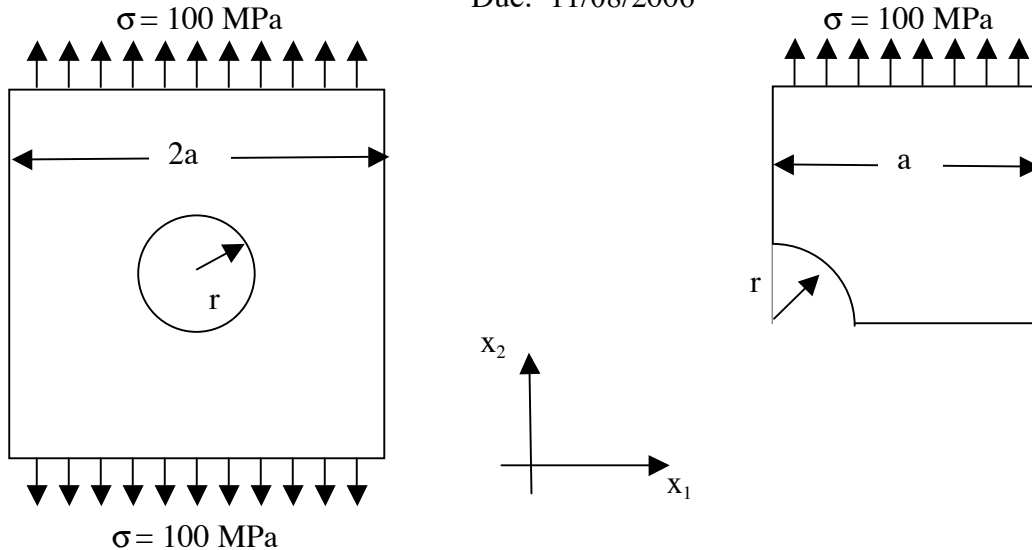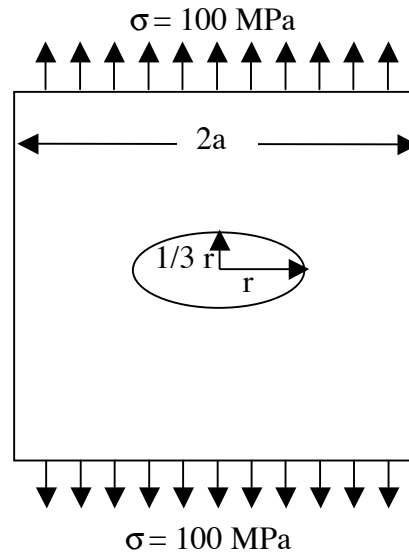Computer Assignment 1
Stressing a plate with a circular or elliptical hole
Due: 11/08/2006

A square plate with sides length 2a and a circular hole with radius r is shown above. The plate is under remote tensile loading, σ, as shown. A finite element model of the figure on the figure on the right, which takes advantage of the symmetry, is given in the input file *strnrhl-elps.inp* (see the end of this assignment for input file).

(1) Run the input file *strnrhl-elps.inp*. Notice that there is no loading given in the static step. This input file just creates the mesh for the figure shown on the right. Notice that an element set called "LOADED" is defined. Make sure you understand the commands used to generate the mesh (*NGEN, *NFILL, *ELGEN)

(2) Modify the input file used in part (1) to analyze the problem of a plate under remote tensile loading.
   a. Use the element set "LOADED" to apply the appropriate loading on the boundary. One way to do this is to define a distributed load on the element faces at the boundary using the *DLOAD command.
   b. Modify the step definition so that a perturbation step is used.
   c. Print and Run your modified (and well commented) input file. (NOTE: in *strnhl-elps.inp* the output requests have been commented out – you will have to change this to get output to the data and output database files)
   d. Use ABAQUS/Viewer to examine and prepare plots of your solutions, these should include: the deformed shape, contour plots of stresses, contour plots of strains.

(3) The input file *strnrhl-elps.inp* uses 8-noded isoparametric elements. Write an input file to solve the same problem using constant-strain-triangular elements. Run the file and examine similar output as mentioned in part (2).

σ = 100 MPa

2a

1/3 r

r

σ = 100 MPa

(4) The geometry for parts (1)-(3) involved a circular hole in a square plate. Now consider a plate with an elliptical hole. Modify the input files used in parts (2) and (3) so that the round hole becomes an elliptical hole, with dimensions shown above. To do this, you can use the command *NMAP:

```
*NMAP, NSET = MAPSET, TYPE=RECTANGULAR
0,0,0,1,0,0
0,1,0
0,0.333,0
```

Look up this command so that you understand how it changes the nodal coordinates. Repeat parts (2) & (3) for this configuration.

(5) The solution for an infinite plate with a circular hole under remote tensile stress loading σ is derived in Rice, *Solid Mechanics*, pp. 65-68, and some results from the solution for an elliptical hole are given there too. Provide a *clear, careful* and *detailed* comparison of your numerical solutions from (2), (3), and (4) to those results. E.g., compare to predicted maximum stresses, to σ_θ versus r for the circular case and to displacements of the hole boundary along the rays $\theta = 0°$ and 90°. How could you determine whether differences were due primarily to inaccuracies of the numerical procedure, or to the infinite versus finite overall plate dimensions?

2

```
****************************************          HOLE1, HOLE2
**                                                *NGEN, NSET=EDGE1
**   written by James R. Rice                     441, 449, 1
**                                                *NGEN, NSET=EDGE2
**   last modified: 10/26/2006                    449, 457, 1
**             by:  Nanshu Lu                      *NFILL, BIAS=0.88, TWO STEP, NSET=NALL1
**                                                 HOLE1, EDGE1, 22, 20
****************************************          *NFILL, BIAS=0.88, TWO STEP, NSET=NALL2
**                                                 HOLE2, EDGE2, 22, 20
**   brief description:                           *NSET, NSET=HORSYM, GENERATE
**                                                 1, 441, 20
**                                                *NSET, NSET=VERSYM, GENERATE
**   Units used in what follows are                17, 457, 20
**   milimeters (mm) for lengths,                 **
**   Newtons (N) for forces, and hence            ****************************************
**   N/mm^2 = MPa (Pascals) for moduli and        **
**   stresses                                     **   Element Definitions
**                                                **
****************************************          ****************************************
**                                                **
**   heading information                          *ELEMENT, TYPE=CPS8
**                                                 1, 1, 41, 43, 3, 21, 42, 23, 2
****************************************          *ELGEN, ELSET=ELALL
**                                                 1, 8, 2, 1, 11, 40, 10
*HEADING                                          *ELSET, ELSET=LOADED, GENERATE
stressfield in sq elastic plate with hole         105, 108, 1
**                                                **
****************************************          ****************************************
**                                                **
**   Parameter Definitions                        **   Material Definitions
**                                                **
****************************************          ****************************************
**                                                **
*PARAMETER                                        *SOLIDSECTION,ELSET=ELALL,MATERIAL=ELAS
E = 2E5                                           *MATERIAL, NAME=ELAS
nu = 0.30                                         *ELASTIC
**                                                 <E>, <nu>
**   E:  Young's Modulus (MPa)                    **
**   nu:  Poisson ratio                           ****************************************
**                                                **
****************************************          **   Boundary Conditions
**                                                **   look up the below boundary conditions
**   Node definitions                             **   so that you understand them, and add
**                                                **   comments.
****************************************          **
*NODE                                             **
1,  1., 0.                                        ****************************************
9,.707, .707                                      **
17,    0., 1.                                     *BOUNDARY
441,4., 0.                                         VERSYM, XSYMM
449,4., 4.                                        **
457,  0., 4.                                      **
1000, 0., 0.                                      *BOUNDARY
*NGEN, LINE=C, NSET=HOLE1                          HORSYM, YSYMM
1, 9, 1, 1000                                     **
*NGEN, LINE=C, NSET=HOLE2                         ****************************************
9, 17, 1, 1000                                    **
*NSET, NSET=MAPSET                                **   Step 1:  apply loading
```

3

```
**
****************************************
**
*STEP, NAME=STEP-1
*STATIC
**
****************************************
**
**  Loads
**
****************************************
**
**
**
****************************************
**
**  OUTPUT REQUESTS
**
****************************************
**
**  The following option is used to write
**  output to the output database file
**  (for plotting in ABAQUS/Viewer)
**
***OUTPUT, FIELD, VARIABLE=PRESELECT
**
**  The following options are used to
**  provide tabular printed output of
**  element and nodal variables to
**  the data and results files
**
***EL PRINT,POSITION=CENTROIDAL
** S,COORD
**
**
***NODE PRINT
** U,COORD
**
****************************************
**
**
*END STEP
```