



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Examination Answer Books

12 Pages

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.

Complete, fold and seal
(see note 2 below)

SURNAME:

Ward

FORENAME(S):

Milo James

1	Student Number	150471
2	Title of Examination Paper	CAE 4 Stress Analysis
3	Module Code	M5Y02064
4	Date and Time of Examination	12pm 9/5/14
5	Examination Venue	EQ 310
6	Seat Number	5016
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
2	2 1/2
3	11
4	9
Total	22 1/2

(Gweler yr ochr arall am y fersiwn Cymraeg)

37.5%

Notes

Split

Interpret

Material

Physical properties

Loading

Evaluate

Define

Gather

Generate

Analyse

Implement

3a Discuss the difference between a design problem and an analysis problem?

A design problem is an issue normally discovered in the design and development stage, normally during CAD. This could be where a part has been designed and built via CAD, but then later realising one of the fixtures can not be reached when the part is fully assembled.

A analysis problem is more usually found in the analysis of the product, when the product is being tested and a weak spot is found when the part is being tested virtually and simulating the forces being put through the product. When this is done via stress, part of the product may snap virtually, showing that it isn't strong enough.

5 A design process is usually a iterative process as the part is fully designed and then flaws are found in the product. This then requires an entire restart of the product or a major redesign to try and ~~stop~~ fix the problem that has occurred. This would ~~be~~ mean there is the ~~the~~ first iteration, which is then tested and fails, and then a redesign, which creates a second iteration which may solve the problem but may encounter another. So, another redesign occurs and the next iteration and so forth until the ~~correct~~ design is correct and fit for the job. This can be quite a time consuming and therefore ~~pre~~ costly process.

On the other hand, an analysis problem is more sequential (suggesting each part ~~leads~~ design leads on from the needs rather than new designs) due to the accuracy ~~of~~ and how specific the changes can be to make sure they are correct. Where the analysis problem has seen the issues that need to be solved straight away, it can ~~see~~ ~~where~~ ~~has~~ seen where the improvements must go in that product. If for example the part has extra stress on a mounting bracket this can be analysed in FEA and seen early that this will be the weak spot (analysis problem) and extra material or higher strength can instantly be added to that area to reduce the risk of the part failing while under full load. This can then be instantly checked ~~against~~ by FEA to see if the product has been improved and if that product can be carried forward.

15

C One theory is ~~start~~ the five step process. This requires the problem to first be defined, find what the problem is, what does the company want and a large amount of ideas should be gathered ruling nothing out.

The next stage is to gather, this requires research to be done, this involves find if the ϕ is already products on the market for this product, if so are they good, what are they bad at. How are they priced, can they be improved? If there isn't a solution on the market, it should be considered if this product will sell, if so how much, will it make money, would it look like people expect it to, does it look nice and ~~are~~ would it be safe to use.

After that, generate ideas. This should be done via brainstorming, ruling nothing out. Then the best ideas should be taken forwards from there. These designs should then be narrowed down and the process of FEA and CAE can start. The product should be created using SIMPLE to get the best product for the job. Take the product down to one final design and move this forward.

The fourth step is analyse the product, ~~the~~ Does it do the job it was set out and created for, is it safe and easy to use, is it going to fail or cause issues with other products. Does it conform to what is expected of the product and does it meet laws and regulations that are set out for it so that it can sell.

The final stage is Implement, put this product on the market, patent the property so it can be copied and document everything so that it can be proven that

it is certified and up to spec.

The five step process is one of the most commonly used and accepted process of today as it splits the steps down into small but descriptive sections that are easy to follow and achieve as long as the product is acceptable. A disadvantage to this process is that it is aimed towards both production or mass production over one offs or prototype designs due to the complexity that can be involved and most certainly costing.

SIMPLE is another design process that can be used with the five step or on its own, it starts with S-Split. This is split the product into finite elements to allow for 1D, 2D, 3D geometry to be created, this allows for the advice to start to be prepared.

I-Interpret, this is to ~~ass~~ make mathematical assumptions for the small parts that will have ~~to~~ no overall effect on the product apart from increasing run time and dragging the process out. ~~Causing~~ more time and money to be used.

M-Material, by now the mesh ~~should~~ of the product should have been created. The material properties should be inputted in to create a more real simulation.

P-Physical properties is adding in the material thickness, the orientation, ~~the loading of the stresses on the product~~, the direction of travel of the product ready for analysis.

L-loading, the loading of where the stress would be and the forces that the product would be under must be put onto the product. The simulation can then be run.

E-Evaluation, See how the product performs while under load. If it performed as expected or whether changes need to be made to make this product more suitable for its job.

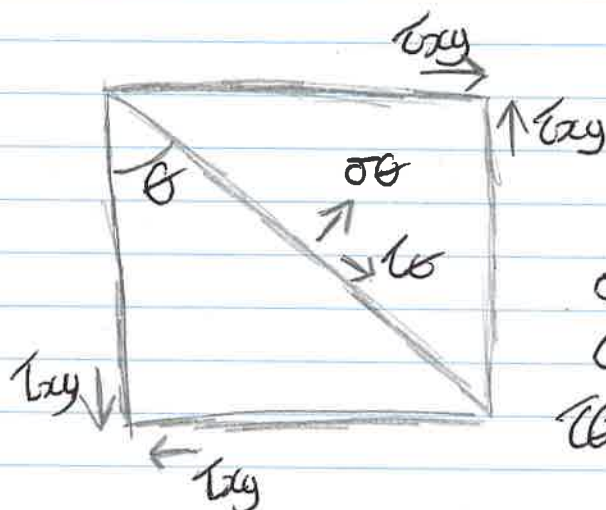
The advantages of simple is that it is a clear and precise method to follow, using FEA as the base and getting a product without spending any money on a real produce prototype.

A disadvantage of this method is that it can't work for all products and the software really needs to be understood fully so that it can be used to its full capabilities. Also, a real product should be produced before manufacturing to make sure the computer is completely correct in its analysis.

2a Principal stress is the main stress that the object is going to be put under. The principle stress is the major force effecting it, this could be on a mounting point where of a handle bar to a clip on where all the force going through the handle bar which welded together. ~~The direction of principle stress is away from the body of the clip on and at that point is the principle of stress~~ The principle plane is then the direction of travel that the stress is going through, whether this is a horizontal stress X, Y, Z plane

that the stress is being forced through.

b



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

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

$$\sin \theta \cos \theta = \frac{1}{2} \sin^2 \theta - \cos^2 \theta = \cos 2\theta$$

4. One way of Optimisation by using FEA is Topology. ~~This can be done once a product has been~~ Putting in the potential geometry and the desired forces, onto a unknown product, FEA is able to ~~great~~ help create and develop a product that completes the required job. If the forces/stress have been loaded, it is able to work out where the greatest amount of stress would be on the product and where the strongest parts would need to be. For example, ~~extra~~ placing on a swing arm on one part while there is a gap elsewhere. Knowing how much stress one part is under, it can build material into that section of swing arm so that it is able to cope with the desired amount of stress. But then other parts of the same swing arm may be under no/little stress, so less material or a weaker material can be used here to save weight and money and that is the most crucial

thing for a business. Creating the best product in the cheapest and quickest way.

2

A The major limitation for gradient based optimization is over complexity which leads to longer and sometimes unsolvable run times. Although the greater complexity would give greater and more detailed results, with this it gets harder and more complex for the computer to solve, resulting in the need for better and more expensive computers or the inability to run a product virtually to see if it would work. Leaving the only option to try it in real life. Which in turn could get more expensive and still be incorrect.

(4)

B One way gradient based optimization can be overcome is greater processing power and capabilities in the computer that is running the software so that it is able to handle the greater number of things that are being calculated at the same time and if the computer is able to do this, it will be able to decrease the run time and potentially not crash. The disadvantage to this is the greater investment in hardware of computer to run this and having the need to have someone that can run, repair, and look after this level of equipment. Unless the company can justify spending that

amount of money on ~~expensive~~ hardware and be able to return a sizable profit to make it justifiable. That is the only way it could work. If not it would be a poor business decision and ~~only~~ although it would greatly improve the optimisation and increase the accuracy of the FEA and FEA so it is even closer to real world. Getting close to being able to completely skip the prototype and real life testing phase and going straight into manufacturing (the desired way for most companies as the testing and ~~one off~~ small batch production for testing is the most expensive stage) It really wouldn't be justifiable for many companies.

(2)

Question No.

Examiner Only

Arholwr yn unig

Unit y Cwestiwn

Question No.

Examiner Only

Question No.

Examiner Or



Llyfr Atebion Arholiadau

12 Tudalen

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, 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 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, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

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

[illegible]

(See the other side for English version)

Llenwch, plygwrch a seliwrch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF: