Elettrostatica

COSTANTE: $\epsilon_0 = 8.85 \cdot 10^{-12} \left[\frac{C^2}{N \cdot m^2}\right]$

Gauss: $\phi_E = 4\pi r^2 E = \frac{Q_{int}}{\epsilon_0}$ | $\nabla \cdot E = \frac{\rho}{\epsilon}$ $V = \frac{1}{4\pi\epsilon_0}\int \frac{\rho}{r} d\tau$ | **Discontinuità**: $\Delta E_\perp = \frac{\sigma_{tot}}{\epsilon_0}$ $\Delta E_\parallel = 0$

Energia Elettrica $U_E = \frac{1}{2}\int \rho V d\tau = \frac{\epsilon_0}{2}\int E^2 d\tau$ | **Pressione Elettro**: $p_0 = \frac{\sigma^2}{2\epsilon_0}\hat{u}_n$ $\frac{dP}{d\tau} = E \cdot j = \sigma E^2$

Dipolo: $E = \frac{2p\cos\theta}{4\pi\epsilon_0 r^3}\hat{u}_r + \frac{p\sin\theta}{4\pi\epsilon_0 r^2}\hat{u}_\theta = \frac{p}{4\pi\epsilon_0}\sqrt{3\cos^2\theta + 1}$ | $U = -\vec{p} \cdot \vec{E}$ | $M = \vec{p} \times \vec{E}$

Conduttori: $E_{int} = 0$ | $V = cost$ | $\rho = 0$ | $E_{sup} = \frac{\sigma^2}{2\epsilon_0}\hat{u}_n$

Condensatori: *Serie*: $\frac{1}{C} = \sum \frac{1}{C_i}$ *Parallelo*: $C = \sum C_i$ *Energia*: $U_E = \frac{1}{2}\sum V_i Q_i$ | $VC = Q$

Piano: $E = \frac{Q}{\epsilon_0 S}$ | $V = Eh = \frac{Qh}{\epsilon_0 S}$ | $C = \frac{\epsilon_0 S}{h}$ *Sferico*: $E = \frac{Q}{4\pi\epsilon_0 R^2}$ | $V = \frac{Q}{4\pi\epsilon_= r}$ | $C = 4\pi\epsilon_0 \frac{R_1 R_2}{R_2 - R_1}$ *Cilindrico*: $E = \frac{Q}{2\pi\epsilon_0 hr}$ | $V = \frac{Q}{2\pi\epsilon_0 h}\log\frac{R_2}{R_1}$ | $C = \frac{2\pi\epsilon_0 l}{\log\frac{R_2}{R_1}}$

Correnti: $DI = j \cdot d\Sigma$ | $j = Nq\langle v\rangle$ | $j = \sigma_{conduttivita}E$ | $j = \frac{Nq^2\tau E}{m}$ | $\sigma_{conduttività} = \frac{NQ^2\tau}{m}$

Ohm: $V = RI$ | $R = \rho\frac{l}{S}$ | $E = \rho_{resistività}\, j$ | $\sigma_{conduttività} = \rho^{-1}$ | $\rho = [\Omega m]$ | $RC = \rho\epsilon_0$ | $U = \frac{1}{2}CV^2$ | $P = VI$

Kirchoff: *Nodi* $\sum I_i = 0$ *Maglie* $\sum R_i I_i = 0$ **Dielettrici**: $p = \alpha\epsilon_0 E_{agente}$ | $\sigma_p = P \cdot \hat{u}_n$ | $\rho_p = -\nabla \cdot P$ | $\Delta D_\perp = \sigma_{lib}\hat{u}_n$ | $D = \epsilon_0 E + P = \epsilon_0(1 + \chi_E)E = \epsilon_0 kE$ | $U = \frac{1}{2}\epsilon E^2 \tau$ | $w_e = \frac{1}{2}D \cdot E$

Forza elettrica che un dielettrico in un condensatore: $F = \frac{1}{2}V^2\frac{dC}{dx}$

Magnetismo

COSTANTE: $\mu_0 = 4\pi \cdot 10^{-7}\left[\frac{T \cdot m}{A} = \frac{N}{A^2}\right]$

Lorentz: $F = q(E + v \times B)$ | $r = \frac{mv}{qB}$ | $\omega = -\frac{qB}{m}$ | $E = \frac{F}{q} = v \times B$ | passo $d = v_0\frac{2\pi m}{qB}\cos\theta$

Fili: $dF_m = Ids \times B$ | Forza tra due fili (forza per metro) $F_d = \frac{\mu_0 I_1 I_2}{2\pi R}$ | $B = \frac{\mu_0 IN}{2\pi r}$

Spira/Dipolo: $M = IS \times B = \mu \times B$ | $B = \frac{\mu_0 NIr^2}{2(r^2+x^2)}$ | $\mu = IS$ | $U = -\mu \cdot B$ | $d\mu = Id\Sigma$

Flusso: $\Phi = MI$ | $\Phi = LI$ | $\varepsilon = -\frac{d\Phi_B}{dt}$ | $\int_\gamma E \cdot ds = -\frac{d\Phi_B}{dt}$ | $\varepsilon = \int E \cdot ds = \int v \times B \cdot ds$

Solenoide Toroidale: $B = \frac{\mu_0 IN}{2\pi r}$ | **Solenoide rettilineo indefinito**: $B = \frac{\mu NI}{d}$ | **Solenoide rettilinea finito**: $B(0,0,z) = \frac{\mu_0 NI}{2}\left(\frac{h/2 - z}{\sqrt{(h/2-z)^2 + R^2}} + \frac{h/2 + z}{\sqrt{(h/2+z)^2 + R^2}}\right)\hat{u}_z$

Energia: $U_L = \frac{1}{2}LI^2$ | $U_B = \frac{1}{2}\frac{B^2}{\mu_0}$ | $U_{tot,circ,B} = \frac{1}{2}\sum LI_j^2 + \sum_{i>j} MI_i I_j$

Discontinuità: $\Delta B_\parallel = \mu_0 k$ | $\Delta B_\perp = 0$

Correnti: $j_m = \nabla \times M$ | $\oint B \cdot dl = \epsilon_0\mu_0\frac{\partial\Phi_E}{\partial t}$ | $\nabla \times B = \mu_0 j_m$ | $\nabla \cdot B = 0 = \oint B \cdot d\Sigma$ | $\oint B \cdot ds = \mu_0 I_{conc}$

Material Magnetici: $M = \frac{du}{d\tau}[A/m]$ | $k_{m,(condu\ superf)} = M \times \hat{u}_n$ | $H = \frac{B}{\mu_0} - M$ | $\nabla \times H = j_c(conduzione)$ | $\oint H \cdot ds = I_c$ | $M = \chi_m H$ | $B = \mu_0(1+\chi_m)H = \mu_0 kH$

Discontinuità nei materiali: $\Delta H_{\parallel} = K_c \times \hat{u}_n$ | $\Delta B = -\Delta M$

Cavità nei materiali: *parallela* $H_{in} = H_{out}$ | $B_{in} = B_{out} - \mu_0 M$ *perpend* $B_{in} = B_{out}$ | $H_{in} = H_{out} + M$

Diamagnetici: $M = \frac{-e^2 n \langle r^2 \rangle B}{6m_e} = \frac{\chi_m}{\chi_m + 1}\frac{B}{\mu_0}$ **Paramagnetici:** $M = \frac{N\mu^2 B}{3kT}$ | $\chi_m = \frac{N\mu^2\mu_0}{3kT}$

Onde

Fondamentali: $k = \frac{2\pi}{\lambda}$ | $\omega = \nu k = 2\pi v$ | $\lambda = \frac{v}{\nu}$ | $E = cB$ | $n = \frac{\lambda_0}{\lambda} = \frac{c}{v}$ | $c^2 = \frac{1}{\epsilon_0\mu_0}$ | (pressione tot ass) $p = \frac{I}{c}\cos^2\theta$ | $I = \frac{1}{2}\epsilon_0 cE$ | *Antenna Dipolare* $I = \frac{1}{r^2} I_0 \sin^2\theta$, $I = \frac{3P\sin^2\theta}{8\pi r^2}$, $P = \int I d\Sigma$

Riflessione/Trasmissione : *Polarizzazione* : *Parallela* $R = \left(\frac{\tan(\theta_i - \theta_t)}{\tan(\theta_i + \theta_t)}\right)^2$ *Perpendicolare* $R = \left(\frac{\sin(\theta_i - \theta_t)}{\sin(\theta_i + \theta_t)}\right)^2$ | $T = 1 - R$ | *Incidenza Normale:* $R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$

Interferenza: $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos(\frac{2\pi}{\lambda}(r_2 - r_1))$ | $MAX : \sin\theta = \frac{\lambda}{d}m$ $MIN : \sin\theta = \frac{m\lambda}{Nd}$ $MAXSECOND : \sin\theta = \frac{(2m+1)\lambda}{2Nd}$

Diffrazione: $MAX : \sin\theta = \frac{(2m+1)\lambda}{2aN}$ $MIN : \sin\theta = \frac{m\lambda}{a}$

Roba Immaginaria

Impedenze Complesse: $Resistenza : Z_R = R$ $Induttanza : Z_L = i\omega L$ $Condensatore : Z_C = \frac{1}{i\omega C}$

Circuito RLC in serie: $\omega_0^2 = \frac{1}{LC}$ | $\hat{V} = ZI$ | $\hat{V} = V_0 e^{i\omega t}$ | $\hat{I} = I_0 e^{i(\omega t + \phi)}$ | $Z = Z_0 e^{i\phi} = Z_R + iZ_x$ | $Z_0 = \sqrt{Z_R^2 + Z_x^2}$ | $Z_R = R$ | $Z_x = \omega L - \frac{1}{\omega C}$ | $\langle P \rangle = \frac{1}{2} I_0^2 \Re(Z) = \frac{1}{T}\int_0^T P(t)dt$ | $\hat{I} = \frac{\hat{V}}{Z} = \frac{V_0}{z_0} e^{i(\omega t - \phi)}$ | $I_{max} = \frac{V_0}{|\Re(Z)|}$

Maxwell

$\nabla \times E = -\frac{\partial B}{\partial t}$	$\oint_\gamma E \cdot ds = -\frac{d\Phi_B}{dt}$
$\nabla \times B = \mu_0 j + \mu_0\epsilon_0\frac{\partial E}{\partial t}$	$\oint_\gamma B \cdot ds = \mu_0 I_c + \mu_0\epsilon_0\frac{d\Phi_E}{dt}$
$\nabla \cdot B = 0$	$\oint_\Sigma B \cdot d\Sigma = 0$
$\nabla \cdot E = \frac{\rho}{\epsilon_0}$	$\oint_\Sigma E \cdot d\Sigma = \frac{Q}{\epsilon_0}$

Equazioni Fondamentali

Continuità: $\vec{\nabla} \cdot \overrightarrow{j_c} + \frac{\partial\rho}{\partial t} = 0$

Nei mezzi: $\overrightarrow{j_c} = \sigma_0\vec{E}$ | $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{k\epsilon_0}$ | $\frac{\partial\rho}{\partial t} = -\frac{\sigma_0}{k\epsilon_0}\rho$ | $\overrightarrow{j_s} = k\epsilon_0\frac{\partial\vec{E}}{\partial t}$ | $\vec{\nabla} \times \vec{B} = \mu_0(\overrightarrow{j_c} + \overrightarrow{j_s})$

$[V = J/C]$ | $E = [\frac{N}{C}] = [\frac{V}{m}]$ | $\Phi_E = [\frac{N}{C}m^2]$ | $[A = \frac{C}{s} = \frac{V}{\Omega}]$ | $[T = \frac{N}{A \cdot m}]$ | $\Phi_B = [T \cdot m^2] = [\frac{N \cdot m}{A}]$ | $L = [H] = \left[\frac{T \cdot m^2}{A}\right] = \left[\frac{N \cdot m}{A^2}\right]$

$\nabla \cdot f(r) = \frac{1}{r^2}D[r^2 f(r)]$ **!! Solo in cartesiane e** $f(r) = f(r)\hat{u}_r$ **!!**