UNIVERSITY OF GHANA

SCHOOL OF ENGINEERING SCIENCES

B.Sc. (Engineering) FIRST SEMESTER EXAMINATIONS 2014/2015

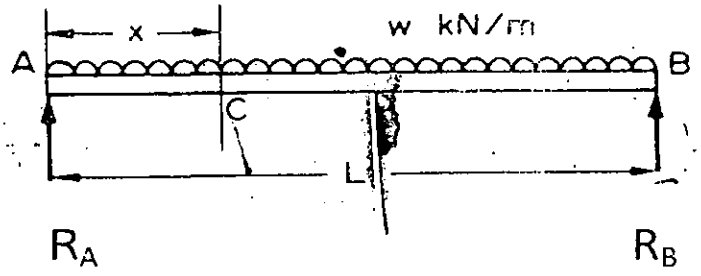
FAEN 203: STRENGTH OF MATERIALS (3 CREDITS)

INSTRUCTION: **ANSWER ALL QUESTIONS**

TIME ALLOWED: **TWO (2) HOURS**

QUESTIONS

1. Complete the following statements
   a) In a tensile stress test, the work done on a unit volume of material up to the proportional limit is.....
   b) The working stress of a material may be obtained by dividing the stress at yield by a .....
   c) From the diagram below, complete the following statements



   i. $R_A = R_B =$ .....
   ii. Bending moment (B.M) at section C in terms of W and X
   M. = ...
   iii. Differentiating, $\frac{dM}{dX}$ = ... and so M is ..... or ..... when $\frac{dM}{dX}$ =0
   iv. The sheer force (S.F) at C, Q = ...
   v. The slope of the B.M. diagram is given by .....
   vi. Therefore S.F. (Q) represents the .....

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d) Two effects of forces and couples acting on beam are

i. .....

ii. .....

e) The simple bending theory may be stated as $\frac{MC}{I} = \frac{M}{Z}$ where C is the

..... and Z is called .....

f) Complete the following statements

i. In a two-dimensional stress system, there are two planes separated by ..... on which the shearing stress is ..... These planes are called ..... and the corresponding values of the stress are called .....

ii. Springs are ..... units whose function is to store energy and release it.

2. A concrete column, 45 cm square is reinforced with steel rods each of 2.5 cm diameter embedded in the concrete near the corners of the square. Estimate the compressive stresses in the steel and concrete if the total load on the column is 1 MN. Given E for steel = 200 GN/m^2 and E for concrete = 14 GN/m^2

3.

a) State the ***Simple Bending Theory*** and mention three assumptions made in its derivation.

b) A cantilever beam of length 3.0 m is loaded by a concentrated force P at its tip. The beam is of circular section with a radius (R) of 100 mm. The material is titanium alloy having an allowable working stress in bending of $600MP_a$.Determine the maximum allowable value of the force P. (Given, $I= 0.59R^4$) (I has the usual meaning)

4.

a) State the ***theory of pure torsion*** for a solid shaft of uniform circular cross-section
Define all the terms

b) A hollow steel shaft 3.0 m long must transmit a Torque of 25 KN.m at 100 rev/min. The total angle of twist in this length is not to exceed 3^o. If the inside and outside diameters are 145 mm and 125 mm respectively, determine

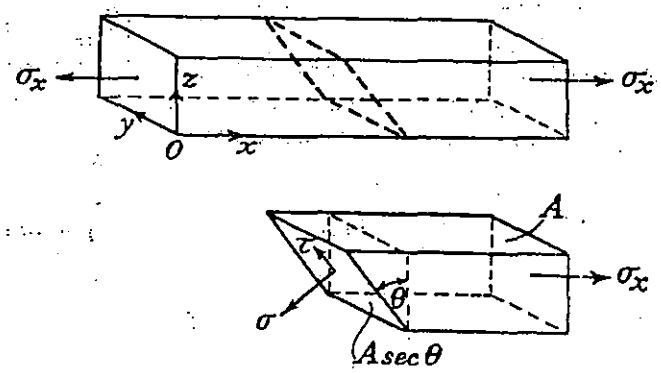
i. The maximum allowable shearing stress

ii. The power transmitted

(Given $J = \frac{\pi(D^4 - d^4)}{32}$ and 1 radian = 57.3°)

5.

a) The figure below shows a steel bar with a rectangular cross-section of area A stressed uniformly in tension in the X direction.



Show that the direct stress (σ) and the shear stress (τ) acting on the inclined cross-section are given by

$$\sigma = \sigma_x \cos^2\theta$$

$$\tau = \sigma_x \cos\theta \sin\theta$$

b) A plate is subjected to two mutually perpendicular stresses, one tensile of 75MN/m^2, the other compressive of 45MN/m^2 and a shearing stress of 45MN/m^2.

i. Evaluate the values and directions of the principal stresses.

ii. What is the greatest shearing stress

Given :

$$\sigma = \frac{1}{2}(\sigma_x + \sigma_y) \pm \frac{1}{2}\sqrt{[(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2]}$$

$$\tan 2\theta = \frac{2\tau_{xy}}{(\sigma_x - \sigma_y)}$$

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