1. A passive linear two-port circuit is driven by two voltage sources as shown. $\omega_1 \neq \omega_2$. A certain element within the two-port has its power quantities defined as follows:

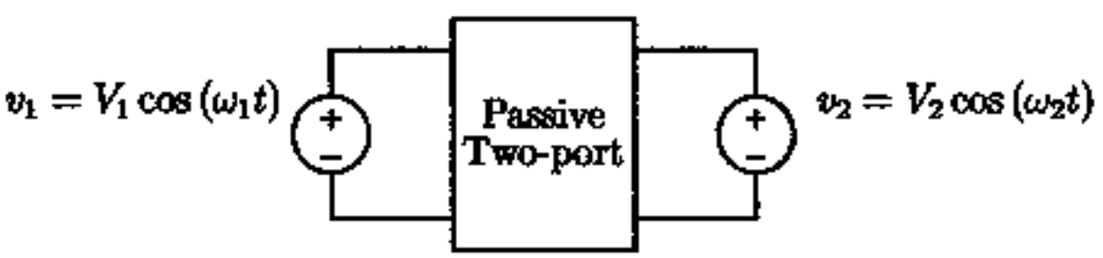
   - $P_1, p_1(t)$: the average power and instantaneous power when v_1 is active and v_2 is off.
   - $P_2, p_2(t)$: the average power and instantaneous power when v_1 is off and v_2 is active.
   - $P_{total}, p_{total}(t)$: the average power and instantaneous power when both v_1 and v_2 are active.

   Please answer the following questions:

   (a) Can the phasors of v_1 and v_2 be defined on the same phasor plane (Yes/No)? Why?

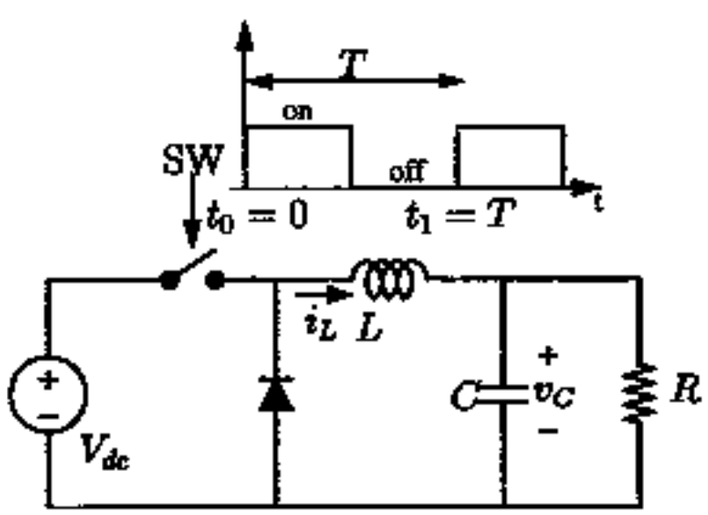
   (b) Can P_{total} be obtained by super-imposing P_1 and P_2 (Yes/No)? Prove your answer mathematically.

   (c) Can $p_{total}(t)$ be obtained by super-imposing $p_1(t)$ and $p_2(t)$ (Yes/No)? Prove your answer mathematically.



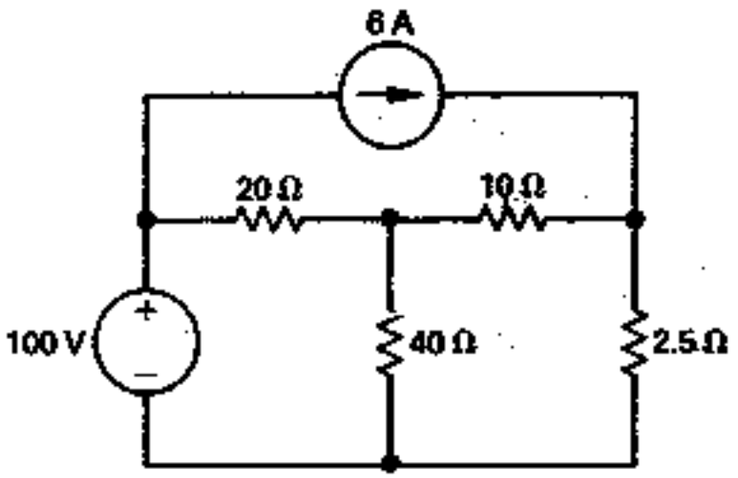
(20%)

2. Assume the switch and the diode in the given circuit are both ideal. The switch turns on and off at duty ratio of 50% as shown in the timing waveform. Please calculate and sketch $i_L(t)$ and $v_C(t)$ between t_0 and t_1. $L = 5\,\text{mH}$, $C = 500\,\mu\text{F}$, $R = 1\,\Omega$. $i_L(0) = 45\,\text{A}$, $v_C(0) = 45\,\text{V}$, $V_{dc} = 100\,\text{V}$. $f = \frac{1}{T} = 10\,\text{kHz}$.

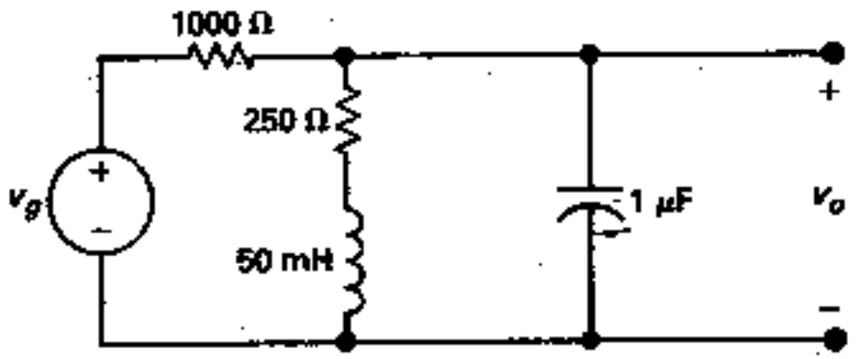


(15%)

3. Find the power dissipated in the 40 Ω resistor. (10%)



4. For the circuit shown below, (a) determine the transfer function H(s)=Vo/Vg; (b) if Vg=120cos(5000t+30°), find the steady state expression for Vo. (10%)



5. A resistive two-port network which is symmetric and reciprocal, when port 2 is opened V_1=95V and I_1=5A are measured: when port 2 is shorted V_1=11.52V and I_2=-2.72A are measured. Calculate the z-parameters of this two-port network. (10%)

6. The input voltage to an ideal bandpass filter is

$$v(t)=\begin{cases}120\ e^{-24t}\ \text{volt}, & t\geq 0\\ 0, & t<0\end{cases}$$

The filter passes all frequencies that lie between 24 and 48 rad/sec, without attenuation, and completely rejects all frequencies outside this passband. What percentage of the total 1Ω energy content of the signal at the input of the filter is available at the output?

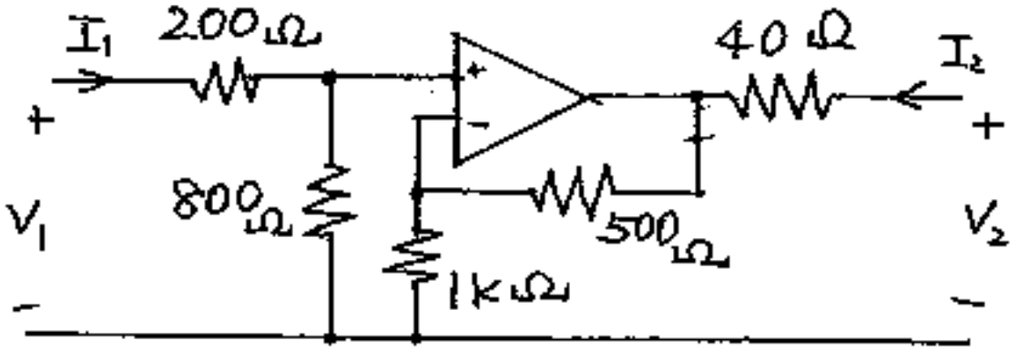
Hint : $\int \frac{1}{x^2+a^2}\,dx=\frac{1}{a}\tan^{-1}\frac{x}{a}$

$$\tan^{-1}2=\frac{\pi}{2.84}$$

$$\tan^{-1}1=\frac{\pi}{4}$$

(20%)

7. The operational amplifier in the following circuit is ideal. Find the g parameters of the circuit.



(15%)

Hint :