

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

**EXAMINATION PERIOD
FEBRUARY 2021**

**CYFNOD ARHOLIADAU
CHWEFROR 2021**

**MODULE CODE:
M6X00420: Advanced Stress & FEA (PART TIME)**

TIME: 2 HOURS

ANSWER THREE OUT OF FOUR QUESTIONS

Equipment or materials required – None

Adnoddau neu ddefnyddiau sydd eu hangen – Dim

University approved calculators are permitted.

Assume 'g' = 9.81 m/s².

Question 1

FEA can be used to make the design process more efficient. Discuss the following:

- a. How this can be used to reduce the number of physical prototypes used in the testing phase.
[10 marks]
- b. Why physical prototypes may still be needed.
[4 marks]
- c. Why correlation is needed between test and FEA and how confidence may be achieved in the FEA model.
[6 marks]

Question 2

Discuss the steps that you would undertake when carrying out some FE analysis. Your discussion should include the following:

- a. What steps you would carry out during the pre-processing stage. [10 marks]
- b. What is meant by the processing stage. [5 marks]
- c. What steps you would carry out during the post-processing stage. [5 marks]

Question 3

When designing a machine that needs to be efficient in bending and stiffness/weight is of importance, it may be beneficial to use Aluminium in terms of the structural performance over Steel.

- a. By considering a structural panel 300mm x 300mm constrained in all 6 degrees of freedom on one edge such that it is in pure tension from a 1000N load evenly distributed on the opposite edge, calculate the deflection that would be seen if this were made from 1mm sheet steel. Compare this to a panel 300mm x 300mm made from 3mm Aluminium. ($E_{\text{Steel}} = 200\text{GPa}$, $E_{\text{Aluminium}} = 69\text{GPa}$). Calculate the stiffness of each panel in tension.

[4 marks]

- b. By considering the same structural panel from part a, constrained in all 6 degrees of freedom on one edge such that it is in pure bending out of plane from a 1000N load evenly distributed on the opposite edge, calculate the

Flexural stiffness (EI) of the panel given $I_{NA} = \frac{BD^3}{12}$ that would be seen if this were made from 1mm sheet steel. Compare this to a panel 300mm x 300mm made from 3mm Aluminium.

[4 marks]

- c. Given that the densities of each of the materials below, calculate the stiffness/weight ratios of each of the panels considered in parts a and b. ($\rho_{\text{Steel}} = 7900\text{kg/m}^3$, $\rho_{\text{Aluminium}} = 2700\text{kg/m}^3$)

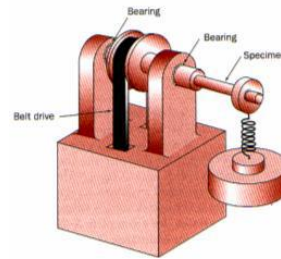
[4 marks]

- d. Discuss the statement made at the start of this question, using your answers to part a, b, and c to evidence your argument.

[8 marks]

Question 4

- a. A diagram of a Wohler machine can be seen below. Discuss how this could be used to generate an S/N curve.



[5 marks]

- b. With the aid of a diagram, show what the loading cycle would look like for the specimen loaded in part a.

[3 marks]

- c. With the aid of a diagram, show what the S/N curve would be expected to look like that has been generated in part a. By adding additional curves to your diagram, discuss what a P/S/N curve is.

[5 marks]

- d. By annotating your diagram in part c, show the impact of increasing the mean stress.

[2 marks]

- e. Theories proposed by Goodman, Geber and Soderberg discuss the relationship between mean stress and stress amplitude during fatigue testing. With the use of a diagram, compare these three theories to each other and also relate them to experimental data.

[5 marks]