

Student Code Number \_\_\_\_\_

Department of Mechanical Engineering  
Michigan State University

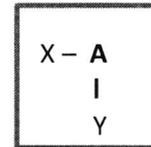
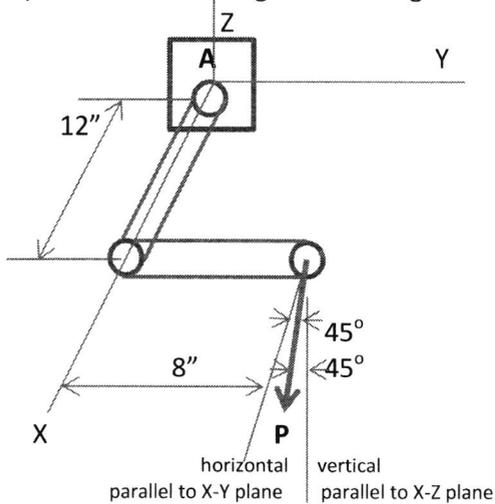
Solid and Structural Mechanics  
Ph.D. Qualifying Exam

January 2016

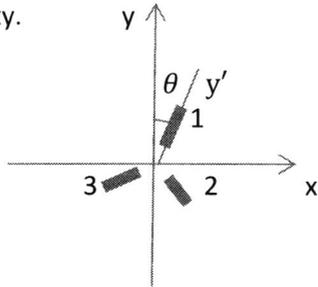
Closed book and notes  
You may use a one page (8.5x11) – **one sided** formula sheet.  
All four questions are weighted equally.

Prepared by  
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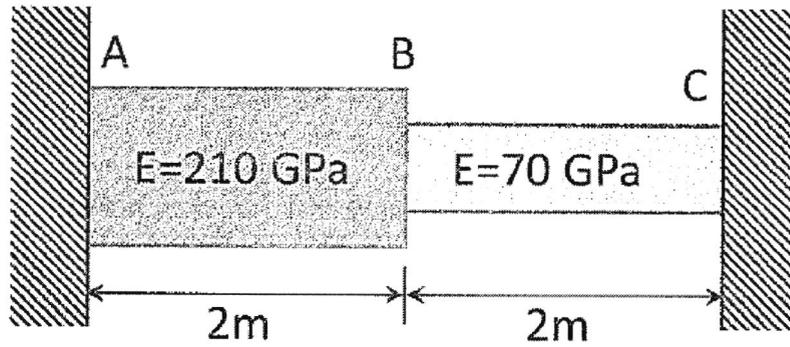
1. An L-shaped beam with a circular cross-section (radius  $r = 10\text{mm}$ ) shown below is loaded with a force  $P = 2000\text{N}$  parallel to  $xz$ -plane with a  $45^\circ$  angle from both the vertical  $x$ -plane and the horizontal  $z$ -plane. Give the stress element at points A (top view onto  $xy$ -plane with  $+x$  to the left while  $+y$  pointed toward you) which is located right at the origin of the  $xyz$  coordinate system on the top of the fixed end.



2. The following strain rosette has three elements identified as 1, 2, and 3. Each element is oriented  $120^\circ$  from each of the remaining two. Due to installation error, an angle of  $\theta = 5^\circ$  was introduced as shown in the diagram. If the readings from the three legs are  $\epsilon_1 = 100\mu$ ,  $\epsilon_2 = 200\mu$  and  $\epsilon_3 = 300\mu$ , find  $\epsilon_{xx}$ ,  $\epsilon_{yy}$  and  $g_{xy}$ .



3. The steel rod AB (coefficient of thermal expansion  $\alpha = 12 \text{ E-}06 / ^\circ\text{C}$ ) and aluminum rod BC (coefficient of thermal expansion  $\alpha = 24 \text{ E-}06 / ^\circ\text{C}$ ) are attached to rigid supports and are unstressed when rod AB is at  $-6^\circ\text{C}$  and rod BC is at  $5^\circ\text{C}$ . The temperature in both rods is raised to  $15^\circ\text{C}$ , find: 1) The resultant force at both walls, 2) the internal stress in rod AB and rod BC and 3) the displacement of point B. The radius of AB is  $0.0407 \text{ m}$  and BC is  $0.0204 \text{ m}$ .



4. The steel rods AB and CD are attached to rigid supports at the ends and a cupronickel rod is attached at the center. A torque  $T=28 \text{ Nm}$  is applied at B. Find 1) the resulting moments at point A and D. 2) The angle of twist at B.

Radius of rod AB = 0.01m, radius of rod BC = 0.005m, radius of rod CD = 0.01m

The direction of torque applied at B on AB is shown as viewed from C.

