Equations to Know

Chapter 30

Mutual Inductance	$M_{21} = \frac{N_2 \Phi_{21}}{I_1}$
EMF Induced in Coil 2 Due to a Changing Current in Coil 1 (2 parts)	$\mathcal{E}_2 = -N \frac{d\Phi_{21}}{dt} = -M \frac{dI_1}{dt}$
Mutual Inductance for a Coil Wrapped around a Solenoid	$M_{CS} = \mu_0 \left(\frac{NA}{\ell} \right)_S N_C$
Self-Inductance	$L = \frac{N\Phi_B}{I}$
EMF Due to Self-Inductance (2 parts)	$\mathcal{E} = -N \frac{d\Phi_B}{dt} = -L \frac{dI}{dt}$
Power being supplied to an Inductor	$P = LI \frac{dI}{dt}$
Energy Stored in an Inductor	$U = \frac{1}{2} LI^2$
Energy Stored in a Solenoid	$U = \frac{1}{2} \frac{B^2}{\mu_0} A\ell$
Energy Density in a Magnetic Field (2 parts)	$u = \frac{U}{Volume} = \frac{1}{2} \frac{B^2}{\mu_0}$
Coaxial Cable Inductance per Unit Length with Picture	$\frac{L}{\ell} = \frac{\mu_0}{2\pi} \ln \frac{r_2}{r_1}$
Energy Stored per Unit Length in a Coaxial Cable	$\frac{U}{\ell} = \frac{\mu_0 I^2}{4\pi} \ln \frac{r_2}{r_1}$
LR Circuit: Time Constant	$\tau = \frac{L}{R}$
LR Circuit: Current @ t=0 when battery is connected	$I = \frac{V_0}{R} \left(1 - e^{-\frac{R}{L}t} \right)$
LR Circuit: Current @ t=0 when circuit is “shorted”	$I = I_0 e^{-\frac{R}{L}t}$
LC Circuit: Angular Frequency (2 parts)	$\omega = 2\pi f = \sqrt{\frac{1}{LC}}$

LC Circuit: Current	$I = \underbrace{\omega Q_0}_{I_0} \sin(\omega t + \phi)$
LC Circuit: Total Energy Stored (2 parts)	$U = U_E + U_B = \frac{1}{2}\frac{Q_0^2}{C}$
LRC Circuit: Time Constant (2 parts)	$\tau = \frac{1}{\alpha} = \frac{2L}{R}$
LRC Circuit: Angular Frequency	$\omega' = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$
LRC Circuit: Charge across Capacitor	$Q = Q_0 e^{-\frac{R}{2L}t} \cos(\omega' t + \phi)$
LRC Circuit: Underdamped	$R^2 < \frac{4L}{C}$
LRC Circuit: Critically Damped	$R^2 = \frac{4L}{C}$
LRC Circuit: Overdamped	$R^2 > \frac{4L}{C}$