Stress and Elasticity Mini Project
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Evaluating Failure in Stress Analysis in Infinite Plate with Circular Hole

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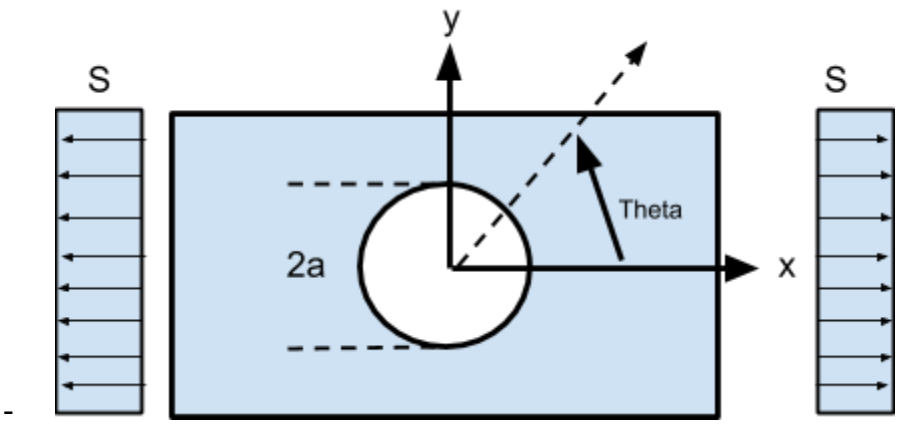
1. Introduction

- Given Infinite plate with a circular hole of radius ‘a’
- Evaluate failure under the stress ‘S’
- Given diagram as below



2. Result (with aid on MATLAB)

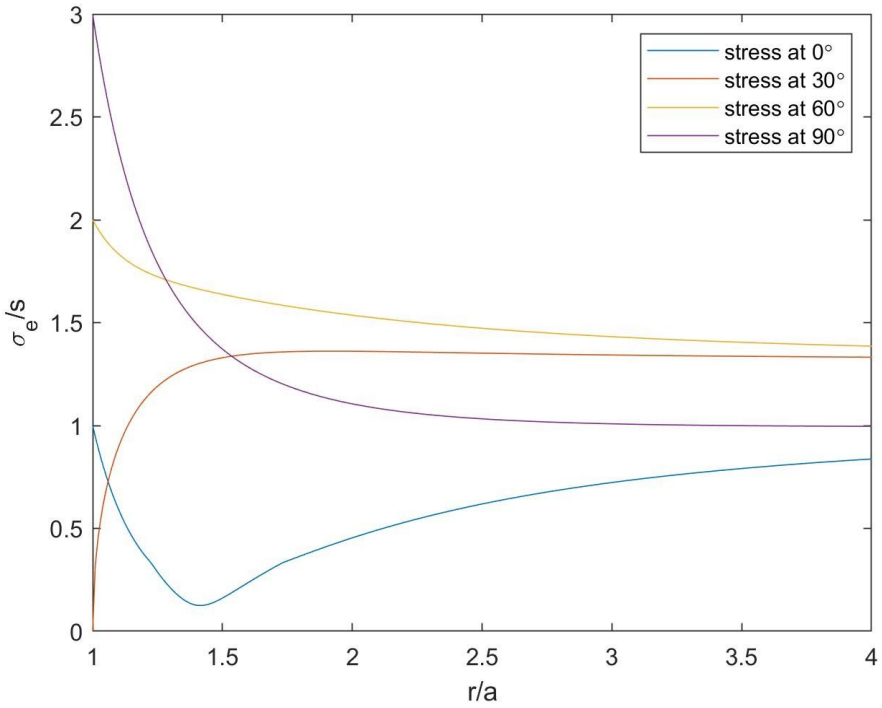
Code for MATLAB

```
clc; close all; clear all;
%% initialize
double maxth;
double maxr;
double maxt;

%radius of hole
a=1;

length=6*a;
width=6*a;

%number of pieces each unit is divided into
div=100;

%resizing length in regards to division of pieces
l=length*div;

%degrees of surface which will be evaluated
d=360;

%initialize arrays
sigth=zeros([d l-a*div]);
sigr= zeros([d l-a*div]);
tau= zeros([d l-a*div]);

%% polar matrix for stress

%evaluate stress across surface (polar)
for theta=0:d
```

```
    for x=a*div:l
        r=x/div;
   %need to index
        sigth(theta+1, x-(a*div-1))=((1+(a/r)^2)-(1+3*a^4/r^4)*cos(deg2rad(2*theta)))*0.5;
        sigr(theta+1, x-(a*div-1))=((1-(a/r)^2)+(1-4*(a/r)^2+3*a^4/r^4)*cos(deg2rad(2*theta)))/2;
        tau(theta+1, x-(a*div-1))=-(1+2*(a/r)^2-3*(a/r)^4)*sin(deg2rad(2*theta))/2;
    end
end

sige=sqrt(abs(sigr).^2 - abs(sigr.*sigth) + abs(sigth).^2 + 3.*abs(tau));
%% max stress
maxth=max(max(abs(sigth)));

maxr=max(max(abs(sigr)));

maxt=max(max(abs(tau)));

maxe=max(max(abs(sige)));

%% covert to cartesian

[r,t]=meshgrid(a:1/div:length, 0:pi/180:deg2rad(d));
x=r.*cos(t);
y=r.*sin(t);

pt1=linspace(a,length,(l-(a*div-1)));

%% plot

%question 1
figure
plot(pt1, sige(1,:), pt1,sige(31,:),pt1,sige(61,:),pt1,sige(91,:))
legend('stress at 0\circ','stress at 30\circ','stress at 60\circ','stress at 90\circ')
%only r/a when a=1
xlabel('r/a');
ylabel('\sigma_e/s');
xlim([a 4*a])

%question 2
figure
contourf(x,y,sige);
xlim([-(4*a) (4*a)])
ylim([-(4*a) (4*a)]);
xlabel('x/a');
ylabel('y/a');

%question 3
disp('maximum (Von Mesies stress)/s:'); disp(maxe);
```

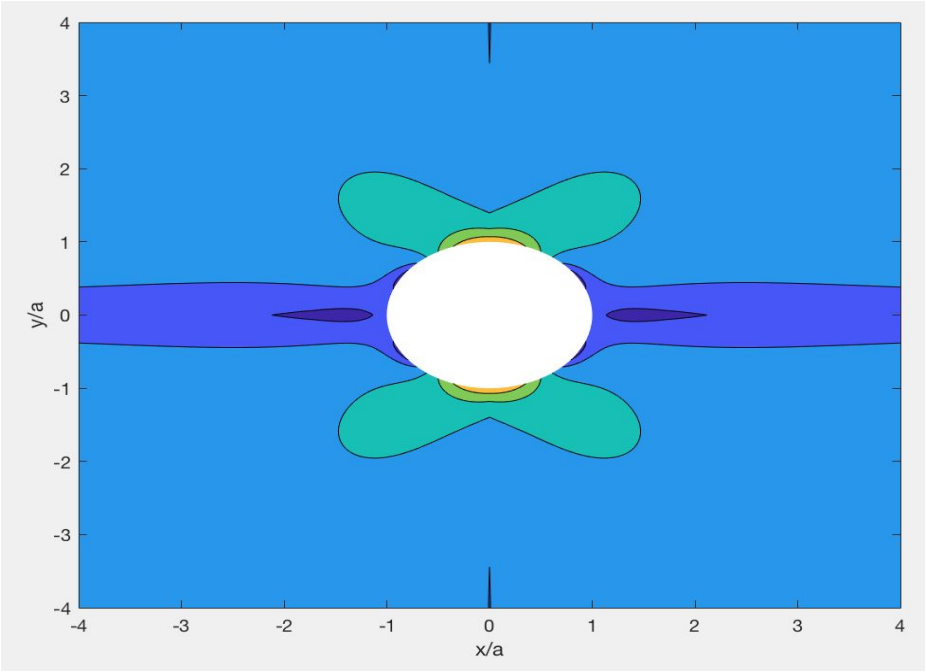
I. Plot $(\frac{\sigma e}{s})$ *vs.* $(\frac{r}{a})$ *for* $1 \leq \frac{r}{a} \leq 4$, $\theta = 0,\ 30,\ 60\ , 90.$ *with all four curves in one graph.*

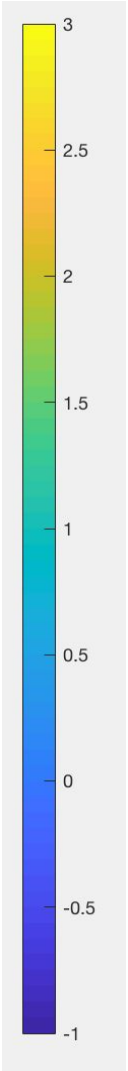
- Graph
- Each line indicated the stress at $\theta = 0,\ 30,\ 60\ , 90$.
- Y axis : $\frac{\sigma_e}{s}$ and X axis : $\frac{r}{a}$



II. Draw contour plot $(\frac{\sigma e}{s})$ *over the following three regions of the plate* :

$$-4 \leq \frac{x}{a} \leq +4, \quad -4 \leq \frac{y}{a} \leq +4, \quad 1 \leq \frac{r}{a}$$





III. Max $(\frac{\sigma e}{s})$ *on a grid*

- Max $\frac{\sigma e}{s}$ is 3
- Calculation done on MATLAB :

```
Command Window
  maximum (Von Mesies stress)/s:
        3
```

- The area / top and bottom/ around the hole is where the max Von Mises stress is noticed.

IV . Find the critical region, where $(\frac{\sigma e}{s})$ *is maximum, where plastification will occur first with max value of* $(\frac{\sigma e}{s})$

-The circled area (the top and the bottom of the hole is where the critical region., where Von Mises Stress =3, depicted yellow on the graph.