

FINAL EXAM - ADDITIONAL EQUATIONS

The equations given below may be used as starting points for solving problems on the final exam. Vector quantities are shown in **bold** type (or with arrows).

$$\mathcal{E} = -d\Phi_B/dt \quad I_d = \epsilon_0 \frac{d\Phi_E}{dt} \quad \Phi_B \equiv \int \vec{B} \cdot \hat{n} dA \quad \oint_C \vec{B} \cdot d\vec{l} = \mu_0(I + I_d)$$

Capacitor discharge: $Q(t) = Q_0 e^{-t/\tau}$ where $\tau = RC$

$$\mathcal{E}_{ind} = -L \cdot dI/dt \quad \Phi = LI \quad U_L = 0.5LI^2 \quad u_B = B^2/(2\mu_0)$$

$$\mathcal{E}_{ind 2} = -M_{12} \cdot (dI_1/dt) \quad M_{12} = M_{21} \quad \Phi_2 = M_{21}I_1 \quad \mathcal{E}_s/\mathcal{E}_p = N_s/N_p \text{ (transformer)}$$

Inductor discharge: $I(t) = I_0 e^{-t/\tau}$ where $\tau = L/R$ LC: $Q(t) = Q_0 \cos(\omega t + \phi_0)$ where $\omega = 1/(LC)^{0.5}$

$$\langle P(t) \rangle = V_{RMS}^2/R \quad V_{RMS} = V_0/\sqrt{2} \text{ (sine or cosine waveform)} \quad \langle P(t) \rangle = (V_{RMS}^2/Z) \cos(\phi)$$

$$X_L = j\omega L \quad X_C = 1/(j\omega C) = -j/(\omega C) \quad Z = R + X \quad \text{where } j = (-1)^{0.5}$$

ac Circuits: $I(t) = (V_0/|Z|) \cdot \cos(\omega t - \phi)$ where $|Z| = (R^2 + |X|^2)^{0.5}$ and $\phi = \tan^{-1} [Im(Z)/Re(Z)]$

EM Wave: $\mathbf{E} = \mathbf{E}_0 \cos(kx - \omega t)$ and $\mathbf{B} = \mathbf{B}_0 \cos(kx - \omega t)$ $v_p = c = f\lambda = \omega/k$ $\vec{k} \parallel (\vec{E} \times \vec{B})$

$$\epsilon_0 \mu_0 \frac{\partial^2 E}{\partial t^2} = \frac{\partial^2 E}{\partial x^2} \quad B_0 = E_0/c \quad \vec{S} \equiv \frac{\vec{E} \times \vec{B}}{\mu_0} \quad \frac{d\vec{p}}{dt} = A \frac{\vec{S}}{c}$$

<u>QUANTITY</u>	<u>SYMBOL</u>	<u>UNIT OR VALUE</u>	<u>COMMENTS</u>
Induced emf	\mathcal{E}	V	
Magnetic Flux	Φ_B	Wb	
Self Inductance	L	H	
Mutual Inductance	M	H	
Magnetic Energy Density	u_B	J/m ³	
Capacitive Reactance	X_C	Ω	
Inductive Reactance	X_L	Ω	
Phase Shift	ϕ	rad	
Impedance	Z	Ω	
Wavelength	λ	m	
Wave Number	k	m ⁻¹	$k = 2\pi/\lambda$
Speed of light	c	3.00 x 10 ⁸ m/s	
Poynting Vector	S	W/m ²	