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% Deep Patel
% HW 7 - Vehicle Dynamics
```

Problem 15.11

```
clear all, close all, clc

W = 1850;
kf = 110;
kr = 130;
L = 110/12;
DI = 0.9;
oc1 = [];
oc2 = [];
for i = 0:30
    Wr = (0.35+(i/100))*W;
    Wf = W-Wr;
    b = (Wr*L)/(Wr+Wf);
    c = L-b;
    rad = (DI*b*c)^0.5;
    m = (1/32.17)*[W 0; 0 W*rad*rad];
    k = 12*[kf+kr, c*kr-b*kf; c*kr-b*kf, ((c)^2)*kr+((b)^2)*kf];

    syms w;
    eqn = (-w^2*m(1,1) + k(1,1))*(-w^2*m(2,2) + k(2,2)) - k(1,2)*k(2,1) == 0;
    sol = double(vpasolve(eqn,w));
    w1 = sol(3);
    w2 = sol(4);

    [Vec, Val] = eig(-w1^2 * m + k);
    Z1 = [Vec(2,1);Vec(2,2)];
    [Vec, Val] = eig(-w2^2 * m + k);
    Z2 = [Vec(1,1);Vec(2,1)];
    d1 = Z1(1)/Z1(2);
    d2 = Z2(1)/Z2(2);
    oc1 = [oc1 d1];
    oc2 = [oc2 d2];
end
oc1
oc2
Wrear = W*[0.35:0.01:0.65];
figure;
plot(Wrear, oc1,'r-'); grid on
xlabel('Wr (lb)','FontSize',14); ylabel('Locations of Center of Oscillations (ft)')
title('Center of Oscillation - 1st Mode (bouncing)','FontSize',14);

figure;
plot(Wrear, oc2,'b-'); grid on
xlabel('Wr (lb)','FontSize',14); ylabel('Locations of Center of Oscillations (ft)')
title('Center of Oscillation - 2nd Mode (pitching)','FontSize',14);
```

oc1 =

Columns 1 through 3

0.154100115401197 0.155367393374545 0.156550012380784

Columns 4 through 6

0.157622433502902 0.158552285536021 0.159298165206515

Columns 7 through 9

0.159806563540834 0.160007495575713 0.159808166471878

Columns 10 through 12

0.159083598899247 0.157662450660886 0.155305047733496

Columns 13 through 15

0.151668571614512 0.146250836535749 0.138298967398369

Columns 16 through 18

0.126665991765378 0.109621319639545 0.084790090145258

Columns 19 through 21

0.050085968261217 0.007351602300833 -0.034732165368061

Columns 22 through 24

-0.068079995414134 -0.091644474817978 -0.107786938216932

Columns 25 through 27

-0.118872495677242 -0.126554598722343 -0.131906034048840

Columns 28 through 30

-0.135622036466524 -0.138162556035993 -0.139839917029636

Column 31

-0.140871763327565

oc2 =

Columns 1 through 3

-0.377181381960725 -0.369396059238073 -0.362359150228757

Columns 4 through 6

-0.356074848362647 -0.350564280826705 -0.345869763542820

Columns 7 through 9

-0.342061449224797 -0.339247769289298 -0.337592144471424

Columns 10 through 12

-0.337340513370767 -0.338868450048703 -0.342765773496499

Columns 13 through 15

-0.349997778747505 -0.362236052520965 -0.382603923007200

Columns 16 through 18

-0.417575082674468 -0.482695589219785 -0.624805630160798

Columns 19 through 21

-1.059850992478275 -7.241041154831246 1.538252214342658

Columns 22 through 24

0.788268897421218 0.588687771198879 0.503606344531091

Columns 25 through 27

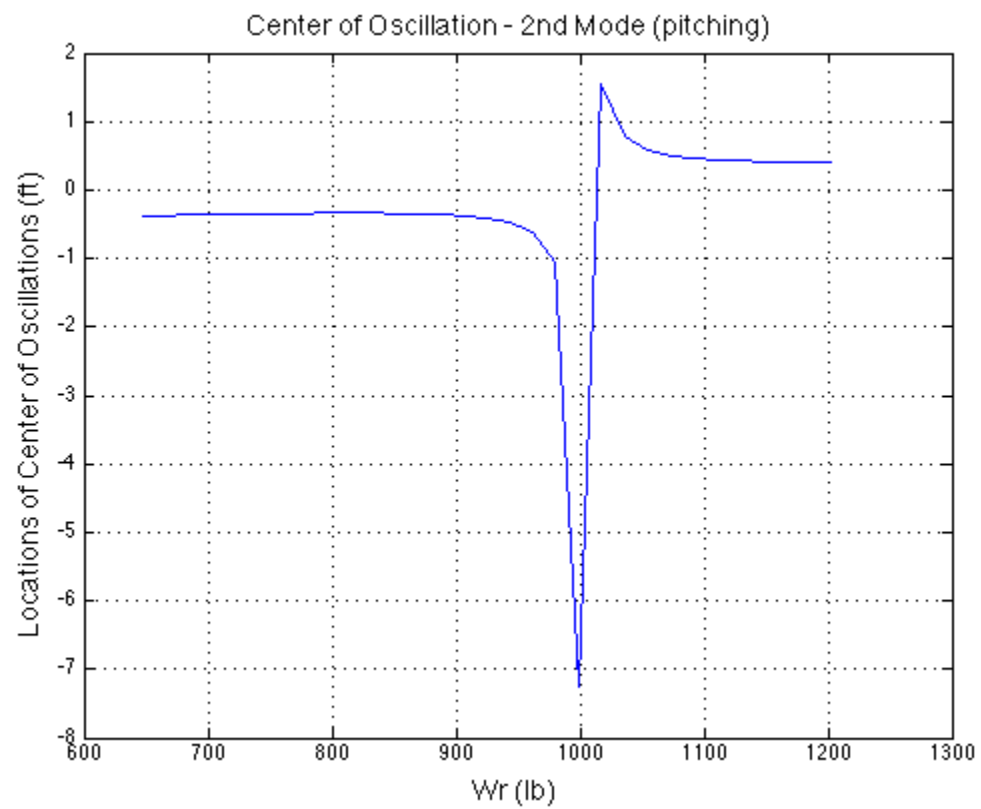
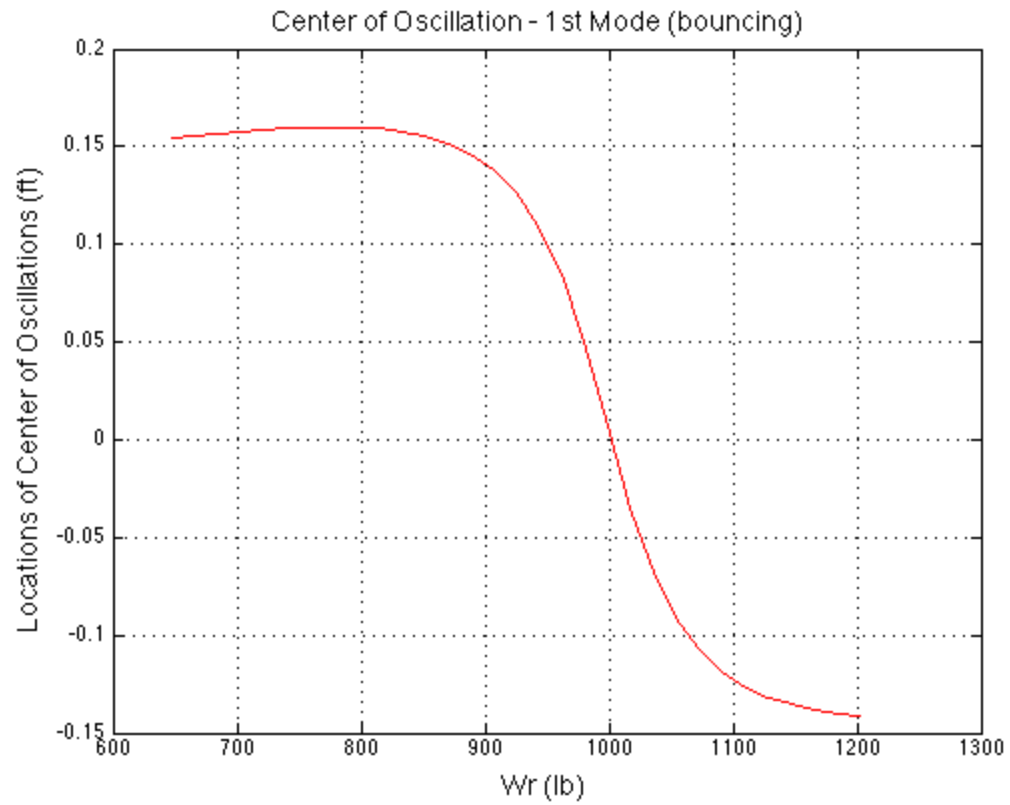
0.459851241525483 0.435356907524652 0.421381541437181

Columns 28 through 30

0.413836759647473 0.410583960532868 0.410412878280564

Column 31

0.412600035055837



Problem 15.12

```
clear all, close all, clc

L = 2.7;
mass = 1350;
mr = 540;
DI = 0.9;
b = mr*L/mass;
c = L-b;
rad = (DI*b*c)^0.5;
kf = 3224.399757835894
kr = b/c*kf
m = [mass 0; 0 mass*rad*rad];
k = 12*[kf+kr, c*kr-b*kf; c*kr-b*kf, ((c)^2)*kr+((b)^2)*kf];

syms w;
eqn = (-w^2*m(1,1) + k(1,1))*(-w^2*m(2,2) + k(2,2)) - k(1,2)*k(2,1) == 0;
sol = double(vpasolve(eqn,w));
f1 = sol(3)/(2*pi)
f2 = sol(4)/(2*pi)
```

$kf =$

$3.224399757835894e+03$

$kr =$

$2.149599838557263e+03$

$f1 =$

1.1000000000000000

$f2 =$

1.159501808728406

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