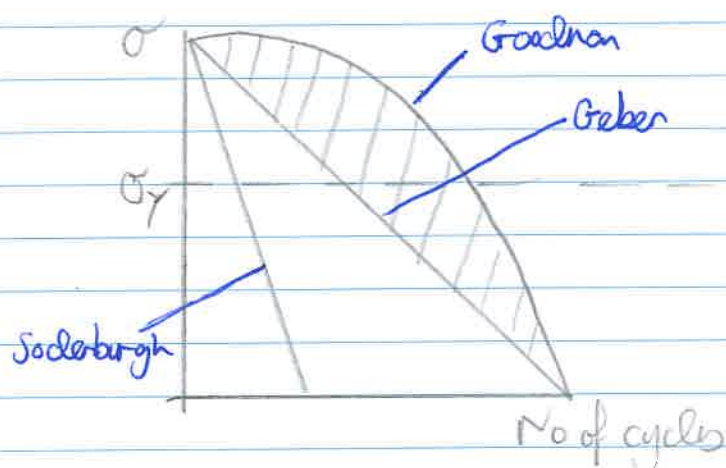


Fig 1

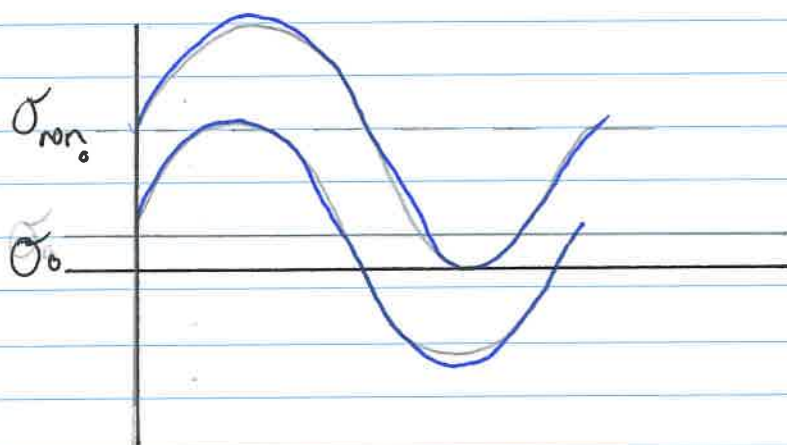


Fig 1.1

The Goodman, Geber and Soderburg theory relationship has produced a method of generating a factor of safety into fatigue. Geber and Goodman are widely accepted as the more accurate theories where the experimental results typically fall between the two, see fig 1.1 hatched area. The results generated via Soderburg are a more conservative value and are considered to include a built-in factor of safety. This could be important in instances of non-zero stress cyclic loading as the yield strength of a component would greatly reduce with this type of loading condition. The non-zero stress can be demonstrated by fig 1.1

Question No.

Examiner On

Arholwr yn unig

ni ff y Cwestiwn

③

The mesh selection process is vital to an accurate and efficient FEA study.

The correct selection of 1D, 2D or 3D elements will depend on geometry and complexity of a component. The ability to utilise a 1D element over 2D, 3D will produce large reductions in solve time. But this can only be considered in ideal circumstances. Secondly the selection of first or second order mesh elements can ~~also~~ produce differing stress values due to the accuracy of stress calculated. The number of nodes is much higher in second order elements and therefore produce larger stiffness matrices and more accurate results. But this is at a significant increase in solve times.

Once a mesh chosen and applied to a component the quality of the mesh must be evaluated. The element size is of upmost importance.

As mesh size decreases, the number of elements, nodes and degrees of freedom increase. This results in larger stiffness matrices and therefore longer solve times. In addition a mesh should be checked for element duplicates. This is typically due to CAD error where a component has not been produced properly. The result is duplicate element nodes which are in the same position and produce inaccurate stress results.

Element free edges will cause similar problems, as the boundary condition of the element will not be accurate for the study.

Element normals or direction are particularly important where there are contact faces. The direction of these elements is critical to

correctly considered the relationships in these contact areas.

Finally the quality of each element must be considered. Ideally every element would be of equal size and shape. This would produce the most accurate result.

This can become particularly different in components of complex geometry. The meshing cycle will try to calculate the most efficient method of element placement.

This can be checked using various tools within FEA software. These check for aspect ratio, jacobian ratio, skewness, volumetric skewness, duplicate elements.

There are also tools such as H and P adaptive. These automatically mesh components, identifying areas of high stress. They continuously refine the mesh until the result converge at $\pm 2\%$ of stress and strain.

15

b)

FEA models can be correlated by a number of physical tests. Strain gauges, photo elastic gauges, etc gauges can be used to verify the displacement in relation to the results produced by an FEA study. In addition to this physical hand calculations can be performed to prove simulated stress values.

4

Question No.

Examiner On

Arholwr yn unig

Yn y Cwestiwn

Question No.

Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Question No.

Examiner On

Arholwr yn unig

hif y Cwestiwn

the 1990s, the number of people with a mental health problem has increased by 50% (Mental Health Foundation 1999).

There is a growing awareness of the need to address the needs of people with mental health problems, and the importance of providing them with appropriate services. This has led to a number of initiatives, including the development of mental health services, the establishment of mental health trusts, and the implementation of mental health legislation.

The purpose of this paper is to review the current state of mental health services in the UK, and to discuss the challenges facing mental health services in the future. The paper will first review the current state of mental health services in the UK, and then discuss the challenges facing mental health services in the future.

The current state of mental health services in the UK is characterized by a number of challenges. These include a growing demand for services, a shortage of resources, and a need for better coordination of services.

The growing demand for services is a result of a number of factors, including an increase in the number of people with mental health problems, and a growing awareness of the need for services. The shortage of resources is a result of a number of factors, including a shortage of staff, and a shortage of funding.

The need for better coordination of services is a result of a number of factors, including a lack of communication between different services, and a lack of coordination between different services. This can lead to people with mental health problems not receiving the services they need.

There are a number of initiatives that are being implemented to address these challenges. These include the development of mental health services, the establishment of mental health trusts, and the implementation of mental health legislation.

The development of mental health services is a key initiative. This involves the development of new services, and the improvement of existing services. The establishment of mental health trusts is another key initiative. This involves the establishment of new trusts, and the improvement of existing trusts.

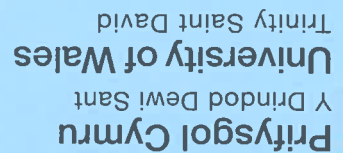
The implementation of mental health legislation is another key initiative. This involves the implementation of new legislation, and the improvement of existing legislation. This can help to ensure that people with mental health problems receive the services they need.

There are a number of challenges facing mental health services in the future. These include a growing demand for services, a shortage of resources, and a need for better coordination of services.

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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.

CYFENN:

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

- Rhaid i'r atebion fod mewn llawysgriften ddarlennadwy. Gall yr Arholwyr naill ai anwyblyddu sgript annarllennadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.
- Ysgrifennwch eich atebion mewn inc.
- Ni ddylid rhwgo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
- Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyllywrr/gwylwyr.
- 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 Archoliad	
3	Cod y Modwl	
2	Teitl y Papur Arholiad	
1	Rhif Myfyrwr	

[illegible]

(See the other side for English version)