

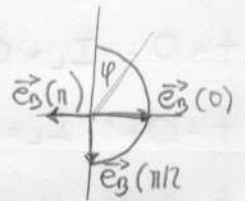
$$1.) \quad \vec{B} = \frac{\mu_0 I'}{2\pi(c-b)} (-\vec{e}_y) = \frac{\mu_0 I'}{2\pi\left(\frac{a^2}{b} - b\right)} \frac{\mu_r - 1}{\mu_r + 1} (\vec{e}_y)$$

$$\vec{F}' = I B \vec{e}_z \times (-\vec{e}_y) = \boxed{\frac{\mu_0 I'^2 b}{2\pi(a^2 - b^2)} \frac{\mu_r - 1}{\mu_r + 1} \vec{e}_x}$$

2.) (i)



$$(ii) \quad d\vec{B} = \frac{\mu_0 dI}{2\pi a} \vec{e}_B \quad \text{mit } dI = \frac{I}{\pi a}$$



$$\vec{e}_B = \vec{e}_B(\varphi) = \cos\varphi \vec{e}_x - \sin\varphi \vec{e}_y$$

$$\vec{B}(\theta) = \frac{\mu_0 I}{2\pi^2 a^2} \int_0^\pi \cos\varphi \vec{e}_x - \sin\varphi \vec{e}_y = \frac{\mu_0 I}{2\pi^2 a^2} (\sin\varphi \vec{e}_x + \cos\varphi \vec{e}_y) \Big|_0^\pi$$

$$= \boxed{\frac{\mu_0 I}{\pi^2 a^2} (-\vec{e}_y)}$$

3.)

$$\frac{U_c}{U} = \frac{1}{j\omega C} \frac{1}{R + j\omega L + \frac{1}{j\omega C}} = \frac{1}{1 - \omega^2 LC + j\omega RC}$$

$$\left| \frac{U_c}{U} \right| = \frac{1}{\sqrt{(1 - \omega^2 LC)^2 + (\omega RC)^2}} = \frac{1}{f(\omega)} \quad \text{max für } f(\omega) = \text{min}$$

$$f(\omega) = \omega^4 L^2 C^2 + \omega^2 (R^2 C^2 - 2LC) + 1$$

$$\frac{df(\omega)}{d\omega} = 4\omega^3 L^2 C^2 + \omega (2R^2 C^2 - 4LC) = 0$$

$$2\omega^2 L^2 C^2 = 2LC - R^2 C^2$$

$$\boxed{\omega = \sqrt{\frac{1}{LC} - \frac{R^2}{2L^2}}} \quad f = \frac{\omega}{2\pi}$$

$$4.) \bar{u} = \frac{1}{T} \int_0^T u(t) dt = \frac{1}{T} \left( 2 \frac{T}{7} \cdot 5V \cdot \frac{1}{2} + \frac{1}{7} T \cdot 5V \right)$$

$$= \frac{10}{7} V + \frac{5}{7} V = \frac{15}{7} V \approx \boxed{2,143 V}$$

$$5.) B = \frac{\Phi}{\alpha R} = \frac{\Phi}{c \alpha \rho} \quad H = \frac{B}{\mu_0} = \frac{\Phi}{\mu_0 c \alpha \rho}$$

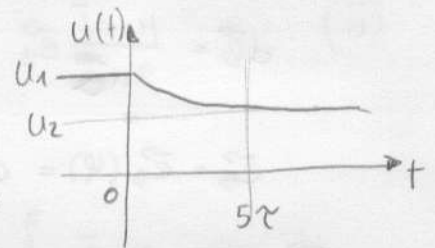
$$V = \int_a^b H dr = \frac{\Phi}{\mu_0 c \alpha} \ln\left(\frac{b}{a}\right) \quad C_{lm} = \frac{\Phi}{V} = \boxed{\frac{\mu_0 c \alpha}{\ln(b/a)}}$$

$$6.) t < 0: I_L = 0 \quad u(t) = R_1 I_q = U_1$$

$$t = 0+: I_L = 0 \quad u(t) = R_1 I_q = U_1$$

$$t \rightarrow \infty: U_L = 0 \quad u(t) = I_q \frac{R_1 R_2}{R_1 + R_2} = U_2$$

$$\tau = \frac{L}{R_1 + R_2}$$



$$7.) \underline{z}_L = R_1 + j\omega L$$

$$\underline{z}_C = \frac{R_2}{1 + j\omega R_2 C}$$

$$\underline{z} = \underline{z}_L + \frac{\underline{z}_C \underline{z}}{\underline{z}_C + \underline{z}}$$

$$\underline{z}^2 + \underline{z} \underline{z}_C = \underline{z}_L \underline{z}_C + \underline{z}_L \underline{z} + \underline{z}_C \underline{z}$$

$$\underline{z}^2 - \underline{z}_L \underline{z} - \underline{z}_L \underline{z}_C = 0$$

$$\underline{z} = \frac{\underline{z}_L}{2} \pm \sqrt{\frac{\underline{z}_L^2}{4} + \underline{z}_L \underline{z}_C} = \boxed{\frac{\underline{z}_L}{2} \left( 1 \pm \sqrt{1 + 4 \frac{\underline{z}_C}{\underline{z}_L}} \right)}$$

$$8.) \quad \underline{I}_1 + \underline{I}_2 + \underline{I}_3 = 0 \quad \underline{I}_1 = \frac{U_1}{Z_1} \quad \underline{I}_2 = \frac{U_2}{Z_2} \quad \underline{I}_3 = \frac{U_3}{Z_3}$$

$$\underline{U}_{23} = \varrho^2 \underline{U} \quad \underline{U}_{31} = \varrho \underline{U} \quad \text{mit } \varrho = e^{j2\pi/3}$$

Maschen Gleichungen

$$\underline{U}_1 = \underline{U}_2 + \underline{U} \quad \underline{U}_3 = \underline{U}_2 - \varrho^2 \underline{U}$$

In Knotengleichung einsetzen  $\frac{\underline{U}_2 + \underline{U}}{Z_1} + \frac{\underline{U}_2}{Z_2} + \frac{\underline{U}_2 - \varrho^2 \underline{U}}{Z_3} = 0$

$$\underline{U}_2 = \underline{U} \frac{\varrho^2 Z_1 Z_2 - Z_2 Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}$$

$$9.) \quad \underline{Z}_W = \sqrt{\underline{Z}_u \underline{Z}_L}$$

$$\frac{1}{\underline{Z}_u} = \frac{Y' l}{2} + \frac{1}{Z_1'} = \frac{Y' Z_1' l^2 + 2}{2 Z_1'} \quad \underline{Z}_u = \frac{2 Z_1'}{Y' Z_1' l^2 + 2}$$

$$\frac{1}{\underline{Z}_L} = \frac{Y' l}{2} + \frac{Y' l}{2 Y' l^2 + 2} = \frac{Y' l (Z_1' Y' l^2 + 4)}{2 (Z_1' Y' l^2 + 2)} \quad \underline{Z}_L = \frac{2 (Z_1' Y' l^2 + 2)}{Y' l (Z_1' Y' l^2 + 4)}$$

$$\underline{Z}_W = \sqrt{\frac{4 Z_1'}{Y' (Z_1' Y' l^2 + 4)}} = 2 \cdot \sqrt{\frac{Z_1'}{Y' (Z_1' Y' l^2 + 4)}}$$

$$10.) \quad \underline{E} = \frac{Q}{4\pi\epsilon_0 r^2} \quad U = \frac{Q}{4\pi\epsilon_0} \int_a^\infty \frac{1}{r^2} dr = \frac{Q}{4\pi\epsilon_0} \left( \frac{1}{a} \right) \quad C = 4\pi\epsilon_0 a$$

$$(i) \quad W_e = \frac{CU^2}{2} = \frac{Q^2}{2C} = \frac{Q^2}{8\pi\epsilon_0 a}$$

$$(ii) \quad Q = -e \quad W_e = m_e c \omega^2 \quad a = \frac{Q^2}{8\pi\epsilon_0 m_e c \omega^2} \approx 1,407 \cdot 10^{-15} \text{ m}$$