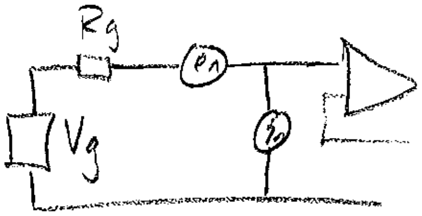
081027

1 a)



Uncorrelated sources
→ The noise power contribution should be added

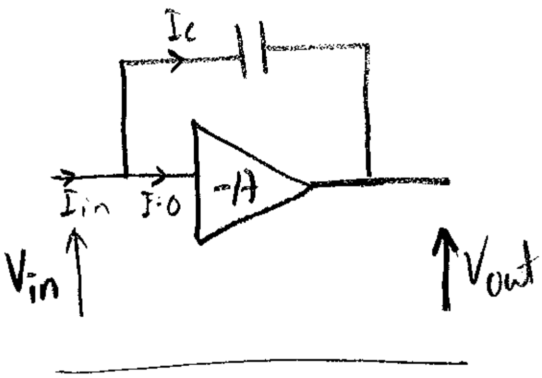
$$V_n = \sqrt{e_n^2 + (R_g i_n)^2}$$

b) A current through the device can be controlled by an applied voltage/current in a FET/bipolar transistor

c) The feed-back is increasing the linearity and reducing the gain.

d) A switched mode power supply is in general working at higher frequencies than 50 Hz and less energy need to be stored in each cycle enabling smaller transformers to be used.

2|



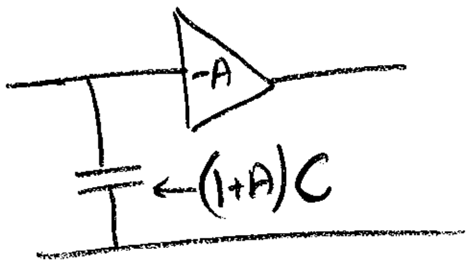
$$V_{out} = -A \cdot V_{in}$$

$$I_{in} = I_C = \frac{V_{in} - V_{out}}{\frac{1}{j\omega C}} = \frac{V_{in} - (-A \cdot V_{in})}{\frac{1}{j\omega C}}$$

$$= V_{in}(1+A)\, j\omega C$$

$$Z_{in} = \frac{V_{in}}{I_{in}} = \frac{\cancel{V_{in}}}{\cancel{V_{in}}(1+A) j\omega C} = \frac{1}{j\omega(1+A)C}$$

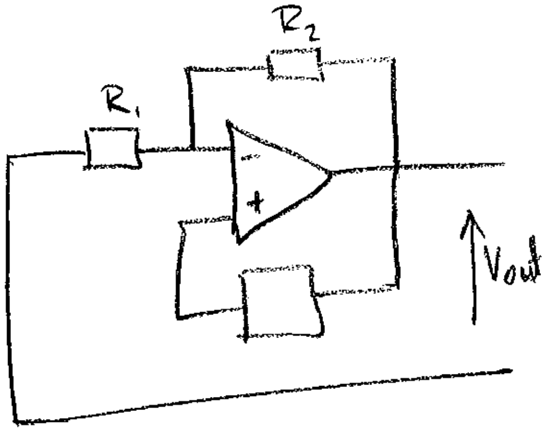
⇓



3/ a) The overall gain should be 1 and the phase shift should be 0.

b) The lead-lag filter gives gain 1/3 with a phase shift $\phi = 0$. (Frequency axis in phase diagram is accidently shifted)
The lead-lag filter is connected to the positive input. The resistor network should thus compensate and give amplification $A_{R_1-R_2} = 3$.

c)



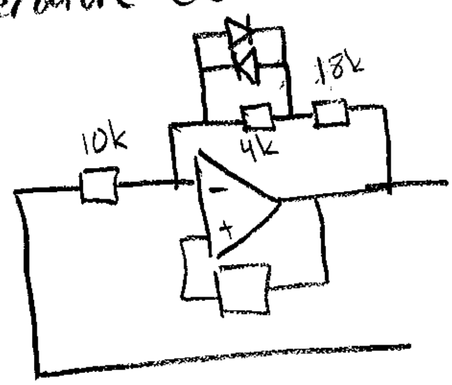
$R_1 - R_2$ forms an non inverting amplifier

$$A_v = -\frac{R_1 + R_2}{R_1}$$

$R_2 = 2 \cdot R_1$ fulfills the theoretical conditions for oscillation let $R_1 = 10\,k\Omega$ $R_3 = 20\,k\Omega$

However resistors are not exact and parameters change with temperature so it does not give a stable amplitude

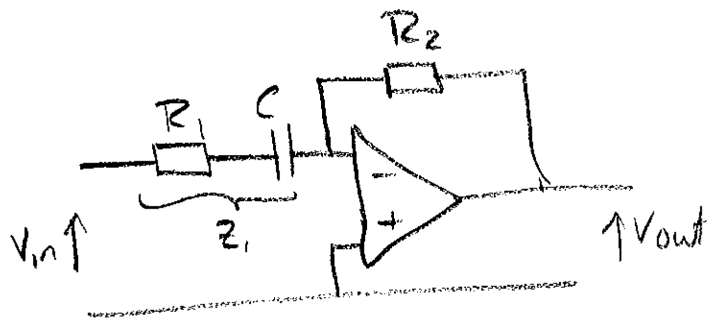
Instead



Small voltage $A_v = \frac{10+18+4}{10} = 3{,}2$

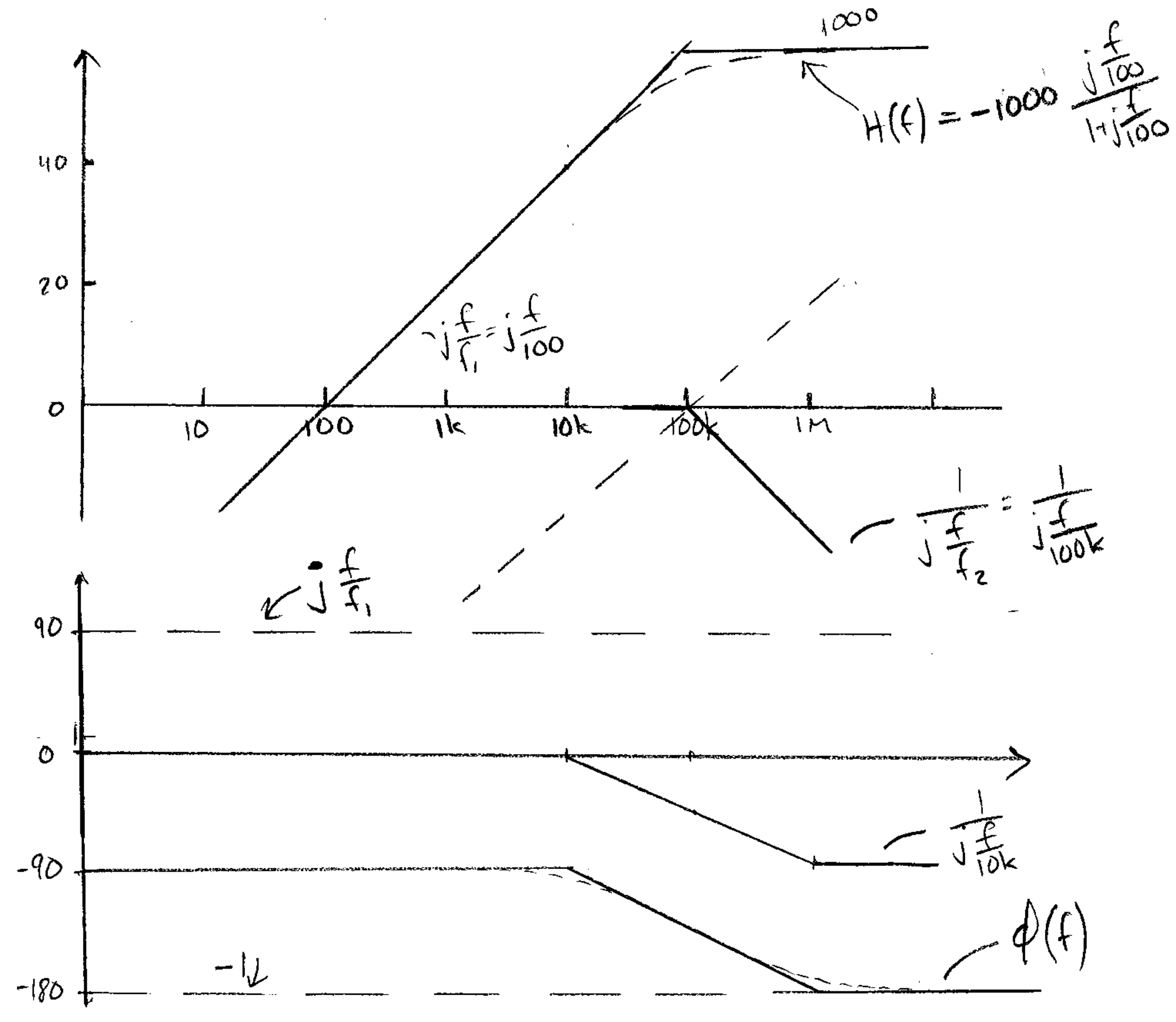
Large voltage $A_v = \frac{10+18}{10} = 2{,}8$

4



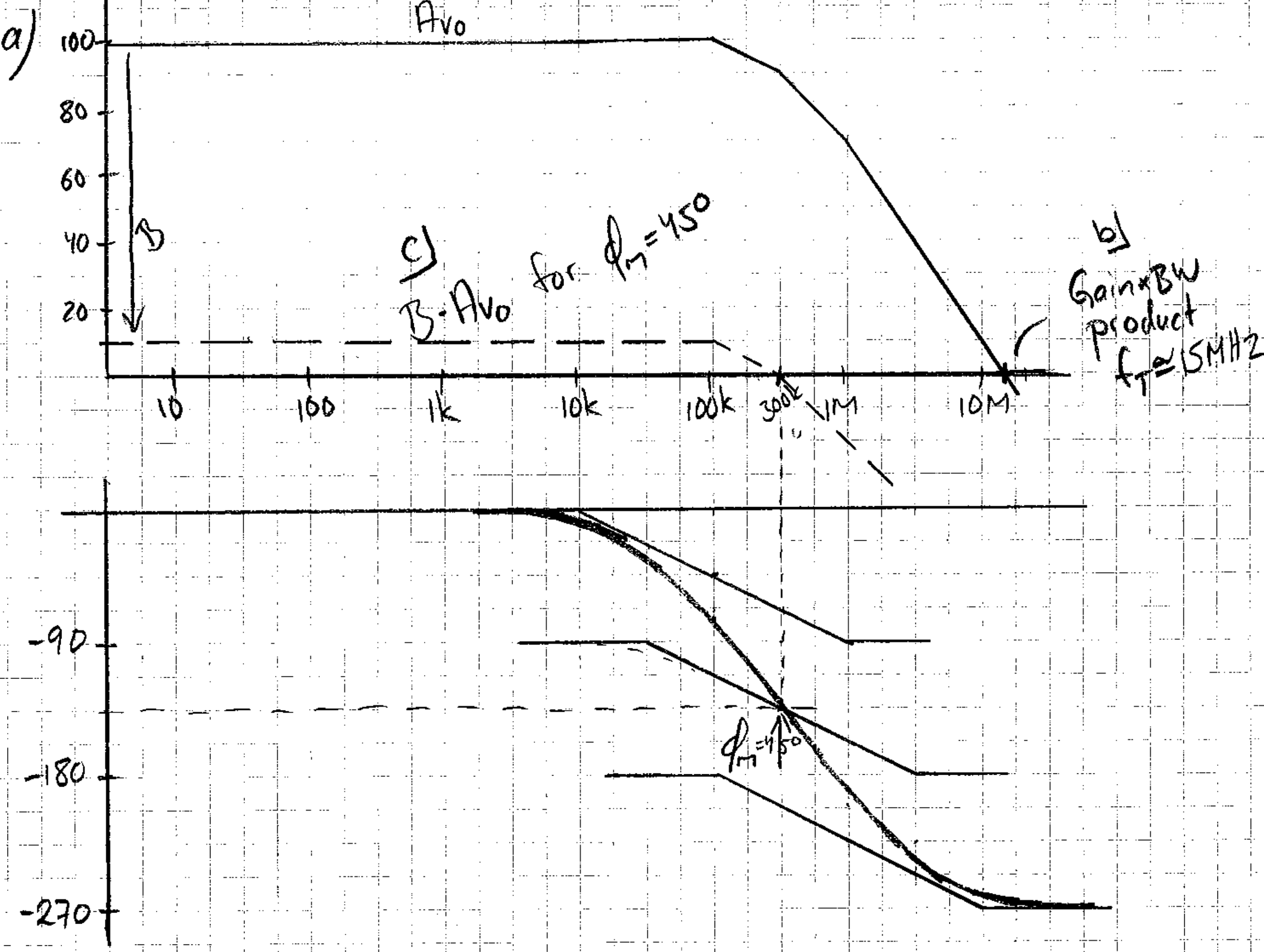
$$\frac{V_{out}}{V_{in}} = -\frac{Z_2}{Z_1} = -\frac{R_2}{R_1 + \frac{1}{j\omega C}} = -\frac{j\omega R_2 C}{1 + j\omega R_1 C} = -\frac{R_2}{R_1}\,\frac{j\omega R_1 C}{1 + j\omega R_1 C} = -\frac{R_2}{R_1}\,\frac{j\frac{f}{f_1}}{1 + j\frac{f}{f_1}}$$

where $f_1 = \frac{1}{2\pi R_1 C} = \frac{1}{2\pi 40 \cdot 40n} = 100k$



5

a)



b) Gain×BW product $= f_T = 15$ MHz

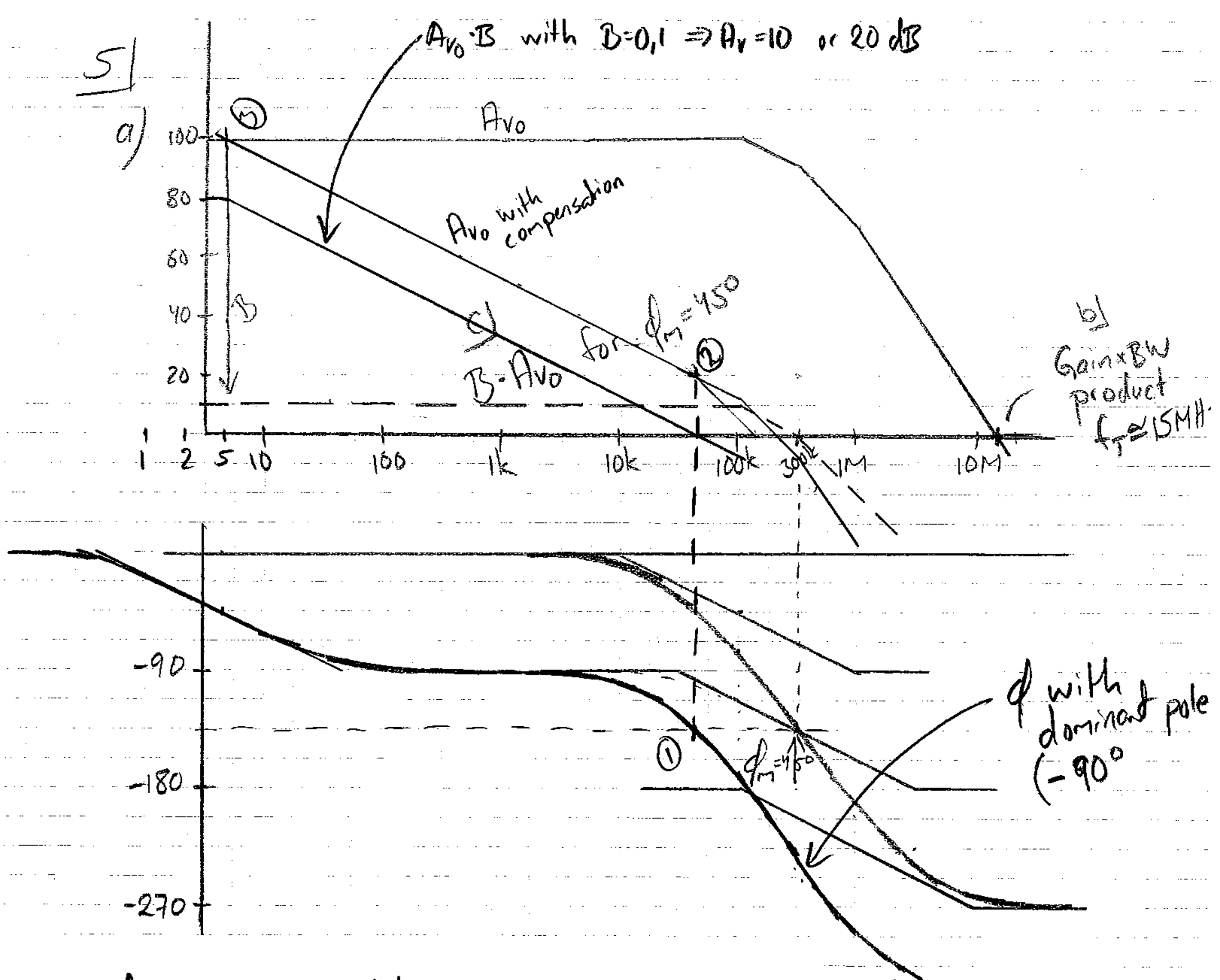
c) Feed-back factor must be < -90 dB for 45° phase margin.

$$\Rightarrow A_v = \frac{1}{B} = 90 \text{ dB}$$

Amplifier stable for gain > $A_v = 90$ dB

5)

a)



d) For stability @ 20 dB gain we add one pole that gives $A_{v_0} = 20$ dB where $\phi = -135°$ (① - ② - ③)

$f_{pole} \simeq 5$ Hz