Suggested Review For P435 Final Exam

0. General/Overall:

- Know/understand physical meaning associated with each/every symbol in *EM* formulae.
- Principle of Linear Superposition.
- Know/understand SI units associated with each/every *EM* quantity.

I. Electrostatics:

- Coulomb's Force Law, Electric Field of Point Charge, Line, Surface, Volume Charge Distributions
- Divergence & Curl of *E* – Gauss' Law & Stoke's Theorem
- Gauss's Law for *E* – integral & differential forms & its uses/applications – see examples & HW's
- Scalar Potential $\vec{E} = -\vec{\nabla}V, \quad \Delta V_{AB} \equiv V_B - V_A = -\int_A^B \vec{E} \bullet d\vec{\ell}$
- Potential & *E* of point charge, line/surface/volume charge distributions, superposition principle
- Equipotentials & E-field Lines!
- Work & Electrostatic Energy, superposition principle
- Properties of Conductors, Forces & Pressure on a Charged Conductor
- Capacitors, Capacitance, Forces on Capacitors
- Image Charge Problems/Method of Images, superposition principle
- Poisson's & Laplace's Equation – Not!!! (*No* electrostatic ∞-series sol'n boundary value problems)
- Electric Multipole Moments – ***especially*** Electric Dipoles: $\vec{p} = q\vec{d}, \; U = -\vec{p} \bullet \vec{E}, \; \vec{\tau} = \vec{p} \times \vec{E}$
- Electrostatic Fields In Matter $\vec{D} = \varepsilon \vec{E} = \varepsilon_o \vec{E} + \vec{\mathrm{P}}, \quad \vec{\mathrm{P}} = \varepsilon_o \chi_e \vec{E},$ Know *physical* definition of Polarization, $\vec{\mathrm{P}}$.
- Gauss's Law for *D* & $\vec{\mathrm{P}}$ – integral & differential forms & its uses/applications – see examples & HW's
- Electrostatic Boundary Conditions on $\vec{D}, \vec{E}$ & $\vec{\mathrm{P}}$; Bound & Free Surface & Volume Charges,…
- Work & Electrostatic Energy associated with Dielectric Materials
- C-M Equation for non-Polar Dielectrics, Langevin Equation for Polar Dielectrics

II. Magnetostatics:

- Electric Line/Surface/Volume Currents, *I, K, J*
- Magnetic Field of a Moving Charged Particle: $\vec{B} = \frac{1}{c^2}\left(\vec{v} \times \vec{E}\right) = \left(\frac{\mu_o}{4\pi}\right) q \left(\frac{\vec{v} \times \hat{r}}{r^2}\right)$ for $v \ll c$
- Lorentz Force $\vec{F} = q\vec{v} \times \vec{B}$, Motion of a Charged Particle in a Magnetic Field
- Magnetic Field associated with line/surface/volume currents
- Magnetic Field of a Long Wire & Circular Loop
- Magnetic Dipole Moments $\vec{m} = I\vec{a}$
- Magnetic Torques for line/surface/volume currents, e.g. $\vec{\tau}_m = I \oint_C \vec{r} \times \left(d\vec{l} \times \vec{B}\right) = \vec{m} \times \vec{B}$
- Biot-Savart Law $\vec{F}_m = I \oint_C d\vec{\ell} \times \vec{B}$ and its uses/applications – line/surface/volume currents
- Divergence & Curl of *B* – Ampere's & Faraday's Laws, Magnetic Flux, and their use/applications
- The Magnetic Vector Potential, A for line/surface/volume currents, $\vec{B} = \vec{\nabla} \times \vec{A}$, and uses/applications
- Multipole Expansion of Vector Potential - ***especially*** Magnetic Dipoles, $\vec{m} = I\vec{a}, \; U = -\vec{m} \bullet \vec{B}, \; \vec{\tau} = \vec{m} \times \vec{B}$
- Magnetic Charge/Magnetic Monopoles, Duality Transforms
- Magnetic Fields In Matter $\vec{H} = \frac{1}{\mu}\vec{B} = \frac{1}{\mu_o}\vec{B} - \vec{\mathrm{M}}, \quad \vec{\mathrm{M}} = \chi_m \vec{H},$ Know *physical* definition of Magnetization, $\vec{\mathrm{M}}$.
- Know Different Types of Magnetism… dia/para/ferro/…
- Ampere's & Faraday's Law for *H* & M – integral & differential forms & its uses/applications
- Magnetostatic Boundary Conditions on $\vec{H}, \vec{B}$ & $\vec{\mathrm{M}}$; Bound & Free Surface & Volume Currents,…
- Work & Magnetostatic Energy associated with Magnetic Materials
- Langevin Equation for Paramagnetic Materials

III. Electrodynamics:

- Current Flow In Conductors: Ohms Law: $\vec{J} = \sigma_C \vec{E}$
- Resistance *R*, Conductance $G = 1/R$, Resistivity ρ_C, Conductivity $\sigma_C = 1/\rho_C$, Ohm's Law, $V = IR$.
- The Hall Effect
- Power, $P = \Delta VI = \Delta V^2 / R = I^2 R$
- Electromotive Force, $EMF, \varepsilon = \Delta V_{AB} = V_B - V_A = +\int_A^B \vec{E} \bullet d\vec{\ell} = -\frac{d\Phi_m}{dt} = -\frac{d}{dt}\left(\int_S \vec{B} \bullet d\vec{A}\right)$
- Ampere's & Faraday's Laws for Electrodynamics, Lenz's Law
- Inductance – Mutual, *M* & Self, *L* Inductance, Inductors, Reciprocity Theorem
- Work and Energy Stored In Electric & Magnetic Fields, Energy Density, Forces & Pressure
- Eddy Currents
- Maxwell's Displacement Current, $\vec{J}_D = \frac{\partial \vec{D}}{\partial t}$
- Electric Charge Conservation – Continuity Equations for Total, Free and Bound Charges
- Maxwell's Equations (Gauss'/NMM/Ampere's/Faraday's Laws) for ***Electrodynamics***.
- Boundary Conditions on $\vec{D}, \vec{E}$ & $\vec{\mathrm{P}}$ and $\vec{H}, \vec{B}$ & $\vec{M}$ for ***Electrodynamical*** situations, including matter.
- Symmetry Properties of *EM* Quantities