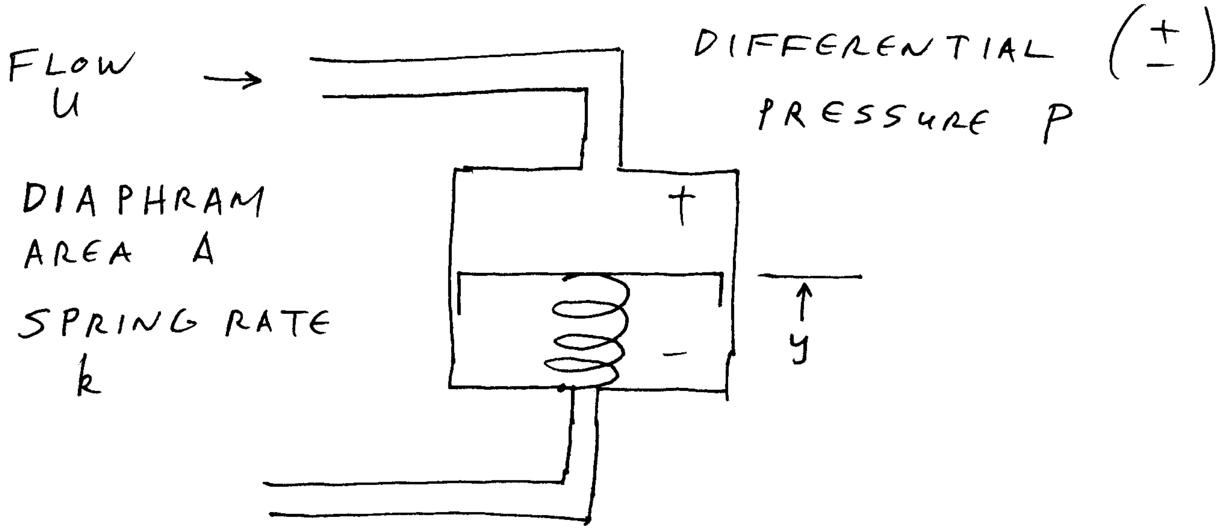
INDUCTOR (L) AND CAPACITOR (C)

2-PORT HYDRAULIC ACCUMULATOR



$$F = ky \qquad P = \frac{F}{A}$$

$$y = \frac{\Delta Vol}{A} \qquad \Delta Vol = \int U\,dt$$

SO

$$P = \frac{k}{A^2}\int U\,dt$$

$$U = \frac{A^2}{k}\frac{dP}{dt} = C\frac{dP}{dt}$$

FOR $C = \frac{A^2}{k}$ BIG A, SOFT SPRING, BIG C

2-PORT ELECTRIC ACCUMULATOR

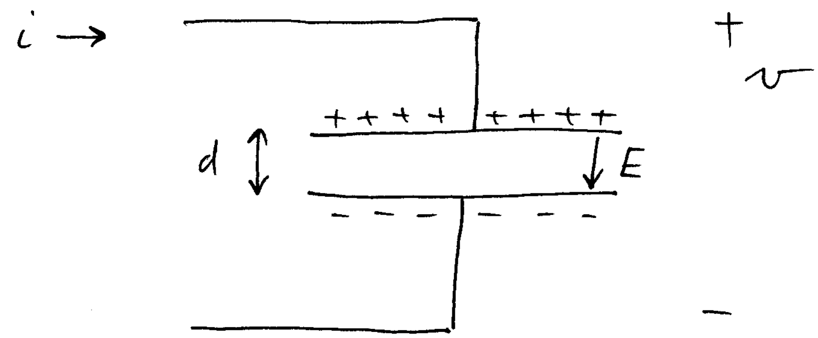


PLATE AREA A

PLATE SEPARA[TION] d

CHARGE Q

CHARGE DENSITY $\rho = \dfrac{Q}{A}$

$$E = \frac{1}{\varepsilon}\rho \qquad v = Ed$$

SO $$v = Ed = \frac{1}{\varepsilon}\frac{Q}{A}d$$

$$Q = \int i\,dt$$

$$v = \frac{1}{C}\int i\,dt$$

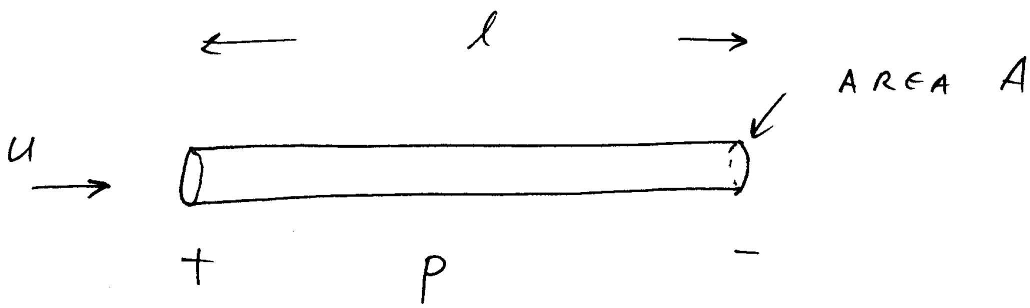
$$i = C\frac{dv}{dt}$$

$$C = \frac{\varepsilon A}{d}$$

FOR BIG C, NEED BIG ε, A

SMALL d

HYDRAULIC INERTIA



FLUID DENSITY ρ

$$F = m \frac{dv}{dt} \qquad v = \frac{u}{A}$$

$$m = \rho l A$$

$$p = \frac{F}{A}$$

SO

$$F = m \frac{dv}{dt}$$

$$p = \frac{m}{A} \frac{dv}{dt}$$

$$p = \rho l \frac{d}{dt} \frac{u}{A}$$

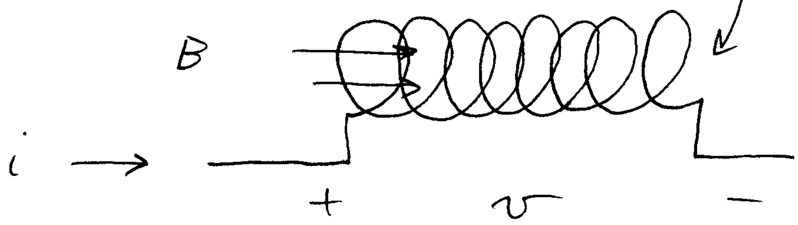
$$= \frac{\rho l}{A} \frac{d}{dt} u$$

$$p = L \frac{d}{dt} u \qquad L = \frac{\rho l}{A}$$

$$u = \frac{1}{L} \int p\, dt$$

BIG L NEEDS BIG ρ, LONG TUBE, NARROW TUBE

MAGNETIC INERTIA



B : MAGNETIC FIELD

$\phi = B \cdot A$ MAGNETIC FLUX

$\phi = N \cdot i \cdot \mu \frac{A}{\ell}$ N : TURNS OF WIRE

μ MAGNETIC PERMEABILITY

FARADAY LAW OF MAGNETIC INDUCTION

$$v = N \frac{d\phi}{dt}$$

$$= N^2 \mu \frac{A}{\ell} \frac{di}{dt}$$

$$v = L \frac{di}{dt} \qquad L = N^2 \mu \frac{A}{\ell}$$

BIG L MANY TURNS N
HIGH μ (IRON)
LARGE, SQUAT COIL

ALSO $i = \frac{1}{L} \int v \, dt$

INDUCTOR

$$v = L \frac{di}{dt} \qquad i = \frac{1}{L}\int v\, dt$$

INDUCTANCE

L UNIT H (henry)

CAPACITOR

$$i = C \frac{dv}{dt} \qquad v = \frac{1}{C}\int i\, dt$$

CAPACITANCE

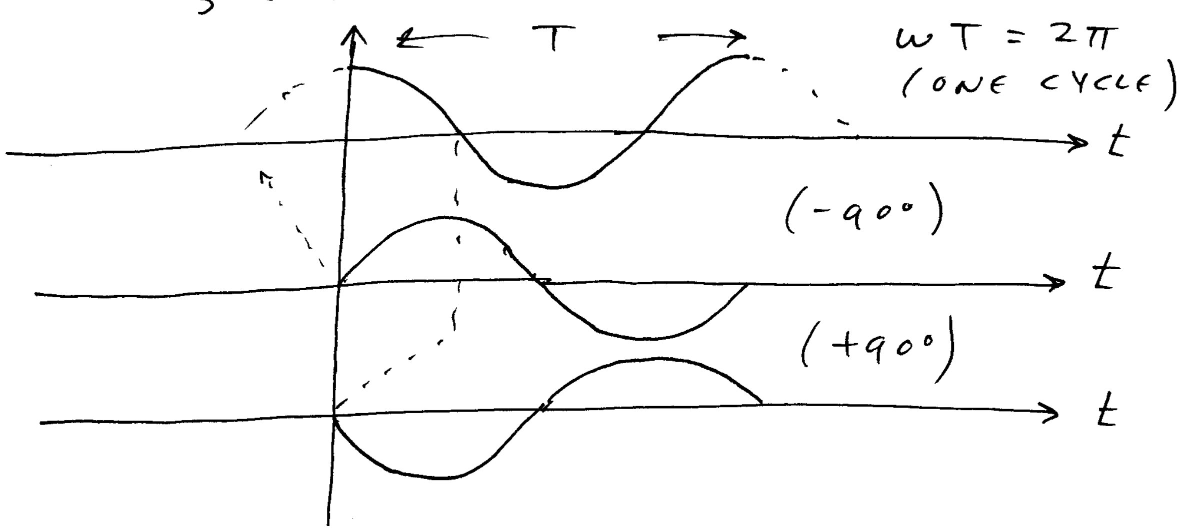
C UNIT F (FARAD)

SINUSOIDAL SIGNALS

$$v_1(t) = \cos \omega t$$

$$v_2(t) = \sin \omega t = \cos \omega t - 90^\circ$$

$$v_3(t) = -\sin \omega t = \cos \omega t + 90^\circ$$



$v(t) = \cos \omega t$

$\frac{d v(t)}{dt} = -\omega \sin \omega t = \omega \cos \omega t + 90°$

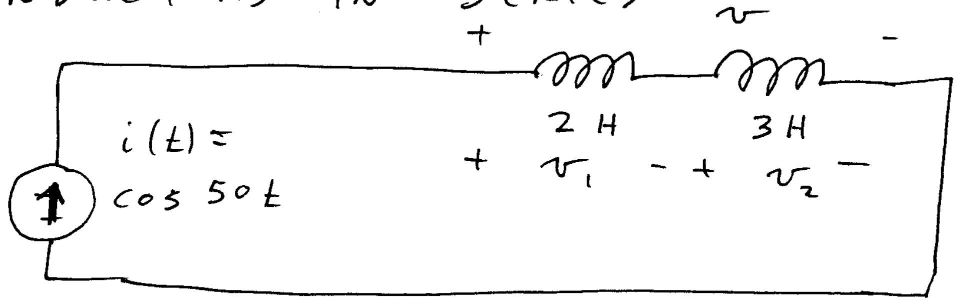
$\int v(t)\,dt = \frac{1}{\omega} \sin \omega t = \frac{1}{\omega} \cos \omega t - 90°$

$i(t) = \sin \omega t = \cos \omega t - 90°$

$\frac{d i(t)}{dt} = \omega \cos \omega t$ ↙ $+90°$ ↓ $-90°$

$\int i(t)\,dt = -\frac{1}{\omega} \cos \omega t = \frac{1}{\omega} \cos \omega t - 180°$

INDUCTORS IN SERIES



$v_1 = L_1 \frac{di}{dt} = (2) \frac{d}{dt} \cos 50t$

$= -100 \sin 50t$

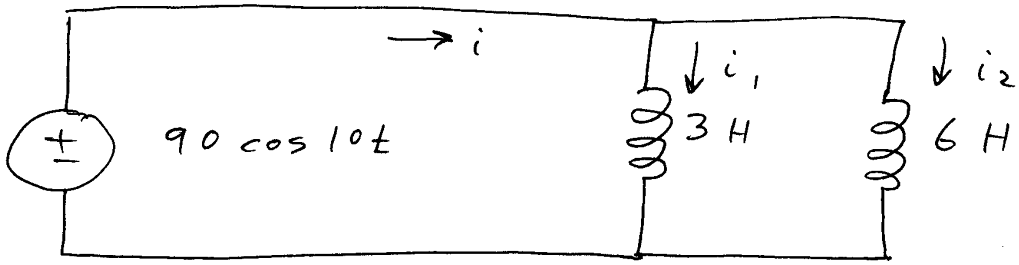
$v_2 = L_2 \frac{di}{dt} = (3) \frac{d}{dt} \cos 50t$

$= -150 \sin 50t$

$v_3 = -250 \sin 50t = (5) \frac{d}{dt} \cos 50t$

$= 5 \frac{di}{dt}$

INDUCTORS IN PARALLEL



$$i_1 = \frac{1}{L_1}\int v\,dt = \frac{1}{3}\int 90\cos 10t\,dt$$

$$= \frac{90}{(3)(10)}\sin 10t = 3\sin 10t$$

$$i_2 = \frac{1}{L_2}\int v(t)\,dt = \frac{1}{6}\int 90\cos 10t\,dt$$

$$= \frac{90}{(6)(10)}\sin 10t = 1.5\sin 10t$$

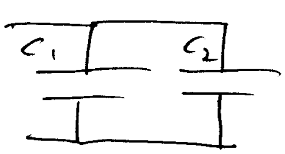
$$i(t) = i_1 + i_2 = \left(\frac{1}{3} + \frac{1}{6}\right)\frac{90}{10}\sin 10t$$

$$= \left(\frac{1}{3} + \frac{1}{6}\right)\int 90\cos 10t\,dt$$

$$= \frac{1}{L_{EFF}}\int v\,dt$$

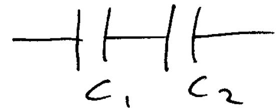
$$L_{EFF} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2}} = L_1 \,||\, L_2$$

CAPACITORS IN //



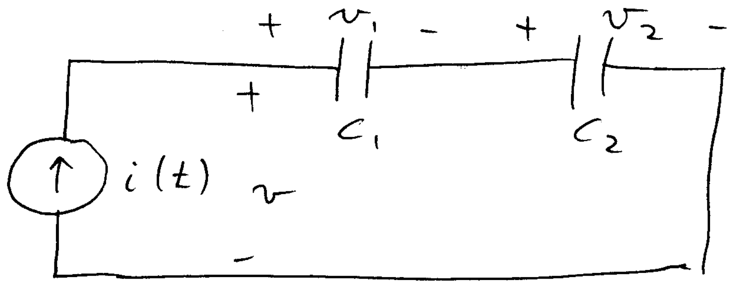
$C_{EFF} = C_1 + C_2$

IN SERIES



$C_{EFF} = C_1 \,||\, C_2$

CAPACITORS IN SERIES

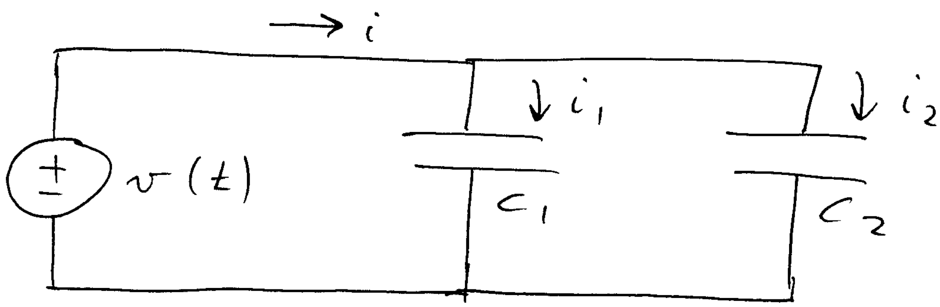


$$v_1 = \frac{1}{C_1}\int i\,dt \qquad v_2 = \frac{1}{C_2}\int i\,dt$$

$$v = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)\int i\,dt$$

$$= \frac{1}{C_{EFF}}\int i\,dt$$

CAPACITORS IN PARALLEL



$$i_1 = C_1\frac{dv}{dt} \qquad i_2 = C_2\frac{dv}{dt}$$

$$i = i_1 + i_2 = (C_1 + C_2)\frac{dv}{dt}$$

$$= C_{EFF}\frac{dv}{dt}$$