EE 2019

1) In the LDO shown below, assume that R is very large compared to other resistances in the circuit. The opamp has a gain A(s) given by

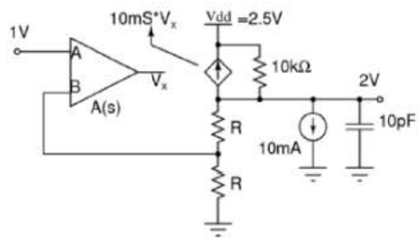
$$A(s) = \frac{100}{1 + (2X10^{-8})s}$$

(a) Determine the signs of the opamp for proper negative feedback operation. **(1 Marks)**

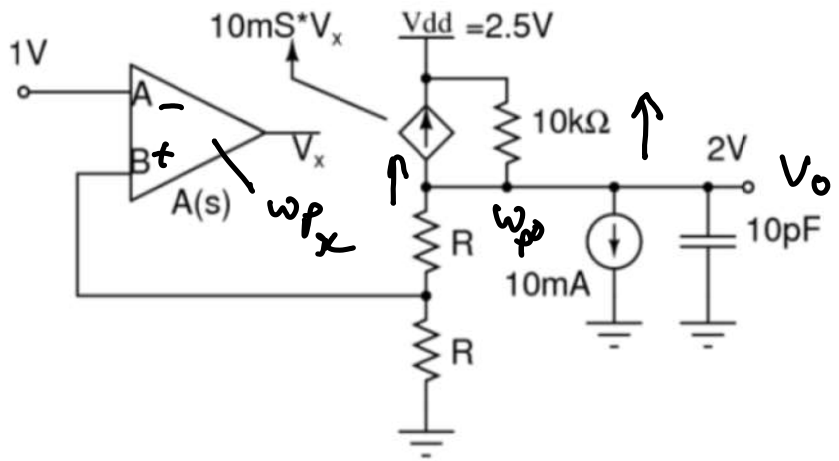
(b) What is the dc value of V_x? **(1 Marks)**

(c) Perform dominant pole compensation on this feedback system for a phase margin of 45°, for maximum possible bandwidth. **(4 Marks)**

(d) Draw the bode plots of magnitude and phase for the loop gain before and after compensation, clearly labelling DC gain, positions of poles and slopes at various points. **(2 Marks)**



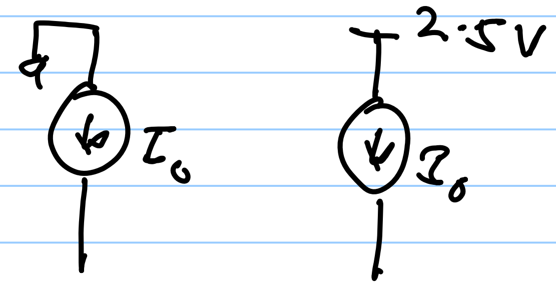
(a) find A & B signs



Sign from V_x to V_o = −ve

A = − & B = +

(b) $V_x = ?$



$V_o = I_o \times R_o$

$I_o = I_{load} = 10mA$

$V_o = 2V$

$I_{load} = 10mA, \Rightarrow g_m V_x = -10mA$

$$V_x = \frac{-10mA}{g_m} = \frac{-10mA}{10m} = -1V$$

(c) $$A(s) = \frac{100}{1 + 2\times10^{-8}s}$$

Two pole system.

$$\omega_{p_x} = \frac{1}{2\times10^{-8}} = 50\ \text{Mrad/sec.}$$

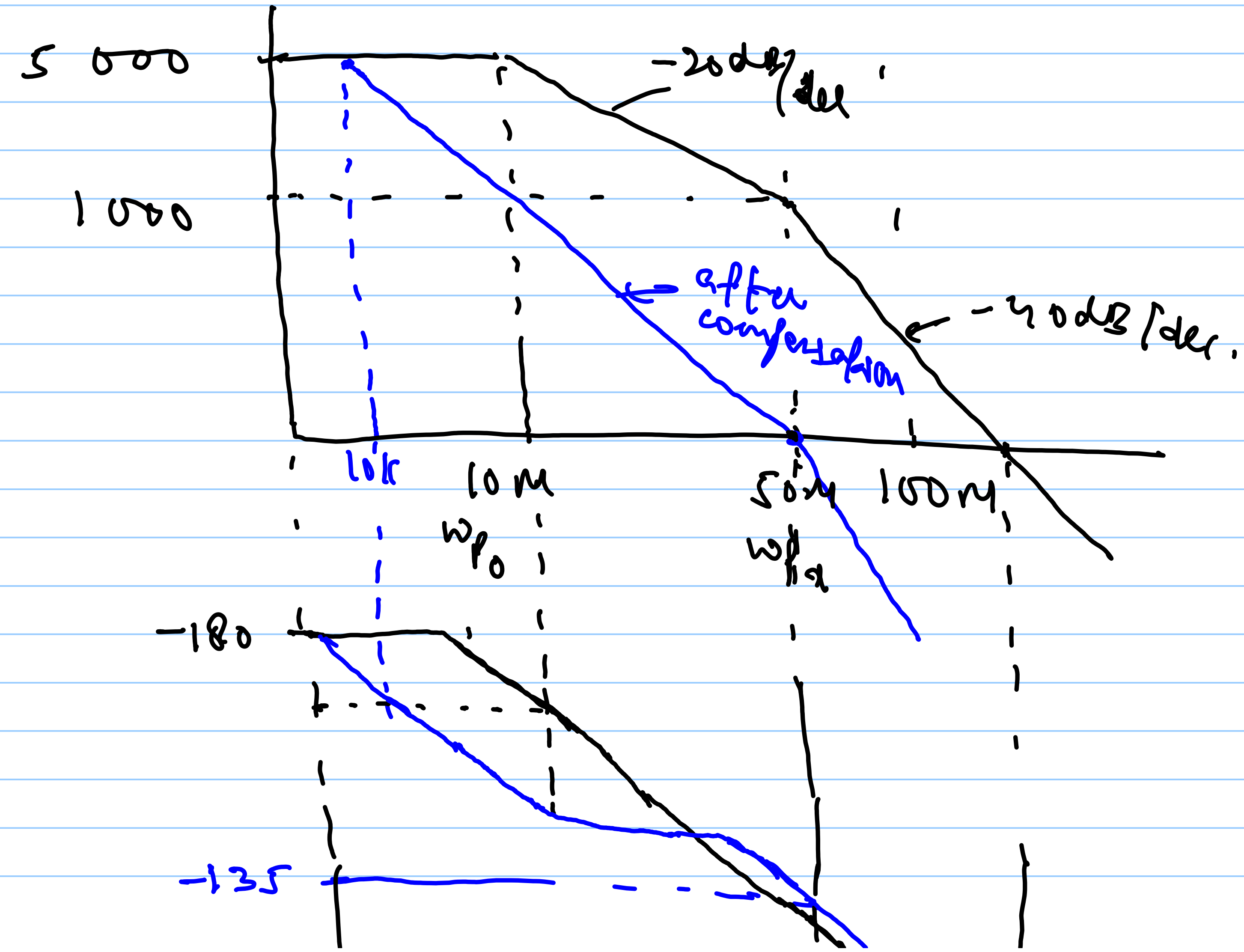
$$\omega_{p_o} = \frac{1}{R_o C_o} = \frac{1}{10k\times10\times10^{-12}} = 10\ \text{Mrad/sec.}$$

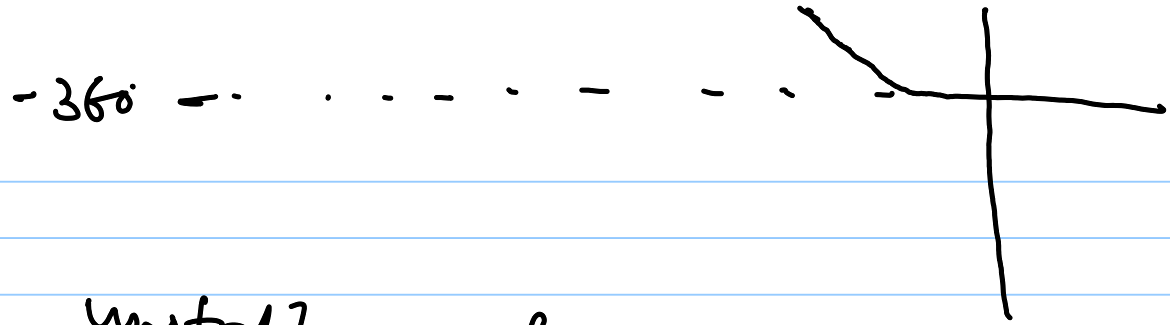
$$A\beta(dc) = 100\times(10\times10) = 10^4$$

$$LG(s) = A\beta = \frac{-10^4 \times 1/2}{(1+s/\omega_{p_x})(1+s/\omega_{p_0})}$$

$$= -\frac{5000}{(1+s/\omega_{1_x})(1+s/\omega_{p_0})}$$

$\omega_{1_x} = 50 \text{ Mrad/s}$ & $\omega_{p_0} = 10 \text{ Mrad/sec.}$


5 000
1 000
-20dB/dec
-40dB/dec.
after compensation
10k
10M
ω_{p_0}
50M
ω_{p_1}
100M
-180
-135



unstable system.

$PM = 45^\circ$

For maximum bandwidth dominant pole compensation should be done at lower freq. pole i.e ωp_0.

$\omega p_x = \omega_{gc}$ for 45° PM.

$\omega_{ugb} = \omega_{p_x} = 50$ Mrad/sec.

ω_{p_0} after compensation,

$$\omega_{p_0} = \frac{\omega_{ugb}}{A\beta} = \frac{50 \text{ Mrad/s}}{5000}$$

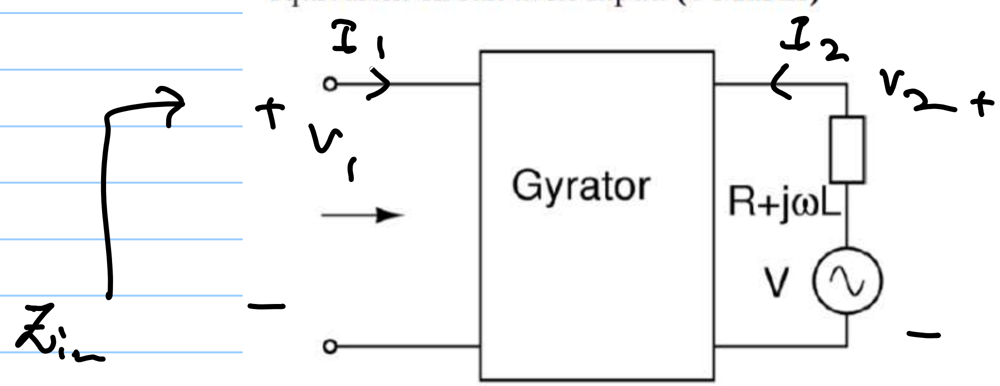
$$= \frac{50 \times 10^6}{5 \times 10^3} = 10 \text{ K rad/sec.}$$

$$\omega_{p_0} = \frac{1}{R_0 C_0} \qquad R_0 = 10K\Omega$$

$$C_0 = \frac{1}{10K \times 10K} = 10nF$$

(2)

2) The output port of a gyrator (with parameter G_m) is loaded with a voltage source V in series with an impedance (R+jωL). Determine the equivalent circuit at its input. **(6 Marks)**



$$I_1 = G_m V_2 \quad \& \quad I_2 = -G_m V_1$$

$$V_2 = -I_2(R + sL) - V$$

$$I_1 = G_m V_2 = -G_m I_2 (R + sL) - G_m V$$

$$I_2 = -G_m V_I$$

$$I_1 = -G_m(-G_m V_1)(R + sL) - G_m V$$

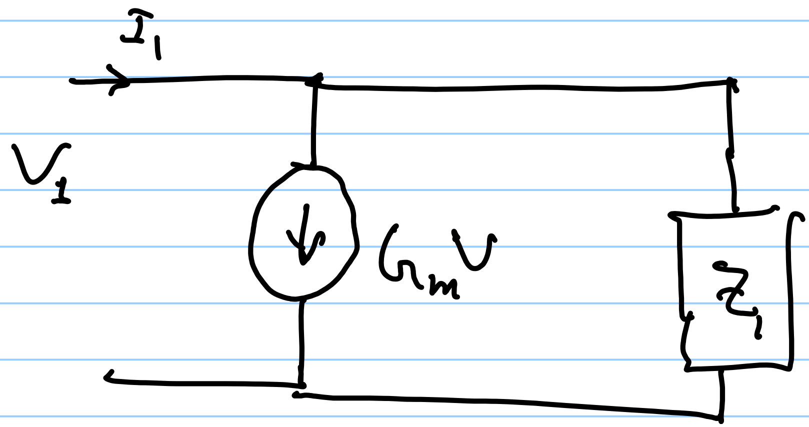
$$I_1 = G_m^2 (R + sL) V_1 - G_m V$$

G

$$I_1 = I_{Z_1} - I$$

$$I = G_m V$$

$$I_{Z_1} = G_m^2 (R + sL) V_1$$



$$= \frac{1}{G\omega^2 (R + jL)}$$