ΤΥΠΟΛΟΓΙΟ ΦΥΣΙΚΗΣ II

Coulomb

$\vec{F}=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\hat{r}\rightarrow\frac{q}{4\pi\varepsilon_0}\sum\frac{q_i}{r_i^2}\hat{r}_i\rightarrow\frac{q}{4\pi\varepsilon_0}\int\frac{\rho\hat{r}}{r^2}dV$	$\rho = dq/dv$	$\sigma = dq/dS$	$\lambda = dq/dl$

Ηλεκτροστατικό πεδίο

$\vec{E}=\vec{F}/(+q)=-\nabla U\equiv -\text{grad}U$	$E_{\text{επιφ. αγ.}}=\sigma/\varepsilon_0$	$U_\Sigma=-\int_\infty^\Sigma \vec{E}\,d\vec{s}$	$U_r=\frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$

Gauss

$\Phi_{\text{ολ}}=\oint_S\vec{E}\,d\vec{S}=q/\varepsilon_0$	$\oint_S\vec{D}\,d\vec{S}=Q$	$\vec{D}=\varepsilon\vec{E}\equiv\varepsilon_0\varepsilon_r\vec{E}\equiv\varepsilon_0(1+\chi)\vec{E}=\varepsilon_0\vec{E}+\vec{P}$

Πυκνωτές

$C=\frac{Q}{V}$	$C_{\text{επ.}}=\varepsilon\frac{S}{l}$	$C_{\text{σφ.}}=4\pi\varepsilon\frac{Rr}{R-r}$	$C_{\text{κυλ.}}=\frac{2\pi l\varepsilon}{\ln(R/r)}$	$\varepsilon_r=\frac{C}{C_0}=\frac{V_0}{V}=\frac{E_0}{E}$	$C_{\text{ολ.π.}}=\sum_i C_i$
$1/C_{\text{ολ.σ.}}=\sum_i 1/C_i$	$W=\frac{1}{2}QV$	$w\equiv\frac{dW}{dv}=\frac{1}{2}\varepsilon_0E^2$	**Δίπολα:**	$\vec{p}=q\vec{l}$	$U=\frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\cdot\hat{r}}{r^2}$
$\vec{M}=[\vec{p}\times\vec{E}]$	**Διηλεκτρικά:**	$\vec{P}\equiv\frac{d\vec{p}}{dv}=\varepsilon_0(\varepsilon_r-1)\vec{E}\equiv\varepsilon_0\chi\vec{E}$	$Q_p=-\oint\vec{P}\,d\vec{S}$	$\sigma_p=(\vec{P}\cdot\hat{n})$	

Ρεύματα / Πηγές

Ρεύματα			Πηγές	
$i=\frac{dq}{dt}=\int_S\vec{j}\,d\vec{S}$	$I=\frac{Q}{t}=jS$	$\vec{j}=\gamma\vec{E}$	$E=\frac{W^{\text{προσφ.}}_{\text{από πηγή}}}{q}=\int_-^+\vec{E}_{\mu\sigma}\,d\vec{l}=-\int_-^+\vec{E}\,d\vec{l}$	$E^\sigma_{\text{ολ}}=\sum_i E_i$

Ωμικές αντιστάσεις

$E^\pi_{\text{ολ}}=E$	$R=\frac{U}{I}=G^{-1}$	$R_{\text{ολ.σ.}}=\sum R_i$	$1/R_{\text{ολ.π.}}=\sum 1/R_i$	$R_{\text{μετ.αγ.}}=\rho l/S$	$\rho=\gamma^{-1}$

Απλό κύκλωμα:	$I_{\text{ολ}}=\frac{E_{\text{ολ}}}{R_{\text{ολ}}+r_{\text{ολ}}}$	**Κανόνες Kirchhoff:**	$\sum I_j=0$ $\sum E_j=\sum R_jI_j$	$W=UIt \quad P=dW/dt$ $P=UI=I^2R=U^2/R$
RC:	$u_{\text{φορτ.}}=E\left[1-e^{-t/(RC)}\right]$	$u_{\text{εκφ.}}=Ee^{-t/(RC)}$	$i=u_{\text{εκφ.}}/R$	**Ηλεκτρόλυση:** $m=AQ=$ $=AIt \quad A=M/(\Sigma F)$

Μαγνητικό πεδίο

Lorentz $\vec{F}=q[\vec{v}\times\vec{B}]$	$\Phi=\oint_S\vec{B}\,d\vec{S}=0$	Ampere $\Phi=\oint_L\vec{B}\,d\vec{l}=\mu_0 i_{\text{ολ}}$	Biot-Savart: $d\vec{B}=\frac{\mu_0 i}{4\pi}\frac{[d\vec{l}\times\vec{r}]}{r^3}$

$B_{\text{σωλ.}}=\mu_0 ni$	$B_{\text{ευθ.αγ.}}=\frac{\mu_0 i}{2\pi r}$	$B_{\text{κε.κυκλ.αγ.}}=\frac{\mu_0 i}{2r}$	$\vec{F}_{\text{αγ.}}=-I\int[\vec{B}\times d\vec{l}]\overset{\text{ευθ. αγωγ.}}{=}I[\vec{l}\times\vec{B}]$	$F_{\text{παρ.αγ.}}=\frac{\mu_0 l I_a I_b}{2\pi r}$

Ηλεκτρομαγνητική επαγωγή

$\vec{M}=I[\vec{S}\times\vec{B}]$	$E_{\varepsilon\pi}=-\frac{d\Phi}{dt}=\oint_L[\vec{v}\times\vec{B}]d\vec{l}-\oint_S\frac{\partial\vec{B}}{\partial t}d\vec{S}=\oint_L vB\sin(\vec{v},\vec{B})\cos(\vec{F}_L,d\vec{l})dl-\oint_S\frac{\partial\vec{B}}{\partial t}d\vec{S}$
$E_{\varepsilon\pi}\left(\begin{matrix}\vec{v}\ \&\ \vec{B}=\text{σταθ.}\\ \text{αγωγός}=\text{ευθύγραμμος}\end{matrix}\right)=[\vec{v}\times\vec{B}]\vec{l}=vBl\sin(\vec{v},\vec{B})\cos(\vec{v}\times\vec{B},\vec{l})$	$\vec{v}\perp\vec{B}\perp\vec{l}=\text{σταθ.}\Rightarrow E_{\varepsilon\pi}=vBl$

$E_{\text{αεπ.}}=-L\cdot di/dt$	$E_{\text{αμ.επ.}}=-\Lambda di/dt$	$W_\mu=dW_\mu/dv=B^2/(2\mu_0)$	$W_{\mu\ \text{σωλ.}}=Li^2/2$

ΤΥΠΟΛΟΓΙΟ ΦΥΣΙΚΗΣ ΙΙ

Εναλλασσόμενα ρεύματα

Μιγαδικά μεγέθη

$\underline{z} = x + jy = r(\cos\varphi + j\sin\varphi) = re^{j\varphi} \equiv r\angle\varphi$			$\lvert \underline{z} \rvert = r = \sqrt{x^2+y^2}$	$e^{\pm j\varphi} = \cos\varphi \pm j\sin\varphi$	
$\pm j = e^{\pm j\pi/2} \equiv \angle \pm\pi/2$	$\overline{\underline{z}} = x - jy$ $\quad \overline{\underline{z}+\underline{w}} = \overline{\underline{z}} + \overline{\underline{w}}$ $\quad \overline{\underline{z}\cdot\underline{w}} = \overline{\underline{z}}\cdot\overline{\underline{w}}$ $\quad \underline{z}\cdot\overline{\underline{z}} = \lvert\underline{z}\rvert^2$			$\underline{z} = re^{j\varphi}$ $\quad \overline{\underline{z}} = re^{-j\varphi}$	
$\underline{z}_1 \cdot \underline{z}_2 = r_1 r_2 \angle \varphi_1 + \varphi_2$	$j\underline{z} = r\angle\varphi + \pi/2$	$\dfrac{\underline{z}_1}{\underline{z}_2} = \dfrac{r_1}{r_2}\angle\varphi_1 - \varphi_2$	$\dfrac{\underline{z}}{j} = r\angle\varphi - \pi/2$	$\underline{z}^{\nu} = r^{\nu}\angle\nu\varphi$	$1/j = -j$
$\underline{z} = re^{j(\omega t+\varphi)}$ $\quad d\underline{z}/dt = j\omega t$ $\quad \int \underline{z}dt = \underline{z}/(j\omega)$			$\alpha = A_0\sin(\omega t + \varphi)$	$\omega = 2\pi\nu = 2\pi/T$	

$\underline{u} = U_0\angle\omega t$ $\quad \underline{i} = I_0\angle\omega t+\varphi$ $\underline{Z} = Z\angle\arctan\dfrac{\mathrm{Im}(\underline{Z})}{\mathrm{Re}(\underline{Z})}$	$\underline{i} = \underline{u}/\underline{Z}$ $\quad I_0 = U_0/Z$ $\varphi = -\arctan\dfrac{\mathrm{Im}(\underline{Z})}{\mathrm{Re}(\underline{Z})}$ $Z = \sqrt{\mathrm{Re}^2(\underline{Z}) + \mathrm{Im}^2(\underline{Z})}$	$u = \mathrm{Im}(\underline{u})$ $i = \mathrm{Im}(\underline{i})$ $I = I_0/\sqrt{2}$ $U = U_0/\sqrt{2}$	$\underline{Z}_{\sigma\varepsilon\iota\rho.} = \sum \underline{Z}_i$ $1/\underline{Z}_{\pi\alpha\rho.} = \sum 1/\underline{Z}_i$ $\overline{P} = \dfrac{1}{2} I_0 U_0 \cos\varphi =$ $I^2 Z\cos\varphi = I^2\mathrm{Re}(\underline{Z})$

Κύκλωμα RLC σε σειρά

$\underline{Z}_{RLC} = R + \underline{R}_L + \underline{R}_C = R + j[\omega L - 1/(\omega C)]$	$\underline{R}_L = j\omega L$ $\quad \underline{R}_C = -j/(\omega C)$	$\omega = \sqrt{\dfrac{1}{LC}}$

Η ύλη εντός μαγνητικού πεδίου

$\mu = B/B_0$ $\vec{H} = \dfrac{\vec{B}_0}{\mu_0}$	$\vec{M} = \dfrac{\Delta\vec{B}}{\mu_0} = \dfrac{\vec{J}}{\mu_0}$ $\vec{B} = \mu_0\vec{H} + \mu_0\vec{M} = \mu\mu_0\vec{H}$	$\vec{M} = (\mu - 1)\vec{H} \equiv \chi\vec{H}$	$\chi_{\pi\alpha\rho.} = C/T$ Curie-Weis: $\chi = C/(T - T_C)$

Άτομα

$m = M \cdot u$	Bohr: $L = mrv = nh/(2\pi)$ $\quad E = h\nu = E_{\alpha\rho\chi.} - E_{\tau\varepsilon\lambda.}$	$W = \Delta m\, c^2$
Φυσική ραδιενέργεια: $N = N_0 e^{-\lambda t}$ $\quad T_{1/2} = \ln 2/\lambda$	$D = W/m$ $\quad D_\beta = Q\,D$	

Σταθερές

$e = 1{,}6021 \cdot 10^{-19}$ C	$\varepsilon_0 = 8{,}854 \cdot 10^{-12}$ $C^2/(Nm^2)$	$\mu_0 = 4\pi 10^{-7}$ Wb A^{-1} m^{-1}
$m_e = 9{,}11 \cdot 10^{-31}$ kg	$u = 1{,}66057 \cdot 10^{-27}$ kg	$h = 6{,}626 \cdot 10^{-34}$ Js

Διανύσματα

$\vec{a} = \begin{pmatrix} a_x \\ a_y \\ a_z \end{pmatrix} \equiv a_x\hat{x} + a_y\hat{y} + a_z\hat{z}$	$a \equiv \lvert\vec{a}\rvert = \sqrt{a_x^2 + a_y^2 + a_z^2}$ $(\vec{a}\cdot\vec{b}) = ab\cos(\vec{a},\vec{b}) = a_x b_x + a_y b_y + a_z b_z$	$\hat{a} = \dfrac{\vec{a}}{a}$	$[\vec{a}\times\vec{b}] = \begin{pmatrix} a_y b_z - a_z b_y \\ a_z b_x - a_x b_z \\ a_x b_y - a_y b_x \end{pmatrix}$
$\lvert[\vec{a}\times\vec{b}]\rvert = ab\sin(\vec{a},\vec{b})$ $[\vec{a}\times\vec{b}]\cdot\vec{c} = [\vec{b}\times\vec{c}]\cdot\vec{a} = [\vec{c}\times\vec{a}]\cdot\vec{b}$	$\nabla \equiv \hat{x}\dfrac{\partial}{\partial x} + \hat{y}\dfrac{\partial}{\partial y} + \hat{z}\dfrac{\partial}{\partial z} \xrightarrow[\pi\varepsilon\delta\acute{\iota}o]{\kappa\varepsilon\nu\tau\rho\iota\kappa\acute{o}} \nabla U(r) = \dfrac{dU}{dr}\hat{r}$		