PHYSICS II: An Outline

Chap 22. Electric Charge
1. Charge
2. Coulomb's Law
$\mathbf{F} = k\frac{|q_1||q_2|}{r^2}\hat{\mathbf{r}}$

Chap 23. Electric Fields
1. Electric Field $\mathbf{E} = \frac{\mathbf{F}}{q}$,
$E = \frac{1}{4\pi\varepsilon_0}\frac{|q|}{r^2}$ (point charge),
$dE = \frac{1}{4\pi\varepsilon_0}\frac{dq}{r^2}$
2. Field lines
3. Electric Dipole $\mathbf{p} = q\mathbf{d}$,
$\boldsymbol{\tau} = \mathbf{p}\times\mathbf{E}$, $E = \frac{1}{2\pi\varepsilon_0}\frac{p}{z^3}$

Chap 24. Gauss' Law
1. Electric Flux
$\Phi_E = \int \mathbf{E}\cdot d\mathbf{A}$
2. $\oint \mathbf{E}\cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
3. $E = \frac{\lambda}{2\pi\varepsilon_0 r}$ (line charge),
$E = \frac{\sigma}{2\varepsilon_0}$ (sheet of charge)

Chap 25. Electric Potential
1. Work $W = -q\Delta V$
2. $\Delta U = -\int_a^b \mathbf{F}\cdot d\mathbf{l}$
3. $\Delta V = -\int_a^b \mathbf{E}\cdot d\mathbf{l}$, $E_s = -\frac{\partial V}{\partial s}$
4. $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ (point charge)
$V = Ed$ (Uniform Field)
5. $dV = \frac{1}{4\pi\varepsilon_0}\frac{dq}{r}$

Chap 26. Capacitance
1. Capacitance: $q = CV$
2. $\parallel$ Plates - $C = \varepsilon_0\frac{A}{d}$
3. Series: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$
4. Parallel: $C = C_1 + C_2$
5. Energy Stored:
$U = \frac{1}{2}CV^2$, $u = \frac{1}{2}\varepsilon_0 E^2$
6. Dielectrics: $K = \frac{E_{vacuum}}{E_{material}}$,
$C = KC_0$, $\varepsilon = K\varepsilon_0$

Chap 27. Current and Resistance
1. Current: $i = \frac{dq}{dt}$
2. Current Density:
$i = \int \mathbf{J}\cdot d\mathbf{A}$, $\mathbf{J} = ne\mathbf{v}_d$
3. Ohm's Law: $V = iR$,
$\mathbf{E} = \rho\mathbf{J}$
4. Resistivity: $R = \rho\frac{L}{A}$
$\Delta\rho = \alpha\rho_0\Delta T$
5. Electric Power: $P = iV$

Chap 28. Circuits
1. Emf $= \frac{dW}{dq}$
2. Series: $R = R_1 + R_2$
3. Parallel: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
4. Terminal Voltage:
$V = \mathcal{E} - i\,r$
5. Kirchoff's Rules:
Point, Loop
6. RC: $i = \frac{E}{R}e^{-t/\tau}$, $\tau = RC$
Charging: $q = CE(1 - e^{-t/\tau})$
Discharging: $q = q_0 e^{-t/\tau}$

Chap 29. Magnetic Fields
1. Magnetic Force on
Current: $\mathbf{F} = i\mathbf{l}\times\mathbf{B}$
Charge: $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$
2. Dipole $\boldsymbol{\tau} = \boldsymbol{\mu}\times\mathbf{B}$, $\boldsymbol{\mu} = Ni\mathbf{A}$
3. Crossed fields: Hall Effect
4. Circulating charge: $r = \frac{mv}{qB}$

Chap 30. Magnetic Fields Due to Currents
1. Ampere's Law:
$\oint \mathbf{B}\cdot d\mathbf{l} = \mu_0 i$
2. Wire: $B = \frac{\mu_0 i}{2\pi r}$
3. Loop: $B = \frac{\mu_0 i}{2R}$
4. Solenoid: $B = \mu_0 ni$, $n = \frac{N}{L}$
5. Biot-Savart:
$d\mathbf{B} = \frac{\mu_0 i}{4\pi}\frac{d\mathbf{l}\times\hat{\mathbf{r}}}{r^2}$

Chap 31. Induction and Inductance
1. Magnetic Flux:
$\Phi_B = \int \mathbf{B}\cdot d\mathbf{A}$
2. Faraday's Law:
$\mathcal{E} = -N\frac{d\Phi_B}{dt}$
3. Moving Conductor:
$\mathcal{E} = Blv$
4. Transformers:
$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$
5. $\mathcal{E}_{\sec} = -M\frac{dI_p}{dt}$,
6. $\mathcal{E} = L\frac{dI}{dt}$, $L = \frac{N\Phi}{i}$
7. Solenoid: $L = \mu_0 N^2 A/l$
8. Stored Energy:
$U = \frac{1}{2}Li^2$, $u = \frac{1}{2\mu_0}B^2$
9. LR: $\tau = L/R$
10. LR, LC, LRC Circuits

Chap 32. Maxwell's Equations
1. $\Phi_B = \oint \mathbf{B}\cdot d\mathbf{A} = 0$,
$\oint \mathbf{E}\cdot d\mathbf{A} = \frac{q}{\varepsilon_0}$,
$\oint \mathbf{B}\cdot d\mathbf{s} = \mu_0\varepsilon_0\frac{d\Phi_E}{dt} + \mu_0 i_{enc}$
$\oint \mathbf{E}\cdot d\mathbf{s} = -\frac{d\Phi_B}{dt}$

Chap 33. EM Oscillations and Alternating Current
1. LC Oscillators:
$Lq'' + Rq' = 0$,
$q = Q\cos(\omega t + \phi)$
2. RLC Circuits
3. $\mathcal{E} = v_0 \sin\omega t$, $\omega = 2\pi f$
$i = i_0\sin(\omega t - \phi)$, $V = IZ$,
$Z = \sqrt{R^2 + (X_L - X_C)^2}$,
$X_L = \omega L$, $X_C = \frac{1}{\omega C}$,
$\tan\phi = \frac{X_L - X_C}{R}$
4. Power loss $= Vi\cos\phi$
5. Resonance:
$X_L = X_C \Rightarrow \omega_0 = \sqrt{\frac{1}{LC}}$

Chap 34. EM Waves
1. $c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$, $f\lambda = c$,
$E = cB$
2. Energy & Poynting vector:
$u = \frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2\mu_0}B^2$,
$\mathbf{S} = \frac{1}{\mu_0}\mathbf{E}\times\mathbf{B}$
3. Polarization: $I = I_0\cos^2\theta$
4. Snell's Law, Brewster's angle, Critical angle-below.

Chap 35. Images
1. Index of refraction: $c = nv$
2. Mirrors: $\theta_i = \theta_r$, $r = 2f$,
$\frac{1}{p} + \frac{1}{i} = \frac{1}{f}$, $M = \frac{h_i}{h_o} = -\frac{i}{p}$
3. Snell's Law:
$n_1\sin\theta_1 = n_2\sin\theta_2$
4. Total Internal Reflection:
$\sin\theta_c = \frac{n_2}{n_1}$
5. Refraction at a Spherical Surface: $\frac{n_1}{p} + \frac{n_2}{i} = \frac{n_2 - n_1}{r}$
6. Apparent Depth
7. Lenses:
$\frac{1}{f} = (n-1)(\frac{1}{r_1} - \frac{1}{r_2})$,
$\frac{1}{p} + \frac{1}{i} = \frac{1}{f}$, $M = \frac{h_i}{h_o} = -\frac{i}{p}$
8. Optical Devices: Eye, Telescope, Microscope, Near and far points. $m = \frac{25\text{cm}}{f}$

Chap 36. Interference
1. $\lambda_n = \lambda/n$
2. Double Slit Constructive
$d\sin\theta = m\lambda$, $m = 0, 1, 2, \ldots$
3. Double Slit Destructive
$d\sin\theta = (m + \frac{1}{2})\lambda$, $m = 0, 1, \ldots$
4. $I = I_o(\cos\frac{\phi}{2})^2$, $\phi = \frac{2\pi}{\lambda}d\sin\theta$
5. Thin Films $2t = m\lambda_n$,
$n_2 > n_1 \Rightarrow 180^o$ shift

Chap 37. Diffraction
1. Single Slit Minima:
$a\sin\theta = m\lambda$, $m = 1, 2, \ldots$
2. $I = I_o\left(\frac{\sin\alpha}{\alpha}\right)^2$,
$\alpha = \frac{\pi}{\lambda}a\sin\theta$
3. Double Slit (ϕ, β above)
$I = I_o\left(\frac{\sin\alpha}{\alpha}\right)^2(\cos\frac{\phi}{2})^2$
4. Rayleigh Criterion:
$\theta = \frac{1.22\lambda}{D}$
5. Diffraction Gratings

Chap 38. Relativity
1. $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$
2. $\Delta t = \gamma\Delta t_0$, $L = L_0/\gamma$,
$m = \gamma m_0$, $p = \gamma m_0 v$
3. Galilean Transformation
4. Lorentz Transformation
$x' = \gamma(x - vt)$, $y' = y$, $z' = z$,
$t' = \gamma(t - \frac{vx}{c^2})$
5. $u = \frac{u' + v}{1 + vu'/c^2}$
6. $KE = mc^2 - m_0c^2$,
$E^2 = p^2c^2 + m_0^2c^4$

Miscellaneous Constants
$g = 9.8$ m/s^2
$k = 9.0\times10^9$ Nm^2/C^2
$e = 1.602\times10^{-19}$ C
$\varepsilon_0 = 8.85\times10^{-12}$ C^2/Nm^2
1 eV$= 1.6\times10^{-19}$ J
$\mu_0 = 4\pi\times10^7$ Tm/A
$c = 3.00\times10^8$ m/s