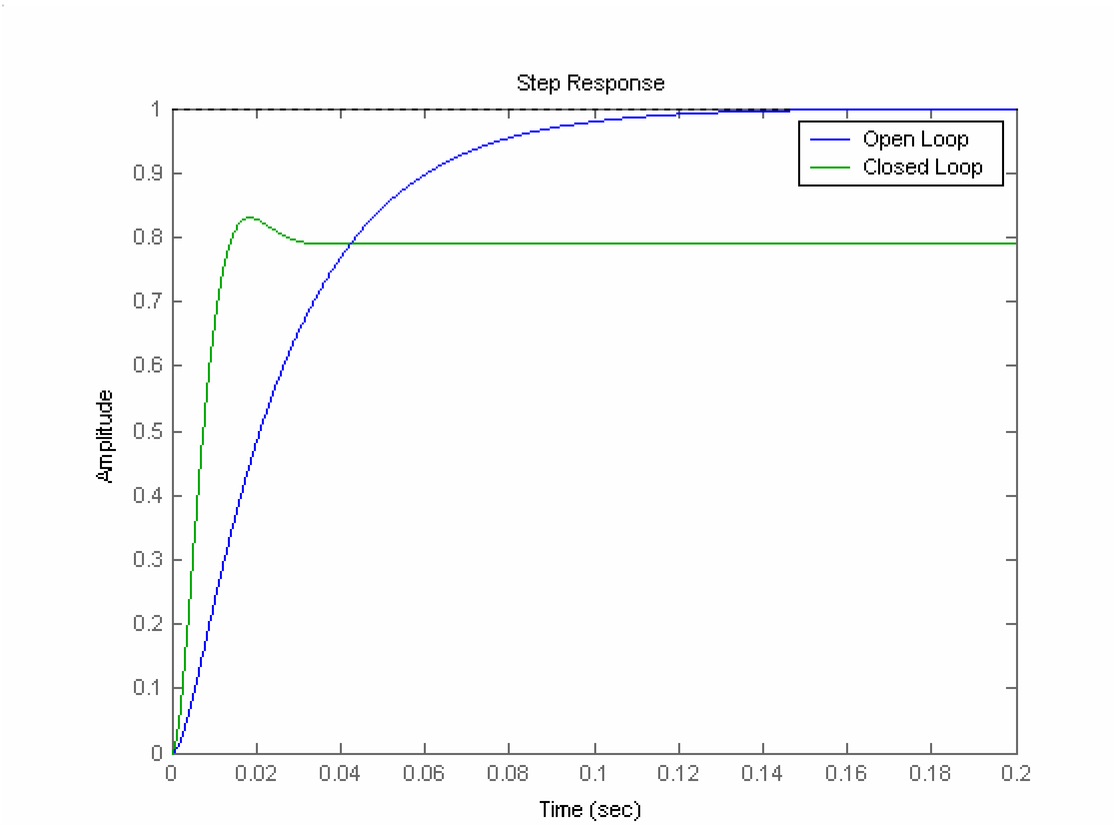
Mechanical Design II HW #6

Part A

```
          C2*wn^2
Gp = ---------------------
    s^2 + 2*z*wn*s + wn^2

Gp =

Transfer function:
      1.141e004
-------------------------
s^2 + 322.5 s + 1.141e004

Gc = Kp     (For a gain of Kp=3.28)

Gcl =

Transfer function:
       4.312e004 s
-----------------------------
s^3 + 322.5 s^2 + 5.452e004 s
```



Part B

Gc = Kp + Kd s   (For a gain of Kp=50 Kd=0.1)

Gc =

Transfer function:

0.1 s^2 + 50 s

----

s

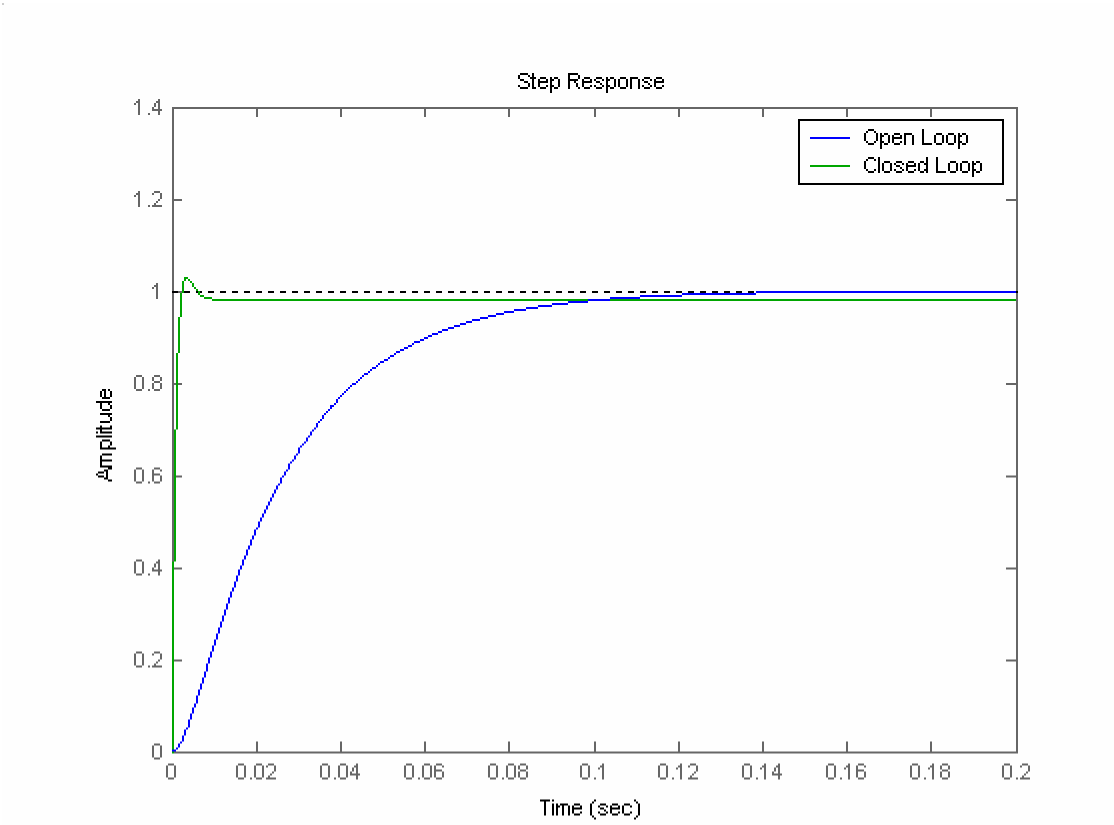
Gcl =

Transfer function:

1141 s^2 + 570312 s

----

s^3 + 1463 s^2 + 5.817e005 s



Notice that the PD compensator provides a faster response.

Part C

Gc = Kp + Ki/s + Kd s (For a gain of Kp=50, Ki=200, Kd=0.1)

Gc =

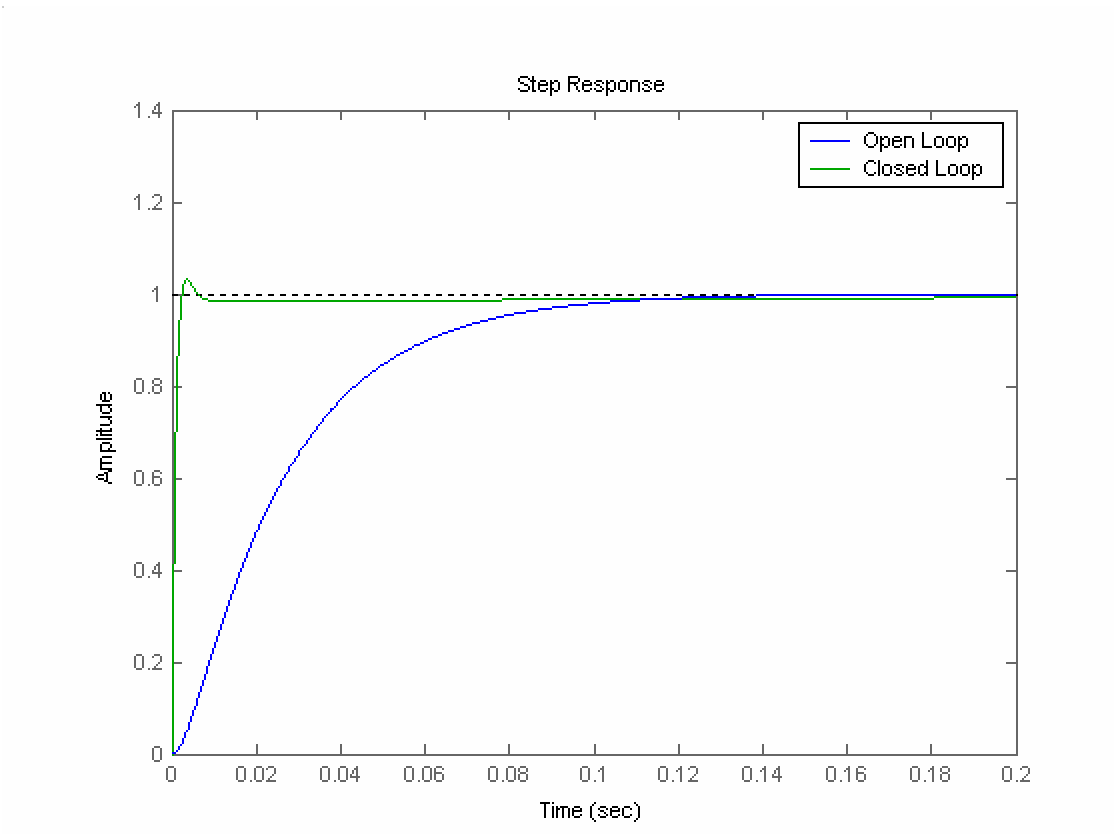
Transfer function:

```
0.1 s^2 + 50 s + 200
--------------------
        s
```

Gcl =

Transfer function:

```
   1141 s^2 + 570312 s + 2.281e006
----------------------------------------
s^3 + 1463 s^2 + 5.817e005 s + 2.281e006
```

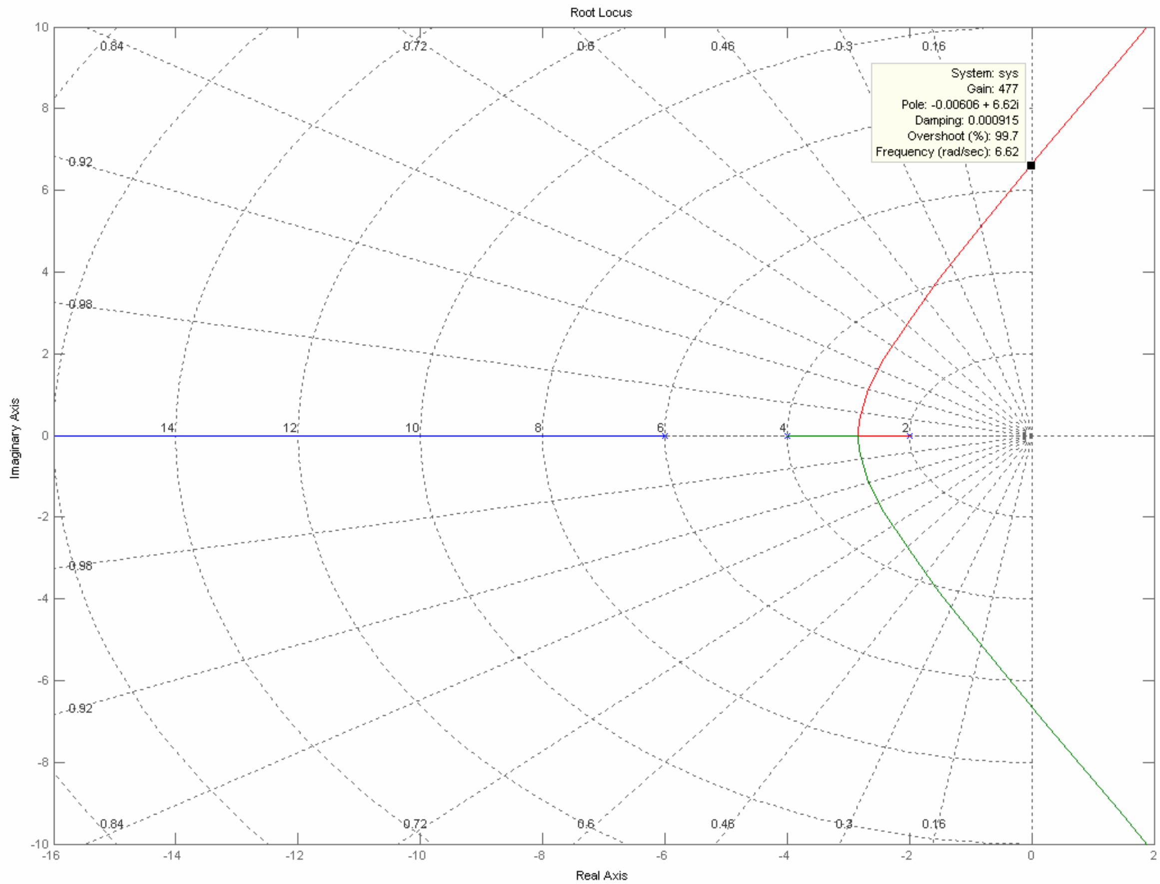


Notice that the PID controller has the best response and can remove the steady-state error.

Part D

Forward path transfer function:

$$\frac{1}{s^3 + 12 s^2 + 44 s + 48}$$



Part E

The point of instability is when the root locus crosses the imaginary axis. The gain when the system goes unstable is K= 480.