1. (20%) Consider the circuit shown in Fig P1.

(a) (10%)Let $v_s(t) = u(t)$. Find **the forced steady-state expression for** $v_C(\infty)$ in terms of L, $R_1$, $R_2$, and C.

(b) (10%)Consider **the natural response** of the circuit. Let L=1H, $R_1$=10Ω, $R_2$=10Ω, and C=0.1F. Would the natural response of the circuit be **overdamped**, **critically-damped**, or **underdamped**? Please **explain** your answers clearly. (hint: derive the characteristic equation for the differential equation in (2).)

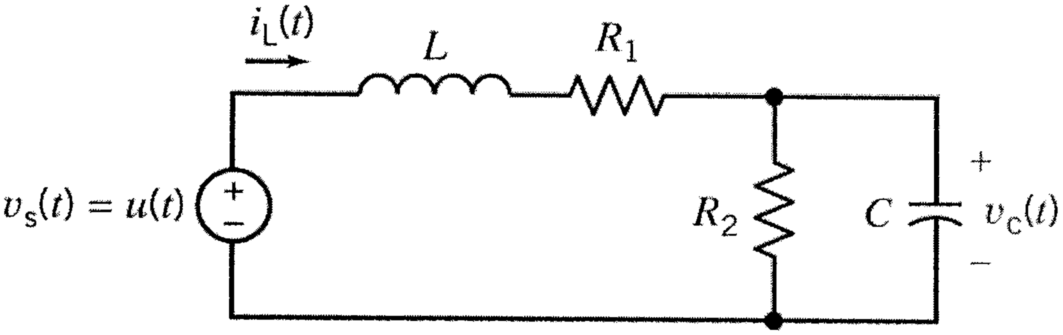


**Fig. P1**

2. (10%) Consider the Opamp circuit in Fig.P2. Assume the Opamp is ideal. Let $v_s(t) = \cos(wt)$. If $w$ is decreased, the **votage gain** $|v_o(t)/v_s(t)|$ will **increase** or **decrease**? Please **explain** your answer clearly.
(hint: represent L=sL and C=1/sC to derive the transfer function $|v_o(s)/v_s(s)|$)

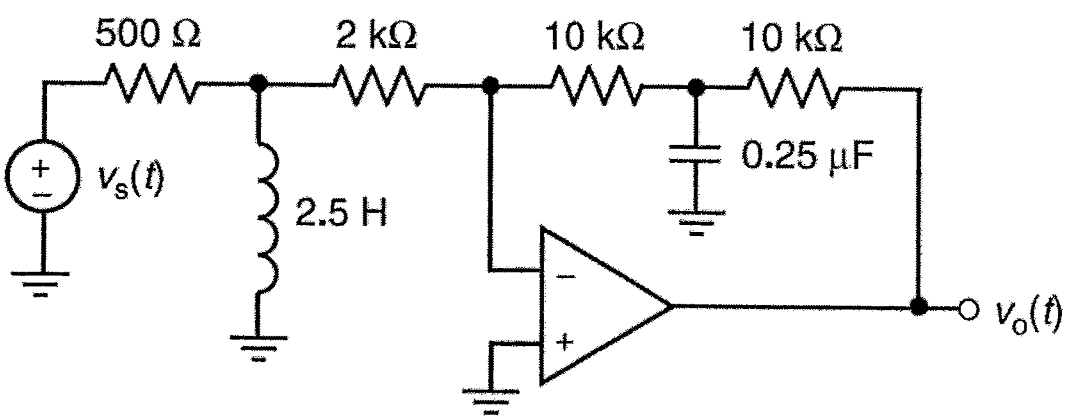


**Fig. P2**

3. (10%)

(a) (5%) Set node $a$ as the reference ground. Also, set the node voltage of node b as $v_b$, the node voltage of node c as $v_c$, and the node voltage of node d as $v_d$. Use node method and write a complete set of equations that solve the node voltages $v_b$, $v_c$, and $v_d$.

(b) (5%) Set node $a$ as the reference ground. For $R_1$=1Ω, $R_2$=2Ω, $R_3$=3Ω, $R_4$=4Ω, $R_5$=8Ω, and $I$=10mA, find all the node voltages and the branch current $i$ as shown in the figure.

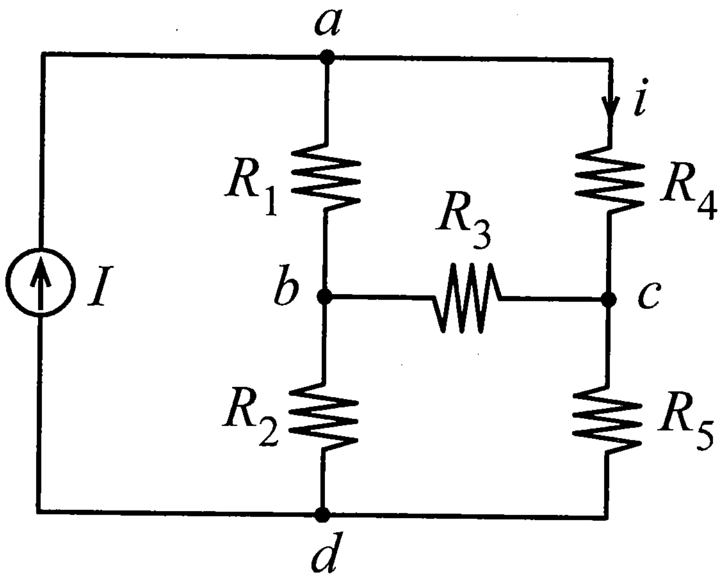


Fig. P3

4. (10%)

(a) (5%) Find the Thevenin equivalent circuit for the following network.

(b) (5%) Write the equation that expresses $i$ as a function of $v$.

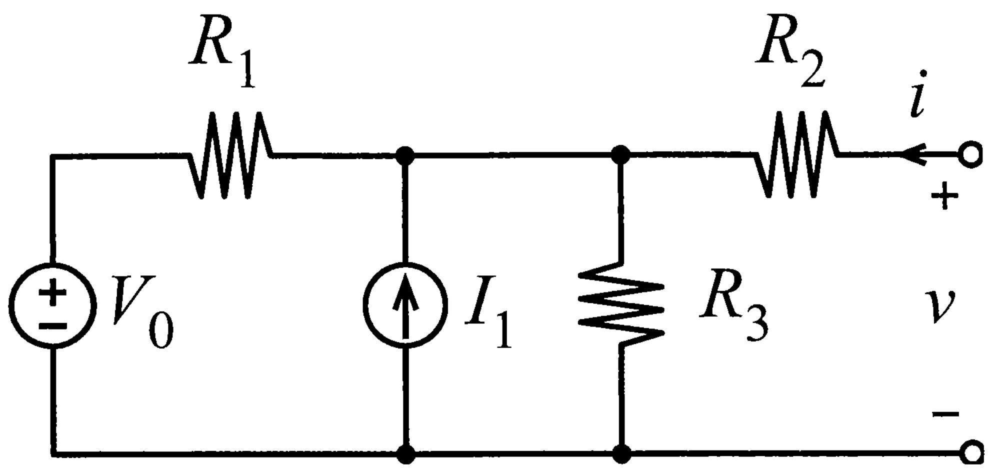


Fig. P4

5.(10%) For the opamp in the following circuit, $v_O = A(v_+ - v_-)$. Find $v_{OUT}$ and $i_{OUT}$ in terms of $v_{IN}$, $A$, $R_1$, and $R_2$.

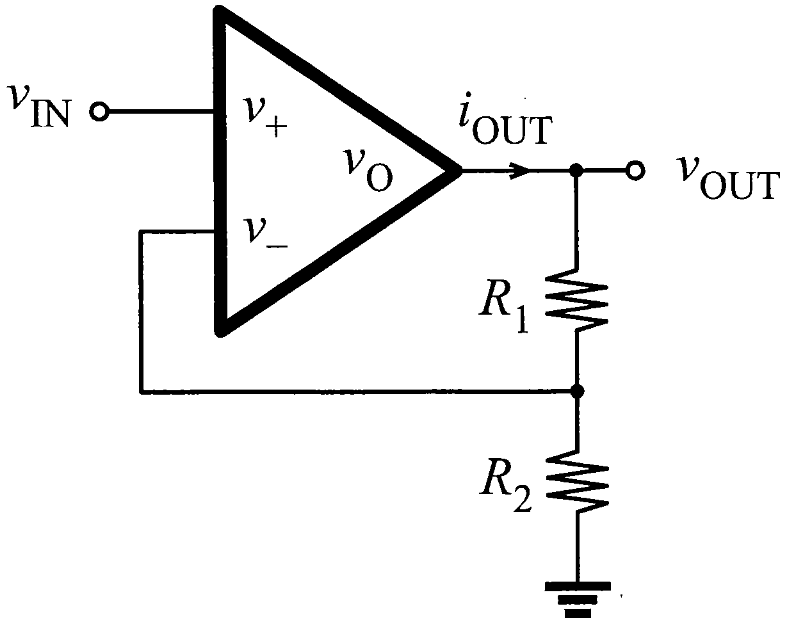


Fig. P5

6.(10%) Use superposition to find the steady-state current $i(t)$ for R = 10 Ohm, L = 200 mH, $v_{s1} = 24\cos(20000t)V, v_{s2} = 8\cos(60000t + 30°)V$.

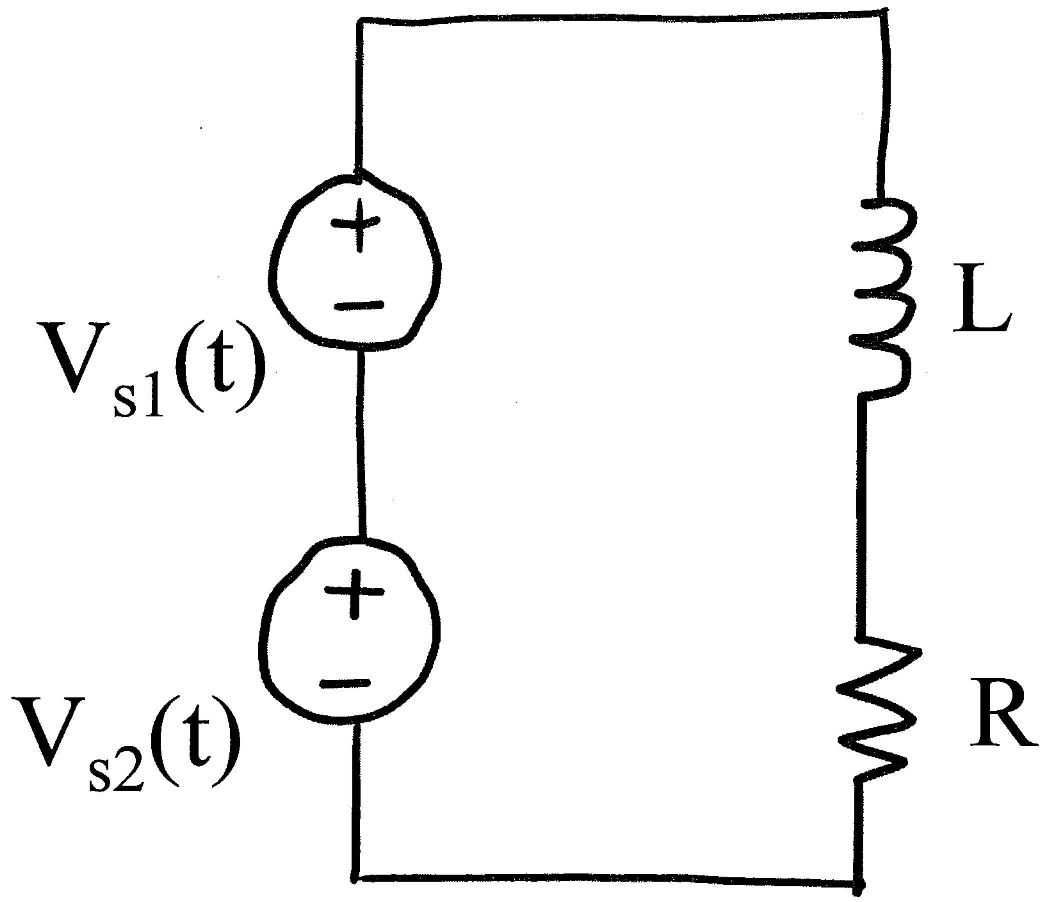


Fig. P6

7.(10%)A 240-V rms 60-Hz supply serves a load that is 10 kW (resistive), 15 kVAR (capacitive), and 22 kVAR (inductive). Find:

(a) the apparent power

(b) the current drawn from the supply

(c) the kVAR rating and capacitance required to improve the power factor to 0.96 lagging

(d) the current drawn from the supply under the new power-factor conditions

8.(10%)

(a) (3%) Draw the circuit topology of an isolated flyback converter.

(b)(7%) This isolated flyback converter operates in the continuous conduction mode with a duty ratio D in PWM control. Use the volt-second balance principle to find the relationship between the input voltage and output voltage.

9.(10%)

(a)(3%) Draw the circuit topology of a buck converter.

(b)(7%) This buck converter operates in PWM control with a duty ratio D. Find the minimum inductance in the boundary condition between the continuous conduction mode and the discontinuous conduction mode.