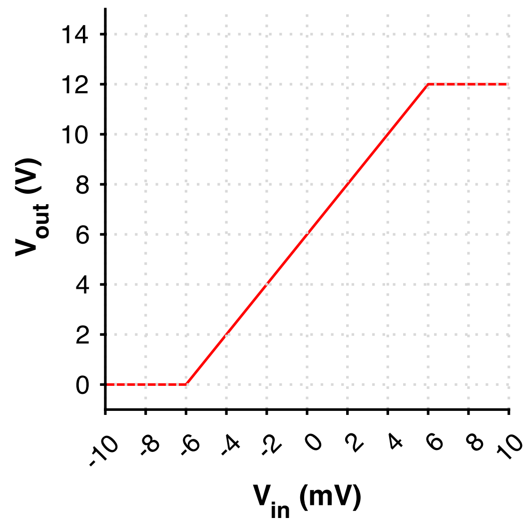
Homework 8

Clearly describe the reasoning behind the work done in each problem.

Problem 1:
Given the amplifier transfer characteristics curve on the right:

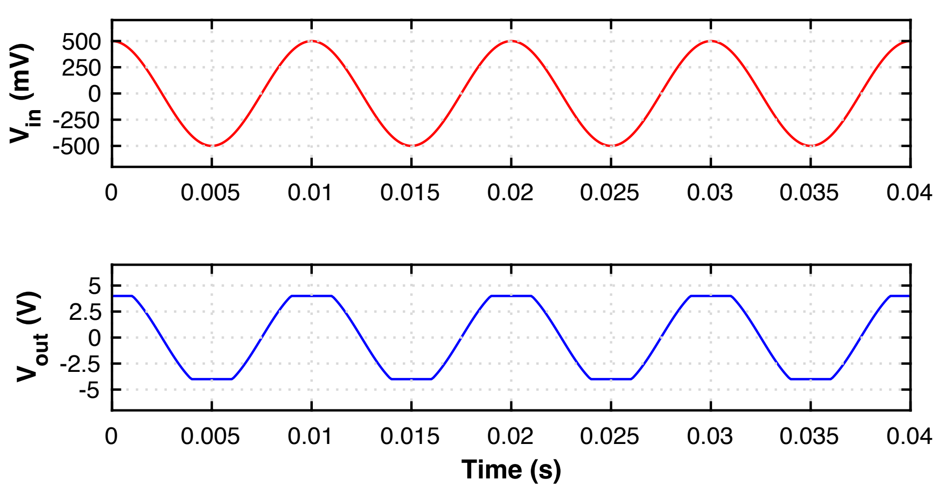
a. Determine whether a single or dual power supply is being used.
b. Determine the power supply voltage.
c. Calculate the voltage amplification.
d. Calculate the power amplification in dB.
e. Plot the output for $v_{in}(t) = 4\cos(100t)\ mV$.
f. Plot the output for $v_{in}(t) = 8\cos(100t)\ mV$.
g. Determine the maximum output sinusoidal voltage possible without clipping.



Problem 2:
An amplifier with a power gain of 80dB is using a dual power supply voltage of ±10V.

a. Calculate the voltage gain of the amplifier.
b. Sketch the transfer characteristics curve of the amplifier.
c. Determine the peak to peak value of the largest input signal that can be amplified without clipping.
d. Determine the peak to peak value of the largest output signal that the amplifier can produce without clipping.
e. Determine the DC offset of the output signal found in part d.

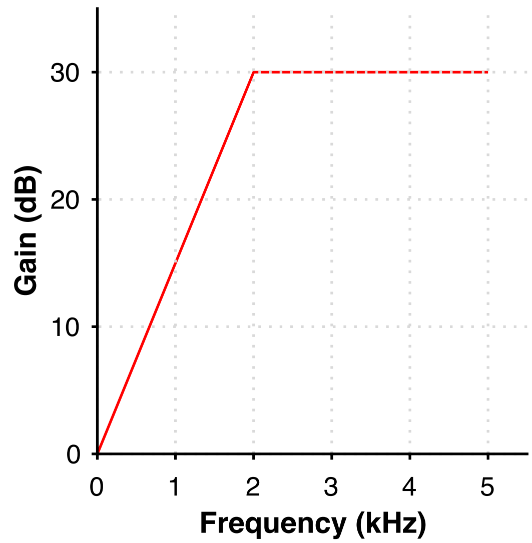
Problem 3:
The input and output of an amplifier is plotted on the right. Plot the transfer characteristics curve of the amplifier. Hint: To do this you need to know gain, single or dual power, max/min output voltages, and inverting or non-inverting.



Problem 4:

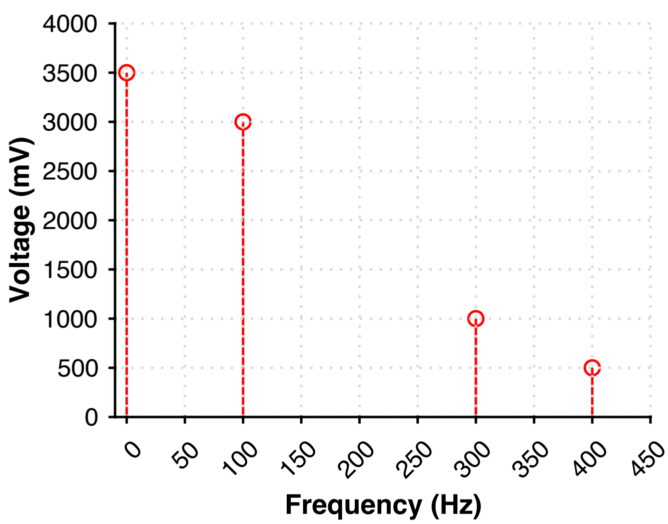
The frequency response of a particular amplifier is shown below. Given the input:
$v_{in}(t) = [20 + 25\cos(2\pi\,1000t + \pi/4) - 15\cos(2\pi\,2000t) + 5\cos(2\pi\,3000t - \pi/4)]\ mV$

a. Plot the power spectrum of the input in dBW.
b. Determine the total normalized signal power of the input.
c. Find the power gain and each input frequency.
d. Plot the power spectrum of the output signal.
e. Determine the total normalized signal power of the output.
f. Calculate the overall amplification of the signal in dB [10 log(e/b)].
g. Plot the magnitude spectrum of the output signal.
h. Write an expression for $v_{out}(t)$. Note: since you do not have the phase information of the amplifier, leave the phase as θ_1, θ_2, and θ_3.



Problem 5:

The frequency response of an amplified sinusoid is shown below. Given the input was a 100 Hz sinusoid, determine the range of cutoff frequencies for a low pass filter to block the harmonics. Was this amplifier powered by a single or dual power supply and why?



Problem 1a

A single power supply is being used because voltage is never negative.

Problem 1b

12 V

Problem 1c

$$A_v = \frac{12 - 0}{0.006 + 0.006}$$

$$= \frac{12}{0.012}$$

$$= 1000 \text{ dB}$$

Problem 1d

$$G = 20 \log(1000)$$

$$= 26.02 \text{ dB}$$

Problem 1e

$$V_{out} = V_{dc} + A_v V_{in}$$

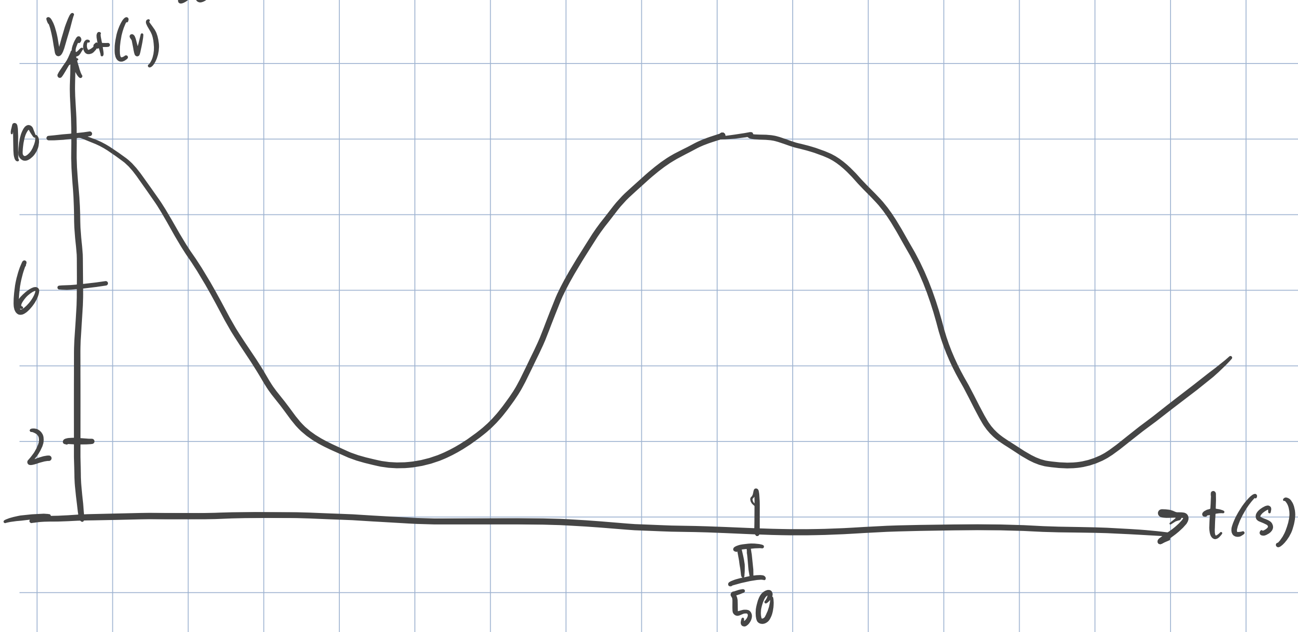
$V_{out[mV]} = 6000 + 4000\cos(100t)$

$V_{out[V]} = 6 + 4\cos(100t)$

$100 = 2\pi f$

$f = \frac{50}{\pi}$

$T = \frac{\pi}{50}$



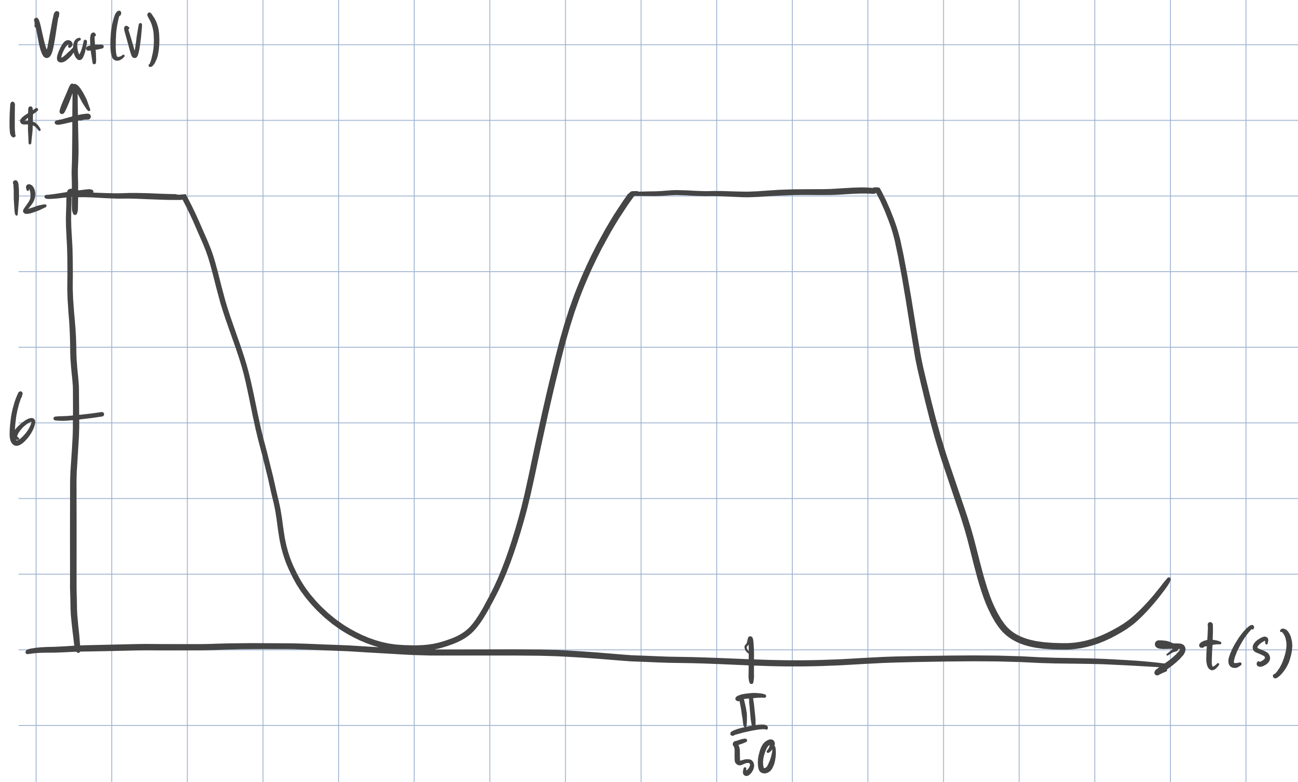
Problem 1f

$V_{out} = A_v V_{in}$

$V_{out[mV]} = 6000 + 8000\cos(100t)$

$V_{out[V]} = 6 + 8\cos(100t)$

$T = \frac{\pi}{50}$



Problem 1g

12v

Problem 2a

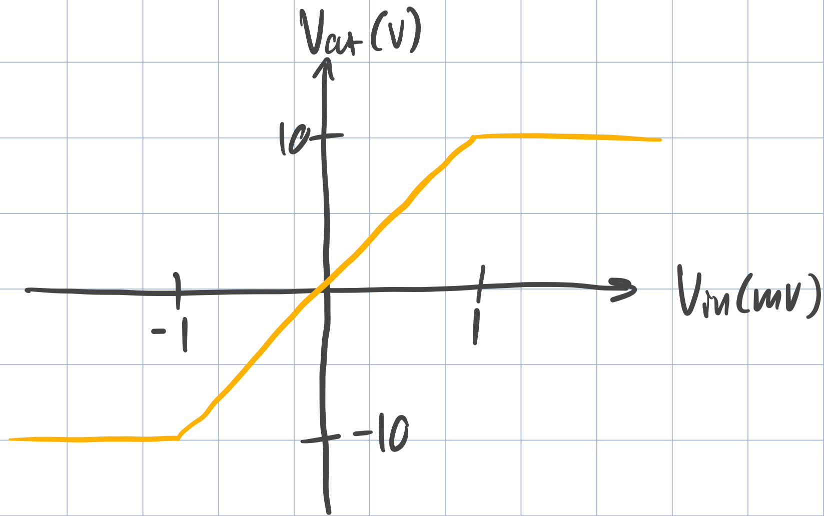
$G = 20\log(A_v)$

$\frac{G}{20} = \log(A_v)$

$A_v = 10^{\frac{G}{20}}$

$= 10000$

Problem 2b



Problem 2c

2mV

Problem 2d

20V

Problem 2e

0V

Problem 3

$$V_{out} = A_v V_{in}$$

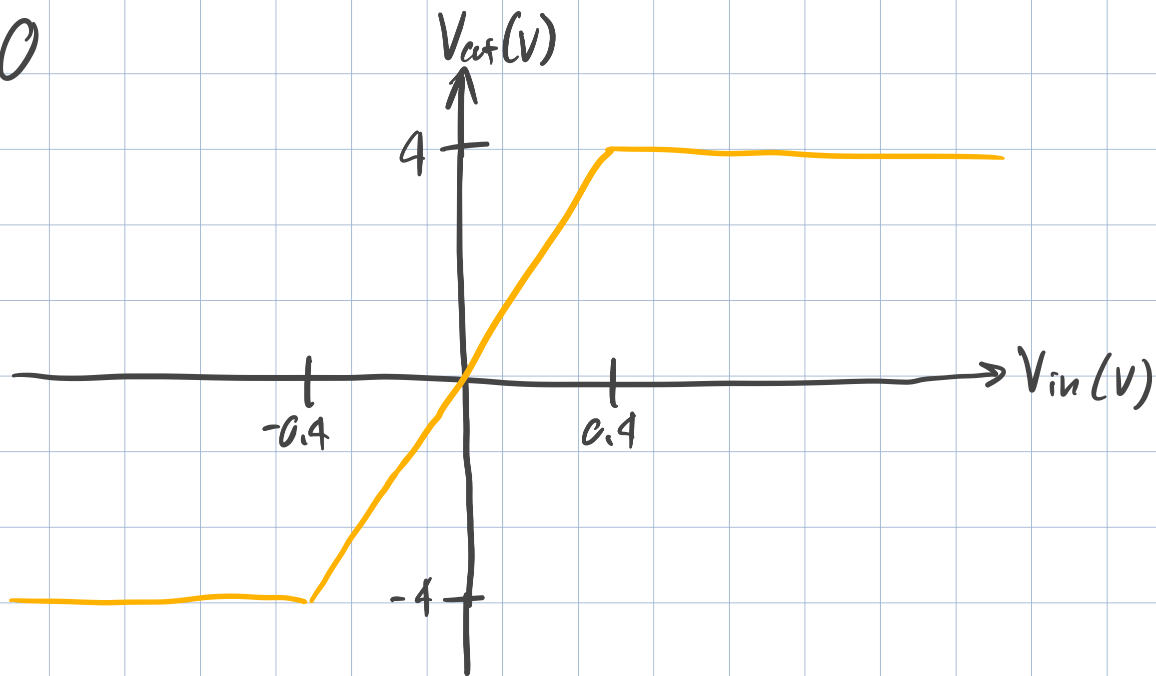
$$V_{in} = 0.5 \cos(2\pi \frac{1}{0.01} t)$$

$$V_{out} = 5\cos\left(2\pi \frac{1}{0.01} t\right)$$

$$5\cancel{\cos\left(2\pi \frac{1}{0.01} t\right)} = A_v \, 0.5 \cancel{\cos\left(2\pi \frac{1}{0.01} t\right)}$$

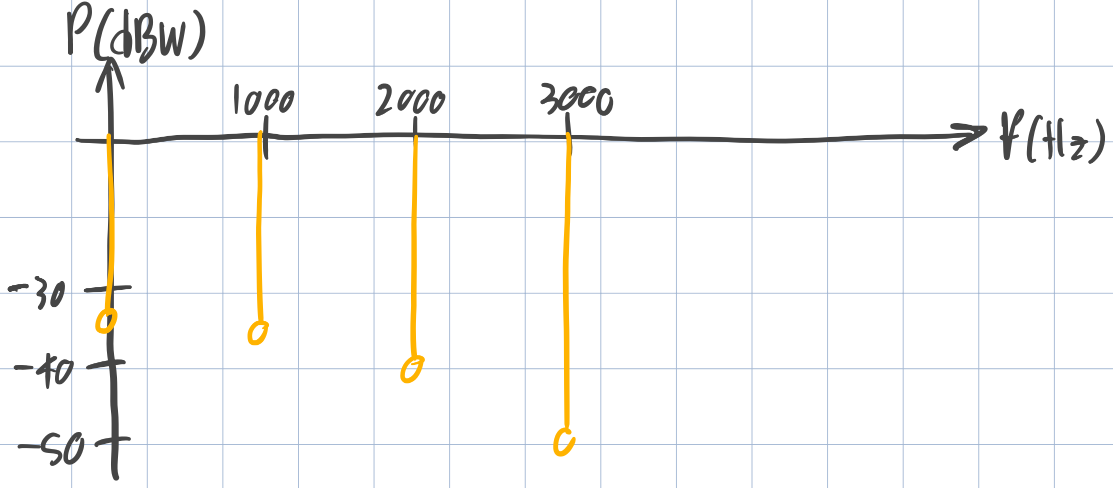
$$A_v = \frac{5}{0.5}$$

$$= 10$$



Problem 4a

f[Hz]	V[mV]	V[V]	Vrms[V]	P[W]	P[dBW]
0	20	0.02	0.02	400e-6	-33.979
1000	25	0.025	17.68e3	312.5e-6	-35.051
2000	-15	-0.015	10.61e3	112.5e-6	-39.488
3000	5	0.05	3.536e3	12.5e-6	-49.031



Problem 4b

$$P_{in[W]} = \sum_{n=1}^{N} P$$

$$= 837.5e^{-6} \text{ W}$$

$$P_{in[dBW]} = -30.77 \text{ dBW}$$

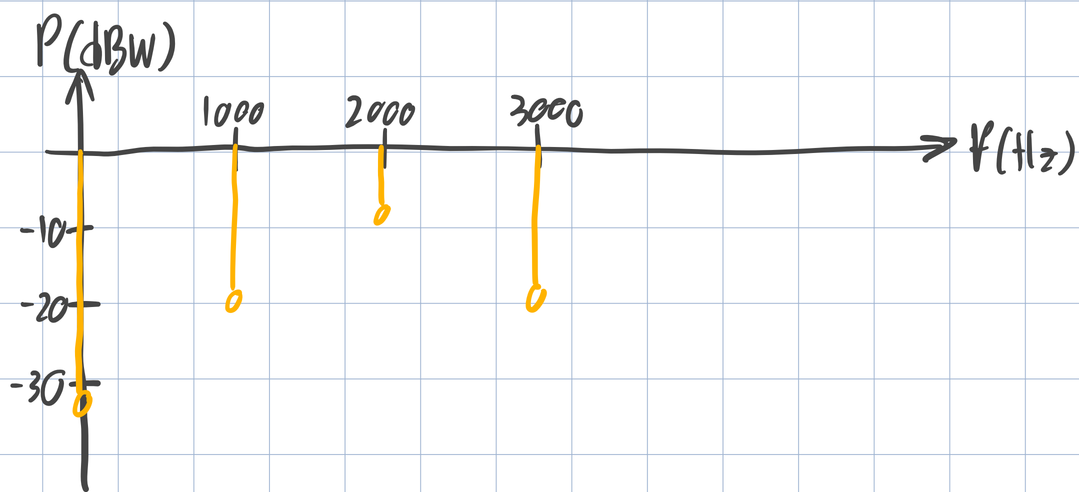
Problem 4c

f(Hz)	Gain(dB)
0	0
1	15
2	30
3	30

Problem 4d

P_{in} (dBW)	G (dB)	P_{out} (dBW)
-33.979	0	-33.979
-35.051	15	-20.051
-39.488	30	-9.488
-49.031	30	-19.031

$P_{out} = P_{in} + G$



Problem 4e

P_{out} (dBW)	P_{out} (W)
-33.979	400.04 e-6
-20.051	9.883 e-3
-9.488	112.512 e-3
-19.031	12.500 e-3

$P_{out}[W] = 135.30\text{e-}3$ W

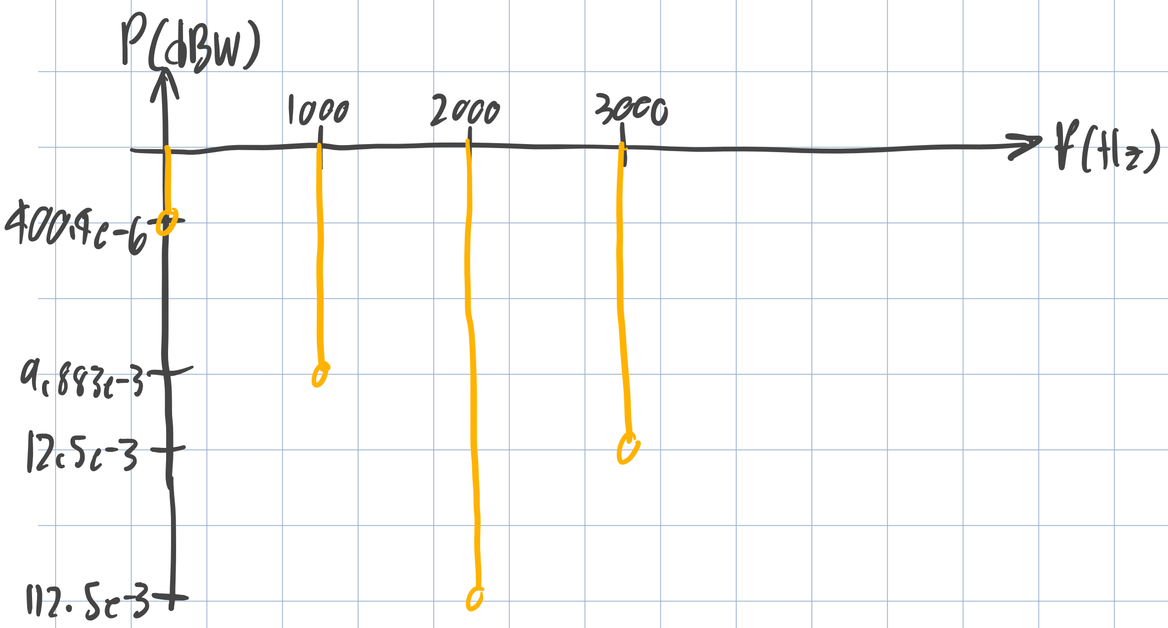
$P_{out[dBW]} = -8.687$ dBW

Problem 4f

$$A_v = 10\log\left(\frac{135.30e-3}{837.5e-6}\right)$$

$$= 22.083$$

Problem 4g



Problem 4h

$$V_{out[V]} = 400.4e-6 + 9.883e-3\cos(2\pi 1000t + \theta_1) + 112.5e-3\cos(2\pi 2000t + \theta_2) + 12.5e-3\cos(2\pi 3000t + \theta_3)$$

Problem 5

The range of frequencies required to block the distortion is from 100 Hz to 300 Hz for this signal.

The power supply is a single power source supply because there is a dc value. If the supply was a dual supply the dc component shall have been 0.