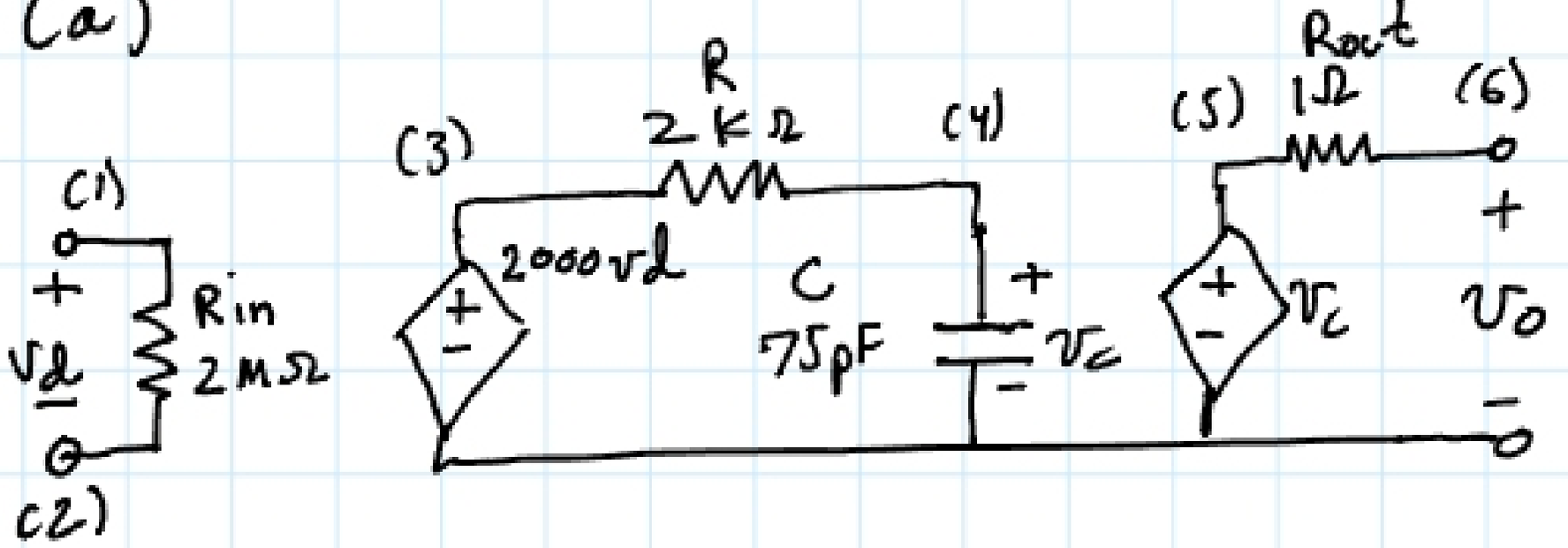
Problem 13 : See attached file ps4_p13_soln.ms12.

Problem 14 : See attached file ps4_p14_soln.ms12.

Problem 15:

1. (a)

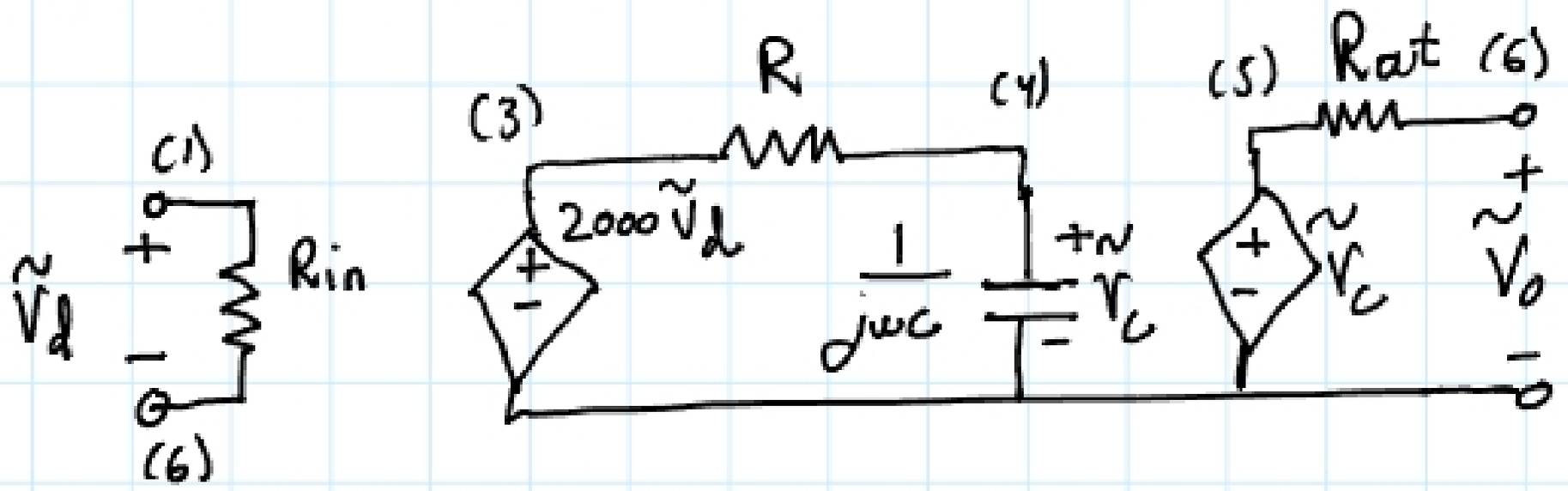


SPICE model:

```
.SUBCKT OPAMP 1 2 6
r Rin  1 2  2MEG
e Vd   3 0  1 2  2K
r R    3 4  2K
c C    4 0  75p
e Vc   3 0  4 0  1
r Rout 3 6  1
.ENDS OPAMP
```

Problem 15

1. (b) Phasor Domain Circuit model



- Because the Op Amp output sees an open circuit, $\tilde{V}_o = \tilde{V}_c$
- Using voltage division

$$\tilde{V}_o = \tilde{V}_c = \frac{1/j\omega C}{1/j\omega C + R} 2000\,\tilde{V}_d$$

$$H(j\omega) = \frac{\tilde{V}_o}{\tilde{V}_d} = 2000\,\frac{\frac{1}{j\omega RC+1}}{\frac{1}{j\omega/\omega_c+1}}$$

$$H(j\omega) = K\,\frac{1}{j\omega/\omega_c+1}$$

$$K = 2000$$

$$\omega_c = \frac{1}{RC}$$

(i) DC gain [V/V] $= H(j0) = K = 2000$

DC gain [dB] $= 20\log_{10}|K| = 66$ dB

Problem 15

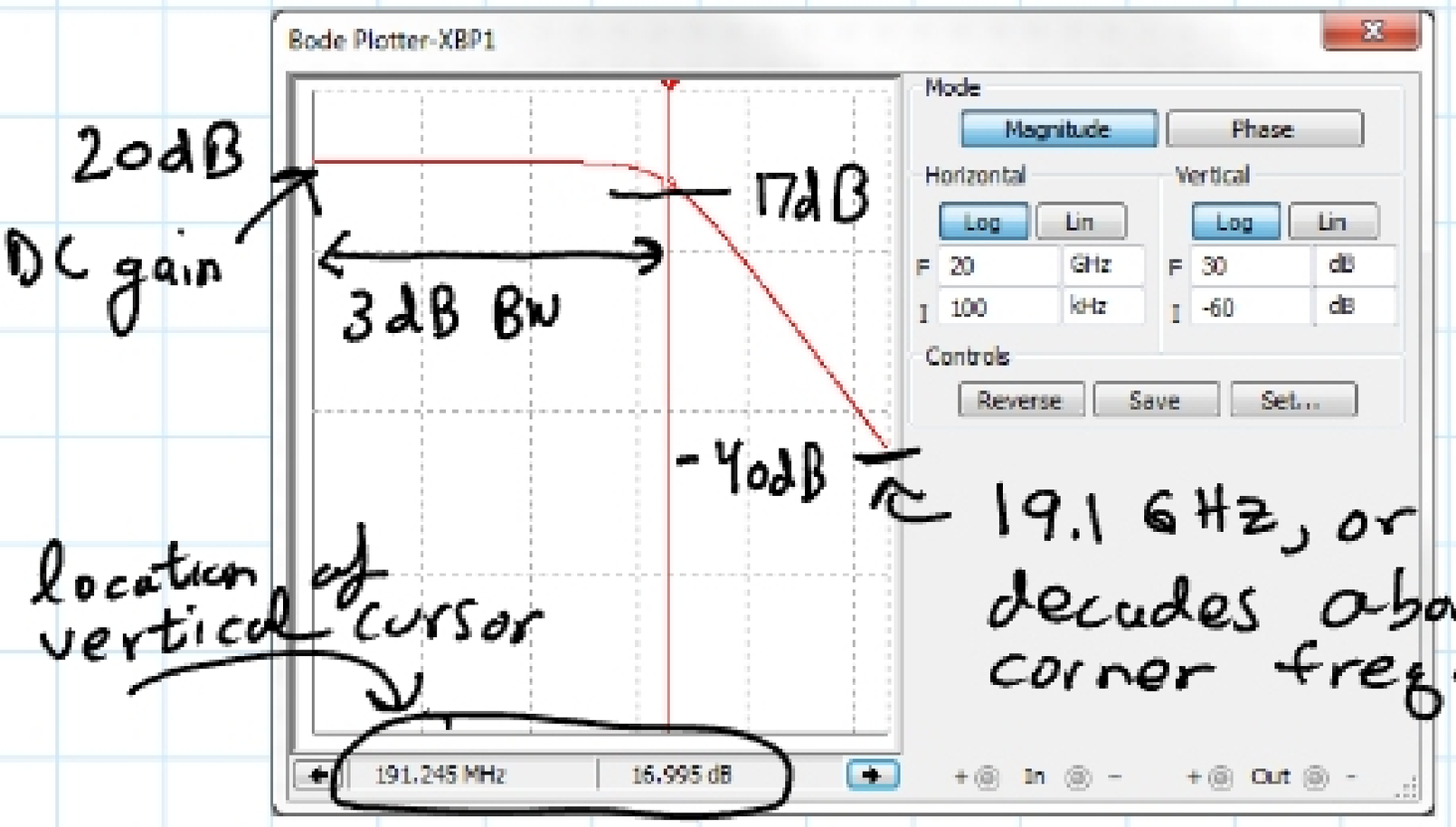
1 (b) (ii)

$$\omega_c = \frac{1}{RC} = \frac{1}{(2000\,\Omega)(75\times10^{-12}\,F)}$$

$$\omega_c = 6.67 \times 10^6 \text{ rad/sec}$$

$$f_c = \frac{\omega_c}{2\pi} = 10.5 \text{ MHz}$$

2. The magnitude response generated by Multisim is



$\approx$ 19.1 GHz, or two decades above the corner frequency at 19.1 MHz

(a) 3dB BW = 191.2 MHz = $1.20\times10^9 \frac{\text{rad}}{\text{sec}}$

In comparison, the 3dB BW of the Op Amp without negative feedback is 10.5 MHz.