



**Complete, fold and seal
(see note 2 below)**

SURNAME: Roberts

FORENAME(S): Elizabeth may

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.**

List the numbers of the questions you have attempted	Office Use
2	7½
3	7
4	14
Total	28½

(Gweler yr ochr arall am y fersiwn Cymraeg)

47.5%



Question two:

a) when a crack is initiated it can be due to imperfections in the material, stress areas due cyclical loading, under constant compression, the crack could cause a weakness, then when loading may show bottle necking areas or arrest lines and then failure.

2

b) when a component has failed due to fatigue you see 3 areas

- point of initiation
- arrest lines or crack propagation
- and final failure where jagged edges are seen where the component has torn at the arrest lines.

3

c) The fatigue in the component would increase and therefore as the stress decreases or stays the same the fatigue increases

+0

d) $\sigma_r^m N_f = K$

No cycles to fail

 σ_r stress 10^9 100×10^6 pa 10^6 200×10^6 pa

?

 150×10^6 pa

+



There are theories which are used for stress calculation, usually failures are seen in between gerber + goodman (hatched area) Soderberg is more conservative usually experimental results seen here.

as the stress amplitude decreases the mean stress increases.

3

Question three

During FEA analysis, 3 things happen
Pre processing, processing & Post processing
during Pre processing we look at 4 out
of the 5 S.I.M.P.L.E. acronyms.

we start off by: S

Splitting: the component geometry down,
making some simple hand calculations
of our component (if possible) to forecast
what we may see, we mesh the component
with a suitable mesh, ensuring that the
element size is adequate and that the
distance between the nodes is small enough
to give accurate results.

~~Next~~ Next we Interpret what we see, is
the mesh sufficient? are there any issues
with the mesh? As all the Quad + tetra
holes? how any geometry reduced our
mesh size in certain places? if so, how
can we combat this? simplifying geometry
such as holes or threads where the mesh
tends to cluster.

Material: Next in to put the material
properties in, this will allow us to
determine if we need a non-linear or
linear solver.

Physical properties: If 1D is used
second polar moment of area should be
provided, if 2D, the thickness specified
and if 3D the geometry will provide this,
These must be present in order for the

mesh to calculate the correct stress and strain.

Loading: loading is added + boundary conditions, this allows the component to know its orientation etc.

meshing is an important part of fea, the mesh breaks the geometry down into finite elements. If the mesh is incorrect the model may fail or the results be inaccurate.

- many errors with meshing are as follows:
~~mismatch~~ in the mesh, the elements have collapsed and create smaller elements causing unnecessary stress concentrations.
- modelling errors, where the component may have been mismodelled in CAD and they are not fixed to each other, therefore extra nodes are provided, meaning the mesh isn't attached at those points, this can be altered in the software to merge all nodes within 1mm of each other.
- You should allow at least 3 nodes per surface if you can, therefore selecting mesh size is important to allow this, also selecting the correct order mesh elements is important, for accurate results 2nd order is preferred.
- using h or p adaptive meshing enables you to automatically enhance mesh to smaller elements in complex geometry and to simplify it in larger areas, you must ensure that the mesh is consistent and there is no element deformation and if any is found this must be manually altered.

X

6

b) FEA models can be used as a tool to aid in designing + Verifying models, this is all done through initial software. However we must ensure that what we see on the computer correlates with the physical prototypes, there are FEA verification tools that can ~~to~~ simulate real-life situations where loading and boundary conditions can be specified along with material + physical properties. These ~~are~~ ^{tools} tools are ~~known as~~ ^{can be} topology optimisation ^{while} ~~that~~ ^{optimising} the component size. We can use static + frequency analysis tools to check stress + strain at static loading or vibrating at natural frequency conditions. Crash testing tools can be used on components to see failure behaviour and safety. Thermographic tools for convection, conduction + radiation can be observed. Linear + non linear tools can be used to see how the stress in certain material can be used. All software still has to be correlated against physical results. Some a prototype would have to be made and tested whether it be ~~as~~ to verify it works or to a destructive method where the component is destroyed.

Question 4:

a) pre processing: This happens before the component has been analysed by the software. The first 4 S.I.M.P.L.E are under taken and are ^{explained} in Q7. but in short we split the geometry down into finite elements, we observe the component mesh ^{what we} to ensure it is sufficient. we Interpret ~~these~~ what we see whether we need to simplify the geometry or change the mesh. we add in material properties to define if it is linear or non linear solver is required, we specify Elementary modules and Yield Strength etc. If 1D or 2D elements are used we must specify physical properties, for 1D second polar moment of area for 2D, element thickness. last we specify loading and boundary conditions, where the loading is, if the component is constrained and how it is constrained etc. all this must be done to run a successful analysis.

Processing: This is when the software is analysing the model, during this time results may or may not be visible. if they are visible checks can be made to see if the hand calculations correlate so far.

Post Processing: This one the model has been analysed and we have a set of results, here we look at whether the results are what we expect to see? if not how can this be changed? Set up? software? if it is what you expect to see how can the component be improved?
* hand calculations can be done on the model to ⁶ forecast what you expect to see

Are Your results reliable if so why?
if not why? background information must be sourced to correctly correlate + Interpret results.

b) when analysing a model, there are many techniques that can be used to analyse it. Inevitably meshing will always be required. There are many automatic options that can mesh Your component, however this can lead to poor results for example if a 6mm component is meshed, it should have a 1.8mm mirroring mesh at its 0.3 of the natural thickness. An automatic meshing may choose a 3mm mesh as standard this means there is 1 node per face. This will create poor results as the element will be too far apart and the stressed areas will not flow properly or give accurate stresses and strain. However, some meshing software such as P or H adaptive will reduce the mesh to very small sizes around complex geometry, this increases Run time and the geometry could be simplified to reduce this. By manually meshing and examining your component you are increasing the accuracy of the results, You are allowing for errors to be picked up and amended.

The techniques that are available work and enable a better insight to be obtained on the component and its behaviour. If automatic systems are used, errors will be missed people will become under skilled and knowledge on why you have certain results will be missed. FEA requires attention to detail it can make a good engineer great or a bad engineer dangerous.

Question No.

Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Question No.

Examiner Or

Arholwr yn unig

itf y Cwestiwn

Question No.

Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Question No.

Examiner On

Arholwr yn unig

nif y Cwestiwn

Question No.

Examiner Only

Arholwr yn uni

Rhif y Cwestiwn

Question No.

Examiner On

Arholwr yn unig

hif y Cwestiwn

the 1990s, the number of people in the UK who are employed in the public sector has increased by 1.5 million, from 2.5 million in 1980 to 4 million in 1995. The public sector has also become an important employer of women, with 5.5 million women employed in the public sector in 1995, compared with 4.5 million in 1980.

There are a number of reasons why the public sector has become an important employer of women. One reason is that the public sector has a high proportion of women in its workforce. In 1995, 88% of the public sector workforce were women, compared with 78% in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.

Another reason why the public sector has become an important employer of women is that it has a high proportion of jobs that are part-time or flexible. In 1995, 22% of the public sector workforce were employed on part-time or flexible contracts, compared with 12% in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.

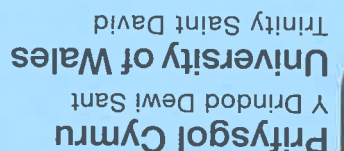
A third reason why the public sector has become an important employer of women is that it has a high proportion of jobs that are well paid. In 1995, the average salary of a public sector employee was £18,000, compared with £15,000 in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.

There are a number of other reasons why the public sector has become an important employer of women. One reason is that the public sector has a high proportion of jobs that are well located. In 1995, 22% of the public sector workforce were employed in the public sector, compared with 12% in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.

Another reason why the public sector has become an important employer of women is that it has a high proportion of jobs that are well paid. In 1995, the average salary of a public sector employee was £18,000, compared with £15,000 in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.

A third reason why the public sector has become an important employer of women is that it has a high proportion of jobs that are well located. In 1995, 22% of the public sector workforce were employed in the public sector, compared with 12% in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.

There are a number of other reasons why the public sector has become an important employer of women. One reason is that the public sector has a high proportion of jobs that are well paid. In 1995, the average salary of a public sector employee was £18,000, compared with £15,000 in 1980. This is due to a number of factors, including the fact that the public sector has a high proportion of jobs that are traditionally considered to be 'female' jobs, such as teaching, nursing, and social work.



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) i guddio'ch enw.

3. Rhaid i'r atebion fod mewn llawysgriften ddarllenadwy. Gall yr Arholwyr nall 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 rhwygo 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/gwylywyr.

8. Rhaid dychwelyd pob llyfr. Ni chanafeir 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)

CYFENW:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: