## Example 2-18: Car Response to a Pothole.

### Purpose:

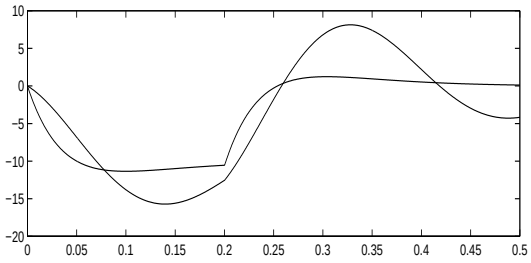
Simulate the response of a car driven at 5 m/s over a 1-m long, 10-cm deep pothole if the damping constant of its shock absorber is (a) $10^4$ N·s/m or (b) 2000 N·s/m. All other attributes are the same as those in Example 2-17, namely $m = 1000$ kg and $k = 10^5$ N/m.

### Inputs:

M=car mass in kg.
K=spring constant of coil in N/m.
B=damping of shock absorber in N·s/m.
A=pothole depth in cm.
W=pothole width in m.
V=speed of car in m/s.

### Output:

Y=displacement of car in cm.




### Comments:

- Travel time across the pothole is T=W/V.
- Curb response is $A[y_{\text{step}}(t) - y_{\text{step}}(t - T)]$ where $y_{\text{step}}(t)$ is the step response.
- Divide the car mass M by 4, since each wheel supports 1/4 of car mass.
- The formula for the overdamped case also works for the underdamped case.
- For the critically damped case, perturb B. The output does not change noticeably.

### Program:

```
clear;M=1000;K=100000;A=10;
W=1;V=5;T=W/V;%pothole parameters.
M=M/4;for B=[10001 2000];
%Use formulae from the text.
a1=B/M;a2=K/M;b1=B/M;b2=K/M;
wo=sqrt(a2);aa=a1/2;xi=aa/wo;
p1=wo*(-xi+sqrt(xi*xi-1));
p2=wo*(-xi-sqrt(xi*xi-1));
A1=(b1*p1+b2)/(p1-p2);
A2=-(b1*p2+b2)/(p1-p2);
t=linspace(0,0.5,1000);
S=A*A1/p1*(exp(p1*t)-1);
S=S+A*A2/p2*(exp(p2*t)-1);
%Pothole travel time:
D=round(1000/0.5*T);DD=1000-D;
Y=-S+[zeros(1,D) S(1:DD)];
subplot(211),plot(t,Y),
axis([0 0.5 -20 10]),hold on,end
```