SET 3

7.26)

The circuit equation is developed from $V_c = Q/C$ and $V_l = L\frac{dI}{dt}$. Here Q is the charge on the capacitor, and I is the current in the circuit. As the charge, Q, decreases, the current increases. Then;

$$I/C + L\frac{d^2I}{dt^2} = 0$$

The solution has the form $I = I_0 e^{i\omega t}$, with $\omega^2 = 1/LC$

When a resistance is added in series, the equation for the current becomes;

$$I/C + R\frac{dI}{dt} + L\frac{d^2I}{dt^2} = 0$$

The solution has the form, $I = I_0 e^{i\omega t}$ but now ω is complex representing exponential decay of the current.

$$-\omega^2 L + i\omega R + 1/C = 0$$

$$\omega = \frac{-iR/L \pm \sqrt{-(R/L)^2 + 4(1/LC)}}{2}$$

7.28)

Use a uniform current density in the wire. Then apply Ampere's law;

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{inside} = \mu_0 I (r/R)^2$$

$$B = \frac{\mu_0 I r}{2\pi R^2}$$

One can calculate the energy in a volume of wire of length, x.

$$W = (1/2)LI^2 = \int 2\pi x s\, ds\, (1/2\mu_0)B^2 = \frac{\mu_0 x I^2}{16\pi}$$

$$L = \frac{\mu_0 x}{8\pi}$$

7.36)

There is an equivalent Faraday's law for a magnetic monopole.

$$\vec{\nabla} \times E = -\mu_0 \vec{J}_m - \frac{\partial \vec{B}}{\partial t}$$

In integral form the above is;

$$\oint \vec{E}\, d\vec{l} = EMF = -\mu_0 I_m - \frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a}$$

If the magnetic charge passes through a loop in a plane, the total flux change is zero, but there is a current through the loop. The voltage across the inductance gives;

$$EMF = -L\frac{dI}{dt} = \mu_0 \frac{dQ_m}{dt}$$

$$I = \frac{\mu_0 Q_m}{L}$$

7.58)

We treat two long, parallel strips as a long capacitor system, and neglect edge effects. The capacitance per unit length of the strips is;

$$C/s = \epsilon_0 s w/h$$

The inductance is due to sheet currents flowing in opposite directions. This gives a magnetic field between the sheets;

$$B = \mu_0 I/w$$

The flux through a lenght s is;

$$\phi = Bsh = \mu_0 Ish/w$$

The inductance per unit length is;

$$L/s = \mu_0 h/w$$

Then ;

$$(L/s)(C/s) = \mu_0 \epsilon_0$$