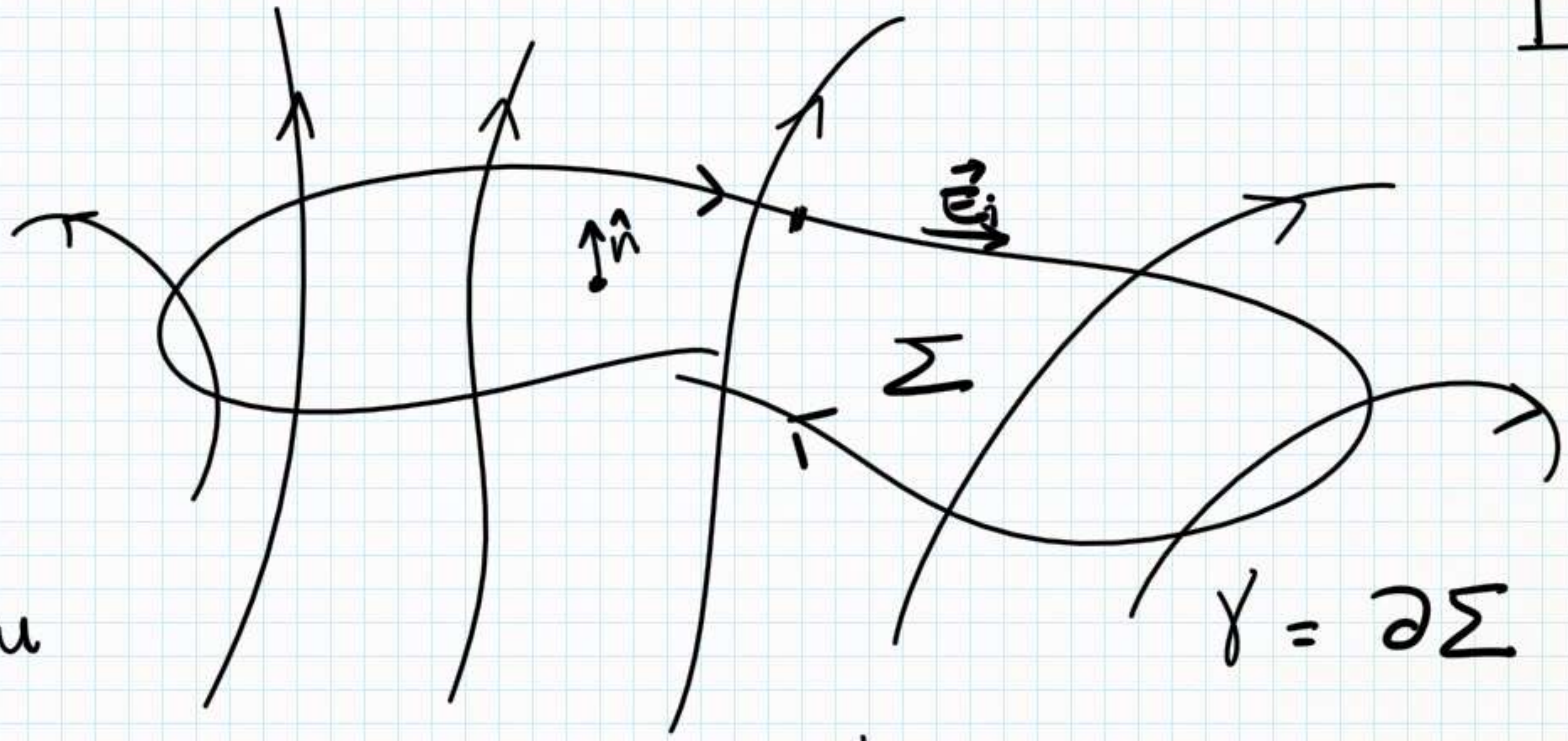
FARADAY - NEUMANN - LENZ

$$\boxed{f_i = f_{em} = - \frac{d\Phi_{B(t)}}{dt}}$$

$\updownarrow$

$$\vec{\nabla} \times \vec{E} = - \frac{\partial \vec{B}}{\partial t}$$ III MAXWELL

ELETTROST: $\vec{\nabla} \times \vec{E} = 0$



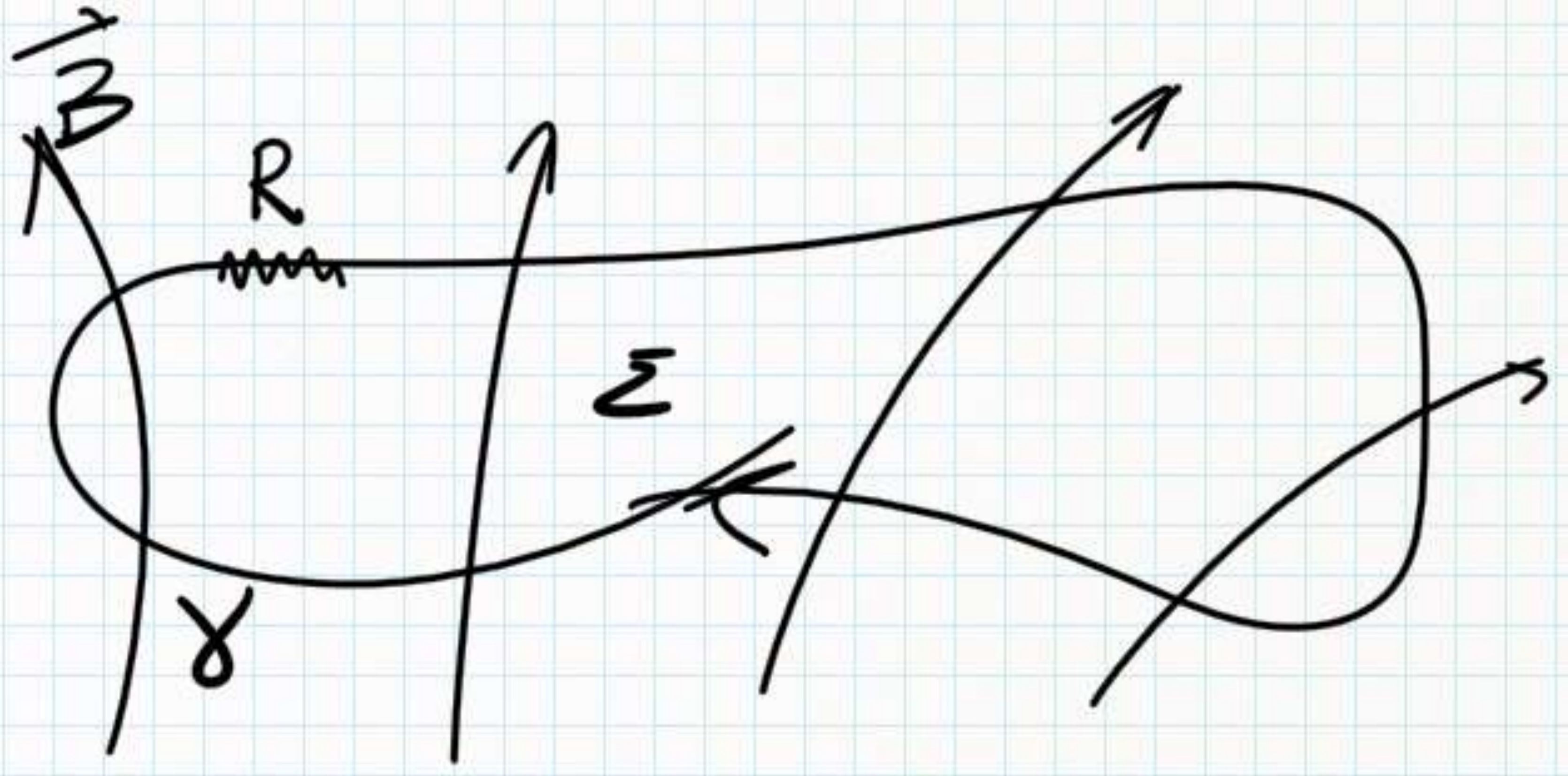
- $$\underbrace{\Phi_B^{\Sigma}(t) = \iint_{\Sigma} \vec{B} \cdot \hat{n} \, dS}_{\text{ESERCIZI}} \xrightarrow{-\frac{d}{dt}} \underline{f_{em}} = -\oint_{\gamma} d\vec{l} \, \vec{E}_i$$

$\downarrow$

ESERCIZI

LEAEI 12/06/23 EX 2

$$\Phi_\Sigma(t) = 3(\alpha t^3 + \beta t^2 - 7)\ T\cdot m^2 \qquad \begin{cases} \alpha = 0.6\ s^{-3} \\ \beta = 0.5\ s^{-2} \end{cases}$$



$R = 2\ \Omega$

(i) f_i ? ($f_i(t)$) $\longrightarrow$ F.N.L.

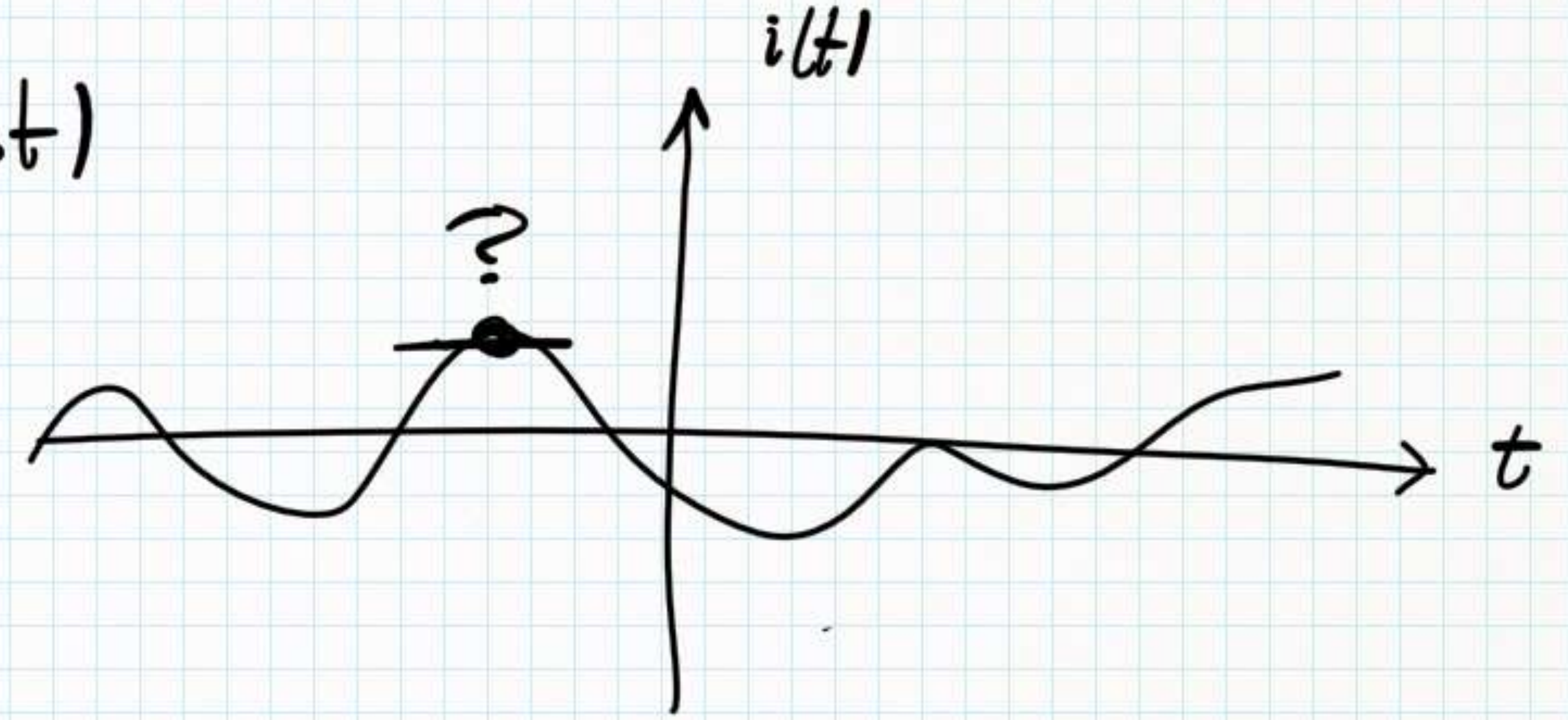
(ii) CORRENTE MAX $t \in \mathbb{R}$ $\longrightarrow$ LEGGE DI OHM

(iii) $[0,3]\ s = \Delta E_{DISS} = ?$ $\longrightarrow$ EFFETTO JOULE

SOLUZIONE:

(i) $\Rightarrow$ $f_i = -\dfrac{d\Phi}{dt} = -3(3\alpha t^2 + 2\beta t)\ T\cdot m^2$ ✓

(ii) $i_{MAX} = ?$ $\qquad i(t) = \frac{f_i(t)}{R} = -\frac{3}{R}(3\alpha t^2 + 2\beta t)$



• $i'(\bar t) = -\frac{3}{R}\underbrace{(6\alpha t + 2\beta)}\Big|_{\bar t} = 0$

$$\bar t = -\frac{\beta}{3\alpha}$$

• $i''(\bar t) > 0$ MINIMO ×

$i''(\bar t) < 0$ MAX ✓

$i''(\bar t) = 0$ ×

$i''(t) = -\frac{3}{R}(6\alpha) = \frac{-9\alpha}{R} < 0$ MASSIMO

$$i_{MAX} = i(\bar t) = \frac{-3}{R}\left(3\alpha\left(-\frac{\beta}{3\alpha}\right)^2 + 2\beta\left(-\frac{\beta}{3\alpha}\right)\right) = \frac{-3}{R}\left\{\frac{\beta^2}{3\alpha} - 2\frac{\beta^2}{3\alpha}\right\} = +\frac{\beta^2}{\alpha R}$$

(iii) $\begin{cases} P = \dfrac{dE}{dt} \\ P = Ri^2 = \dfrac{f_i^2}{R} = \dfrac{9}{R}\left(9\alpha^2 t^4 + 12\alpha\beta t^3 + 4\beta^2 t^2\right) \end{cases}$

$$\Delta E_{Diss} = \int_{0s}^{3s} \frac{dE}{dt}\,dt = \int_{0s}^{3s} P(t)\,dt = \frac{9}{R}\int_0^3 dt\left[9\alpha^2 t^4 + 12\alpha\beta t^3 + 4\beta^2 t^2\right] =$$

$$= \frac{9}{R}\left[9\alpha^2 \frac{t^5}{5} + 12\alpha\beta\frac{t^4}{4} + 4\beta^2\frac{t^3}{3}\right]\Bigg|_{\cancel{0}}^{3} =$$

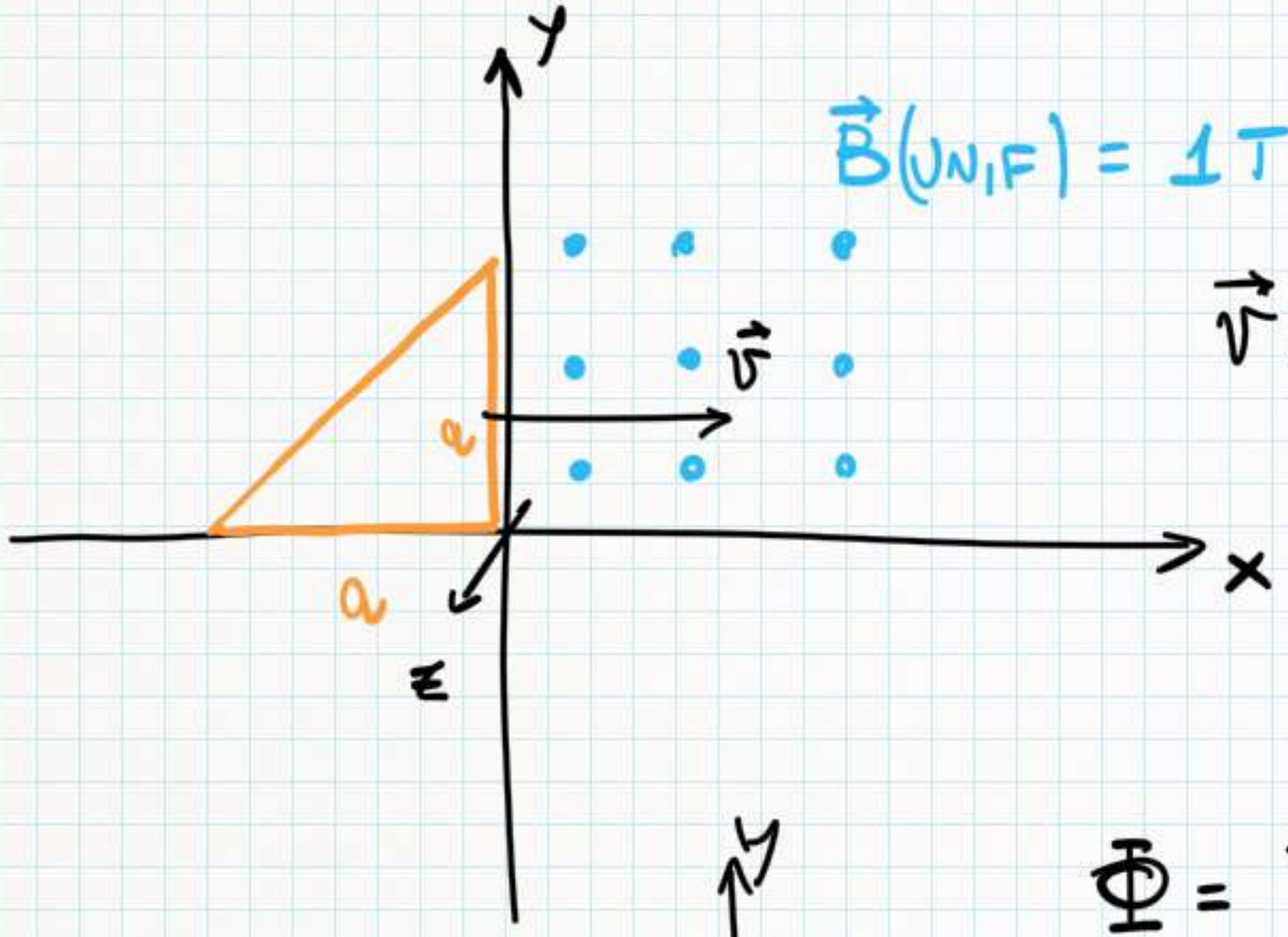
$$\boxed{= 1077{,}14\ J}$$

22 - 07 - 15 EX 3

(i) fem indotta ?

(ii) fem(t) vs t GRAFICO

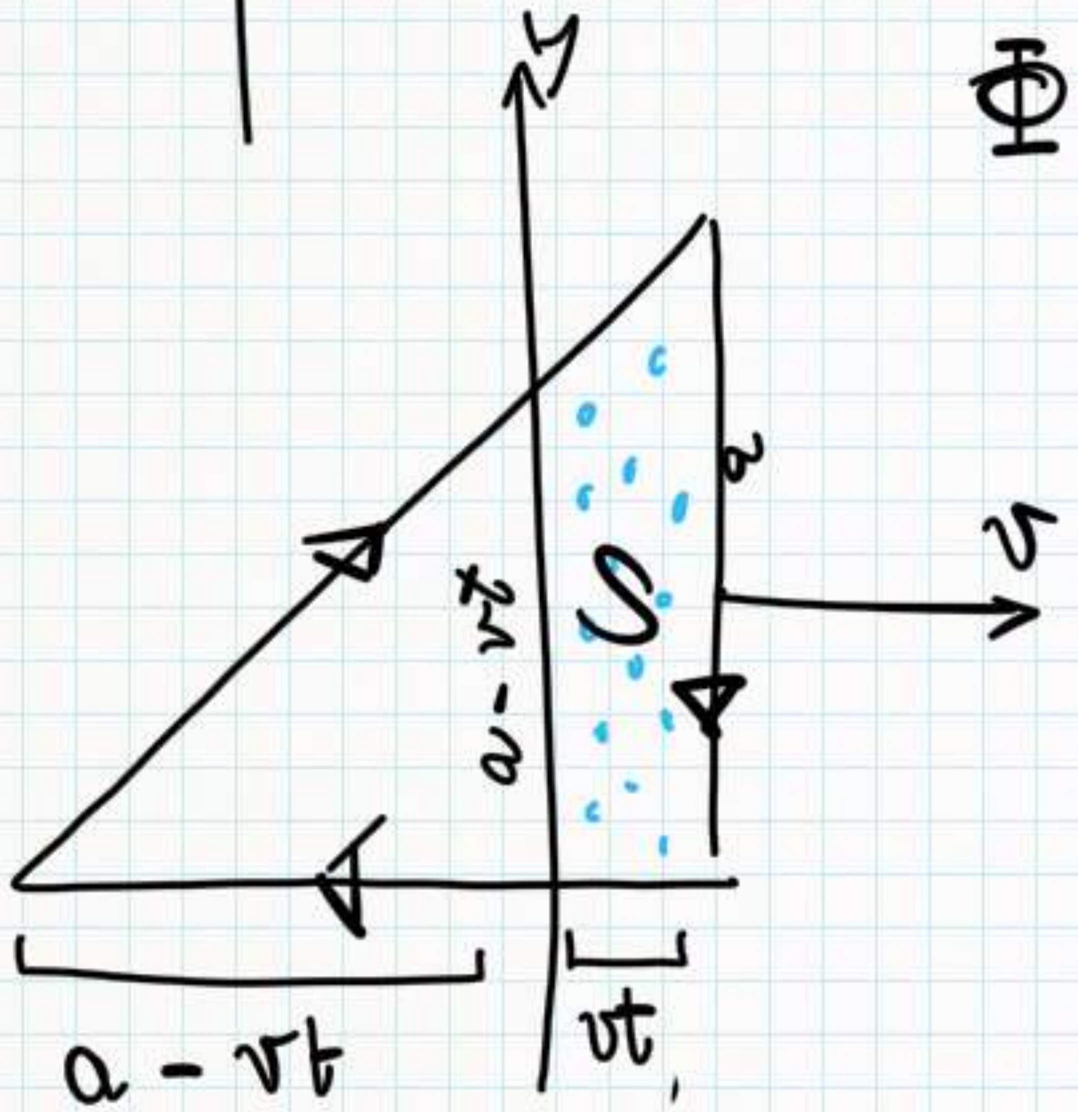
$$f_i = - \frac{d\Phi(t)}{dt}$$



$\vec{B}(\text{UNIF}) = 1\,T\,\hat{z}$

$\vec{v} = 0.5\ \frac{m}{s}\ \hat{x}$

$a = 0,1\ m$



$$\Phi = \vec{B} \cdot \vec{S} = BS \qquad S = S(t)$$

$$S(t) = \frac{(a + (a - vt)) \cdot vt}{2} = \frac{\cancel{2}\,avt}{\cancel{2}} - \frac{1}{2} v^2 t^2 = avt - \frac{1}{2} v^2 t^2$$

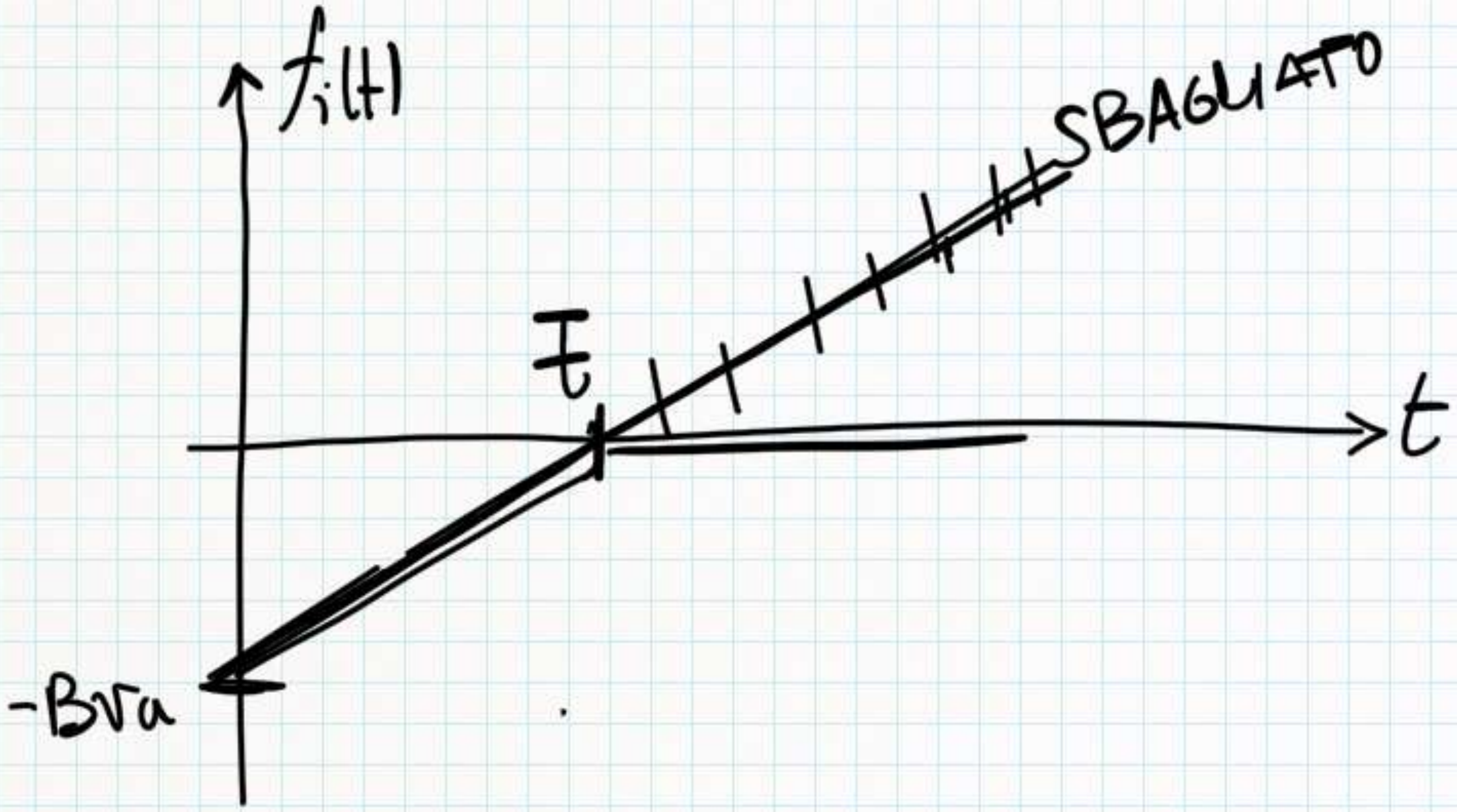
$$\Phi(t) = Bavt - \frac{1}{2} B v^2 t^2$$

$$f_i(t) = - \frac{d\Phi}{dt} = - Bav + Bv^2 t = \boxed{Bv(vt - a)}$$

GRAFICO

$t > 0$

$f_i(t) = Bv(vt - a)$

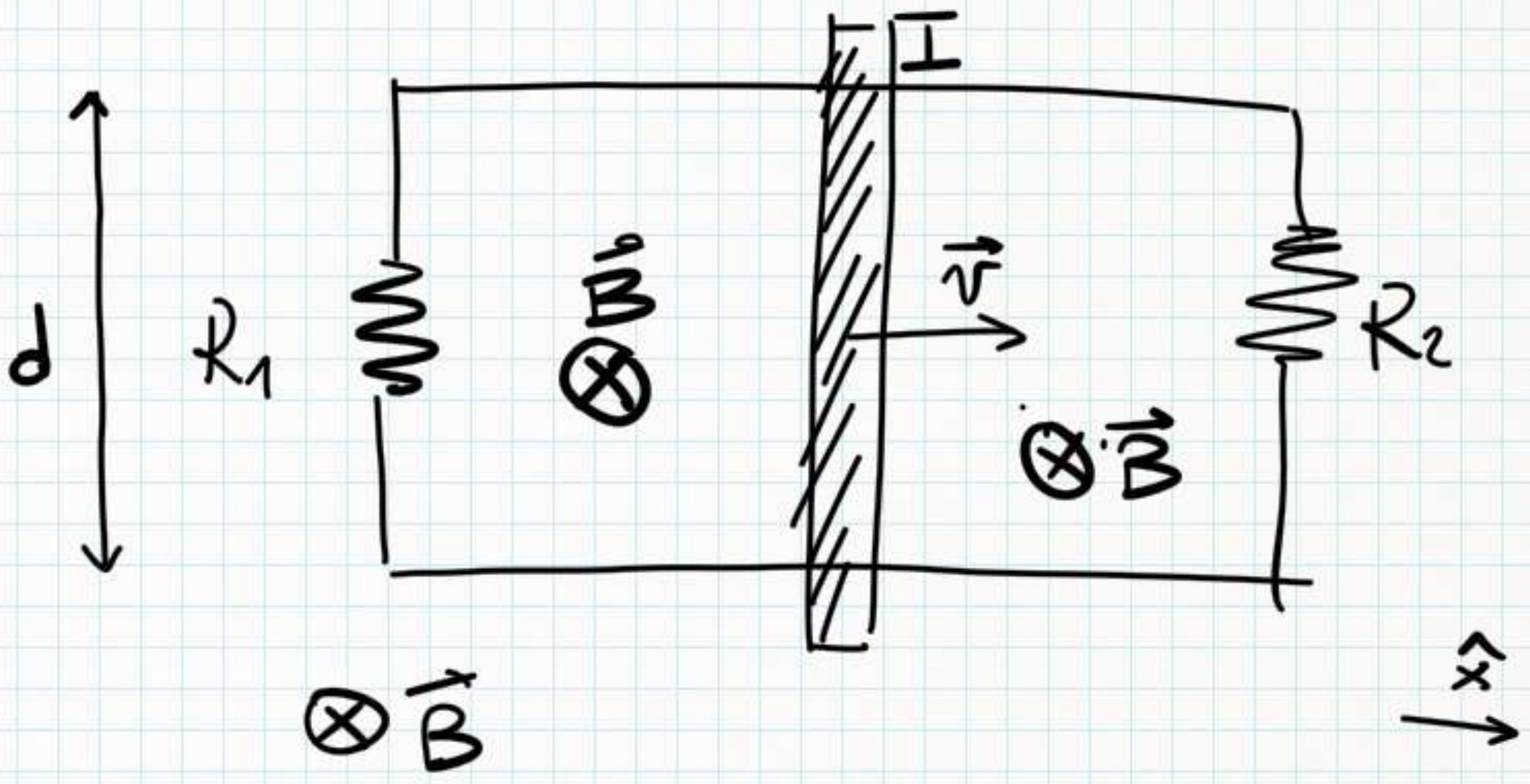


$\bar{t} \rightarrow$ TEMPO NECESSARIO AFFINCHÉ LA SPIRA ENTRI COMPLETAMENTE IN $\vec{B}$

$$\bar{t} = \frac{\Delta x}{v} = \frac{a}{v}$$

$$f_i(\bar{t}) = Bv\left(v\frac{a}{v} - a\right) = 0$$

LEACI 08-11-2018 Ex 2



$R_1 = 3\Omega \quad R_2 = 4\Omega$

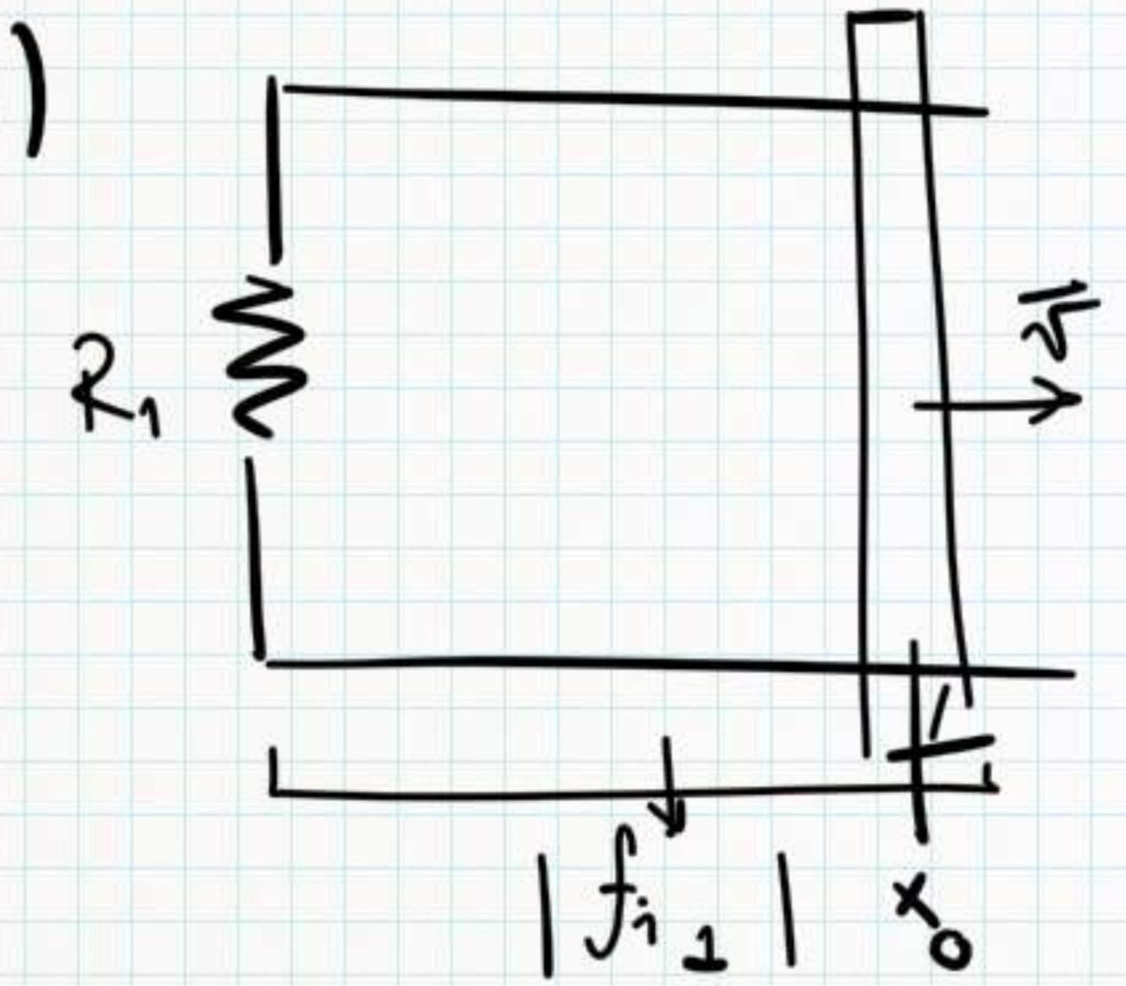
$B = 0.7\ \mathrm{mA}$

$v = 0{,}45\ \mathrm{m/s}$

1) $|f_i(t)|_{1,2}$ 2) $I_{SBARR.}$

3) $\vec{F}_{EXT}$ 4) Potenza diss P

1)



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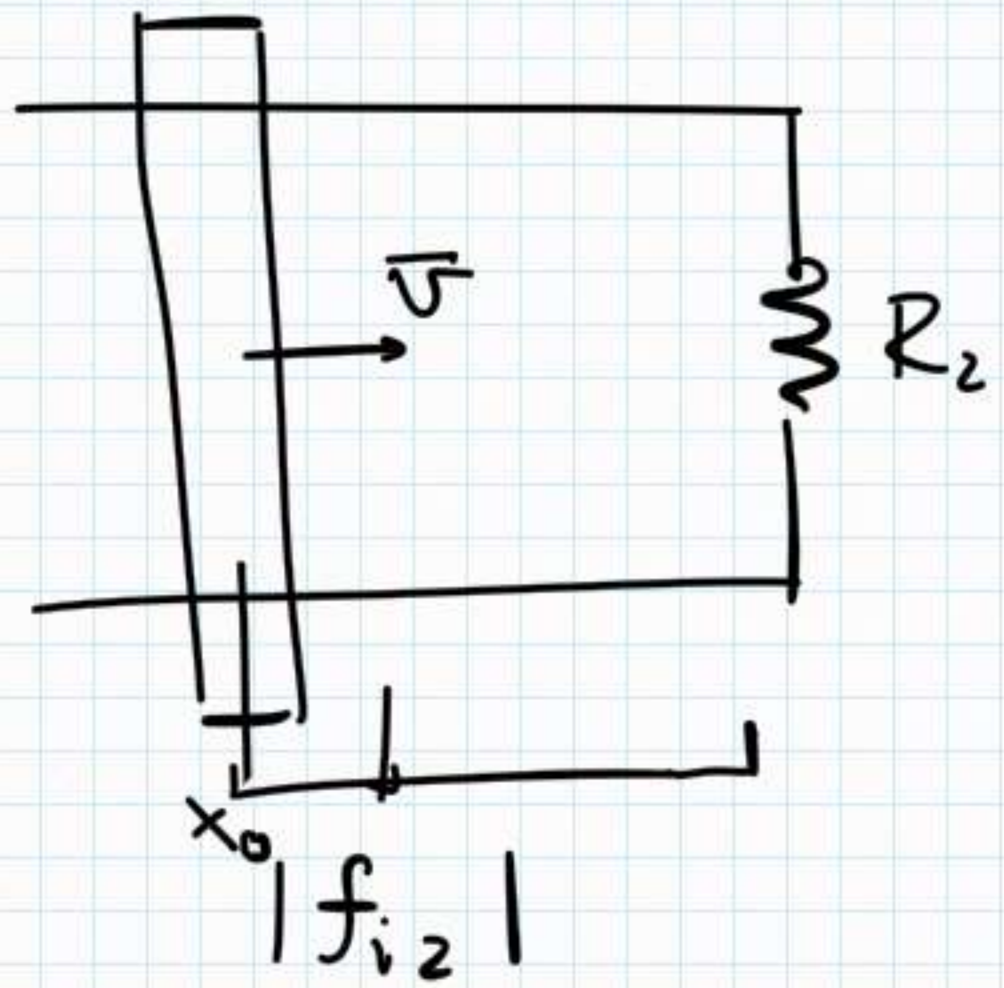


$x(t) = x_0 + vt$

$S_1 = d\cdot x(t) = d(x_0 + vt)$ | $S_2 = d(x_0 - vt)$

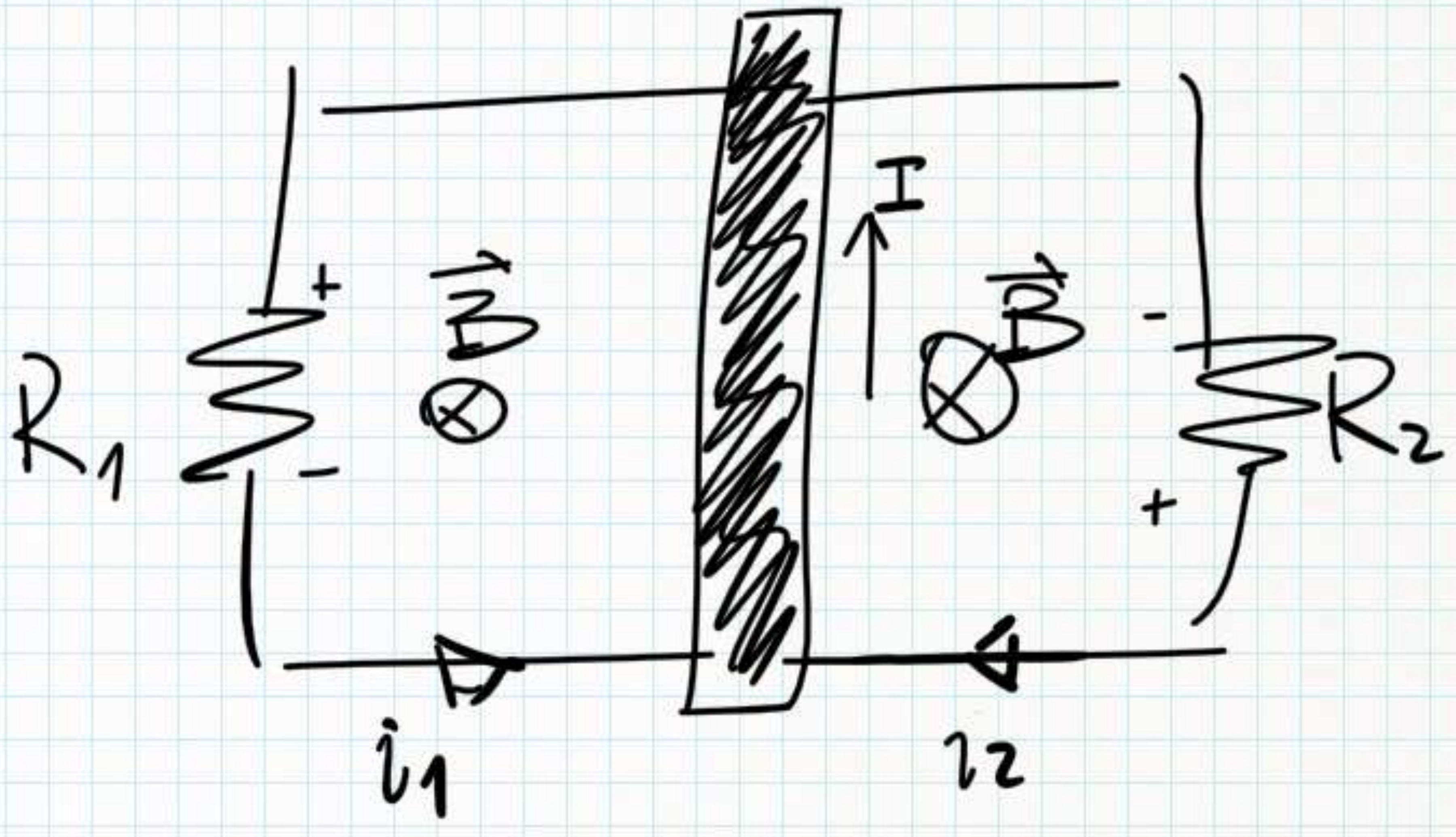
$\Phi_1 = Bd(x_0 + vt)$ | $\Phi_2 = Bd(x_0 - vt)$

$f_1 = -Bdv$ | $f_2 = +Bdv$

$|f_1| = |f_2| = Bdv = 57\ \mathrm{mV}$

(2) $i_1 = \dfrac{Bvd}{R_1}$

$i_2 = \dfrac{Bvd}{R_2}$



$$I = i_1 + i_2 = Bvd\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{Bvd(R_1+R_2)}{R_1R_2}$$

$$= 33\ mA$$

(3) $\vec{F}_{LAPL} = I\vec{d} \times \vec{B} = -\hat{x}\cdot IdB$

$\vec{F}_{EXT} = +IdB\,\hat{x} = 4.1\cdot 10^{-3}\,N\cdot\hat{x}$

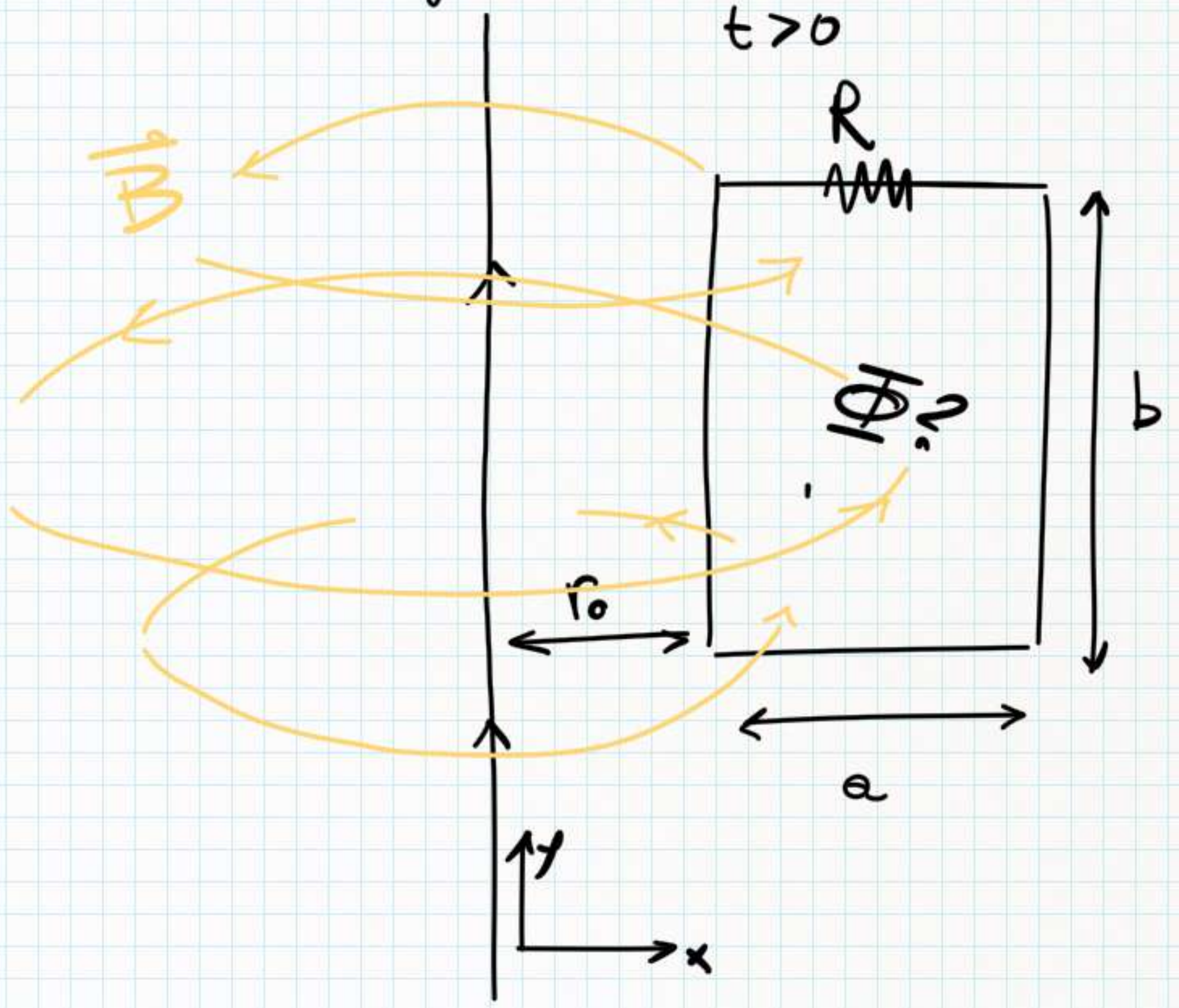
(4) $P = P_1 + P_2 = \dfrac{|f_i|^2}{R_1} + \dfrac{|f_i|^2}{R_2} = (Bvd)^2\left(\dfrac{1}{R_1} + \dfrac{1}{R_2}\right) = \dfrac{B^2v^2d^2(R_1+R_2)}{R_1R_2} = 1{,}8\cdot 10^{-3}\ W$

19-02-18 RAPAGNANI EX 2

(1) fem ind. ?

(2) Q_{TOT} in $\square$?

$$i_f(t) = i_0 e^{-t/2T} \qquad t>0$$



$$2\pi r B(r) = \mu_0 i_f(t) \rightarrow B(r) = \frac{\mu_0 i_f(t)}{2\pi r}$$

$$\Phi = \int_{r_0}^{a+r_0} dx \int_0^b dy \frac{\mu_0 i_f(t)}{2\pi x} = \frac{\mu_0 i_f(t)}{2\pi} \cdot \int_{r_0}^{a+r_0} \frac{dx}{x} \cdot \int_0^b dy =$$

$$= \frac{\mu_0 i_f(t)}{2\pi} \cdot \ln\left(\frac{a+r_0}{r_0}\right) \cdot b = \frac{\mu_0 b i_f(t)}{2\pi} \ln\left(\frac{a}{r_0}+1\right) =$$

$$= \frac{\mu_0 b i_0}{2\pi} e^{-t/2T} \cdot \ln\left(1+\frac{a}{r_0}\right)$$

$$fem = -\frac{d\Phi}{dt} = +\frac{\mu_0 b i_0}{4\pi T} \ln\left(1+\frac{a}{r_0}\right) e^{-\frac{t}{2T}}$$

$R = 3\,\Omega \quad i_0 = 3A \quad T = 6\,s$

$r_0 = 1{,}8\ cm$

$a = 4\ cm \quad b = 8\ cm$

$$(2) \quad Q_{TOT} = \int_0^\infty i(t)\, dt = \int_0^\infty \frac{f_{em}(t)}{R} dt = \underbrace{\frac{\mu_0 b i_0}{4\pi R T} \ln\left(1 + \frac{a}{r_0}\right)}_{:= \alpha} \int_0^\infty e^{-t/2T} dt =$$

$$= \alpha \int_0^\infty dt\, e^{-t/2T} = \qquad \frac{t}{2T} = s$$

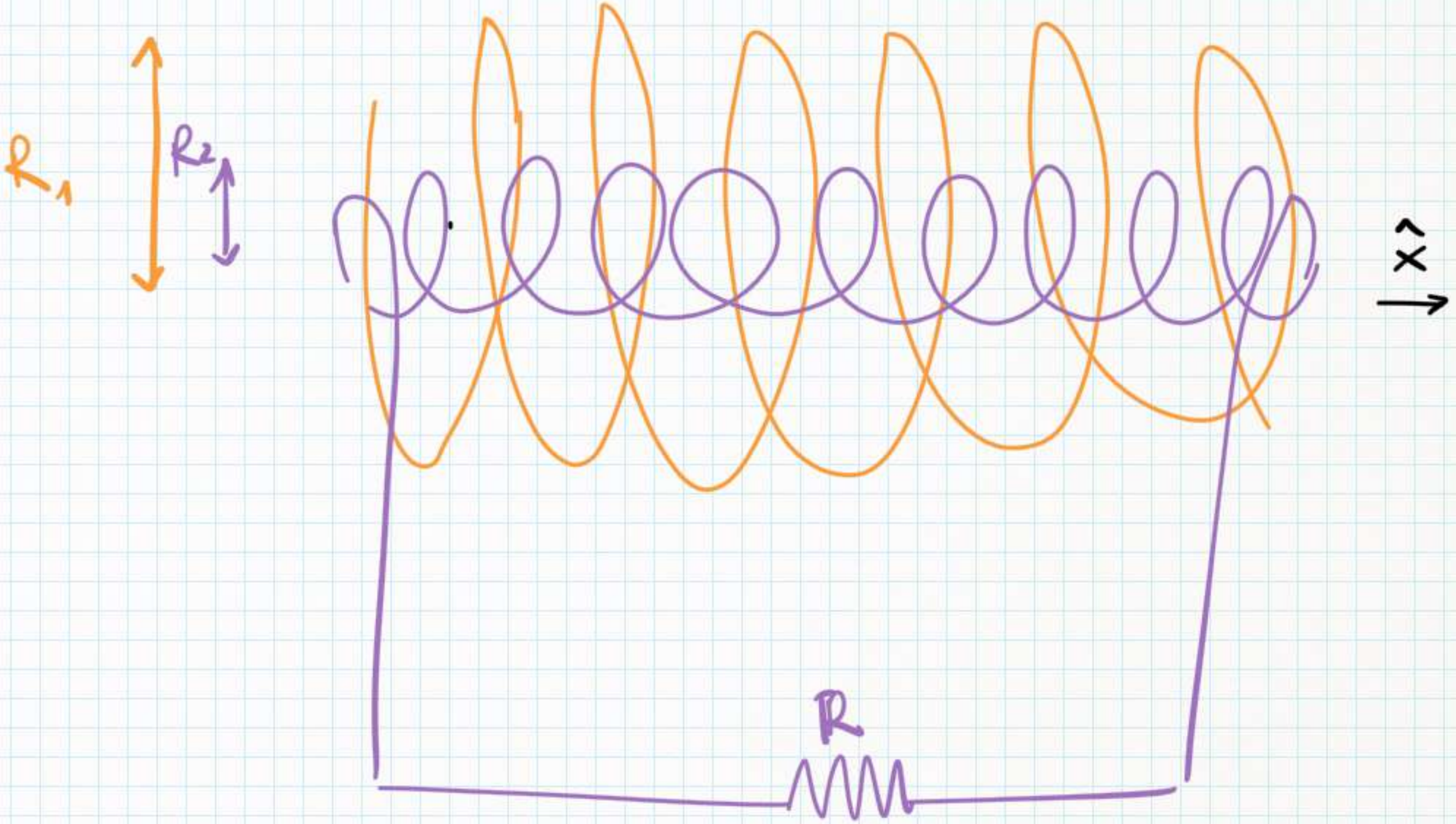
$$= \alpha\, 2T \int_0^\infty \frac{dt}{2T} e^{-t/2T} = \alpha\, 2T \int_0^\infty ds\, e^{-s} = \alpha \cdot 2T \cdot \left(-e^{-s}\right)\Big|_0^\infty = \alpha 2T =$$

$$= \frac{\mu_0 i_0 b}{2\pi R} \ln\left(1 + \frac{a}{r_0}\right) = \underline{\underline{1.8 \cdot 10^{-8}\, C}}$$

EX

① (trascurando l'autoinduzione) calcolare

$\Phi_2(\vec{B}_1)$, $\Phi_1(\vec{B}_2)$ $\qquad$ i_1, i_2 DATE



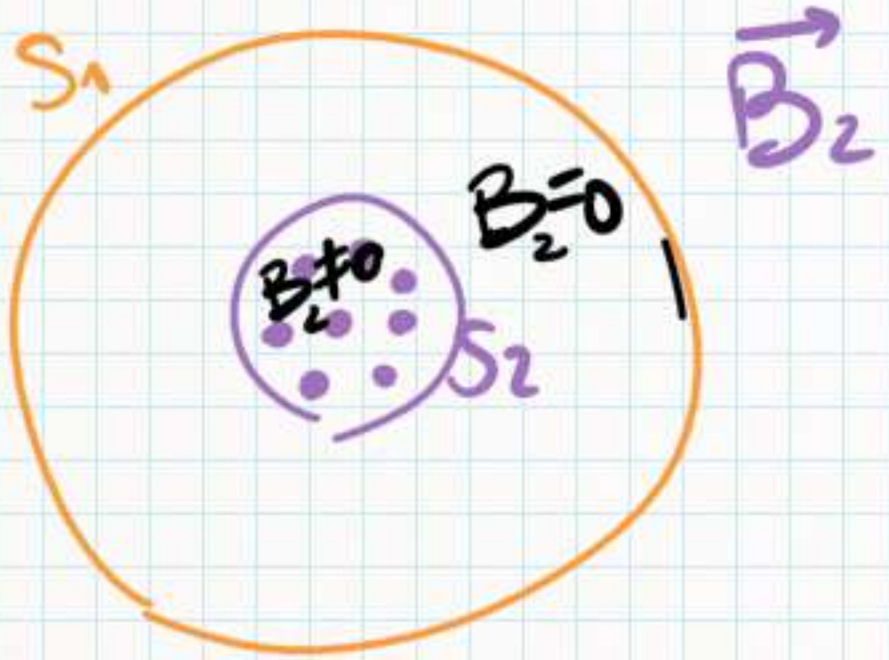
- $\Phi_2(\vec{B}_1)$

$$\vec{B}_1 = \mu_0 i_1 n \hat{x}$$

$$\Phi_2(\vec{B}_1) = B_1 \cdot (S_2 \cdot N) = \pi R_2^2 N \mu_0 n \cdot i_1$$

- $\Phi_1(\vec{B}_2)$ $\qquad \vec{B}_2 = \mu_0 i_2 n \hat{x}$

$$\begin{cases} R = 20\ \Omega \quad R_1 = 2R_2 = 4\text{cm} \\ N_1 = N_2 = N = 300 \\ l_1 = l_2 = l = 20{,}0\ \text{cm} \\ n = \dfrac{N}{l} \end{cases}$$



$$\Rightarrow \Phi_1(\vec{B}_2) = (\mu_0 i_2 n) N \pi R_2^2$$

$$\begin{cases} \Phi_2(\vec{B}_1) = \mu_0 \frac{N^2}{L} \pi R_2^2 \cdot i_1 \\ \Phi_1(\vec{B}_2) = \underbrace{\mu_0 \frac{N^2}{L} \pi R_1^2}_{\text{COEFF. MUTUA INDUZIONE}} \cdot i_2 \end{cases}$$

$$\to \Phi_i = M_{ij}\, i_j \qquad i,j = 1,2 \qquad M_{12} = M_{21}$$

$$\Phi_i = M_{ij}\, i_j$$

$$M_{ij} = M_{ji}$$ → QUESTO E' UN <u>TEOREMA</u>