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%---ME 325 bending and pitting factor of safety calculator
%---Matthew Szmurlo, Ben Felmlee----

%--------- List of User inputs---------
%phi-pressure angle for gear and pinion
%phi_hlix-helix angle for helical gear
%P-diametral pitch
%N_p-#pinion teeth
%N_g-#gear teeth
%m-gear ratio
%F-face width
%Q_v-AGMA quality-control number
%R-reliability

%K_T-temperature factor
%K_o-overload factor
%K_s-size factor
%K_B-rim thickness factor
%J-bending geometry factor
%Y_n-stress-cycle factor
%S_t-allowable bending stress

%I-wear geometry factor
%S_c-contact strength
%Z_N-stress cycle factor
%C_H-hardness-ratio factor

%--------------End user inputs----------------------

clc
clear all

units= menu('Unit System','SI','USCS');
if units==1
    hp=input('Enter power in kW: ');
else
    hp=input('Enter power in Horsepower: ');
end


%asks user to enter pinion velocity
omega_p=input('Pinion angular velocity in rpm: ');

%asks user to input if it is a full or stub tooth gear
depth= menu('Gear depth','full','stub');

%defines full and stub
if depth==1
    k=1;
else
    k=.8;
end


%asks user to input diametral pitch for both gear and pinion
P=input('Diametral pitch: ');
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%asks user to input # of teeth for pinion
N_p=input('Number of teeth on pinion: ');

% asks user to input # of gear teeth
N_g=input('Number of teeth on gear: ');

%defines gear ratio as m
m=N_g/N_p;

%asks user if Helix gear set
a=menu('Helical or Spur gear?', 'Helical','Spur');

%if yes ask user to enter helix angle
if a==1
phi=input('Enter normal pressure angle in degrees: ');
    phi_helix=input('Enter helix angle in degrees: ');
    phi_tangential=atand((tand(phi)/cosd(phi_helix)));

N_pmax=ceil(((2*k*cosd(phi_helix))/((3)*(sind(phi_tangential))^2))*(1+(
(1+(3)*(sind(phi_tangential))^2))^.5)); % min number of teeth Pinion %
    fprintf('The Minimum number of teeth for pinion is % .2f Teeth \n',
N_pmax);

    N_gmax=floor(((N_pmax)^2*(sind(phi_tangential))^2-
(4*(k^2)*((cosd(phi_helix))^2)))/((4*k*(cosd(phi_helix)))-
2*N_pmax*(sind(phi_tangential))^2));   % Max number of teeth on gear %
    fprintf('The Maximum number of teeth for gear is % .2f Teeth \n',
N_gmax);


%other
else
    phi=input('Enter spur gear pressure angle in degrees: ');


N_pmax=ceil(((2*k)/((1+(2*m))*(sind(phi))^2))*(m+(((m^2)+(1+(2*m))*(sin
d(phi))^2))^.5)); %min number of teeth Pinion %
    fprintf('The Minimum number of teeth for pinion is %.2f Teeth \n',
N_pmax);

    N_gmax=floor(((((N_p)^2)*(sind(phi))^2)-(4*(k^2)))/((4*k)-
(2*N_p*(sind(phi))^2)));   %Max number of teeth on gear%
    fprintf('The Maximum number of teeth for gear is %.2f Teeth \n',
N_gmax);

end

%defines d_p and d_g
d_p=N_p/P;
d_g=N_g/P;

rP_base=(d_p/2)*cos(phi);
rG_base=(d_g/2)*cos(phi);
L_ab=(((d_g)^2-(2*rG_base)^2)^.5+((d_p)^2-
(2*rP_base)^2)^.5+(((d_p+d_g)/2)*sin(phi)));
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p_c=pi/P;

%contact ratio
m_contact=L_ab/(p_c*cos(phi));

    if m_contact >= 1.1
        display 'Minimum contact ratio has been met.';
    else
        display 'Minimum contact ratio not met.';
    end

%Asks user to input face width
F=input('Enter face width: ');

%Determines if face width is within an acceptable range of 3p<= F <=5p
if(F>5*p_c);
display 'Face width exceeds maximum limit.';
elseif(F<3*p_c);
display 'Face width under the minimum limit.';
else
display 'Face width is in the acceptable range.';
end


Q_v=input('Enter AGMA quality-control number (Qv): ');

%Calculates K_s for pinion and gear
y_p=input('Enter Lewis form factor for pinion');
y_g=input('Enter Lewis form factor for gear');

Y_p=y_p/pi;
Y_g=y_g/pi;

K_sp=1.192*(((F*(sqrt(Y_p)))/P)^0.0535);
K_sg=1.192*(((F*(sqrt(Y_g)))/P)^0.0535);

fprintf('Ks_pinion is %.2f \n', K_sp);
fprintf('Ks_gear is %.2f \n', K_sg);

%dynamic effects
B=.25*(12-Q_v)^(2/3);
A=50+56*(1-B);

r=d_p/2;
V=2*pi*r^2*omega_p/12;
K_v=((A+sqrt(V))/A)^B;
fprintf('K_v is %.2f ft/min \n', K_v);




if units==1
    W_t=(hp*60000)/(pi*d_p*omega_p);
    fprintf('W_t is %.2f kN \n', W_t);
    W_r=W_t*tand(phi);
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    fprintf('W_r is %.2f lbf \n', W_r);
    Force_gear=W_t/(cos(phi));
    fprintf('The Force exerted on gear tooth is %.2f kN \n',
Force_gear);
else
    W_t=(hp*33000)/((pi*d_p*omega_p)/12);
    fprintf('W_t is %.2f lbf \n', W_t);
    W_r=W_t*tand(phi);
    fprintf('W_r is %.2f lbf \n', W_r);
    Force_gear=W_t/(cos(phi));
    fprintf('The Force exerted on gear tooth is %.2f lbf \n',
Force_gear);
end




V_tmax=((A+(Q_v-3))^2)/200;
fprintf('The maximum theoretical velocity for quality index is %.2f
\n', V_tmax);

%Calculates K_m, Cpf, Cmc,Cpm, Cma, Ce
Cmc= menu('crowned or uncrowned', 'uncrowned teeth', 'crowned teeth');

if Cmc==1
    C_mc=1;
else
    C_mc=0.8;
end

if F<=1;
    C_pf= F/(10*d_p);
elseif (1<F)&&(F<=17);
    C_pf= (F/10*(d_p))-0.0375+0.0125*F;
elseif (17<F)&&(F<=40);
    C_pf= (F/(10*d_p))-0.1109+0.0207*F-0.000228*F^2;
end

fprintf('C_pf is %.2f \n', C_pf);

C_ma=.247+0.0167*F+(-0.765*10^-4)*F^2;
fprintf('C_ma is %.2f \n', C_ma);

K_m=1+C_mc*(C_pf*1+C_ma*1);
fprintf('K_m is %.2f \n', K_m);

%Calculates K_R, pg. 755
R=input('reliability: ');

if (0.5<R)&&(R<0.99);
    K_R=0.658-0.0759*log(1-R);
else
    K_R=0.50-0.109*log(1-R);
end

fprintf('K_R is %.2f \n', K_R);
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%Factor of safety against bending
K_T=input('Enter Temperature factor K_T (1 if T<250 degrees F): ');
K_o=input ('Enter overload factor K_o (1 if otherwise): ');
K_B=input ('K_B (1 for ratio >= 1.2): '); %pg. 756
J=input ('J:');
Y_n=input ('Enter Stress-Cycle Factor Y_n, (1 if greater than 10^7
cycles): ');
S_t=input ('Enter allowable bending stress S_t: ');
sigma=W_t*K_o*K_v*K_sp*(P/F)*((K_m*K_B)/J); %(k_H=K_m)
FOS_bending=(S_t*Y_n/(K_T*K_R))/sigma;
fprintf('The factor of safety against bending is %.2f \n',
FOS_bending);

%Calculates I, pg. 747
m_G=N_g/N_p;
I=((cosd(phi)*sind(phi))/2)*(m_G/(m_G+1));
fprintf('The geometry factor is %.2f \n', I);

%Factor of safety against pitting
S_c=input('S_C: '); %pg. 743, 744
Z_N=input('Z_N: '); %pg. 755
C_H=input('C_H: '); %pg. 753
C_p=input('C_p: '); %pg. 749   %28260
sigma_c=(C_p)*((K_v*W_t*K_o*K_sp*(K_m/(P*F))*(1/I)))^.5;

FOS_pitting=((S_c*Z_N*C_H)/((K_T*K_R)))/sigma_c;
fprintf('The factor of safety against pitting is %.2f \n',
FOS_pitting);
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