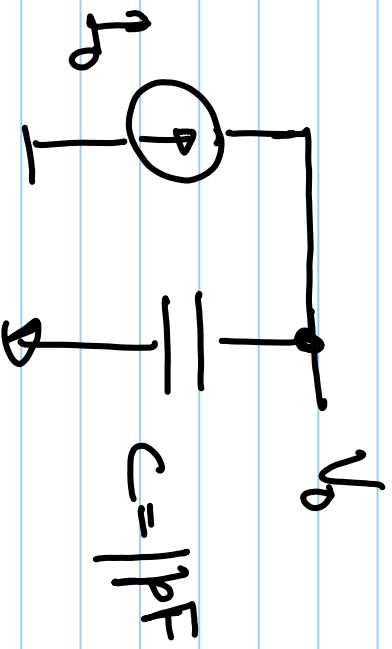
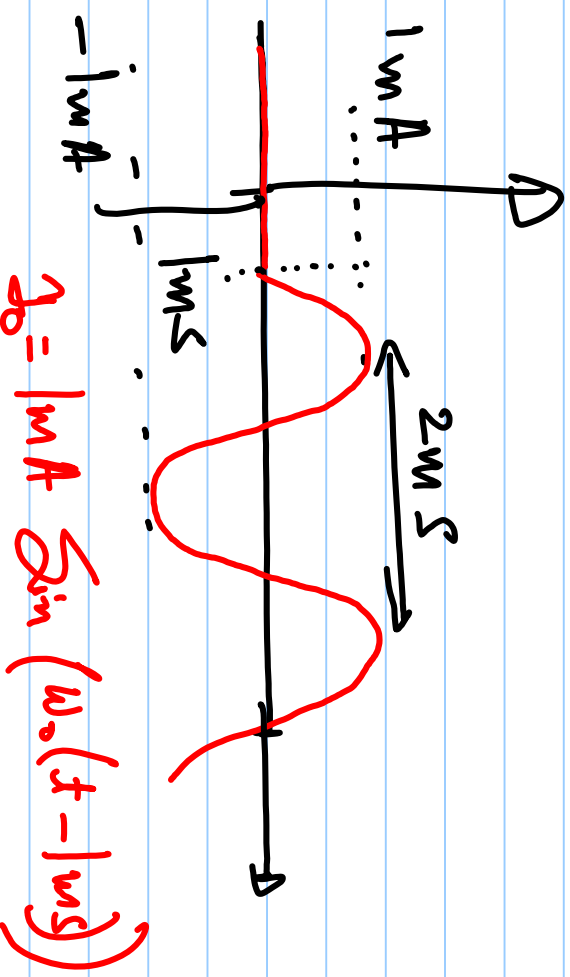
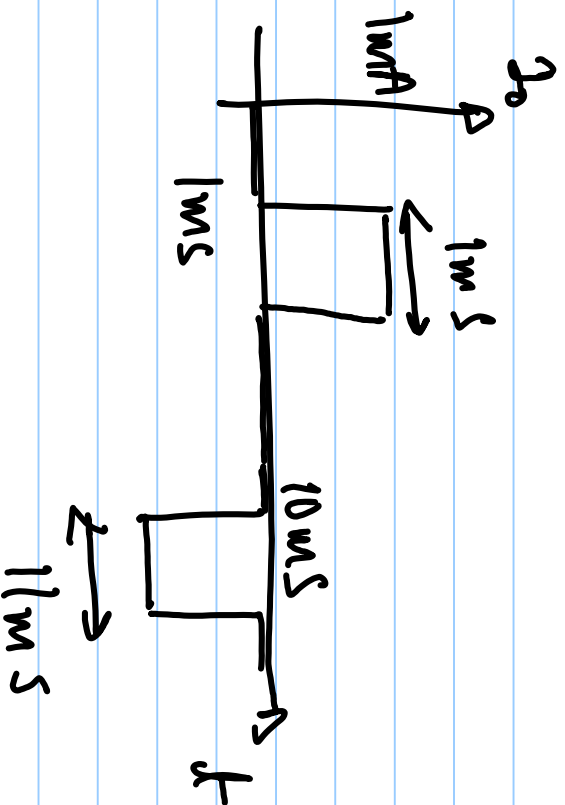


Problem Set #1

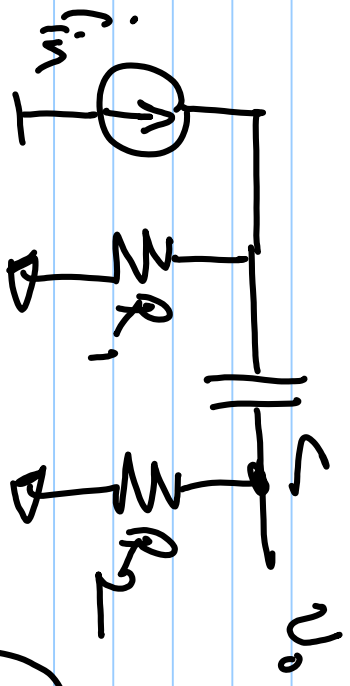
①



Plot V_o for the following current wave forms



2



a) find $\frac{v_o(s)}{i_{in}(s)}$

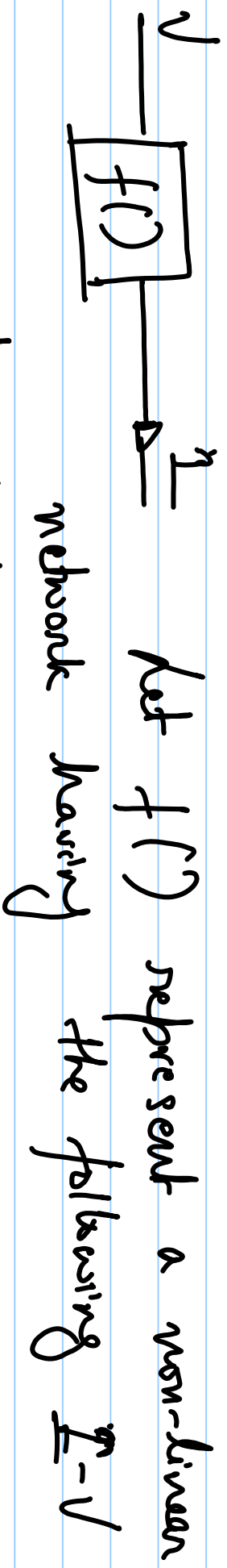
b) what are the pole and zero locations of v_o/i_{in} ?

c) what is the time-constant of the circuit?

d) Assume $R_1 = R_2 = 10k$ $C = 100pF$

- what is ω_o if $i_{in} = V_p \sin(\omega t)$
- i) $\omega_o = 1k \text{ rad/s}$
 - ii) $1M \text{ rad/s}$
 - iii) $1G \text{ rad/s}$

③



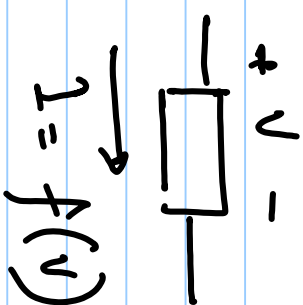
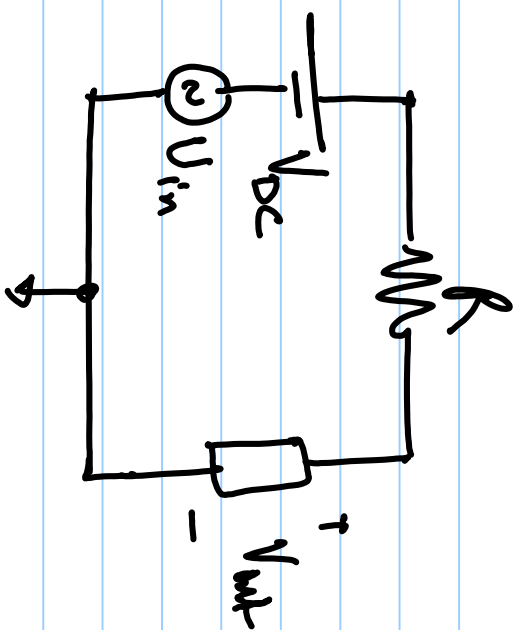
$$I = I_A \exp(V/V_A) \quad \text{where } I_A = 1 \text{ mA}$$

$$V_A = 100 \text{ mV}$$

Qf $V = V_p \sin(\omega t)$, find the frequency components of I . (Expand $f(I)$ in Taylor series and retain the first three terms).

- (b) Find the amplitude of the sinusoid @ ω_0 and $2\omega_0$. What's the ratio?
- (c) g_s this ratio independent of V_p ?
- (d) Find V_p for which the ratio = 1000:1
- (e) Find V_p for which the ratio = 10000:1

④



A non-linear element is embedded in a network as shown in the figure.

Assume $V_{dc} = 3V$, and $U_{in} = V_p \sin(\omega t)$, $R = 1k\Omega$

Find the small signal V_{out} if

$$\textcircled{a} f(x) = 2mS x + 4mA/V^2 x^2 \quad \left. \begin{array}{l} \text{for } x \gg 0 \\ \text{else } f(x) = 0 \end{array} \right\}$$

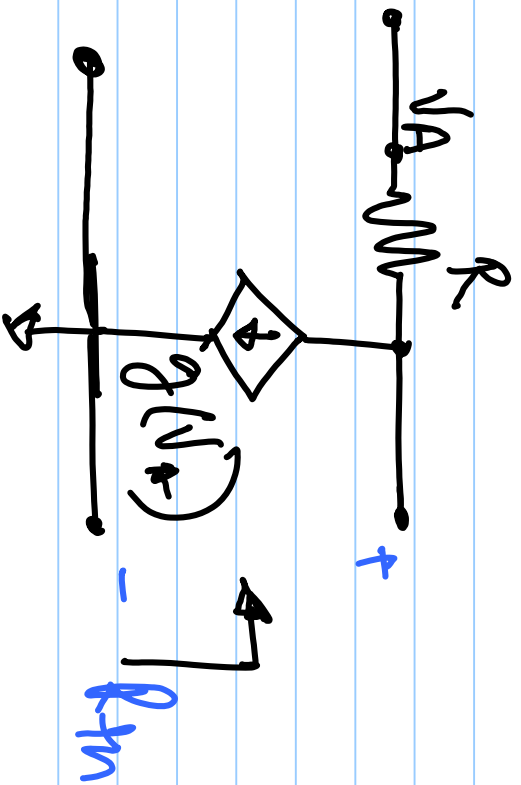
$$\textcircled{b} \quad f(x) = \lim_{s \rightarrow \infty} x + \lim_{s \rightarrow \infty} \frac{1}{s^2} x^2 + \lim_{s \rightarrow \infty} \frac{1}{s^5} x^5 \quad \text{for } x > 0$$

To find Q-point for this part you can use numerical approximations, or any trial and error method.

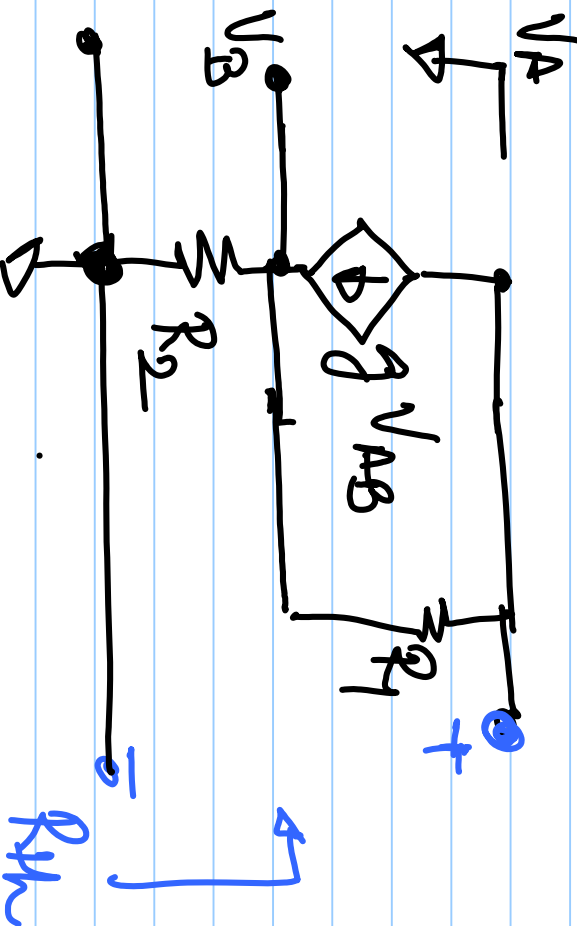
6

Find R_{th} of the following networks.

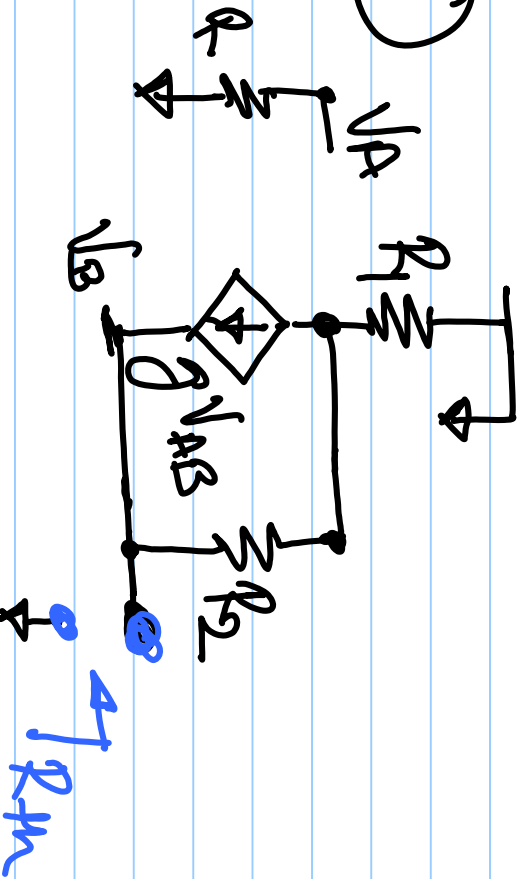
(a)



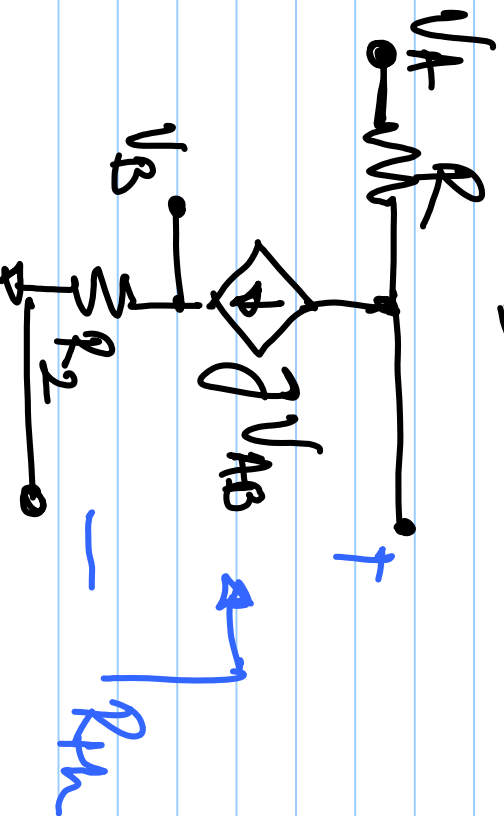
(b)

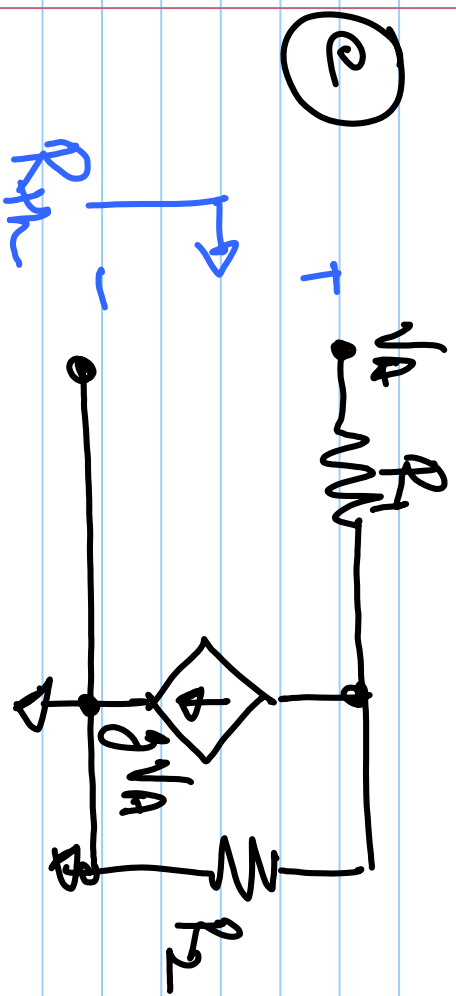


(c)



(d)



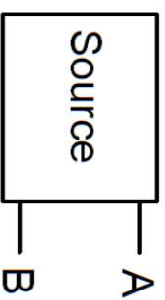


Also find R_{Th} when $R_2 \rightarrow \infty$
 Do this by making $R_2 = \infty$
 in the expression and
 also by removing R_2 from the
 figure.

- 4 For part (c), plot R_{Th} with respect to
 R_1 as R_1 varies from 0 to ∞ .
 Assume $g = 1 \text{ mS}$, $R_2 = 100 \text{ k}\Omega$.

6

You have procured a source which has two output terminals as shown in Fig . The black box which



is supposed to contain the source has the following properties. If you apply a voltmeter across A and B , it reads 10 V . If you apply an ammeter across the terminals it reads 1 A . Consider the measuring equipments to be ideal.

a) : In your opinion is the source that you procured a voltage source or a current source?

b) : Is your answer of the previous question dependent on the type of load that you want to drive? If yes, what is the constraint which will make the source behave like a voltage source, or a current source? If no, justify your answer.