# J Ö F N U R

## RAFSTÖÐUFRÆÐI

$k = 1/(4\pi\epsilon_0)$

Coulomb $\mathbf{F} = \frac{kqQ}{r^2}\hat{\mathbf{r}}$

Rafsvið

$$\mathbf{E} = \frac{kQ}{r^2}\hat{\mathbf{r}} \quad \mathbf{E} = k\int \frac{dq}{r^2}\hat{\mathbf{r}}$$

Umhverfis langan vír $E = 2k\lambda/R$

Við þynnu $E = \sigma/2\epsilon_0$

Milli þynna, þéttir $E = \sigma/\epsilon_0$

Tvískautsvægi $\mathbf{p} = q\,\mathbf{d}$

$\mathbf{E} = k(-\mathbf{p}/r^3 + 3(\mathbf{p}\cdot\mathbf{r})\mathbf{r}/r^5)$

$\boldsymbol{\tau} = \mathbf{p}\times\mathbf{E}$

$U = -\mathbf{p}\cdot\mathbf{E}$

$\mathbf{F} = \nabla(\mathbf{p}\cdot\mathbf{E})$

Rafflæði $\Phi_E = \oint \mathbf{E}\cdot d\mathbf{A}$

Lögmál Gauss $\oint \mathbf{E}\cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$

Rafmætti

$$V_B - V_A = -\int_A^B \mathbf{E}\cdot d\mathbf{s}$$

í einsleitu sviði $\Delta V = \pm E\,d$

fyrir punkthleðslu $V = \frac{kQ}{r}$

dreifð hleðsla $V = \int \frac{k\,dq}{r}$

Mættisorka $U = q\,V$

$\mathbf{E} = -\nabla V$

Rýmd $C = Q/V$

Plötuþéttir $C = \epsilon_0 A/d$

Hliðt. $C_{eq} = C_1 + C_2 + \ldots + C_N$

Raðt. $1/C_{eq} = 1/C_1 + 1/C_2 + \ldots + 1/C_N$

$U_E = Q^2/2C = QV/2 = CV^2/2$

Orkuþéttleiki $u_E = \frac{1}{2}\,\epsilon_0 E^2$

Rafsvari $C = \kappa C_0 \quad E_D = E_0/\kappa$

## RAFSEGULFRÆÐI

Straumur $I = dQ/dt \quad J = I/A$

$\mathbf{J} = nq\,\mathbf{v}_d \quad \mathbf{J} = (1/\rho)\mathbf{E} = \sigma\mathbf{E}$

$R = V/I \quad R = \rho l/A \quad V = IR$

$P = IV = I^2R = V^2/R$

$\rho = \rho_0(1 + \alpha(T - T_0))$

Kirchhoff: $\mathbf{\Sigma}I = 0 \quad \mathbf{\Sigma}V = 0$

Viðnám

raðt. $R_{eq} = R_1 + R_2 + \ldots + R_N$

hliðt. $1/R_{eq} = 1/R_1 + 1/R_2 + \ldots + 1/R_N$

Afhleðsla og hleðsla þéttis

$Q = Q_0 e^{-t/\tau}; \qquad I = I_0 e^{-t/\tau}$

$\tau = RC$

$Q = Q_0(1 - e^{-t/\tau}); \quad I = I_0 e^{-t/\tau}$

$\mathbf{F} = q\,\mathbf{v}\times\mathbf{B} \qquad \mathbf{F} = I\boldsymbol{\ell}\times\mathbf{B}$

$d\mathbf{F} = I\,d\mathbf{l}\times\mathbf{B} \qquad \boldsymbol{\mu} = NIA\,\hat{\mathbf{n}}$

$\boldsymbol{\tau} = \boldsymbol{\mu}\times\mathbf{B} \qquad U = -\boldsymbol{\mu}\cdot\mathbf{B}$

Rafeind á braut $evB = mv^2/r$

$\boldsymbol{\mu} = -(e/2m)\mathbf{L}$ $L = mvr$

Lorentz $\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$

Hall $nq = \frac{-J_x B_y}{E_z}$

Langur vír $B = \mu_0 I/2\pi R$

Tveir vírar $F/\ell = \frac{\mu_0 I_1 I_2}{2\pi d}$

Biot-Savart

$$d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{I d\boldsymbol{\ell} \times \hat{\mathbf{r}}}{r^2}$$

Spóla $B = \frac{1}{2}\mu_0 n I(\sin\theta_2 - \sin\theta_1)$

Ampere $\oint \mathbf{B} \cdot d\boldsymbol{\ell} = \mu_0 I$

Segulflæði $\Phi_B = \mathbf{B} \cdot \mathbf{A}$

$\Phi_B = \int \mathbf{B} \cdot d\mathbf{A}$

Faraday $\mathcal{E} = -\frac{d\Phi_B}{dt}$

Sjálfspan, víxlspan

$\mathcal{E}_{11} = -L_1 \frac{dI_1}{dt}$ $N_1\Phi_{11} = L_1 I_1$

$\mathcal{E}_{12} = -M \frac{dI_2}{dt}$ $N_1\Phi_{12} = M I_2$

Spóla $L = \mu_0 n^2 A\ell$

LR-rás

$I = I_0(1 - e^{-t/\tau})$

$I = I_0 e^{-t/\tau}$

$\tau = \frac{L}{R}$ $I_0 = \mathcal{E}/R$

Orka í spólu $U_L = \frac{1}{2} LI^2$

Orkuþéttleiki $u_B = \frac{B^2}{2\mu_0}$

LC- sveiflur

$$\frac{d^2Q}{dt^2} + \frac{1}{LC} Q = 0 \quad \omega_0 = \frac{1}{\sqrt{LC}}$$

Deyfðar LC-sveiflur

$$L\frac{d^2Q}{dt^2} + R\frac{dQ}{dt} + \frac{Q}{C} = 0$$

$$\begin{aligned} Q &= Q_0 e^{-Rt/2L}\cos(\omega' t + \delta) \\ \omega' &= \sqrt{\omega_0^2 - \left(\frac{R}{2L}\right)^2} \end{aligned}$$

Riðstraumur $i = i_0 \sin(\omega t)$

$v = v_0 \sin(\omega t + \phi)$

rms gildi

$I = \sqrt{(i^2)_{av}} = \frac{i_0}{\sqrt{2}} \approx 0.707 i_0$

$V = \sqrt{(v^2)_{av}} = \frac{v_0}{\sqrt{2}} \approx 0.707 v_0$

$X_L = \omega L$ $X_C = 1/\omega C$

Samviðnám $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$\tan\phi = \frac{X_L - X_C}{R}$

Afl

$$\begin{aligned} P &= I^2 R = IV\cos\phi \\ P &= \frac{V^2 R}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \end{aligned}$$

Spennir $i_2 N_2 = i_1 N_1$ $i_2 v_2 = i_1 v_1$

Maxwell

$$\begin{aligned} \oint \mathbf{E} \cdot d\mathbf{A} &= \frac{Q}{\epsilon_0} \\ \oint \mathbf{B} \cdot d\mathbf{A} &= 0 \\ \oint \mathbf{E} \cdot d\boldsymbol{\ell} &= -\frac{d\Phi_B}{dt} \\ \oint \mathbf{B} \cdot d\boldsymbol{\ell} &= \mu_0 \left( I + \epsilon_0 \frac{d\Phi_E}{dt} \right) \end{aligned}$$

Á diffurformi

$$\begin{aligned} \nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon_0} \\ \nabla \cdot \mathbf{B} &= 0 \end{aligned}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$
$$\nabla \times \mathbf{B} = \mu_0 \left( \mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$

Öldulíkingar

$$\nabla^2 \mathbf{E} - \mu_0 \epsilon_0 \frac{\partial^2 \mathbf{E}}{\partial t^2} = 0$$
$$\nabla^2 \mathbf{B} - \mu_0 \epsilon_0 \frac{\partial^2 \mathbf{B}}{\partial t^2} = 0\,.$$

Um þætti sléttrar bylgju

$$\mathbf{E} = E_0 \sin(kz - \omega t)\hat{\mathbf{x}}$$

$$\mathbf{B} = \frac{1}{c}\hat{\mathbf{k}} \times \mathbf{E}$$

$$\mathbf{E} = -c\hat{\mathbf{k}} \times \mathbf{B}$$

$c = (\mu_0 \epsilon_0)^{-1/2} \quad E = cB \quad c = \lambda f$

Orkuþéttleiki

$$u = \epsilon_0 E^2 = \frac{B^2}{\mu_0} = \sqrt{\frac{\epsilon_0}{\mu_0}}\, EB$$

Poynting-vigur

$$\mathbf{S} = \frac{\mathbf{E} \times \mathbf{B}}{\mu_0} \quad S_{ave} = \frac{E_0 B_0}{2\mu_0}$$

Skriðþungi, geislaþrýstingur

$$p = \frac{U}{c} \quad \frac{F}{A} = \frac{S}{c} = u$$

## LJÓSFRÆÐI

$n = \frac{c}{v}$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$m = \frac{y_1}{y_0} = -\frac{q}{p}$

$\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$

$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\delta = m\lambda$

$m = 0, \pm 1, \pm 2, \ldots$

$\delta = \left(m + \frac{1}{2}\right)\lambda$

$d \sin\theta = m\lambda$

$d \sin\theta = \left(m + \frac{1}{2}\right)\lambda$

$I = 4I_0 \cos^2(\frac{\phi}{2})$

$a \sin\theta = m\lambda$

$d \sin\theta = m\lambda$

$I = I_0 \frac{\sin^2(\alpha/2)}{(\alpha/2)^2} \quad \alpha = 2\pi a \sin\theta/\lambda$

Skautun

Malus $\quad I = I_{max} \cos^2\phi$

Brewster $\quad \tan\theta_p = \frac{n_b}{n_a}$

## STÆRÐFRÆÐI

$\nabla \times (\nabla \times \mathbf{F}) = \nabla(\nabla \cdot \mathbf{F}) - \nabla^2 \mathbf{F}$

Vigrar:

$\mathbf{A} \cdot \mathbf{B} = AB\cos\theta = A_x B_x + A_y B_y + A_z B_z$

$$\mathbf{A} \times \mathbf{B} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$|\mathbf{A} \times \mathbf{B}| = AB \sin\theta$

$\hat{\mathbf{C}} = \frac{\mathbf{C}}{|\mathbf{C}|}$

Hornafræði:

$C^2 = A^2 + B^2 - 2AB\cos\gamma$

$\frac{\sin\alpha}{A} = \frac{\sin\beta}{B} = \frac{\sin\gamma}{C}$

$\sin(x+y) = \sin x \cos y + \cos x \sin y$

$$\cos(x+y) = \cos x \cos y - \sin x \sin y$$
$$\sin x + \sin y = 2\sin(\tfrac{x+y}{2})\cos(\tfrac{x-y}{2})$$
$$\cos x + \cos y = 2\cos(\tfrac{x+y}{2})\cos(\tfrac{x-y}{2})$$
$$\sin(-x) = -\sin x$$
$$\cos(-x) = \cos x$$
$$\sin 2x = 2\sin x \cos x$$
$$\cos 2x = 2\cos^2 x - 1$$

Raðir:

$$(1+x)^n = 1 + xn + \tfrac{n(n-1)}{2}x^2 + o(x^3)$$
$$\ln(1+x) = x - \tfrac{1}{2}x^2 + o(x^3)$$
$$\sin x = x + o(x^3)$$
$$\cos x = 1 - x^2/2 + o(x^4)$$
$$e^x = 1 + x + o(x^2)$$

Rúmheildi:

Kartísk hnit

$$\int dx \int dy \int dz\ f(x,y,z)$$

Sívalnings hnit

$$\int_0^R \rho d\rho \int_0^{2\pi} d\varphi \int_0^h dz\ f(\rho,\varphi,z)$$

Kúluhnit

$$\int_0^R r^2 dr \int_0^{2\pi} d\varphi \int_0^{\pi} \sin\theta d\theta\ f(r,\varphi,\theta)$$

Diffurvirkjar:

Kartísk hnit

$$\nabla V = \hat{\mathbf{x}}\,\frac{\partial V}{\partial x} + \hat{\mathbf{y}}\,\frac{\partial V}{\partial y} + \hat{\mathbf{z}}\,\frac{\partial V}{\partial z}$$

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

Sívalningshnit

$$\nabla V = \hat{\rho}\,\frac{\partial V}{\partial \rho} + \hat{\phi}\,\frac{1}{\rho}\frac{\partial V}{\partial \phi} + \hat{\mathbf{z}}\,\frac{\partial V}{\partial z}$$

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho\frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$$

Kúluhnit

$$\nabla V = \hat{\mathbf{r}}\,\frac{\partial V}{\partial r} + \hat{\theta}\,\frac{1}{r}\frac{\partial V}{\partial \theta} + \hat{\phi}\,\frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}$$

$$\begin{aligned}\nabla^2 V &= \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) \\ &+ \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial V}{\partial \theta}\right) \\ &+ \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \phi^2}\end{aligned}$$