Ph.D. Preliminary Qualifying Examination

Cover Page

Solid Mechanics Examination

25 February, 2003 (Tuesday)
9:15 am – 12:15 noon
Rm 1005, Manufacturing Engineering Bldg. (MEB)

General Instructions:

This examination contains five problems. You are required to solve four of the five problems. Clearly indicate which four problems you wish to have graded if you attempt all of them.

Do all your work on the provided pieces of paper. If you need extra sheets, please request them from the proctor. When you are finished with the test, return the exam plus any additional sheets to the proctor.

For identification purposes, please fill out the following information in ink. Be sure to print as well as sign your name. This cover page will be separated from the rest of the exam before the exam is graded. Write your student number on all exam pages. Do not write your name on any of the other exam pages.

Name (print) ____________________________________________

Signature ______________________________________________

Student Number _________________________________________
Problem #1

An element is stressed as shown below. Find (a) principal stresses, and angle of the plane they occur, and (2) the maximum shear stress and the angle of the plane it occurs.

\[ \sigma_{ij} = 6000 \text{ psi} \]

\[ \sigma_X = 6000 \text{ psi} \]

\[ \tau_{Xy} = 1000 \text{ psi} \]
Problem #2

Two initially horizontal bars QC and DG are pinned at Q and G and are also connected by elastic vertical bars BD and CF. The temperature of the bar BD is then raised by an amount $\Delta T$. Determine the force in the two vertical bars. Rigidity of each bar is AE.
Problem # 3

Determine the range of values which the mass $M$ may have so that the 100 kg block shown in the figure will neither start moving up the plane nor slip down the plane. The coefficient of static friction for the contact surfaces is 0.3.
Problem # 4

A cantilever steel plate is subjected to a static end-load $P$ over its width, as shown in the figure. With the constraint the strain in width direction $y$ is negligible, $e_y = 0$. This gives $\sigma_y = \nu \sigma_x$, where $\nu$ is the Poisson's ratio, $\nu = 0.3$. We also neglect all shear stress components. ($\sigma_x = 0$) The material has the yield strength $S_y = 50$ kpsi. Determine the maximum loading capacity of the structure $P_{\text{max}}$ with the safety factor of 2, and plot the load line of Point A with respect to yield loci based on the criteria of (1) maximum shear stress (MSS) and (2) distortion energy (DE), respectively.
Problem #5

Each of the two springs has a stiffness $k$ and is unstretched when $y=0$. Neglect the masses of the links and determine the force $P$ required to produce a given displacement $y$ of point $A$. 