

National Examinations December 2019

16-Mec-A7, Advanced Strength of Materials

3 Hours Duration

Notes:

1. If doubt exist as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. Any non-communicating calculator is permitted. This is an open book exam.
3. Any five problems constitute a complete paper. If you choose to attempt more than five problems, only the first five problems as they appear in your answer book will be marked.
4. All problems are of equal value.

1. A thin square plate of 0.75m by 0.75m is subjected to the following stresses: $\sigma_{xx} = 65$ MPa, $\sigma_{yy} = 100$ MPa and $\tau_{xy} = 75$ MPa. If Modulus of Elasticity $E = 200$ GPa and Shear Modulus $G = 77$ GPa, determine ϵ_{xx} , ϵ_{yy} , ϵ_{zz} , σ_{zz} and γ_{xy} for:

- A) Plane stress condition
- B) Plane strain condition

2. A 60 mm diameter bar is subjected to axial load (P), torsional load (T) and transverse load (F). The allowable stress in tension and in shear on the bar of length 400 mm from free end are 85 MPa and 45MPa respectively. If $T = 0.2F$ (N/m) and $P = 15F$ (N), determine the value of transverse load F.

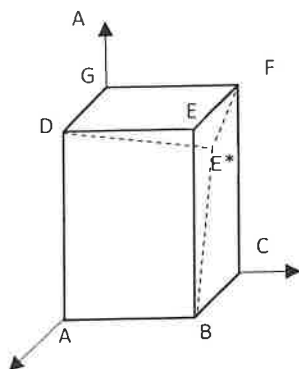
3. A steel cylinder with inside diameter of 100 mm and outside diameter of 180 mm is used as hydraulic cylinder. If the axial stress is negligible, Modulus of Elasticity is $E = 207$ GPa, Poisson ratio is 0.29 and yield strength is, $\sigma_{yield} = 200$ MPa, what is the maximum internal pressure if the factor of safety of 3 is used based on:

- a) maximum distortion energy
- b) maximum Shear failure theory

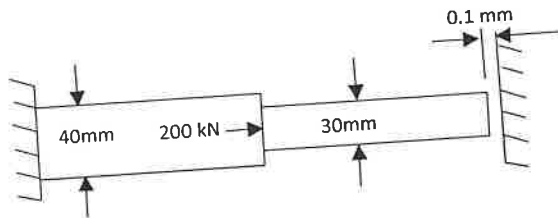
4. The parallelepiped is deformed into the shape as shown below. The displacement is given by the following:

$$u = c_1 xyz, \quad v = c_2 xyz \quad w = c_3 xyz$$

- a) Determine the state of stress of stress at point E when coordinate at of the same point after deformation is (1.504, 1.002, 1.996).
- b) Determine the normal strain at point E in the direction of EA



5. A composite bar is loaded as shown. Bar is fixed in against a rigid wall on left and has a gap of 0.1 mm to rigid wall on the right. Determine the reaction on both end of the bar after 200 kN is applied if the length of both bars are 600 mm.



6. A ship propeller is made of solid steel bar and it is expected to experience axial load of $P = 250$ kN and torque of $T = 50$ kN.m sufficiently from support point. Calculate the minimum diameter of the solid shaft if $\sigma_{\text{yield}} = 250$ MPa based on maximum distortion energy criterion.

7. A pin connected plane structure is subjected to a load of $P = 45$ kN at point B (see the figure below). If:

$$A_1 = 0.0055 \text{ m}^2$$

$$A_2 = 0.0035 \text{ m}^2$$

$$L_1 = 1.5 \text{ m}$$

$$L_2 = 2.5 \text{ m}$$

$$E_1 = 70 \text{ GPa}$$

$$E_2 = 200 \text{ GPa}$$

Determine the deflection at point B.

