Final 4312 F24

Q3

```
Cc = 15.5e-12
Rc = 0
CL = 35e-12
C1 = 0.9e-12
```

DC Bias Point

```
I1 = 100e-6
I3 = I1
I5 = 6*50e-6 => 0.0003
gmoverIn = 10
gmoverIp = 8
lambdan = 1/(70e3*I1)
lambdap = 1/(70e3*I3)
Cgs5 = 10*90*1e-15 => 9e-13

gm1 = 10*I1 => 0.001
go2 = lambdan * I1
1/go2 => 70,000

go4 = lambdap * I3
1/go4 => 70,000

gm5 = gmoverIp * I5 => 0.0024
go5 = lambdap * I5
1/go5 => 23,333.3333
```

```
go6 = lambdan ∗ I5
1/go6 => 23,333.3333
```

Open Loop Small-Signal Analysis

DC Gain

```
A1 = gm1 / (go2 + go4) => 35
A2 = gm5 / (go5 + go6) => 28
ADC = A1 ∗ A2 => 980
20∗log10(ADC) => 59.8245
```

Poles

- Current Mirror

```
gm3 = 800e-6
Cgs3 = 0.3e-12
fcm = 1/2/pi ∗ gm3/2/Cgs3 => 212,206,590.7892
```

- Dominant, unity-gain, non-dominant

```
f1 = 1/2/pi ∗ (go2+go4) / (Cgs5 + (1+A2)∗Cc) =
f1a = 1/2/pi ∗ (go2+go4) / ((1+A2)∗Cc) => 10,1

fu = ADC ∗ f1 => 9,894,179.4107
fua = 1/2/pi ∗ gm1 / Cc => 10,268,060.8446

f2 = 1/2/pi ∗ gm5 / (CL+Cgs5+CL∗Cgs5/Cc) => 10
f2a = 1/2/pi ∗ gm5 / (CL + Cgs5) => 10,639,884
f2b = 1/2/pi ∗ gm5 ∗ Cc/(Cc+Cgs5)/CL => 10,314

fz = 1/2/pi ∗ gm5/Cc => 24,643,346.0271
```

Loop Gain

```
beta = 200/(200+200) => 0.5
TDC = beta * ADC => 490
fuT = fua * beta => 5,134,030.4223

Plag2 = atan(fuT/f2) in degrees => 27.0144 deg
Plagz = atan(fuT/fz) in degrees => 11.7683 deg
PM = 90 degrees - Plag2 - Plagz => 51.2173 deg
```

- using an Rc and LHP zero

```
Rc = 2/gm5 => 833.3333
fLHPz = 1/2/pi/(Rc-1/gm5)/Cc => 24,643,346.027
PleadLHPz = atan(fuT/fLHPz) in degrees => 11.7
PM = 90 degrees - Plag2 + PleadLHPz => 74.7539
```

- putting LHP zero on second pole

```
Rc = 1/2/pi/Cc/f2 + 1/gm5 => 1,436.351
fLHPz = 1/2/pi/(Rc-1/gm5)/Cc => 10,069,842.474

PleadLHPz = atan(fuT/fLHPz) in degrees => 27.0
PM = 90 degrees - Plag2 + PleadLHPz => 90 degr
```

Step response

- step

```
RF = 200e3
Iin = 2.5e-6
Vout = -RF * Iin => -0.5
```

Dominant-Pole Compensation

```
atan(1/3) in degrees => 18.4349 degrees

ratio = 3

f2_DP = 1/2/pi * (go5 + go6) / CL => 389,767.2

fuT_DP = f2_DP/ratio => 129,922.4025
f1_DP = fuT_DP/beta/ADC => 265.1478
CG = (go2+go4)/(2*pi*f1_DP) => 1.715e-8

f1_DP_check = 1/2/pi * (go4 + go2) / (CG + Cgs
fuT_DP_check = beta * ADC * f1_DP_check => 129
Plag_DP = atan(fuT_DP_check/f2_DP) in degrees
PM_DP = 90 degrees - Plag_DP => 71.566 degrees
```