

$$\vec{E} = \frac{1}{4\pi\epsilon} \frac{q_1 q_2}{r^2}$$

$$\vec{E}' = \frac{\vec{E}}{q}$$

$$d\mathcal{L} = -q \vec{E}' \cdot d\vec{l}$$

$$I = \int_S \vec{S} \cdot d\vec{S}$$

$$\vec{S} = \rho_v \vec{v}$$

$$a_{KJ} = \begin{cases} +1 & \text{bato } j \text{ incide nel nodo } K \text{ ed } i \text{ uscente} \\ -1 & \text{bato } j \text{ incide nel nodo } K \text{ ed } i \text{ entrante} \\ 0 & \text{il bato } j \text{ non incide in } K \end{cases}$$

$$\begin{cases} A_i = 0 \\ \vec{v} - A^T \vec{u} = 0 \end{cases}$$

$$\vec{v}^T \vec{u} = \vec{v} \cdot \vec{u} = 0 \quad | \quad \sum P_k = 0$$

$$P_{eq} = \sum v_k i_k \quad \text{Max Trans in R: } R = R_{TH}$$

- 1) Tensioni di bato in funzione dei pot. di nodo
 - 2) Trattare le eq. cont. si scrivono le correnti di bato
 - 3) Si risolvono i vari loop nodali.
- $$\begin{cases} K-O: \text{rimuovi KCL in } K \text{ e aggiungi le eq. cont.} \\ K-h: \text{rimuovi la ingloba b.b e aggiungi le eq. cont.} \end{cases}$$

$$V_J = V \frac{R_J}{\sum R_K} \quad i_J = I \frac{G_J}{\sum G_K}$$

$$\left\{ N=2: i_1 = I \frac{R_2}{R_1+R_2}; i_2 = I \frac{R_1}{R_1+R_2} \right\}$$

$$P' = \underline{V}''^T \underline{i}' \quad P'' = \underline{V}'^T \underline{i}''$$

$$\text{reciproco: } P' = P'' \quad \forall \underline{V}', \underline{V}'', \underline{i}', \underline{i}''$$

SIMMETRICO		
	RECIPROCO	
\mathcal{R}	$R_{12} = R_{21}$	$R_{11} = R_{22}$
\mathcal{G}	$G_{12} = G_{21}$	$G_{11} = G_{22}$
\mathcal{T}	$ \mathcal{T} = 1$	$T_{11} = T_{22}$
\mathcal{H}	$H_{12} = -H_{21}$	$ \mathcal{H} = 1$
\mathcal{H}'	$H'_{12} = -H'_{21}$	$ \mathcal{H}' = 1$

- 1) Passivo ind.
- 2) Ricavo approssimazioni annullando una delle due incognite
- 3) Calcolo contributo degli ind. studiando le porte con modelli apppi

$$\vec{B}' = \underline{G}$$

$$\vec{F} = q(\vec{E}' + \vec{v} \times \vec{B})$$

$$\vec{B} = \frac{\mu_0}{4\pi} q \frac{\vec{v} \times \vec{v}_2}{r^2}$$

$$\text{filo: } \vec{B} = \frac{\mu_0}{2\pi r} I \cdot \vec{v}_0$$

$$\text{Spira lungo l'asse: } B = \frac{\mu_0 I a^2}{2(a^2 + r^2)^{3/2}}$$

$$\text{Stare: } d\vec{B} = \frac{\mu_0}{4\pi} I \frac{d\vec{l}}{r^2} \vec{v}_1 \times \vec{v}_2$$

$$\text{Uare: } \mu_m = -\frac{d\mathcal{E}}{d\vec{B}} \quad v = \frac{d\vec{x}}{d\vec{t}}$$

$$\text{STAR.} \quad \oint_S \vec{E} \cdot d\vec{S} = \frac{Q}{\epsilon}$$

$$\oint_S \vec{B} \cdot d\vec{S} = 0$$

$$\oint_L \vec{E} \cdot d\vec{l} = 0$$

$$\oint_L \vec{B} \cdot d\vec{l} = \mu_0 I$$

$$\text{VAR.} \quad \oint_S \vec{E} \cdot d\vec{S} = \frac{Q}{\epsilon}$$

$$\oint_S \vec{B} \cdot d\vec{S} = 0$$

$$-\oint_L \vec{E} \cdot d\vec{l} = \int_S \frac{\partial}{\partial t} \vec{B} \cdot d\vec{S}$$

$$\oint_L \vec{B} \cdot d\vec{l} = \mu_0 I + \mu_0 \epsilon_0 \int_S \frac{\partial}{\partial t} \vec{E} \cdot d\vec{S}$$

$$i = C \frac{dv}{dt}$$

$$v = L \frac{di}{dt}$$

$$\text{Regime stazionario: } \begin{cases} \equiv C.A \\ \equiv C.C. \end{cases}$$

$$C = \epsilon \frac{S}{d}$$

$$L = \frac{\mu N^2 S}{\ell}$$

$$\alpha e^{\beta(t-\bar{t})} \rightarrow \gamma e^{\beta(t-\bar{t})}$$

$$\sum_{k=0}^N \alpha_k (t-\bar{t})^k \rightarrow \sum_{k=0}^N \gamma_k (t-\bar{t})^k$$

$$\alpha \cos(\omega t + \varphi) \rightarrow \beta \cos(\omega t) + \gamma \sin(\omega t)$$

$$\frac{d}{dt} x = \lambda x + u \rightarrow x = K e^{\lambda(t-t_0)} + x_{ip}$$

$$\lambda < 0 \rightarrow \text{stabile}$$

$$x = \underbrace{K e^{\lambda(t-t_0)}}_{\text{TRANSITORIO}} + \underbrace{x_{ip}}_{\text{REGIME}}$$

$$\cos^2(\alpha) + \sin^2(\alpha) = 1$$

$$\cos(\alpha - \beta) = \cos(\alpha) \cos(\beta) + \sin(\alpha) \sin(\beta)$$

$$\cos(\alpha + \beta) = \cos(\alpha) \cos(\beta) - \sin(\alpha) \sin(\beta)$$

$$\sin(\alpha - \beta) = \sin(\alpha) \cos(\beta) - \cos(\alpha) \sin(\beta)$$

$$\sin(\alpha + \beta) = \sin(\alpha) \cos(\beta) + \cos(\alpha) \sin(\beta)$$

$$\cos(\alpha + \pi/2) = -\sin(\alpha)$$

$$\cos(\alpha - \pi/2) = \sin(\alpha)$$

$$\frac{1}{2} [\cos(\alpha - \beta) + \cos(\alpha + \beta)] = \cos(\alpha) \cos(\beta)$$

$$x_m \cos(\omega t + \varphi) \leftrightarrow x_m e^{j\varphi}$$

$$x(t) = \text{Re} \{ e^{j\omega t} \bar{x} \}$$

$$\frac{d}{dt} \bar{x} = j\omega \bar{x}$$

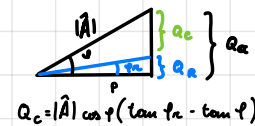
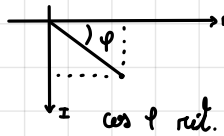
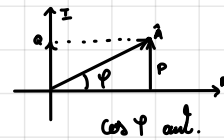
$$\bar{u} = j\omega C \bar{v} \Rightarrow \bar{u} \text{ antiaf. } \frac{\pi}{2}$$

$$\bar{v} = j\omega L \bar{u} \Rightarrow \bar{v} \text{ antiaf. } \frac{\pi}{2}$$

$$\bar{z} = \frac{\bar{v}}{\bar{u}} \quad \gamma = \bar{z}^{-1}$$

$$H(j\omega) = \frac{\sqrt{601}}{\bar{v}_{10}}$$

$$\omega_1: |H(j\omega)| = \frac{\sqrt{2}}{2}$$



$$\text{serie positiva: } \varphi_a = 0; \varphi_b = -\frac{2}{3}\pi; \varphi_c = -\frac{4}{3}\pi$$

$$\text{serie negativa: } \varphi_a = 0; \varphi_c = -\frac{2}{3}\pi; \varphi_b = -\frac{4}{3}\pi$$

$$\vec{E}_v = |\vec{E}_v| e^{j\theta} \rightarrow P_{EFF} = 3 V_p I_p \cos \theta = \sqrt{3} V_L I_L \cos \theta$$

$$X_{EFF} = \frac{X_m}{\sqrt{2}} \quad z_\Delta = 3 z_\gamma$$

$$\Delta \rightarrow \gamma: \bar{v}_p = \frac{\sqrt{6}}{\sqrt{3}} e^{-j\frac{\pi}{6}}$$

$$\gamma - \gamma: \bar{v}_L = \sqrt{3} \bar{v}_p e^{j\frac{\pi}{6}}; \quad \bar{I}_L = \bar{I}_p$$

$$\gamma - \Delta: \bar{v}_L = \sqrt{3} \bar{v}_p e^{j\frac{\pi}{6}}; \quad \bar{I}_L = \sqrt{3} \bar{I}_p e^{-j\frac{\pi}{6}}$$

$$\Delta - \Delta: \bar{v}_L = \bar{v}_p; \quad \bar{I}_L = \sqrt{3} \bar{I}_p e^{-j\frac{\pi}{6}}$$

$$\Delta - \gamma: \bar{v}_L = \bar{v}_p; \quad \bar{I}_p = \bar{I}_L$$

$$\begin{bmatrix} L_1 & M \\ M & L_2 \end{bmatrix} \xrightarrow{L} \text{acc. profilo per } |L|=0$$

Circuito elettrico	Circuito magnetico
R resistenza	\mathcal{R} riluttanza
i corrente	Ψ flusso
e forza elettromotrice	Ni forza magnetomotrice
v tensione elettrica	$v_H = \mathcal{R}\Psi$ "tensione magnetica"

$$\begin{cases} V_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt} \\ V_2 = M \frac{di_1}{dt} + L_2 \frac{di_2}{dt} \end{cases}$$

$$K = \frac{M}{\sqrt{L_1 L_2}} \quad P_a = \frac{d}{dt} W_a$$

$$W_a = \frac{1}{2} L_1 i_1^2 + \frac{1}{2} L_2 i_2^2 + M i_1 i_2$$

$$\text{serie equiv.: } Z_{eq} = j(x_1 + x_2 + 2x_m)$$

$$\text{parallelo equiv.: } Z_{eq} = j \frac{x_1 x_2 - x_m^2}{x_1 + x_2 - 2x_m}$$

$$\text{' contr.: } Z_{eq} = j(x_1 + x_2 - 2x_m)$$

$$\text{' contr.: } Z_{eq} = j \frac{x_1 x_2 - x_m^2}{x_1 + x_2 + 2x_m}$$

$$KCL_m: \sum \psi_k = 0$$

$$KVL_m: \sum v_{HK} = \sum N_k i_k$$

$$\vec{B}' = \mu_0 (1 + \chi_m) \vec{H}' = \mu_0 \mu_r \vec{H}'$$

$$\mathcal{R} = \frac{\ell}{\mu_0 \mu_r S} \quad \Phi = N \Psi = \sum L_k i_k$$

$$\text{Nel trasformatore: } \mathcal{R} = \mathcal{R}_F + \mathcal{R}_T, \text{ se } \mu \gg \mu_0 \mathcal{R} \cong \mathcal{R}_T$$