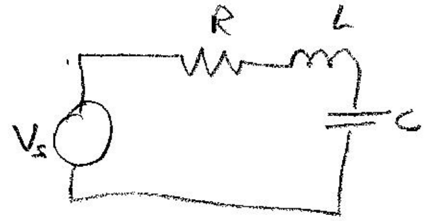
5) Given




$V_s(t) = V_0 \cos(\omega t + \pi/3)$ Volts

$V = IR$

$v_L = L\frac{di}{dt}$

$i_c = C\frac{dv}{dt}$   $q = cv$

$v = \frac{q}{c} = \frac{1}{c}\int i(t)\,dt$

$\sum_{\text{closed loop}} = 0$

a) $0 = V_s(t) - i(t)R - L\frac{di(t)}{dt} - \frac{1}{c}\int i(t)\,dt$

$$V_s(t) = i(t)R + L\frac{di(t)}{dt} + \frac{1}{c}\int i(t)\,dt$$

b) Equivalent phasor equation

$$\tilde{V}_s = R\tilde{I} + j\omega L\tilde{I} + \frac{1}{j\omega C}\tilde{I}$$

c) $\tilde{V}_s = \tilde{I}\left(R + j\omega L + \frac{1}{j\omega C}\right)$

$$\tilde{I} = \frac{\tilde{V}_s}{R + j\omega L + \frac{1}{j\omega C}} = \frac{V_0 e^{j\pi/3}}{R + j\left(\omega L - \frac{1}{\omega C}\right)}$$

$$\tilde{I} = \frac{\omega C V_0 e^{j\pi/3}}{\omega RC + j(\omega^2 LC - 1)}$$

note that resonance occurs when $\omega^2 LC - 1 = 0$

$\omega = \frac{1}{\sqrt{LC}}$

6) Given T.L. of length $l$, frequency $f$, $v_p = c = 3\times 10^8$ m/s

| $l$ | $f$ | $l/\lambda = \frac{lf}{v_p}$ | T.L. effects important |
|---|---|---|---|
| 20cm | $20\times10^3$ | $1.33\times10^{-5}$ | No |
| 50km | 60 | $10^{-2}$ | borderline No/Yes |
| 20 cm | $600\times10^6$ | 0.40 | Yes |
| 1 mm | $100\times10^9$ | 0.33 | Yes |

Transmission line effects negligible when $\frac{l}{\lambda} < 0.01$