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%Name: Samuel Belliel
%Class: ME 452
%Subject: Project 2

clear

%Constants
s2 = 0.03175; %[m]
s1 = s2; %Distances from the crank jounrals to the plates
w2 = 0.0254; %[m]
w1 = w2; %Widths of the rectangular plates
lj = 0.0381; %[m] Length of the rod journal
h = 0.0508; %[m] crank length
S = 2*h; %Stroke length
d = 0.0762; %[m] Diameter of the cylindrical piston
l = .1524; %[m] Length of the connecting rod
%no offset
N = 2500; %RPM crank constant speed
w = (N/60)*2*pi; %Angular velocity [1/s]
W = 13.35; %[N] Weight of the piston in newtons
g = 9.81; %[m/s^2] Gravity
m = W/g;    %Mass of the piston

A = pi*.25*d^2; %Area of piston head

theta_expansion = pi/2;
theta_compression = (630/180)*pi;
theta = 0;
counter = 1;
counter2 = 1;

theta_3 = 0;

%Chosen Variables AISI 1060 Normalized GROUND finish
d_journal = 0.025; %meters
Sut = 800; %MPa


Sut_k = Sut/6.89475728;
d_shaft = d_journal;
r = (w1-d_journal)*(1/2);   %meters the fillet radius
I = pi*d_shaft^4*(1/32);
I_journal = pi*d_journal^4*(1/32);
%Concentration Factors
ratioDoverd = w1/d_journal
ratioroverd = r/d_shaft

Kt = 1.5;
Kts = 1.1;
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%Define Matricies to be filled
F21x_m = [;];
F21y_m = [;];
P_m = [;];
theta_m = [;];
piston_acc_m = [;];
m_prime_m = [;];
theta_2_prime_m = [;];
m_doubleprime_m = [;];
theta_2_doubleprime_m = [;];
F43x_m=[;];
F43y_m=[;];
F32x_m=[;];
F32y_m = [;];
theta_2_m = [;];
r4_m = [;];

%Part 2
phi = 0; %radians
sigma = 0;
sigma_m = [;];
tau = 0;
tau_m = [;];
sigma_m_real = [;];
counter3 = 1;
counter4 = 2;
matrix_m =[;];

if Sut <= 1400 ;
    Se_prime = 0.5*Sut;
else
    Se_prime = 700;
end

%if ka = 'Hot-Rolled';
   %Ka = 57.7*Sut^(-0.718);
%else
 %   if ka = 'Ground';
        Ka = 1.58*Sut^(-0.085);
   % if ka = 'Machined';
     % Ka = 4.51*Sut^(-0.265);
    %else
    %    Ka = 272*Sut^(-0.995);
%end

Kb = 1.24*(d_shaft*1000)^-0.107;

Se = Se_prime*Kb*Ka
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root_a_over_r_bend = ((0.246-3.08*10^-3*Sut_k+1.51*10^-5*Sut_k^2-2.67*10^-8*Sut_k^3)/↙
((r*39.3701)^.5));
root_a_over_r_torsion = ((0.19-2.51*10^-3*Sut_k+1.35*10^-5*Sut_k^2-2.67*10^-8*Sut_k^3)/↙
((r*39.3701)^.5));

Kf = 1+(Kt-1)/(1+root_a_over_r_bend)
Kfs = 1+(Kts-1)/(1+root_a_over_r_torsion)

while theta < 4*pi
    P = 0;
    if theta <= pi/2 && theta >= 0
        P = ((-10.342/theta_expansion)*theta+10.342)*10^6; %[Pa] Pressure value
    else if theta < 4*pi && theta >= theta_compression
        P = ((8.618/theta_expansion)*(theta-theta_compression))*10^6; % [Pa] Pressure↙
value
        end

    end
    %Define theta_2
    theta_2 = asin((-1*h*sin(theta))/l);
    theta_2_m(counter) = theta_2;
    r4 = h*cos(theta)+l*cos(theta_2);
    r4_m(counter) =r4;

    %Kinematic Analysis first derivative
    v11 = -1*l*sin(theta_2);
    v12 = -1*cos(theta_3);
    v21 = l*cos(theta_2);
    v22 = -1*sin(theta_3);
    c1 = h*sin(theta)*1;
    c2 = -1*h*cos(theta)*1;
    V = [v11, v12; v21, v22];

    theta_2_prime = ((c1*v22-v12*c2)/det(V));
    m_prime = ((v11*c2-c1*v21)/det(V));

    m_prime_m(counter) = m_prime;
    theta_2_prime_m(counter) = theta_2_prime;

    d1 = l*cos(theta_2)*theta_2_prime^2+h*cos(theta)*1^2;
    d2 = l*sin(theta_2)*theta_2_prime^2+h*sin(theta)*1^2;

    theta_2_doubleprime = ((d1*v22-v12*d2)/det(V));
    m_doubleprime = ((v11*d2-d1*v21)/det(V));

    m_doubleprime_m(counter) = m_doubleprime;
    theta_2_doubleprime_m(counter) = theta_2_doubleprime;
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piston_acc = m_doubleprime*(w^2)+m_prime*0;
piston_acc_m(counter) = piston_acc;
austin = -1*h*(w^2)*(cos(theta)+(h/l)*cos(2*theta));
austin_m(counter) = austin;



%Dynamic Force Analysis
F43x = m*piston_acc+P*A;
F34x = -1*F43x;
F32x = -1*F34x;
F23x = -1*F32x;
F21x = -1*F23x;

F43y = -1*F43x*sin(theta_2)*(1/cos(theta_2));
Fn = F43y - W;
F34y = -1*F43y;
F32y = -1*F34y;
F23y = -1*F32y;
F21y = -1*F23y;
T12 = -1*F32x*h*sin(theta)+F32y*h*cos(theta);
Fn_m(counter) = Fn;
F43x_m(counter) = F43x;
F43y_m(counter) = F43y;
F32x_m(counter) = F32x;
F32y_m(counter) = F32y;
F21x_m(counter) = F21x;
F21y_m(counter) = F21y;
T12_m(counter) = T12;
P_m(counter) = P;
theta_m(counter) = theta;

%Generate Shear force, bending moment, and torque diagrams
%Rod Journal: Bending moment, shear force
bending_moment_load_RJ = F21x/lj;   %uniform load
F_reaction = F21x/2;    %Force on each end of the rod journal
%Moment_of_inertia = (1/64)*pi*(dj^4); %moment of inertia for an unknown dj
%Shear_RJ =

%Part 2
while phi < 2*pi
   %Plane 1
   Force = F21x*cos(phi)*0.5+F21y*sin(phi)*0.5;
   sigma = ((Force*(s1-r))*d_shaft*0.5)/I;
   sigma_m(counter,counter2) = sigma;
   tau = (T12*0.5*(d_shaft/2))/(pi*d_shaft^4*(1/32))+ (Force)/(pi*d_shaft^2*0.25);
   tau_m(counter,counter2) = tau;
   matrix_m(counter,counter3) = sigma;
   matrix_m(counter,counter4) = tau;
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        %Plane 2
        Force_p2 = F32x*cos(phi)+F32y*sin(phi);
        sigma_p2 = ((Force_p2*(lj-2*r)*0.5)*d_journal*0.5)/I_journal;
        sigma_m_p2(counter,counter2) = sigma_p2;
        tau_p2 = Force_p2/(pi*d_journal^2*0.25);
        tau_m_p2(counter,counter2) = tau_p2;
        matrix_m_p2(counter,counter3) = sigma_p2;
        matrix_m_p2(counter,counter4) = tau_p2;
    counter3 = counter3+2;
    counter4 = counter4+2;
    counter2 = counter2+1;
    phi = phi+0.1;
    end
    counter3 = 1;
    counter4 = 2;
    phi = 0;
    counter2 = 1;

    counter = counter+1;
    theta = theta + 0.1;
end
%z=[theta_m, theta_2_m, theta_2_prime_m, theta_2_doubleprime_m, r4_m, m_prime_m,↙
m_doubleprime_m];
%display(r4_m);
%display(theta_2_m);
%subplot(1,2,1);
%plot(theta_m, T12_m);
%xlabel('Theta [Radians]');
%ylabel('T12 [Newton-Meters]');
%subplot(1,2,2);
%plot(theta_m, Fn_m);
%plot(theta_m, r4_m, theta_m, theta_2_m);
%xlabel('Theta [Radians]');
%ylabel('Fn [Newtons]');
%max(F21y_m);

matrix_m;
```