Assignment - 2

EEC201 - Signals, Systems, and Networks (Monsoon 2024)

Department of Electrical Engineering, IIT (ISM) Dhanbad

Due: 24.10.2024

1. Find the Laplace Transforms of the following (attempt ANY eight):

(a) $\left(t + e^{-t} + t^2 e^{-t} + (t-4)e^{2t}\right)u(t)$ (b) $(\sin^2 t)u(t)$ (c) $\dfrac{\sin kt}{t}u(t)$

(d) $\cosh(t+\theta)u(t)$ (e) $\left(1-(1-t)e^{-3t}\right)u(t)$ (f) $|t|e^{-|t|}$

(g) $x(t) = \begin{cases} t & 0 \le t < 1 \\ e^t & t \ge 1 \\ 0 & \text{else} \end{cases}$ (h) $x(t) = \begin{cases} t-\pi & \pi \le t < 2\pi \\ 0 & \text{else} \end{cases}$ (i) $(t \sin t)\ u(t)$

(j) $x(t) = \begin{cases} 1 & 0 \le t < 2 \\ t^2 - 4t + 4 & t \ge 2 \\ 0 & \text{else} \end{cases}$ (k) $x(t) = \begin{cases} \cos(\pi t) & 0 < t < 4 \\ 0 & \text{else} \end{cases}$

2. Find the Inverse Laplace Transforms of the following (attempt ANY eight):

(a) $\dfrac{24}{s^4} - \dfrac{9}{s^2+9}$ (b) $\dfrac{8}{s^3+4s}$ (c) $\dfrac{1+e^{-2s}}{s^2+6}$ (d) $\dfrac{2s+3}{s^2+4s+13}$

(e) $\dfrac{1}{(s+1)(s^2-1)}$ (f) $\dfrac{s^2-2s}{s^4+5s^2+4}$ (g) $\dfrac{e^{-3s}}{s-2}$ (h) $\dfrac{5(s+2)^2}{s(s+1)^3}$

(i) $\dfrac{2s+5}{s^2+5s+6}e^{-2s}$ (j) $\dfrac{s}{(s-3)^5}$ (k) $\dfrac{3+e^{-(s-1)}}{s^2-2s+5}$ (l) $\dfrac{9+s}{4-s^2}$

3. Verify the Initial value theorem and the Final value theorem for the following (attempt all):

(a) $e^{-t}(t+2)^2\ u(t)$ (b) $(1+e^{-t}(\sin t + \cos t))\ u(t)$

(c) $t^2 e^{-3t}\ u(t)$ (d) $u(t-T)$

4. Solve the following differential equations (attempt ANY six):

(a) $y' + 3y = t^2 e^{-3t} + te^{-2t} + t$ with $y(0) = 1$

(b) $y'' + 4y = 0$ with $y(0) = 1$, $y'(0) = 6$

(c) $y'' + 4y' + 8y = e^{-t}$ with $y(0) = y'(0) = 0$

(d) $y''' - y' = 2$ with $y(0) = y'(0) = y''(0) = 4$

(e) $y'' + 2y' + 5y = 0$ with $y(0) = 2$, $y'(0) = 0$

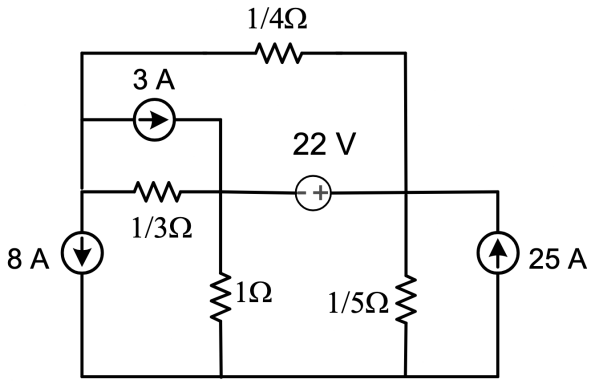
(f) $y'' + 4y' + 3y = 10\cos(t)$ with $y(0) = 1$, $y'(0) = 2$

(g) $y'' + 4y' + 4y = 3te^{-2t}$ with $y(0) = 0$, $y'(0) = 1$

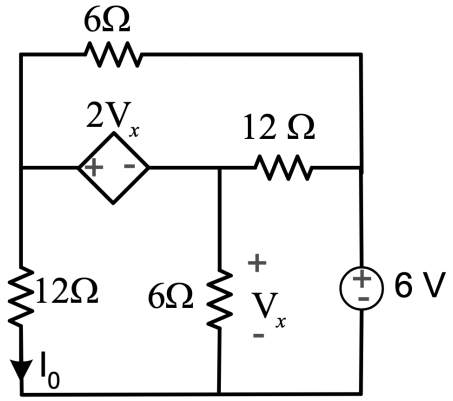
(h) $y'''' + y = 0$ with $y(0) = y'(0) = y''(0) = y'''(0) = 1$

5. Using KCL/KVL and Nodal/Mesh Analysis, answer the following (attempt ANY twenty):

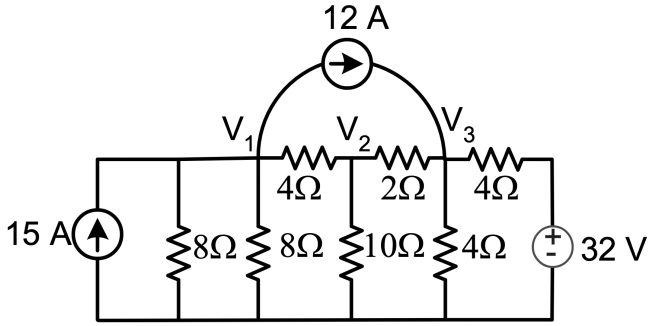
(a) What are the node voltages in this circuit?



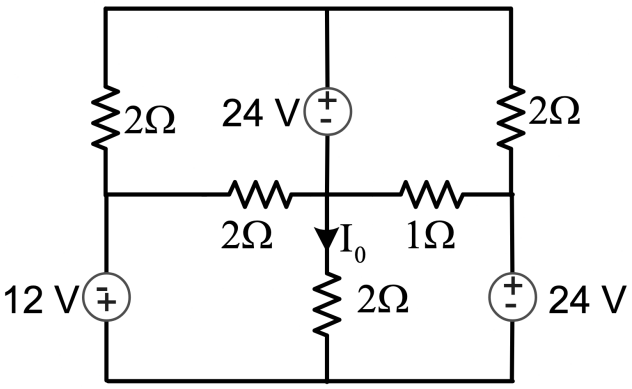
(b) Calculate the node voltages and the current I_0 in the circuit below:



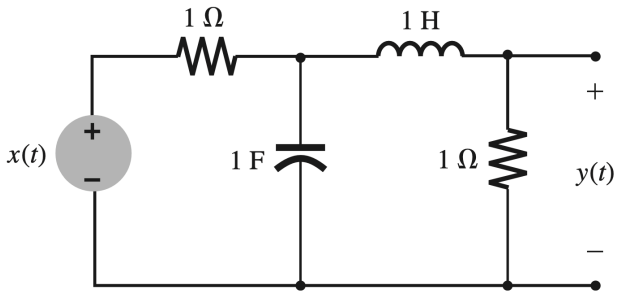
(c) What is the power dissipated by the 10 Ohm resistor?



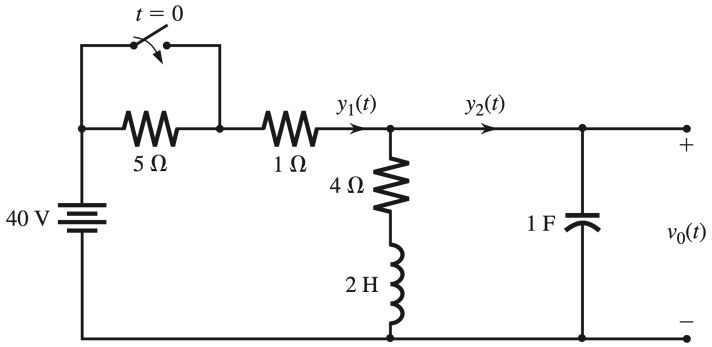
(d) Calculate the current I_0 in the circuit:



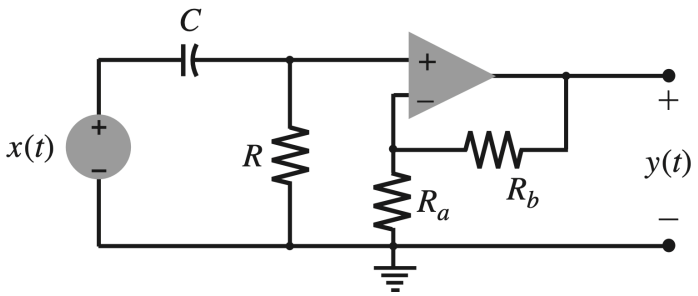
(e) If $x(t) = te^{-t}u(t)$, calculate $y(t)$:



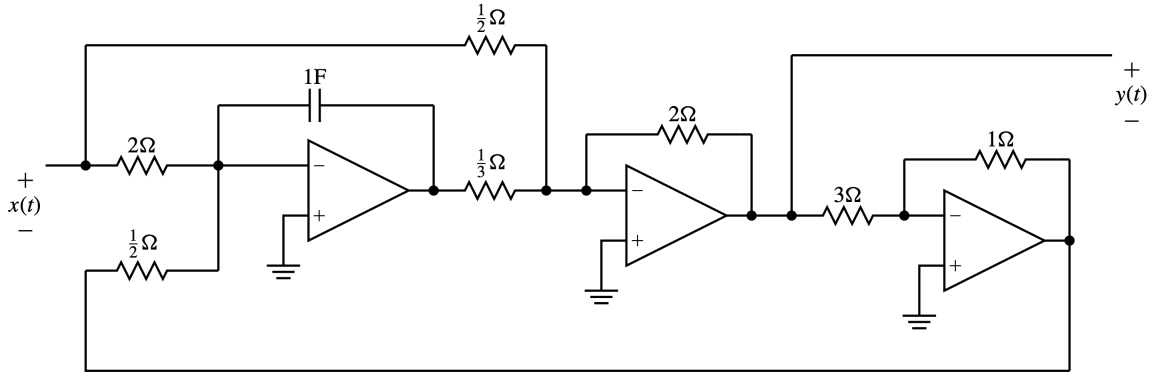
(f) If the switch is open for a long time and suddenly closed at $t = 0$, calculate $y_1(t)$ and $y_2(t)$:



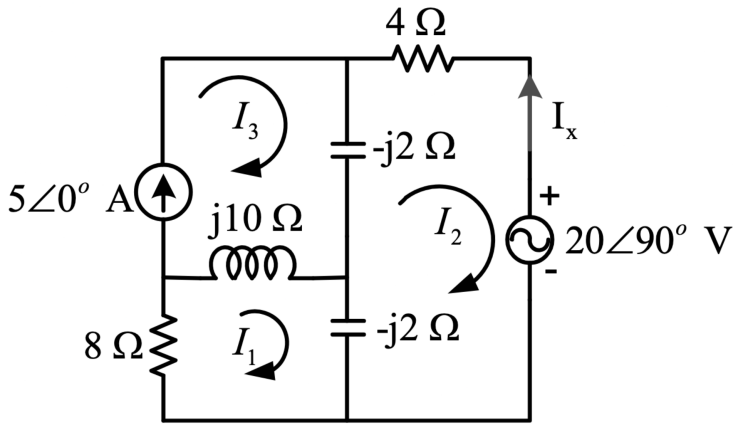
(g) What is the transfer function of this circuit?



(h) What is the transfer function of this circuit?

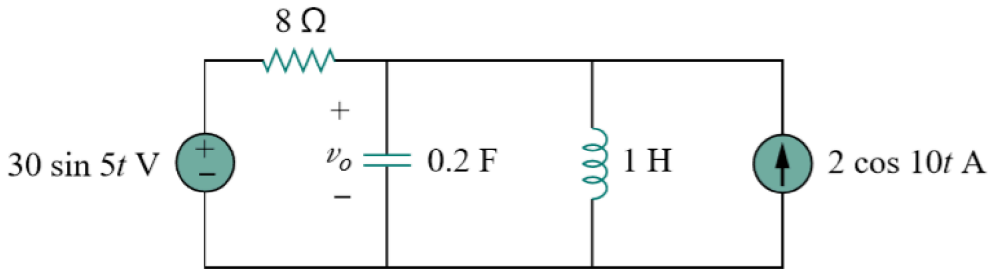


(i) What is the current I_x flowing out of the voltage source?

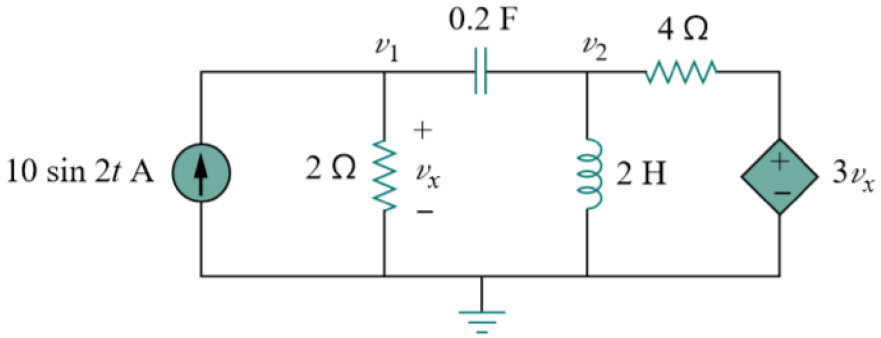


(j) What is the voltage $v_0(t)$ across the capacitor?

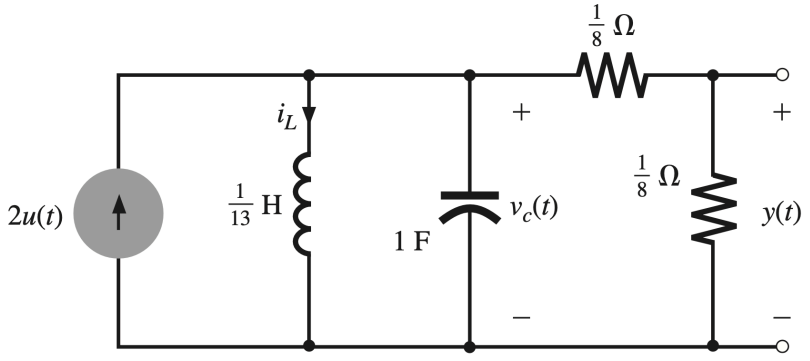
(Hint: Convert the circuit to phasor domain, solve the equations and convert back to the time domain)



(k) What are the node voltages $v_1(t)$ and $v_2(t)$?

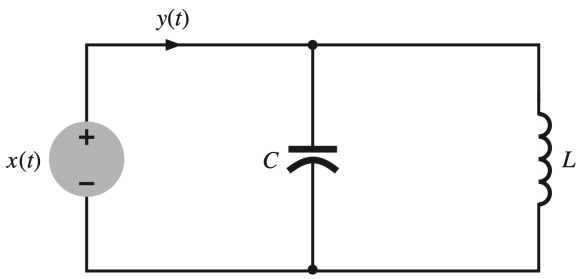


(l) If $i_L(0^-) = 1A$ and $v_C(0^-) = 3V$, calculate the voltage $y(t)$ for $t \geq 0$.

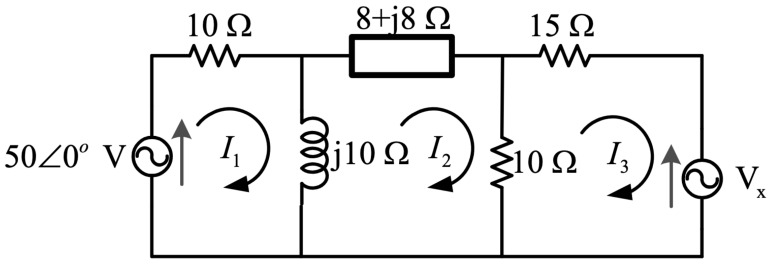


(m) Assuming zero initial conditions and $\omega_0^2 = \dfrac{1}{LC}$, calculate the current $y(t)$ if

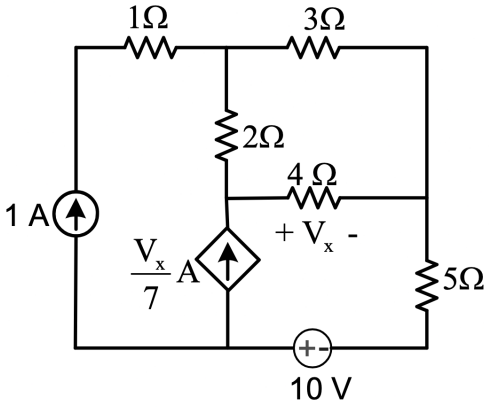
$$x(t) = (A \sin \omega_0 t + B \cos \omega_0 t)u(t)$$



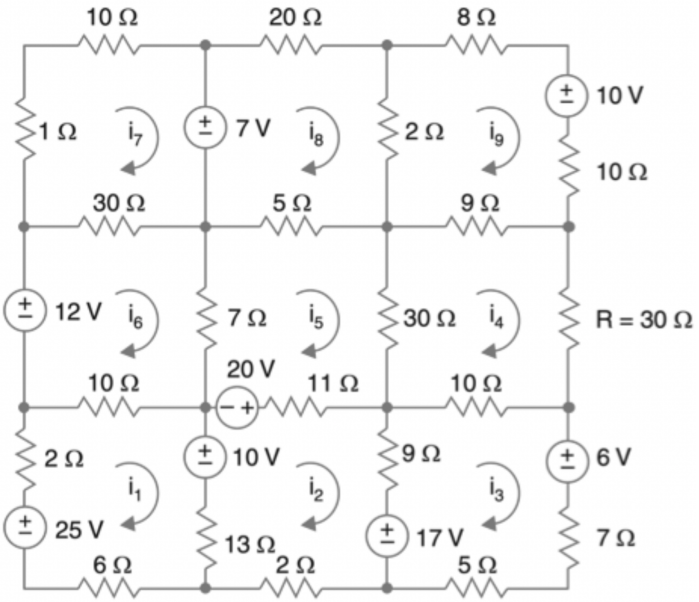
(n) What should be the value of V_x so that no current flows through the impedance $8 + 8j$?



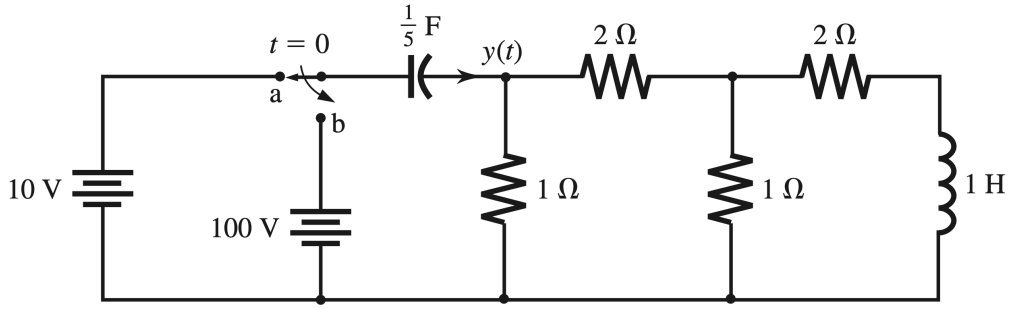
(o) What is the power dissipated or supplied by the voltage source?



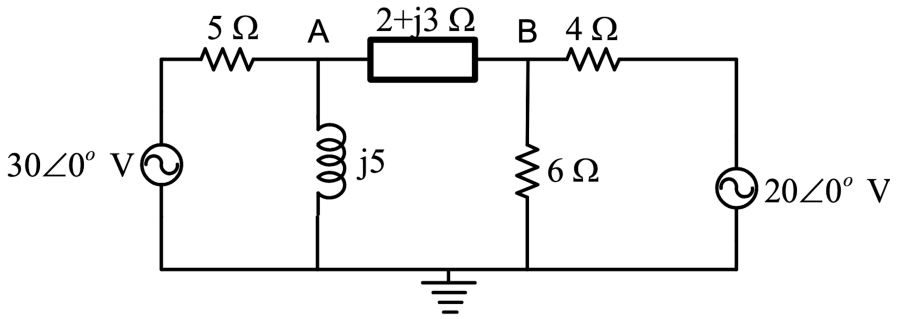
(p) What is the power dissipated by the 30 Ohm resistor?



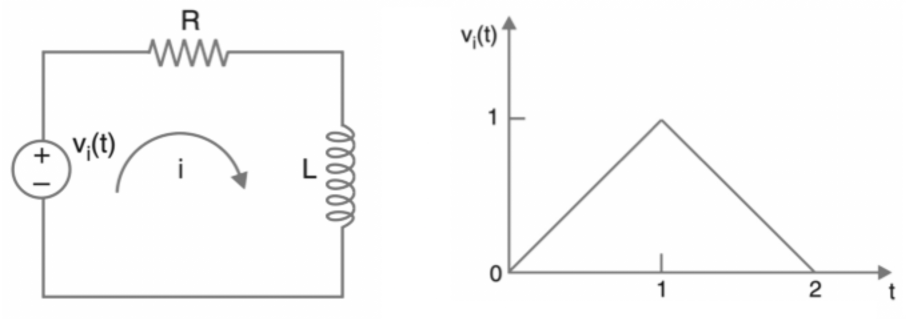
(q) If the switch is at "a" for a long time and suddenly moved to "b" at $t = 0$, calculate $y(t)$:



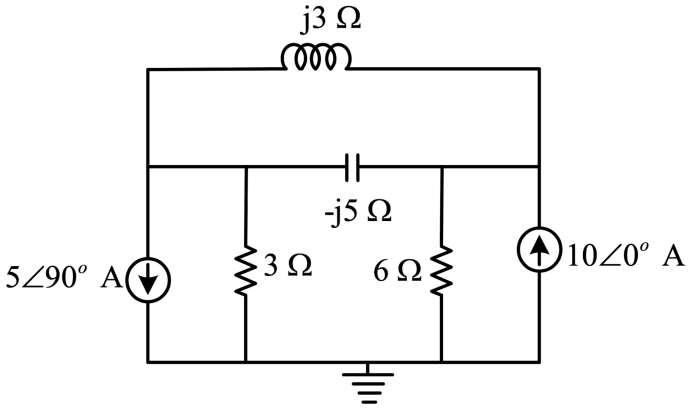
(r) What is the current flowing through the 6 Ohm resistor?



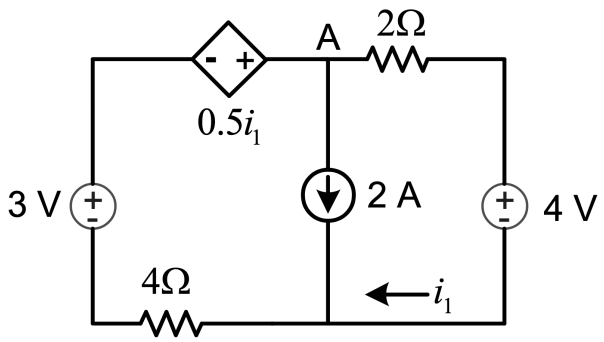
(s) Assuming zero initial conditions and R = 2 Ohms and L = 2 H, calculate the current $i(t)$ in the circuit:



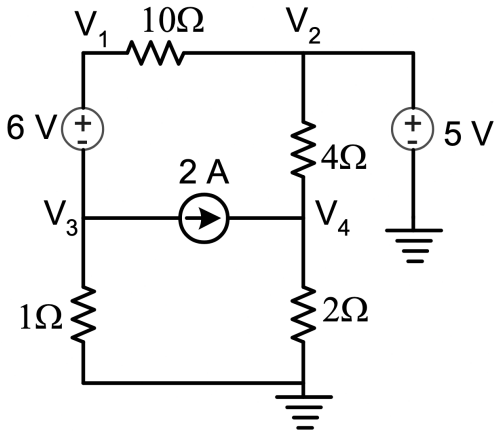
(t) What is the voltage across the 6 Ohm resistor?



(u) Calculate the current flowing through the 4 Ohm resistor:



(v) Calculate all the node voltages in the circuit below:



(w) Calculate the current *i* in the circuit below: