考生注意事項：　1.考試時間 100 分鐘。　　　2.可使用無記憶裝置之計算器。
　　　　　　　　3.共五大題請依序作答並標示題號。

1. The circular propeller shaft ABCD carries the axial loads as shown in Figure. Use the modulus of elasticity 29 (10^6)psi for the propeller, (20%).
   (a) Determine the axial stress (psi) in the part BC?
   (b) Determine the axial strain in the part CD?
   (c) Determine the maximum axial stress (psi) in the shaft?
   (d) Determine the change (in.) in the length of the shaft caused by these loads?

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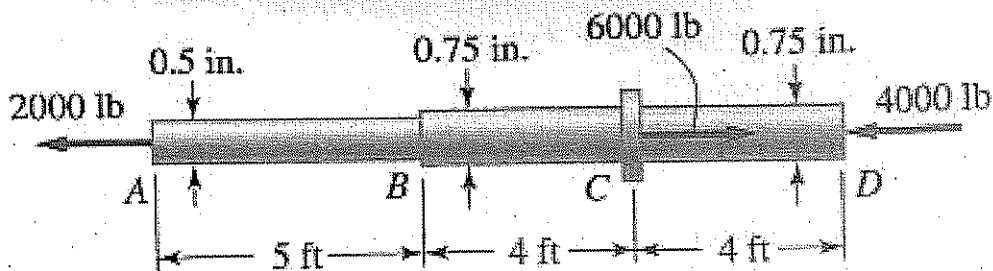
2. A simply supported the beam AC supports a distributed load as shown in the figure. The span is 4 m and the load intensity is 200 kN/m. Neglect the weight of the beam, (20%).
   (a) Derive the expression equation for the transverse shear force.
   (b) Construct the shear force diagram for the beam.
   (c) Derive the expression equation for the bending moment.
   (d) Construct the bending moment diagram for the beam.
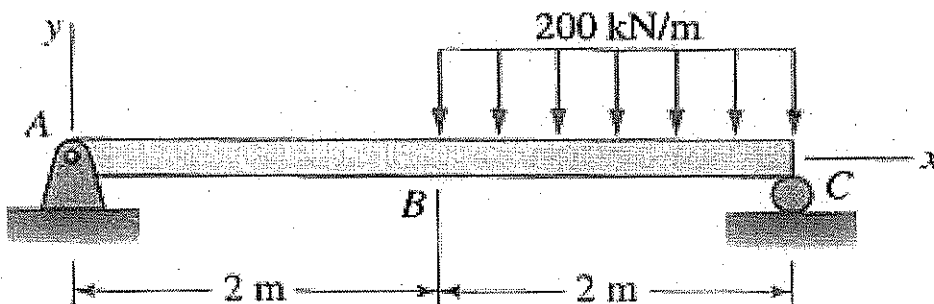
3. The rotor shaft of a helicopter drives the rotor blades that provide the lifting force to support the helicopter in the air. As a consequence, the shaft is subjected to a combination of torsion and axial loading as shown in the figure. For a 52 mm diameter shaft transmitting a tensile force $P = 120$ kN (producing the tensile stress σ_0) and a torque $T = 2600$ N.m (producing the shear stress τ_0) on the surface as the figure shown, determine the following stress on the shaft surface, (20%).

(a) Determine the stresses τ_0 and σ_0 (MPa)?

(b) What is the maximum tensile stress (MPa)?

(c) What is the maximum compressive stress (MPa)?

(d) What is the maximum shear stress (MPa)?

(a)   (b)   (c)

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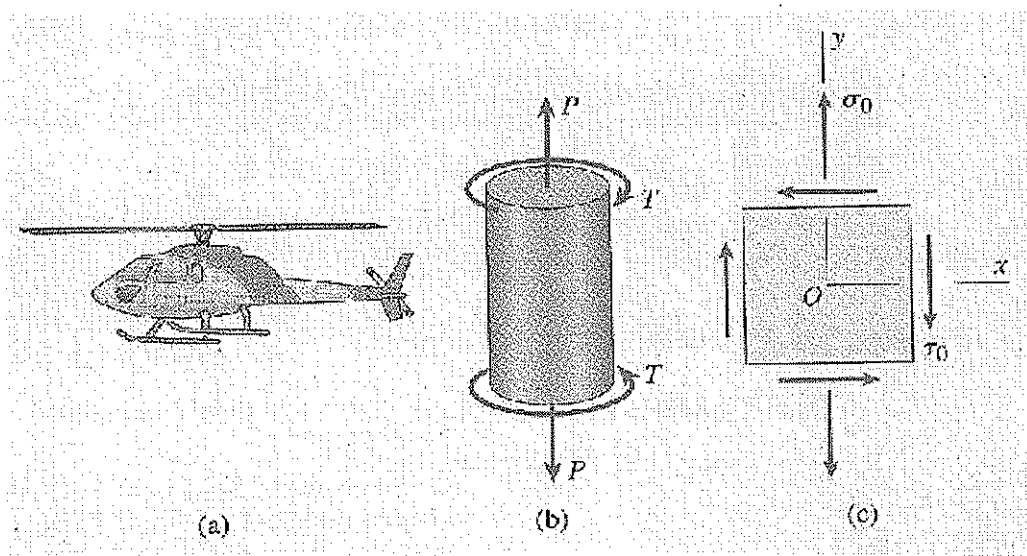
4. A 150 mm diameter steam pipe is laid in a trench at a temperature of 20°C. When steam passes through the pipe, its temperature rises to 110°C. The pipe is made of steel with modulus of elasticity 200GPa and coefficient of thermal expansion, CTE $12(10^{-6})/$°C, (20%).

(a) What is the increased dimension (mm) in the diameter if the pipe is free to expand in all directions?

(b) What is the axial stress (MPa) in the pipe if the trench restrains the pipe so that it axial length does not expand?

(c) What is the axial stress (MPa) in the pipe if the trench restrains the pipe so that it length only one-third as much as it would if it could expand freely?

(d) Write the materials which the CTE are smaller than the steam pipe.

5. The cantilevered beam as shown in the figure is subjected to a vertical load P at its free end. It has the axial length L, the modulus of elasticity E, the rectangular cross section with width b and height $2b$, (20%).

(a) Find the bending moment at distance x form the free end of the beam?

(b) Find the maximum bending stress of the beam?

(c) Determine the equation of the deflection curve of the beam?

(d) Determine the deflection at $x = L/2$?