Name_____

ME 786/886
Fall 2022
Prof. I. Tsukrov

Homework #8
(Due 11/22/22)

Homework expectations: same as HW#1 and HW#2. Show all work and provide printouts!

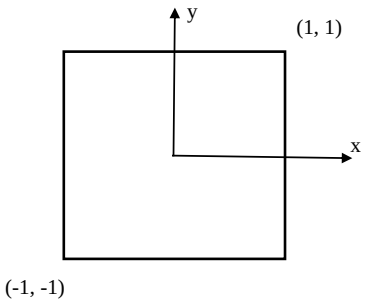
A. **Reading** (Text) 4th edition: 1.4-1.7 - 2D problems; 6.1-6.4 - CST Element
5th edition: 6.3-6.6 - 2D problems and CST element

Problems (The problem numbers are for the 4th edition of the Text).

B. Problem **1.6** (20 pts, modified) A displacement field

$$\begin{cases} u = 2 - 3x + 4x^3 - 5xy^2 \\ v = xy - 2x^2 \end{cases}$$

is imposed on the square element shown below



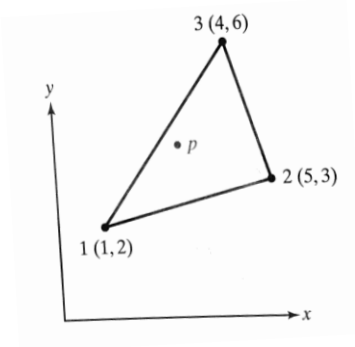
(a) Write down the expressions for $\varepsilon_x, \varepsilon_y$ and γ_{xy}.

(b) Plot contours of $\varepsilon_x, \varepsilon_y$ and γ_{xy} using, say, MATLAB software.

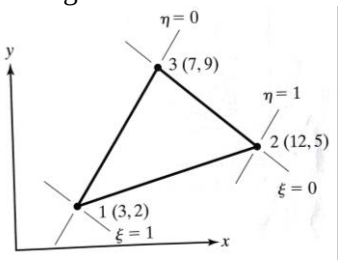
(c) Find were ε_y is maximum within the square.

C. Problems (Text, p. 225-230. *Note:* In your class notes, $\hat{x} \equiv \xi$, $\hat{y} \equiv \eta$):

6.1 (10 pts, modified) The nodal coordinates of the triangular element are shown in the figure below. At the interior point *P*, the x-coordinate is 3.1 and $N_1 = 0.2$. Determine N_2, N_3, and the y-coordinate at point *P*.

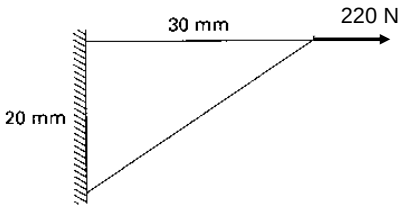


6.2 (10 pts) Determine the Jacobian for the $(x, y) - (\xi, \eta)$ transformation for the element shown below. Also, find the area of the triangle.



T1 (30 pts) Complete tutorial Lab_03_2D_plane_strain_Marc. The tutorial is available in myCourses under *Modules -> MARC labs.*

6.11 (30 pts, Text, p.228, modified)
For the configuration shown in Figure below, assume *plane strain* approximation and determine the deflection at the point of load application. Assume *one point load* of 220 *N/cm* acting vertically.
$E = 110\,GPA,\ \nu = 0.4$



1. Solve the problem longhand for one element (Mathcad or Matlab is OK). Use the "plane strain CST element" handout.
2. Perform MARC simulation with one element. Include one graph with boundary conditions and one graph containing the deformed&original shape and the ***y***-component of displacement.
3. Refine your MARC mesh by using *Subdivide* and *Sweep* commands (choose parameters 6 6 1 for divisions). Again, produce (and submit) the deformed shape and ***y***-displacements. Comment on results.

Hints:

1. For plane strain analysis, the thickness dimension must be much larger than the others. When using this in MARC, an input thickness is required, but will not be used in computations. Enter any value for the thickness.
2. Make sure that the (point) load applied is in consistent units with the rest of the analysis [force/length].
3. Set the element type to a plane strain solid element (type 6).
4. Make sure plane strain analysis is selected under "jobs."