



EXAMINATIONS 2014 / 2015

AHOLIADAU 2014 / 2015

Semester 1

FACULTY OF: Applied Design & Engineering

NAME OF COURSE/PROGRAMME: BEng Manufacturing Systems Engineering
BEng Mechanical & Manufacturing Engineering

YEAR OR LEVEL: Year 3

NAME OF MODULE/UNIT/EXAM PAPER: Advanced Stress Analysis

MODULE NO:

DATE OF EXAMINATION: ??

EXAMINATION TIMES:

START TIME: ?? pm

FINISH TIME: ?? pm

TIME ALLOWED: 2 hours

INSTRUCTIONS TO CANDIDATES:

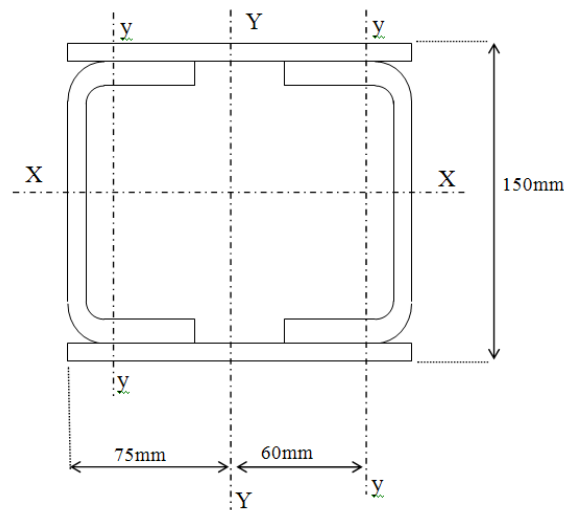
Answer 3 from 4 questions.

1.

- a) Given the fact that Aluminium is approximately one third the density of steel but also one third the stiffness, briefly discuss why, in terms of vehicle stiffness, structural panels made from Aluminium can be beneficial over steel panels.

[2 Marks]

- b) The engine longitudinal of an integral vehicle chassis is fabricated from steel and is 1m long. The fabrication is symmetrical about the YY axis and is constructed from two flat 2mm plates and two 'C section' folded steel sheets as shown below. Given that the Young's Modulus, E , is 200GPa the compressive yield stress, σ_c , is 320MPa and a constant a of 1/7500, assuming the longitudinal is fixed at one end and free at the other, determine the following;



Properties of ONE
folded sheet steel
section;

$$I_{xx} = 1.5 \times 10^6 \text{ mm}^4$$

$$I_{yy} = 5.5 \times 10^5 \text{ mm}^4$$

$$A = 384 \text{ mm}^2$$

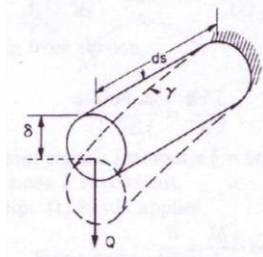
- i. Which axis will the longitudinal buckle about?
[5 Marks]
- ii. What is the radius of gyration about this axis?
[1 Mark]
- iii. What is the slenderness ratio of this longitudinal?
[1 Mark]
- iv. According to Euler theory, what load will this longitudinal buckle at?
[3 Marks]
- v. According to Rankine-Gordon theory, what load will this longitudinal buckle at?
[3 Marks]
- vi. Comment on the results of (iv) and (v), and with the use of a diagram explain the difference between experimental results and buckling loads according to Euler theory.

[5 Marks]

2.

a)

- (i) Consider the below bar subjected to shear, prove from first principles that the shear strain γ , due to the load is given by; $\gamma = \frac{Q}{AG}$, where Q is the shear load, ds is the length of the bar, A is the cross sectional area and G is the Shear Modulus.



[2 Marks]

- (ii) Hence prove that the strain energy, U, for a bar in Shear is given by;

$$U = \frac{Q^2 L}{2AG} \quad [4 \text{ Marks}]$$

- (iii) What is meant by the term Resilience? Hence from prove from the standard relationship for a bar in tension, $U = \frac{P^2 L}{2AE}$, where P is the load and E is the Youngs Modulus, that resilience may be defined as

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

[4 Marks]

- b) (i) A steel rod has a square cross section 15mm x 15mm and a length of 1m. Calculate the strain energy when a stress of 300MPa is produced by stretching it. (E=200GPa)

[3 Marks]

- (ii) The rod then has a metal collar fitted at the lower end, and a mass, m, is dropped onto the collar. Show, by considering the energy transferred from the falling weight to the rod, that the height, h, is related to the stress, σ , by the following relationship;

$$h = \frac{\sigma^2 V}{2Emg} - \frac{\sigma L}{E}$$

Where V is the volume of the bar, and L is the length. Assume that the extension of the bar is significant in the energy transfer.

[4 Marks]

- (iii) If the stress must not exceed 75MPa, from what height could 200kg fall onto the collar, without exceeding this?

[3 Marks]