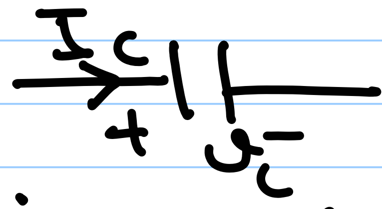
Lecture 17

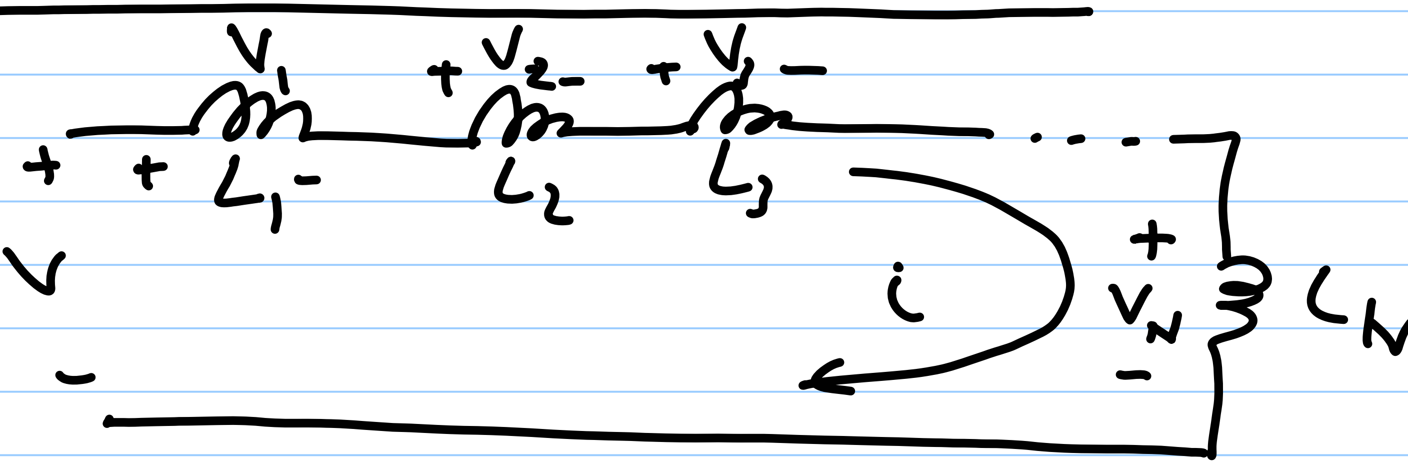
From section 6.3 of Textbook

Solve E6.6-E6.8, 6.46, 6.47, 6.50, 6.56, 6.60, 6.64, 6.66, 6.71

Capacitors vs. Inductors

Capacitors	Inductors
	
$i_c = C \frac{dv_c}{dt}$	$i_L = \frac{1}{L}\int_{-\infty}^{t} v_\ell(\tau)\, d\tau$
$v_c(t) = \frac{1}{C}\int_{-\infty}^{t} i_c(\tau)\, d\tau$	$v_L(t) = L \frac{di_L}{dt}$
Voltage is continuous	Current is continuous
O.C. at DC	S.C. at DC
$W_c(t) = \frac{1}{2} C V_c^2(t)$	$W_L(t) = \frac{1}{2} L\, i_\ell^2(t)$

Connections of Inductors



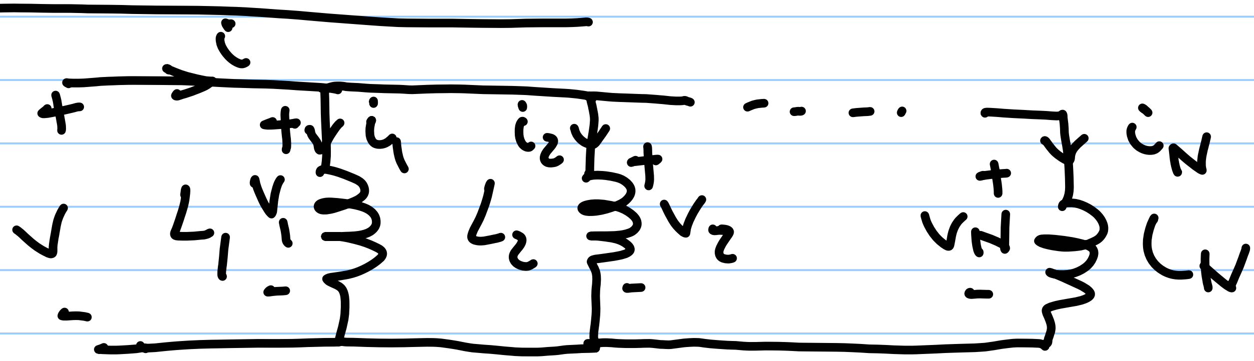
$$V = V_1 + V_2 + \cdots + V_N$$

$$V = L_1 \frac{di}{dt} + L_2 \frac{di}{dt} + \cdots + L_N \frac{di}{dt}$$

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

$$V = L_{eq} \frac{di}{dt}$$ $\Rightarrow$ One equivalent Inductor

Parallel Inductors



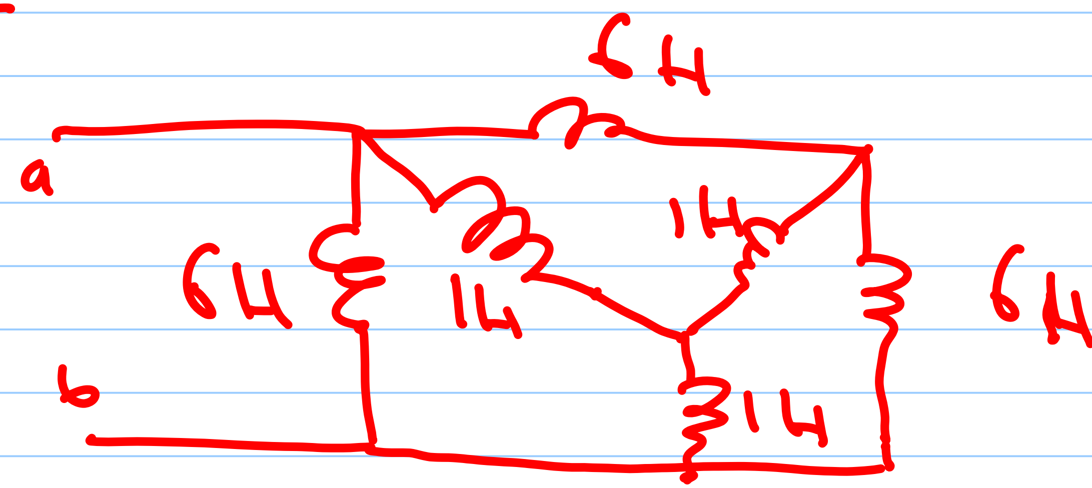
$$i = i_1 + i_2 + \cdots + i_N$$

$$i = \frac{1}{L_1}\int_{-\infty}^{t} v_1(\tau)\,d\tau + \frac{1}{L_2}\int_{-\infty}^{t} v_2(\tau)\,d\tau + \cdots + \frac{1}{L_N}\int_{-\infty}^{t} v_N(\tau)$$

$$i = \left(\frac{1}{L_1} + \frac{1}{L_2} + \cdots + \frac{1}{L_N}\right)\int_{-\infty}^{t} v(\tau)\,d\tau$$

$$i = \frac{1}{L_{eq}}\int_{-\infty}^{t} v(\tau)\,d\tau \Rightarrow$$ one equivalent Inductor

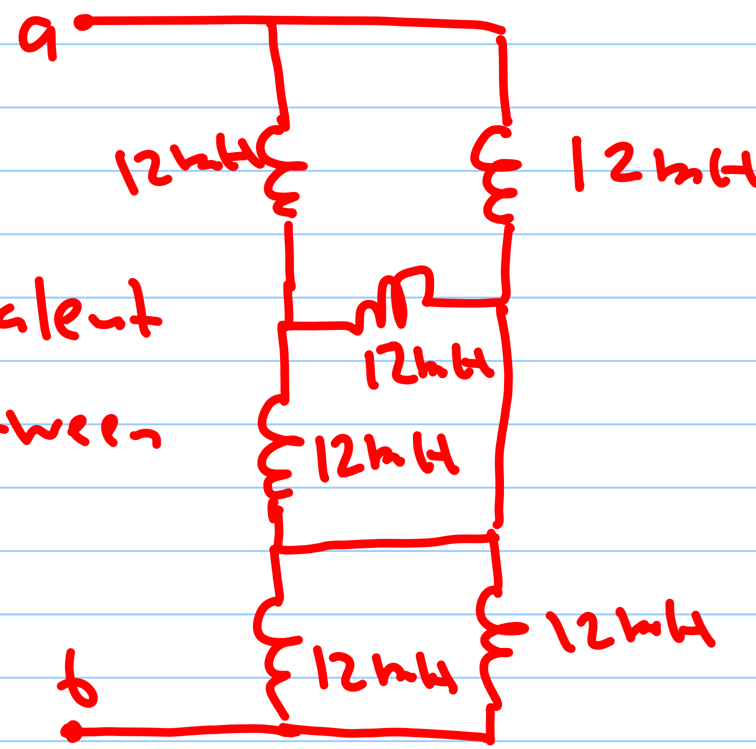
Example



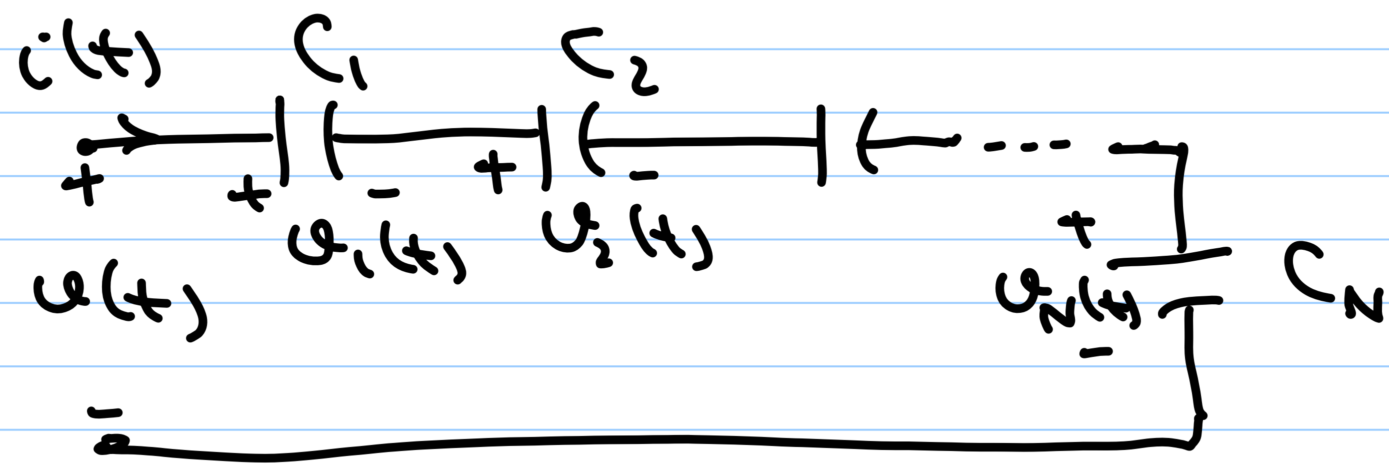
Find the equivalent inductance at the terminals ab.

Example

Find the equivalent Inductance between terminals a and b



Capacitors in series



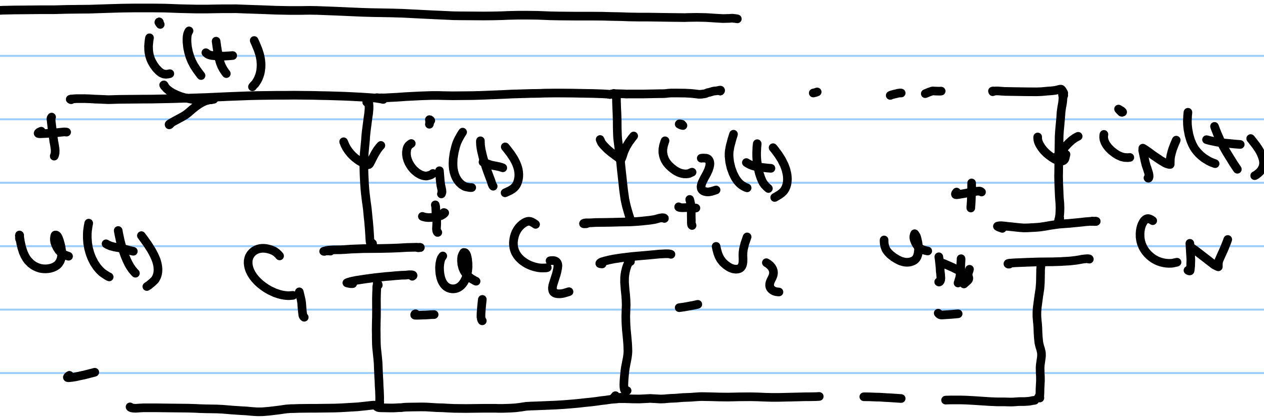
$$v(t) = v_1(t) + v_2(t) + \cdots + v_N(t)$$

$$v(t) = \frac{1}{C_1}\int_{-\infty}^{t} i_1(\tau)\,d\tau + \cdots + \frac{1}{C_N}\int_{-\infty}^{t} i_N(\tau)\,d\tau$$

$$v(t) = \left(\frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_N}\right)\int_{-\infty}^{t} i(\tau)\,d\tau$$

$$v(t) = \frac{1}{C_{eq}}\int_{-\infty}^{t} i(\tau)\,d\tau \Rightarrow$$ one equivalent capacitor

Capacitors in Parallel



$$i(t) = i_1(t) + i_2(t) + \cdots + i_N(t)$$

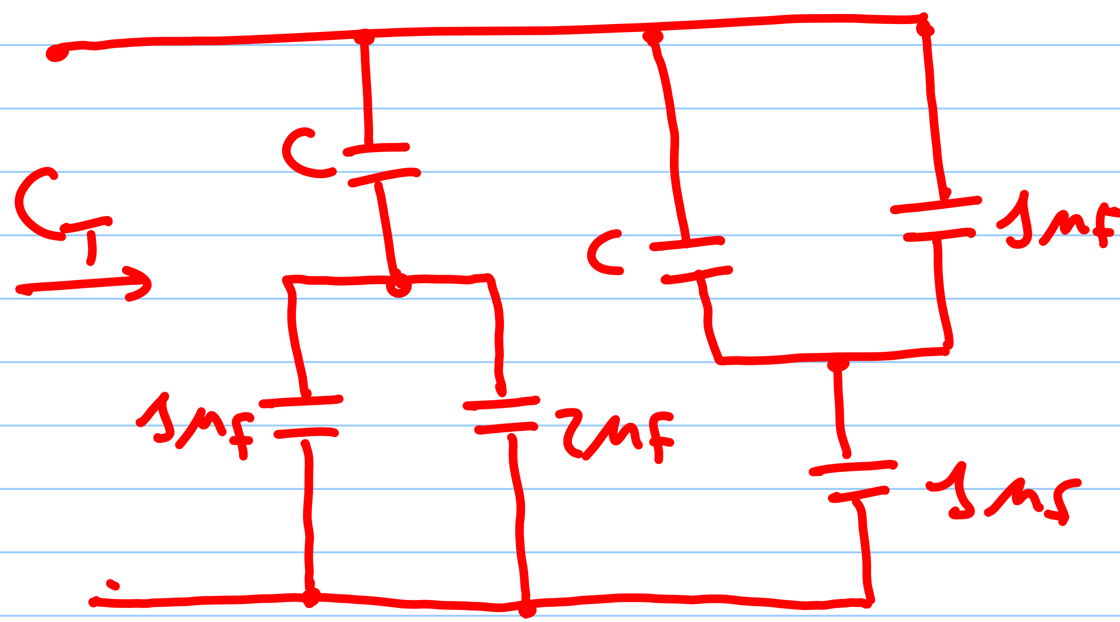
$$i(t) = C_1 \frac{dv_1}{dt} + C_2 \frac{dv_2}{dt} + \cdots + C_N \frac{dv_N}{dt}$$

$$i(t) = (C_1 + C_2 + \cdots + C_N) \frac{dv_N(t)}{dt}$$

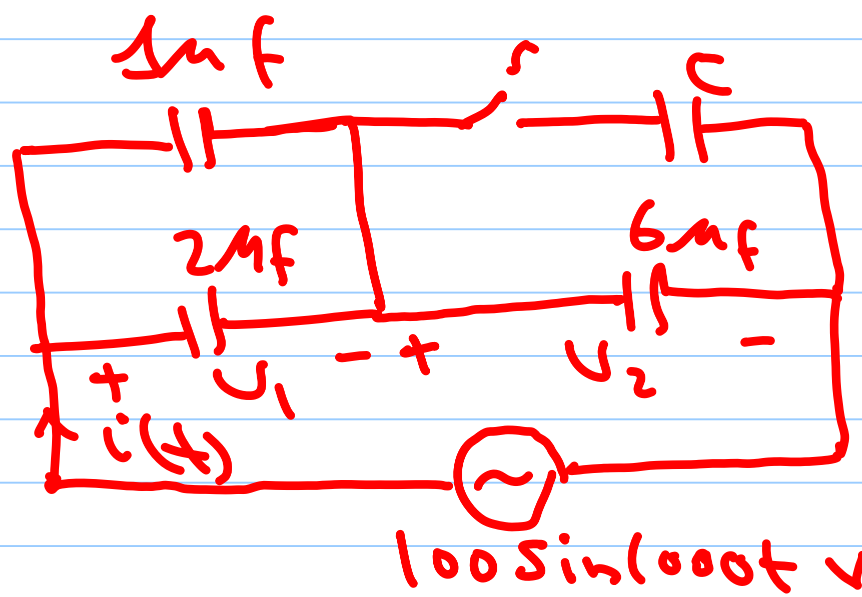
$$i(t) = C_{eq} \frac{dv_N(t)}{dt}$$ ⟹ one equivalent capacitor

Example

Select the value of C such that $C_T = 1nF$



Example



For the circuit shown determine $v_1(t)$ and $v_2(t)$ with s open.

If s is closed find C such that the current $i(t)$ has a peak of 0.25A.