

Θεμα 1

(α)

$$\Phi(x, y, z) = \frac{1}{4\pi\epsilon_0} \left[ \frac{q}{R_1} - \frac{a}{L} \frac{q}{R_2} + \frac{-2q + 2(a/L)q}{r} - \frac{a}{L} \frac{q}{R_3} + \frac{q}{R_4} \right] \quad (r \geq a)$$

$$\Phi(x, y, z) = \Phi(r = a) \quad (r \leq a)$$

$$R_1 = [x^2 + y^2 + (z - L)^2]^{1/2}$$

$$R_2 = [x^2 + y^2 + (z - \frac{a^2}{L})^2]^{1/2}$$

$$r = [x^2 + y^2 + z^2]^{1/2}$$

$$R_3 = [x^2 + y^2 + (z + \frac{a^2}{L})^2]^{1/2}$$

$$R_4 = [x^2 + y^2 + (z + L)^2]^{1/2}$$

(β)

$$\Phi(r = a) = -\frac{q}{2\pi\epsilon_0} \left[ \frac{1}{a} - \frac{1}{L} \right]$$

(γ)

$$\sigma(0, 0, a) = -\frac{q}{4\pi} \left[ \left(1 + \frac{L}{a}\right) \frac{1}{(L-a)^2} + 2\left(1 - \frac{L}{a}\right) \frac{1}{a^2} - \left(1 - \frac{L}{a}\right) \frac{1}{(L+a)^2} \right]$$

Θεμα 2

(α)

$$\vec{A}(x, y, z) = -\hat{i}_y \frac{\mu_0 I}{2\pi} \ln \left[ \frac{R_2 R_3}{R_1 R_4} \right]$$

$$R_1 = [(x+a)^2 + (z-h)^2]^{1/2}$$

$$R_2 = [(x+a)^2 + (z+h)^2]^{1/2}$$

$$R_3 = [(x-a)^2 + (z-h)^2]^{1/2}$$

$$R_4 = [(x-a)^2 + (z+h)^2]^{1/2}$$

(β)

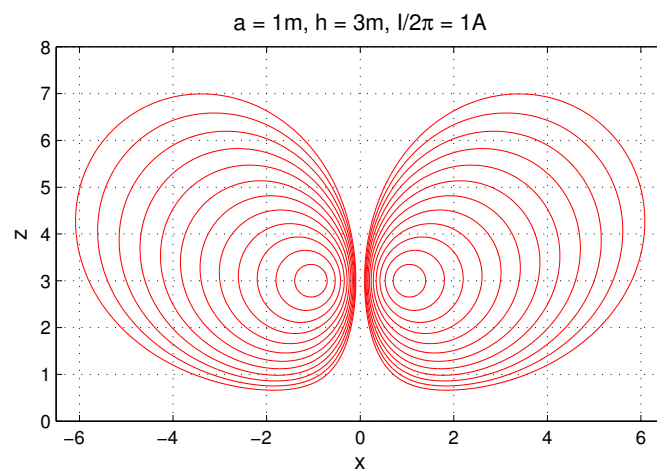
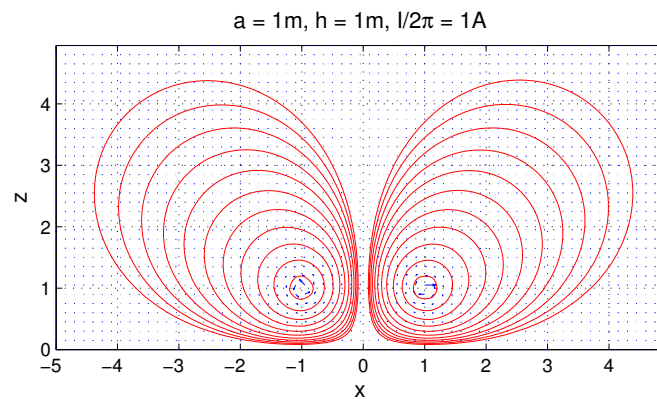
$$H_x = \frac{I}{2\pi} \left[ -\frac{z-h}{R_1^2} + \frac{z+h}{R_2^2} + \frac{z-h}{R_3^2} - \frac{z+h}{R_4^2} \right]$$

$$H_z = \frac{I}{2\pi} \left[ \frac{x+a}{R_1^2} - \frac{x+a}{R_2^2} - \frac{x-a}{R_3^2} + \frac{x-a}{R_4^2} \right]$$

(γ)

$$\vec{K} = -\hat{i}_y \frac{4Ih}{\pi} \frac{xa}{[(x+a)^2 + h^2][(x-a)^2 + h^2]}$$

(δ)



Θεμα 3

(α)

$$\rho_b = 0, \quad \sigma_b = P_0 \sin \phi$$

(β)

$$\Phi_1(r_T, \phi) = \frac{P_0}{2\epsilon_0} r_T \sin \phi \quad (r_T \leq a)$$

$$\Phi_2(r_T, \phi) = \frac{P_0}{2\epsilon_0} \frac{a^2}{r_T} \sin \phi \quad (r_T \geq a)$$

$$\vec{E}_1 = -\frac{P_0}{2\epsilon_0} (\sin \phi \hat{i}_{r_T} + \cos \phi \hat{i}_\phi) = -\frac{P_0}{2\epsilon_0} \hat{i}_y$$

$$\vec{E}_2 = \frac{P_0 a^2}{2\epsilon_0} \frac{1}{r_T^2} (\sin \phi \hat{i}_{r_T} - \cos \phi \hat{i}_\phi)$$

$$\vec{D}_1 = \frac{P_0}{2} (\sin \phi \hat{i}_{r_T} + \cos \phi \hat{i}_\phi) = \frac{P_0}{2} \hat{i}_y$$

$$\vec{D}_2 = \frac{P_0 a^2}{2} \frac{1}{r_T^2} (\sin \phi \hat{i}_{r_T} - \cos \phi \hat{i}_\phi)$$

Θεμα 4

(α)

$$\Psi_m = \frac{I\mu_0 b}{4\pi} \ln \left( \frac{d^2 + L^2 + 2dL \cos \theta}{d^2 + L^2 - 2dL \cos \theta} \right)$$

(β)

$$L_{12} = L_{21} = \frac{\mu_0 b}{4\pi} \ln \left( \frac{d^2 + L^2 + 2dL \cos \theta}{d^2 + L^2 - 2dL \cos \theta} \right)$$

(γ)

$$V(t) = -I\omega \frac{\mu_0 b}{4\pi} \frac{4d^2 L^2 \sin(2\omega t)}{d^4 + L^4 - 2d^2 L^2 \cos(2\omega t)}$$

