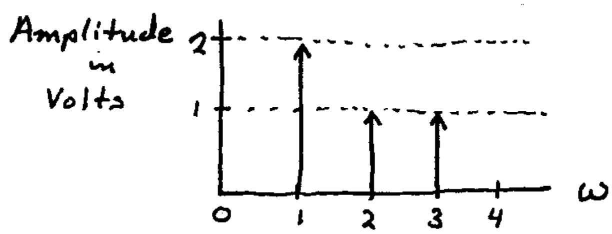
EECS 210 Sec 2 – W'01 Midterm 1 – 2/9/01

50 minutes, closed book, one 8.5"x11" crib sheet, calculator, no scratch sheets

I have neither given nor received aid on this exam, nor have I concealed any violation of the Honor Code.

Name: Solution Set

$v(t)_{in}$ is periodic in time T_{in}, exhibits odd symmetry, and is comprised of a fundamental frequency and two harmonics whose Fourier coefficients are positive and have amplitudes shown in the frequency domain representation:



1.a (5%) What is the period, T_{in}, of $v(t)_{in}$ (in seconds)?

$$\omega_o = \frac{2\pi}{T_{in}} = 1 \Rightarrow T_{in} = 2\pi = 6.28\ s$$

$F(\omega)$ is a high pass filter with a cutoff at $f_{co}= 0.25$ Hz so that all frequencies below 0.25 Hz are blocked. Frequencies above 0.25 Hz are passed without a delay in phase but with a transfer function that looks like $F(\omega)=1-e^{-\omega}$

1.b (15%) If $v(t)_{in}$ is passed through filter $F(\omega)$ and $v(t)_{out}$ is the output, write $v(t)_{out}$ as a sinusoidal series (in Volts).

$\omega=1 \Rightarrow f = \frac{1}{2\pi} = 0.16$ Hz } fundamental is blocked

$\omega=2 \Rightarrow f = \frac{2}{2\pi} = 0.32$ Hz } 2nd harmonic is passed

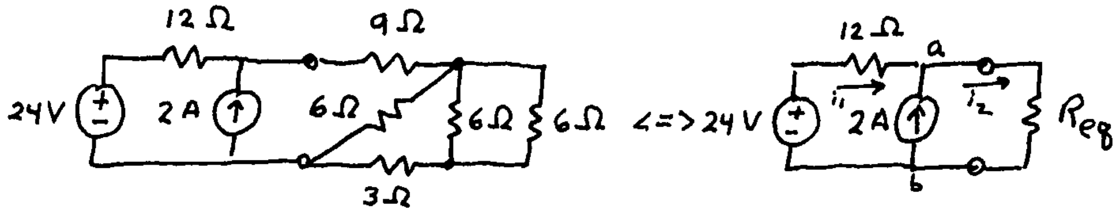
$F(2) = 1 - e^{-2} = 0.86$; $F(3) = 1 - e^{-3} = 0.95$

$$\therefore\ v(t)_{out} = 0.86 \sin 2t + 0.95 \sin 3t \ \ V$$

1.c (5%) Considering $v(t)_{out}$ as a new signal, what is its fundamental frequency (in Hz)?

My error here. I had meant to show the 3rd component at $\omega=4$ rather than at $\omega=3$. Then, for the new signal, the fundamental would have been $\omega=2$ and the 2nd harmonic would have been $\omega=4$. For this case the fundamental frequency would have been $f_o = \frac{2}{2\pi} = 0.32$ Hz

The way I drew the problem, the fundamental is $f_o = 0.16$ Hz, but it is absent in the signal. I will accept either answer.



2.a (10%) Find R_{eq} in the equivalent circuit (in ohms).

$$R_{eq} = ((6 \| 6)+3) \| 6 + 9 = (3+3) \| 6 + 9 = 6 \| 6 + 9$$

$$= 3 + 9 = 12\ \Omega$$

2.b (10%) What is the power dissipated/produced (+/-) by the current source (in Watts)?

We need v_{ab} → nodal analysis at a

$$i_1 + 2 - i_2 = 0$$

$$\frac{24 - v_a}{12} + 2 - \frac{v_a}{12} = 0$$

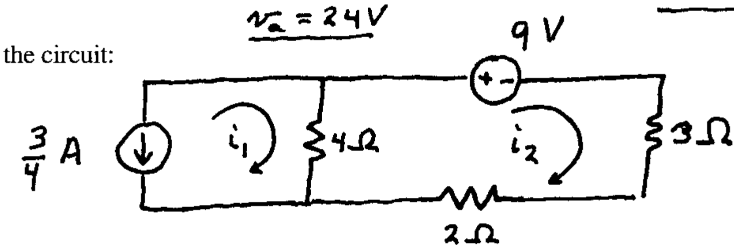
$$\Rightarrow 24 - 2v_a + 24 = 0$$

$$v_a = 24\,V$$

$\therefore P_{2A}$ = (voltage drop in direction of current) x current

$$= -24 \times 2 = -48\ W$$

For the circuit:



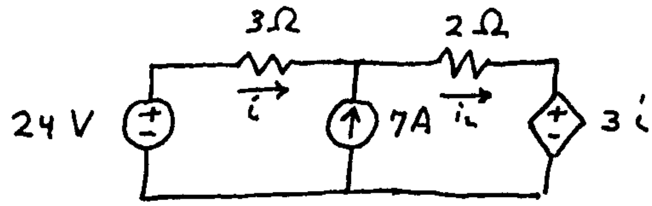
3 (15%) Use mesh-current for loop i_2 to find i_2 (in Amps).

$$-4(i_2 - i_1) - 9 - 5i_2 = 0 \quad \text{but } i_1 = -\tfrac{3}{4}$$

$$\therefore \quad -4(i_2 + \tfrac{3}{4}) - 9 - 5i_2 = 0$$

$$-9i_2 - 12 = 0$$

$$i_2 = -\frac{4}{3}\,A$$

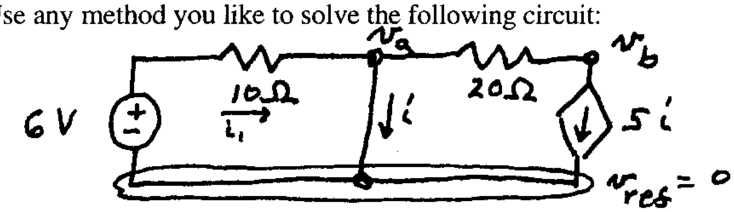


$i_2 = i + 7\ A$

4 (15%) Use KVL around the outer loop to find current i (in Amps)?

$$+24 - 3i - 2(i_2) - 3i = 0$$
$$24 - 3i - 2(i+7) - 3i = 0$$
$$8i = 24 - 14$$
$$i = \frac{5}{4}\ A$$

Use any method you like to solve the following circuit:



5.a (10%) What is the voltage v_a (in Volts)?

By observation, $v_a = v_{ref} = 0\ V$

5.b (15%) What is the voltage v_b (in Volts)?

Try nodal analysis: at a) $i_1 - i - 5i = 0$

but $i_1 = \frac{6 - v_a}{10} = \frac{6-0}{10} = \frac{3}{5}\ A$

$\therefore \quad \frac{3}{5} - i - 5i = 0$

or $i = \frac{1}{10}\ A$

Also $5i = \frac{v_a - v_b}{20} = \frac{0 - v_b}{20}$

$\Rightarrow \quad v_b = -100i = -100\left(\frac{1}{10}\right)$

$v_b = -10\ V$