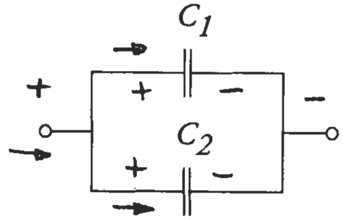
1. (a)



The voltage across C_1 is the same as the voltage across the terminals, so

$$v_1 = v$$

Likewise,

$$v_2 = v$$

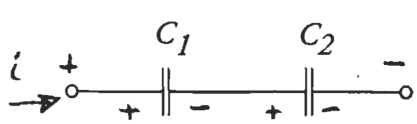
The total current into the + terminal is

$$\begin{aligned} i &= i_1 + i_2 \\ &= C_1 \frac{dv_1}{dt} + C_2 \frac{dv_2}{dt} \\ &= C_1 \frac{dv}{dt} + C_2 \frac{dv}{dt} \\ &= (C_1 + C_2) \frac{dv}{dt} \end{aligned}$$

Therefore, the equivalent capacitance is

$$\boxed{C = C_1 + C_2}$$

(b)



For the series connection,

$$i_1 = i_2 = i$$

Because the capacitors are in series,

$$v = v_1 + v_2$$

$$\Rightarrow \quad \dot{v} = \dot{v}_1 + \dot{v}_2$$

$$= \frac{i_1}{C_1} + \frac{i_2}{C_2}$$

$$= \frac{i}{C_1} + \frac{i}{C_2}$$

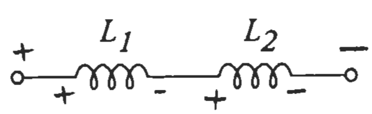
Therefore,

$$i = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1} v$$

$$= \frac{C_1 C_2}{C_1 + C_2} v$$

$$\Rightarrow \quad \boxed{C = \frac{C_1 C_2}{C_1 + C_2}}$$ is the equivalent capacitance

(c)



Because the inductors are in series,

$$i = i_1 = i_2$$

$$v = v_1 + v_2$$

$$= L_1 \frac{di_1}{dt} + L_2 \frac{di_2}{dt}$$

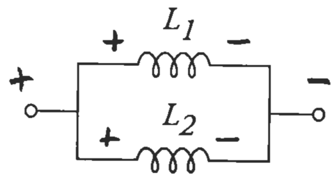
$$= L_1 \frac{di}{dt} + L_2 \frac{di}{dt}$$

$$= (L_1 + L_2) \frac{di}{dt}$$

Therefore, the equivalent inductance is

$$\boxed{L = L_1 + L_2}$$

(d)



Because the inductors are in parallel,

$$v = v_1 = v_2$$

$$i = i_1 + i_2$$

$$\Rightarrow \frac{di}{dt} = \frac{di_1}{dt} + \frac{di_2}{dt}$$

$$= \frac{1}{L_1} v_1 + \frac{1}{L_2} v_2$$

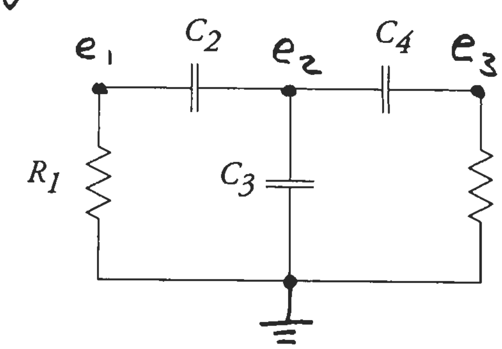
$$= \frac{1}{L_1} v + \frac{1}{L_2} v$$

$$= \left(\frac{1}{L_1} + \frac{1}{L_2} \right) v$$

Therefore, the equivalent inductance is

$$\boxed{L = \left(\frac{1}{L_1} + \frac{1}{L_2} \right)^{-1} = \frac{L_1 L_2}{L_1 + L_2}}$$

2. One way to label the nodes is:



Then the node equations are

$$e_1: \left(C_2 \frac{d}{dt} + G_1\right) e_1 - C_2 \frac{d}{dt} e_2 = 0$$

$$e_2: -C_2 \frac{d}{dt} e_1 + \left(C_2 \frac{d}{dt} + C_3 \frac{d}{dt} + C_5 \frac{d}{dt}\right) e_2 - C_4 \frac{d}{dt} e_3 = 0$$

$$e_3: -C_4 \frac{d}{dt} e_2 + \left(C_4 \frac{d}{dt} + G_5\right) e_3 = 0$$

Plugging in component values,

$$\left(2 \frac{d}{dt} + 1\right) e_1 - 2 \frac{d}{dt} e_2 = 0$$

$$-2 \frac{d}{dt} e_1 + 8 \frac{d}{dt} e_2 - 4 \frac{d}{dt} e_3 = 0$$

$$-4 \frac{d}{dt} e_2 + \left(4 \frac{d}{dt} + 0.2\right) e_3 = 0$$