

มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

การสอบกลางภาค: ประจำภาคการศึกษาที่ 1

วันที่: 3 สิงหาคม 2549

วิชา: 220-502 Advanced Mechanics of Solids

ปีการศึกษา: 2549

เวลา: 09.00-12.00 น.

ห้อง: A201

คำอธิบาย

1. ข้อสอบมีจำนวนทั้งหมด 5 ข้อ
2. ให้เลือกทำข้อสอบ 4 ข้อ
3. อนุญาตให้นำเครื่องคิดเลขทุกชนิดเข้าห้องสอบได้ และให้นำตำราเรียน, เอกสารทุกชนิด เข้าห้องสอบได้
4. ไม่ต้องส่งกระดาษทดเลขที่แจกให้คืน

ผู้ออกข้อสอบ: บุญ จันทรทัตภิชโนภาส

1. (25 marks) The state of stress at a point in a member is given by a stress tensor shown below (unit of the stress components is in MPa).

(a) Determine the principal stresses and their directions.

(b) Determine the normal and shear stress on an oblique plane whose normal lies in the x-y plane and making a counterclockwise angle of 45° with the x-axis. (Hint: Notice that $\sigma_{xz} = \sigma_{yz} = 0$)

$$T = \begin{pmatrix} \sigma_{xx} & \sigma_{xy} & \sigma_{xz} \\ \sigma_{xy} & \sigma_{yy} & \sigma_{yz} \\ \sigma_{xz} & \sigma_{yz} & \sigma_{zz} \end{pmatrix} = \begin{pmatrix} -150 & -40 & 0 \\ -40 & 70 & 0 \\ 0 & 0 & 80 \end{pmatrix}$$

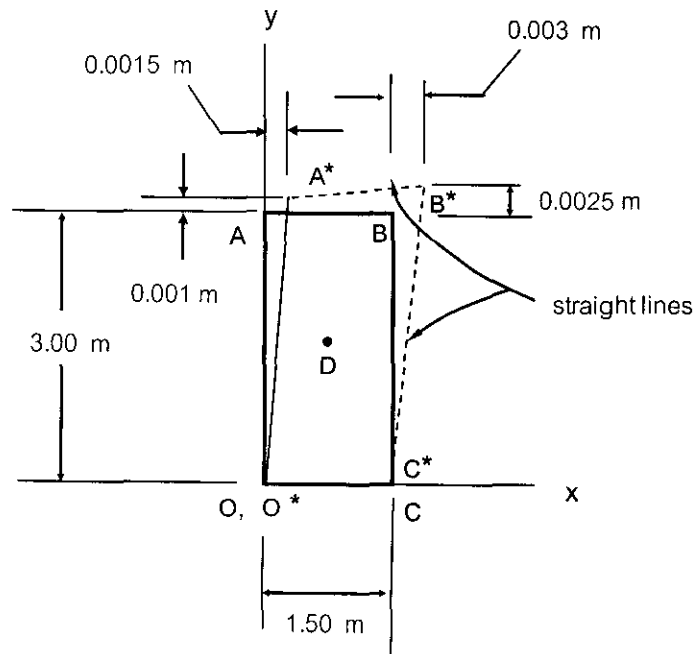
2. (25 marks) A rectangular plate OABC of dimensions 1500 mm x 3000 mm in the x-y plane shown below is loaded so that the plate is in the state of plane strain, ($\epsilon_{zz} = \epsilon_{zx} = \epsilon_{zy} = 0$), and passes to a new position O*A*B*C* .

(a). Determine the displacements (u, v), of the plate for the deformation shown in term of x, y coordinates.

(b). Determine the strain components at the point D(x=0.75 m, y=1.50 m) of the plate.

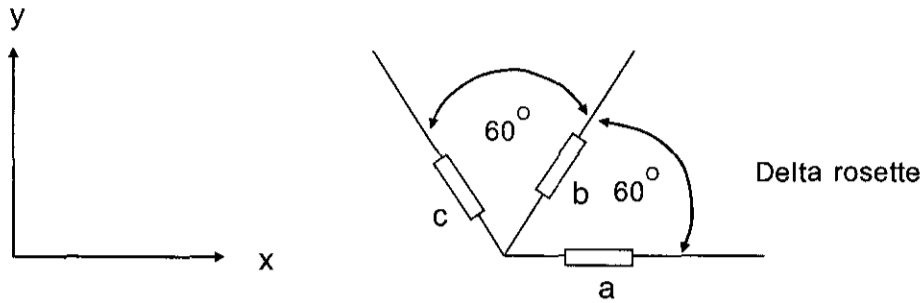
(c). Determine the strain in the direction of the line DB.

at D



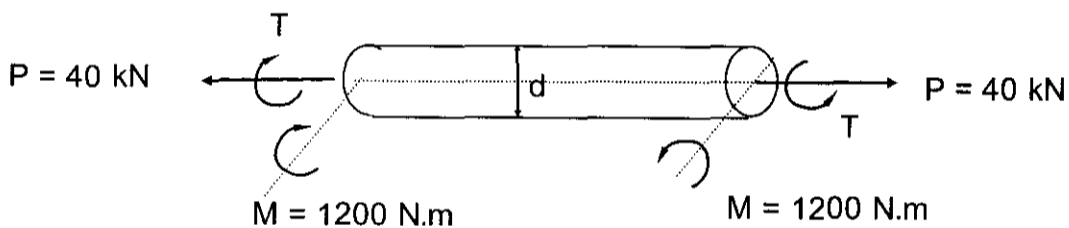
3. (25 marks) A delta rosette is cemented to the free surface of a member made of an isotropic metal alloy. Under loads, the strain readings are $\epsilon_a = 0.00024$, $\epsilon_b = 0.00006$, $\epsilon_c = -0.00015$.

- (a). If $E = 720$ GPa, $\nu = 0.33$, determine the magnitude of the principal stresses and the maximum shear stress.
- (b). Show the orientation of the volume element on which the principal stresses in the plane of the rosette act.



4. (25 marks) A solid steel shaft is designed with a diameter of 50 mm. It is subjected to an axial load $P = 40$ kN, a bending moment $M = 1200$ N.m, and a torque T . The yield strength for the steel is $\sigma_y = 280$ MPa, and assuming that failure occurs at the initiation of yielding.

- (a) If $T = 1600$ N.m, determine the factor of safety used in the design of the shaft based on the maximum shear-stress criterion of failure.
- (b) Determine the maximum allowable value of T if the factor of safety used in the design must be at least 2.20 (based on the maximum shear-stress criterion of failure).



5. (25 marks) A closed-end thin wall tube has a mean radius of 40 mm and wall thickness of 4 mm. It is subjected to an internal pressure $p = 20$ MPa, an axial load $P = 50$ kN, and a bending moment $M = 3000$ N.m. If yielding is impending in the tube, determine the yield strength Y of the material based on the maximum octahedral shear stress criterion of failure.

