```
clear all;
%% Background Information
stu_no = 1008247531;
        %TUVWXYZ

TU = 82;
V = 4;
WX = 75;
YZ = 31;

AF = 250 - (2*TU);
BF = 10 + (8*V);
CF = WX;
DF = -20 - YZ;

t = 0.125;

%Iterations with 6 don't go below 2 completely, no matter the arrangement, so moved
%on to 7

%theta = [0 90 35 -45 90 0]; % In Degrees - For six it doesn't converge for any solution
theta = [5 0 50 2 50 0 5]; % Works for Both Tsai-hill and Tsai-wu with equally distributed loads around the center -a
ny further distribution around this works nicely
theta = theta.*(pi/180); % Conversion to Radians - I my system Default is radians

E1 = 125;
E2 = 9.8;
G12 = 5.5;
nu_12 = 0.24;

sl_up = 900;
sl_down = 800;
st_up = 55;
st_down = 170;
tau = 90;

S = [1/E1 -nu_12/E1 0; -nu_12/E1 1/E2 0; 0 0 1/G12];

Q_local = S^-1;

T = @(x) [(cos(x))^2 (sin(x))^2 2*cos(x)*sin(x); (sin(x))^2 (cos(x))^2 -2*cos(x)*sin(x); -cos(x)*sin(x) cos(x)*sin(x)
 (cos(x))^2 - (sin(x))^2];

%% 1.) Calculating ABD Matrix
A = zeros(3);
B = zeros(3);
D = zeros(3);

for k = 1:4
  z_k = (k-2)*0.125;
  z_k1 = z_k - 0.125;
  Q_global = ((inv(T(theta(k))))*(Q_local)*(inv(transpose(T(theta(k))))));
  A = A + 0.125*Q_global;
  B = B + (0.125*(z_k + z_k1))*Q_global;
  D = D + (0.125*(z_k^2 + z_k1^2 + z_k*z_k1))*Q_global;
```

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end

abd = [A B;B D];

fm = [AF;BF;CF;DF;0;0];
e_mat = abd\fm;

%% 2.) Using epsilon matrix for calculations of Stresses

tsai_hill = zeros(length(theta),1);
tsai_wu = zeros(length(theta),1);
sigma_all = zeros(length(theta),3);
strain_global_all = zeros(length(theta),3);
sigma_global_all = zeros(length(theta),3);

for p = 1:length(theta)

curr_stack = p;
center = t*(length(theta)/2); % Calculating center from bottom
dist = t*((2*curr_stack-1)/2); % Calculating Dist from bottom
epsilon = e_mat(1:3) + (abs(center-dist))*e_mat(4:6);
qbar = ((inv(T(theta(p))))*(Q_local)*(inv(transpose(T(theta(p))))));
sigma_global = qbar*epsilon;

sigma_global_all(p,:) = sigma_global;
strain_global_all(p,:) = epsilon; %capturing sigma global for each ply

F11 = abs(1/(sl_up*sl_down));
F22 = abs(1/(st_down*st_up));
F66 = abs(1/(tau^2));
F1 = (1/sl_up - abs(1/sl_down));
F2 = (1/st_up - abs(1/st_down));
F12 = 0.5*sqrt(F11*F22);

    sigma = T(theta(curr_stack))*sigma_global;
    sigma_all(p,:) = sigma;

    if sigma(2) >= 0
        st = 55;
    else
        st = 170;
    end

    if sigma(1) >= 0
        sl = 900;
    else
        sl = 800;
    end


    tsai_hill(p) = (sigma(1)^2)/(sl^2) - (sigma(1)*sigma(2))/(sl^2) + (sigma(2)^2)/(st^2) + (sigma(3)^2)/(tau^2);

    tsai_wu(p) = F11*sigma(1)^2 + F22*sigma(2)^2 + F66*sigma(3)^2 + F1*sigma(1) + F2*sigma(2) + 2*F12*sigm
a(1)*sigma(2);
```

```
end

transpose(fm)
transpose(strain_global_all)
transpose(sigma_global_all)
transpose(tsai_hill)
transpose(tsai_wu)
```

---------------------------------------Code Ends---

Forces: 86 42 75 -51 0 0
Stack: [5 0 50 2 50 0 5]

Full Stiffness Matrix:

50.7545	4.5943	4.6780	-1.4060	0.3795	0.1025
4.5943	10.1254	4.2053	0.3795	0.6469	0.5061
4.6780	4.2053	6.1630	0.1025	0.5061	0.3795
-1.4060	0.3795	0.1025	3.7129	0.1383	0.2322
0.3795	0.6469	0.5061	0.1383	0.3897	0.0716
0.1025	0.5061	0.3795	0.2322	0.0716	0.2364

plies:

1 2 3 4 5 6 7

Strain(global):

-4.7964	-3.1378	-1.4793	0.1793	-1.4793	-3.1378	-4.7964
-4.5922	-3.0805	-1.5687	-0.0569	-1.5687	-3.0805	-4.5922
11.6897	12.3264	12.9630	13.5997	12.9630	12.3264	11.6897

Strain at mid plane = strain in 4(the center plate)

sigma(global):

-495.6932	-401.2878	217.7413	75.4801	217.7413	-401.2878	-495.6932
-56.3358	-37.7393	306.4547	1.6180	306.4547	-37.7393	-56.3358
25.7561	67.7950	325.6448	77.2898	325.6448	67.7950	25.7561

tsai_hill:

0.9634	0.8447	0.6514	0.6946	0.6514	0.8447	0.9634

tsai_wu:

0.9289	0.7195	-0.3998	0.6360	-0.3998	0.7195	0.9289

AS it can be seen, for the arrangement, the most close to failing is the edges, and as we move to the center, the stress

loading
and the chances to fail, both decrease, resulting in a lower absolute value of both the tsai-hill and tsai-wu criterion.

Practical Considerations taken while designing this laminate:

1.Temperature Effects should be take into considering while designing for practical life.
2.Moisture sensitivity can be a major issue in some conditions
3.Fabrication practicality(Rod example given in class by professor) is an important part to be taken in design conside rations.
4.Proper design to avoid delamination needs to be done apart from deciding the stack angles
5.A proper stress analysis using FEA should be performed for a validation and further fine tuning.