NUMERO: 1634A - ANNO: 2015

A P P U N T I

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MATERIA: Elettrotecnica e Macchine Elettrice + Esercizi + Temi d'esame. Prof.Repetto

ESERCITAZIONE ELETTROTECNICA.

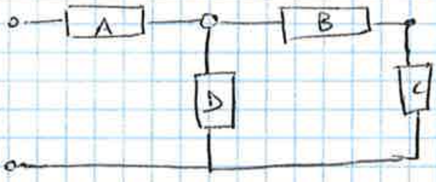
RESISTENZE IN SERIE e PARALLELO

2 DIPOLI

IN SERIE SE:

SONO ATTRAVERSATI DALLA STESSA CORRENTE i.

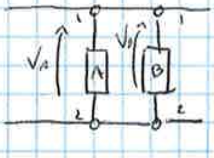
SE ABBIAMO:



A e B NO IN SERIE XKE' SONO ATTRAVERSATI DA CORRENTI DIVERSE

B e C SERIE

IN PARALLELO SE:



~~SONO~~ A e B SONO PERCORSI DALLA STESSA TENSIONE:

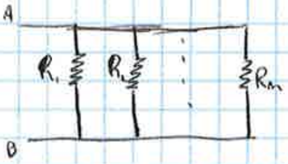
A e B => PARALLELO.

SE ABBIAMO:

1)

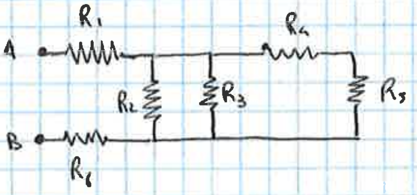
$$\boxed{R_{eq} = \sum_{i=1}^{m} R_i}$$

2)



$$\boxed{R_{eq} = \left(\sum_{i=1}^{m} \frac{1}{R_i} \right)^{-1}}$$

QUARTO ESERCIZIO:

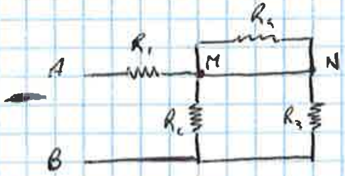


- $R_{AB} = \boxed{R_1} + \boxed{R_2 \| R_3 \| (R_4 + R_5)} + \boxed{R_6}$ SOMMA COMMUTATIVA

NOTA: R1 e R6 SONO ATTRAVERSATI DALLA STESSA CORRENTE QUINDI POSSONO ESSERE CONSIDERATI IN SERIE, DAL PUNTO DI VISTA TOPOLOGICO PERO' NON HANNO UN PERCORSO IN COMUNE PERCIO' NON SONO CONSIDERATI IN SERIE.

R1 e R6 → IN SERIE DAL PUNTO DI VISTA DELLA CORRENTE.
→ ~~NON TOPOL~~ NON IN SERIE DAL PUNTO DI VISTA TOPOLOGICO.

QUINTO ESERCIZIO:

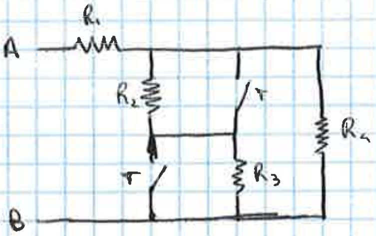


$R_1 =$ ~~1 Ω~~ $1\,\Omega$ $R_2 = R_3 = 2\,\Omega$ $R_4 = 100\,\Omega$

IN QUESTO CIRCUITO, R4 E' IN PARALLELO CON UN CORTOCIRCUITO PERCIO' NON SI CALCOLA R4
"SI DICE CHE R4 E' CORTOCIRCUITATA."

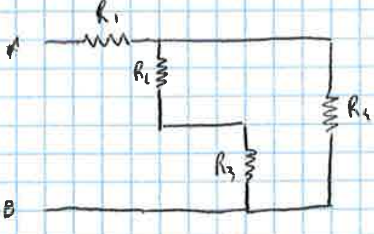
- $R_{AB} = R_1 + R_2 \| R_3 = \boxed{2\,\Omega}$ ~~IN [illegible] PICCOLA [illegible]~~

SESTO ESERCIZIO:



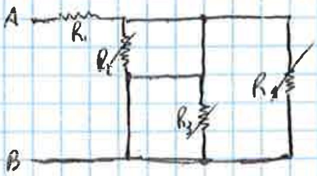
INTERRUTTORE O TASTO : APERTO => RESISTENZA INFINITA : CIRCUITO APERTO.
CHIUSO => CORTOCIRCUITO.

T APERTI:



- $R_{AB} = R_1 + (R_2 + R_3) \| R_4$

T CHIUSI:



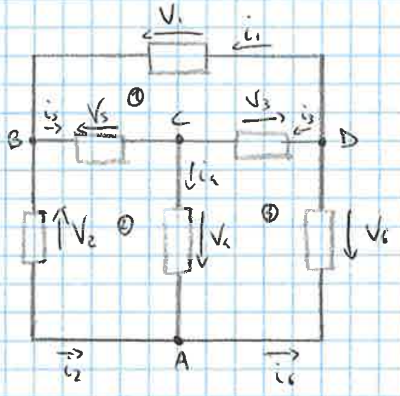
- $R_{AB} = R_1$ PERCHE'? R2 CORTOCIRCUITATA.
R3 CORTOCIRCUITATA.
R4 CORTOCIRCUITATA.

ESERCIZI DI ELETTROTECNICA

DIPARTIMENTO DI ELETTRONICA (POLITO).

• LEGGI DI KIRCHHOFF

(1.1)



DATI:

$V_4 = 7\,V$ $\quad i_3 = 6\,A$

$V_5 = 9\,V$ $\quad i_5 = 8\,A$

$V_6 = 8\,V$ $\quad i_6 = 7\,A$

LKC:

A) $i_2 + i_4 = i_6$

B) $i_1 = i_5 + i_2$

C) $i_5 + i_3 = i_4$

D) $i_6 = i_3 + i_1$

LKT:

1) $V_1 - V_5 + V_3 = 0$

2) $V_5 - V_2 - V_4 = 0$

3) $V_4 - V_6 - V_3 = 0$

4) $V_1 - V_2 - V_6 = 0$

C) $i_4 = 6 + 8 = \boxed{14\,A}$

A) $i_2 = 7 - 14 = \boxed{-7\,A}$

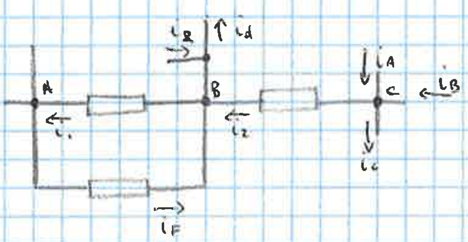
B) $i_1 = 8 - 7 = \boxed{1\,A}$

2) $V_2 = V_5 - V_4 = 9 - 7 = \boxed{2V}$

3) $V_3 = V_4 - V_6 = 7 - 8 = \boxed{-1V}$

4) $V_1 = V_2 + V_0 = 2 + 8 = \boxed{10V}$

(1.2)



$i_A = 8A$ $\quad i_d = -6A$

$i_B = -2A$ $\quad i_e = 8A$

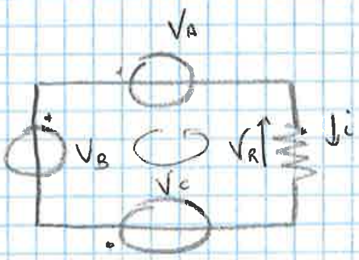
$i_C = 5A$ $\quad i_f = 10A$

B) $i_1 = i_2 - i_d + i_e + i_f = 1 + 6 + 8 + 10 = \boxed{25\,A}$

C) $i_2 = i_A + i_B - i_C = 8 - 2 - 5 = \cancel{8}\ \boxed{1\,A}$

- LEGGE DI OHM E PARTITORI

2.1



$i = ?$

$V_A = 10V$
$V_B = 12V$
$V_C = -8V$
$R = 3\,\Omega$

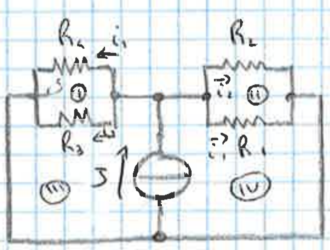
$$V = R \cdot i \quad \Rightarrow \quad i = \frac{V_R}{R}$$

$$LKT: \quad V_A - V_B - V_C + V_R = 0 \quad \Rightarrow \quad V_R = V_B + V_C - V_A = -6V$$

$$i = \frac{-6}{3} = -2\,A$$

$P_R = |V_R \cdot i| = 12$ WATT
$P_A = 10 \cdot -2 = 20$ WATT
$P_B = 12 \cdot -2 = -24$ WATT
$P_C = |-8 \cdot -2| = 16$ WATT

2.2



$R_1 = 60\,\Omega$ $R_2 = 40\,\Omega$
$R_3 = 80\,\Omega$ $R_4 = 20\,\Omega$

$J = 10\,A$
↓
CORRENTI TOT

CORRENTI = ?

~~LKT:~~
~~I) $R_3 i_3 = R_4 i_4$~~
~~II) $R_2 i_2 = R_1 i_1$~~

$$i_1 = J \frac{(R_3 \| R_4) \| R_2}{R_1 + (R_2 \| R_3 \| R_4)} = 10 \frac{\frac{80}{2}}{\frac{80}{2} + 60} = \boxed{1{,}6\ A}$$

$$i_2 = J \frac{R_1 \| R_3 \| R_4}{R_2 + (R_1 \| R_3 \| R_4)} = \boxed{2{,}4\ A}$$

$$i_3 = J \frac{R_1 \| R_2 \| R_4}{R_3 + (R_1 \| R_2 \| R_4} = \boxed{1{,}2\ A}$$

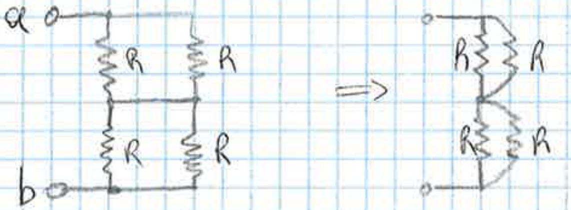
$$i_4 = J \frac{R_1 \| R_2 \| R_3}{R_4 + (R_1 \| R_2 \| R_3)} = \boxed{4{,}8\ A}$$

RESISTENZE EQUIVALENTI

3.1

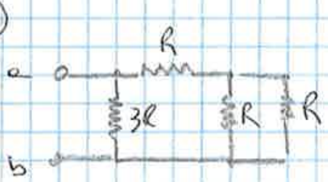
$R_{ab} = 0$ RESISTENZA CIRCUITATA

3.2



$R_{ab}: (R \| R) + (R \| R) = R$

3.4



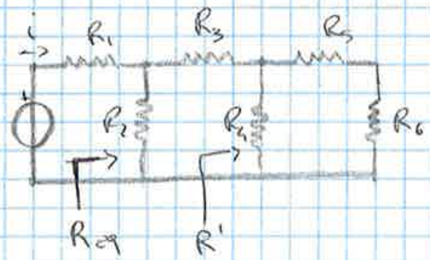
~~$R_{ab} = (R \| R) \| R \| 3R$~~

$R_{ab}: ((R \| R) + R) \| 3R = R$

3.5

$R_{ab} = R \| 2R \| 3R = \frac{6}{11} R$

3.6



~~$R^T =$~~ $E = 10V$ $R_1 = 3\Omega$ $R_2 = 4\Omega$

$R_3 = 2\Omega$ $R_4 = 6\Omega$ $R_5 = 1\Omega$

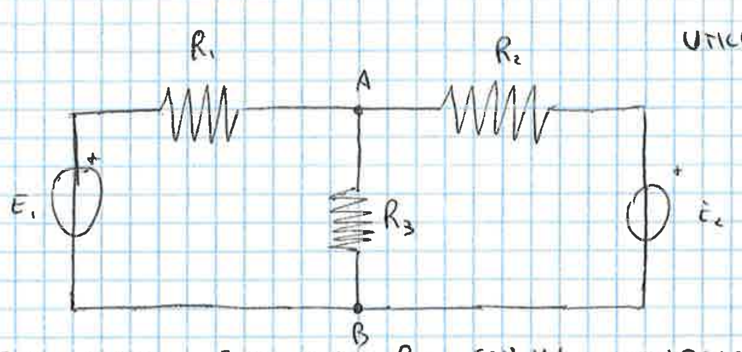
$R_6 = 2\Omega$

$R' = (R_5 + R_6) \| R_4 = 3 \| 6 = 2\Omega$

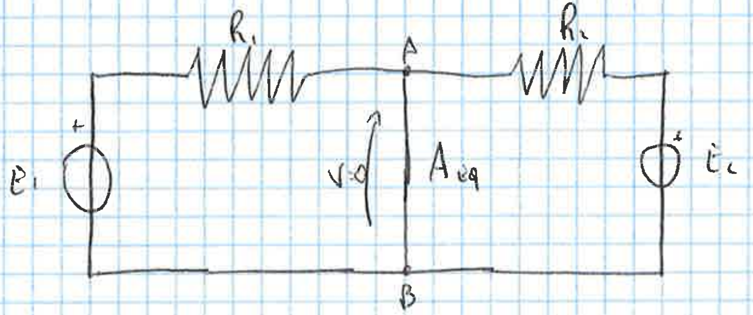
$R_{eq} = ((R' + R_3) \| R_2) + R_1 = 4 \| 4 + 3 = 2 + 3 = \boxed{5\Omega}$

$V = R \cdot i \Rightarrow i = \frac{V}{R} = \frac{10}{5} = \boxed{2A}$

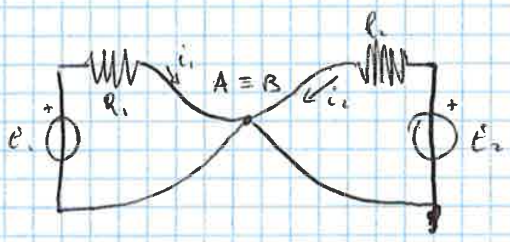
UTILIZZO DI NORTON.



APPLICO NORTON SOSTITUENDO R_3 CON UN CORTOCIRCUITO



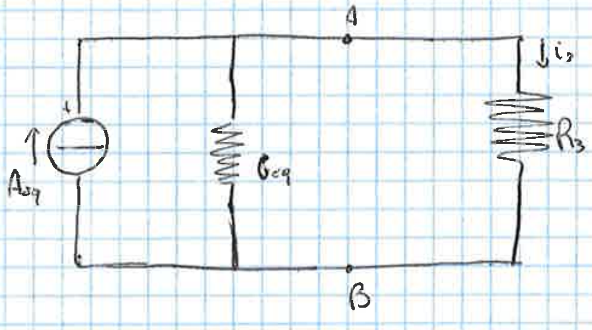
POSSO SCRIVERE COSÌ:



$i_1 = \frac{E_1}{R_1}$ $\qquad i_2 = \frac{E_2}{R_2}$

$A_{eq} = i_1 + i_2 = \frac{E_1}{R_1} + \frac{E_2}{R_2}$

$G_{eq} = \frac{1}{R_{eq}} = \frac{R_1 + R_2}{R_1 R_2}$

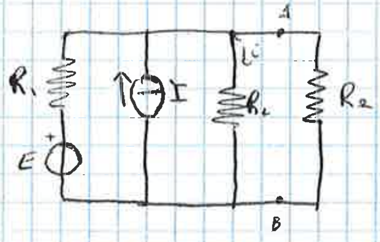


$i_3 = A_{eq} \frac{R_{eq}}{R_{eq} + R_3}$

$i_3 = \left(\frac{E_1}{R_1} + \frac{E_2}{R_2}\right) \frac{\frac{R_1 R_2}{R_1 + R_2}}{\frac{R_1 R_2}{R_1 + R_2} + R_3}$

$i_3 = \left(\frac{R_2 E_1 + R_1 E_2}{\cancel{R_1 R_2}}\right)\left(\frac{\cancel{R_1 R_2}}{R_1 R_2 + R_1 R_3 + R_2 R_3}\right).$

SECONDO ESERCIZIO:



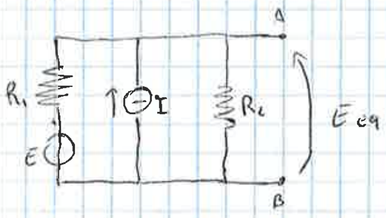
$E = 10\ V$ $R_1 = R_2 = 10\ \Omega$

$I = 10 A$ $R_e = 5\ \Omega$

TROVARE: A) circ. eq. Thevenin ?

B) I_e ?

1) CONSIDERO LA PARTE SINISTRA DEL CIRCUITO:



$$E_{eq} = \underset{\downarrow\; E}{E'_{eq}} + \underset{\downarrow\; I}{E''_{eq}}$$

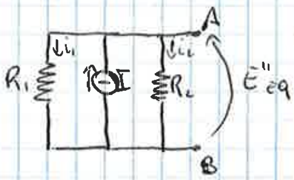
2) PASSIVO IL GENERATORE DI CORRENTE ($E' = ?$)

R_1 SERIE R_2

USO IL PARTITORE DI TENSIONE:

$$E'_{eq} = E\frac{R_2}{R_1+R_2} = \underline{5\ V}$$

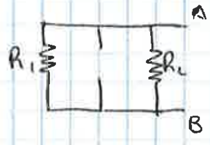
3) PASSIVO IL GENERATORE DI TENSIONE ($E'' = ?$)



$$E''_{eq} = I\frac{R_1R_2}{R_1+R_2} = \underline{50\ V}$$

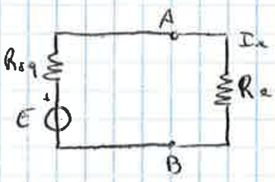
$$E_{eq} = E'_{eq} + E''_{eq} = 5 + 50 = \underline{55\ V}$$

4) PASSIVO I GENERATORI PER CALCOLARE R_{eq}



$$R_{eq} = R_1 \parallel R_2 = \frac{R_1R_2}{R_1+R_2} = \underline{5\ \Omega}$$

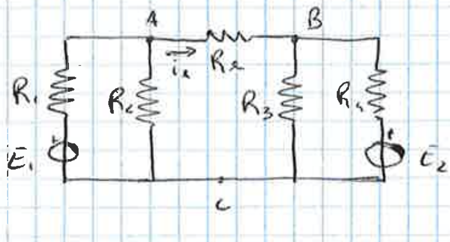
5) CIRCUITO DI THEVENIN:



$$I_e = \frac{E_{eq}}{R_{eq}+R_e} = \frac{55}{10} = \boxed{5,5\ A}$$

ESERCITAZIONE 21/3/2013

PRIMO ESERCIZIO:



$E_1 = 10$ V $E_2 = 10$ V

$R_1 = R_2 = 10\ \Omega$ $R_3 = 2\ \Omega$ $R_4 = 8\ \Omega$

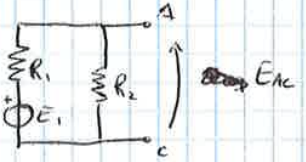
$R_e = 5\ \Omega$

QUESITI:

1) CIRCUITO EQ. THEVENIN AC 2) CIRCUITO EQ. THEVENIN BC 3) I_e

SOLUZIONE:

1) TAGLIO I MORSETTI AC

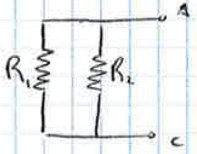


R_1 e R_2 SERIE

USO IL PARTITORE DI TENSIONE:

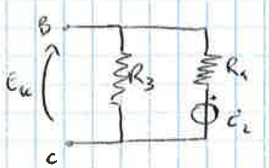
$$E_{AC} = E_1 \frac{R_2}{R_1+R_2} = \boxed{5\ V}$$

PASSIVO E_1



$$R_1 \| R_2 \Rightarrow \frac{R_1 R_2}{R_1+R_2} = \boxed{5\ \Omega}$$

2) TAGLIO I MORSETTI BC



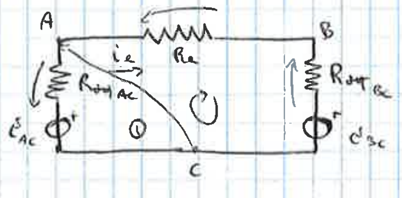
USO IL PARTITORE DI TENSIONE:

$$E_{BC} = E_2 \frac{R_3}{R_3+R_4} = \boxed{2\ V}$$

PASSIVO E_2:

$$R_{BC} = R_3 \| R_4 = \frac{R_3 R_4}{R_3+R_4} = \boxed{1,6\ \Omega}$$

3) CIRCUITO EQ. THEVENIN COMPLETO:



LKT: $E_{AC} - R_{AC} i_e - R_e i_e - R_{BC} i_e - E_{BC} = 0$

$i_e (R_{AC} + R_e + R_{BC}) = E_{AC} - E_{BC}$

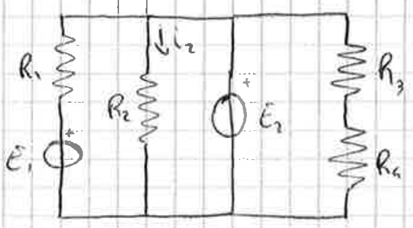
$$i_e = \frac{E_{AC} - E_{BC}}{R_{AC} + R_e + R_{BC}} = \frac{3}{11,6} = \boxed{0,26\ A}$$

VOLENDO CALCOLARE V_{AC} ?

LKT ① $V_{AC} + R_{AC} i_e - E_{AC} = 0$

$\boxed{V_{AC} = E_{AC} - R_{AC} i_e} = \boxed{3,7\ V}$

~~SECONDO~~ ESERCIZIO A CASA



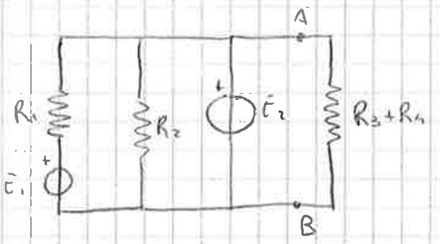
$E_1 = 12\,V$ $E_2 = 10\,V$

$R_1 = 10\ \Omega$ $R_2 = 12\ \Omega$

$R_3 = 1\ \Omega$ $R_4 = 1\ \Omega$

CALCOLARE: 1) V_4 ; 2) I_2 ; 3) P_{E_1} .

SEMPLIFICO IL CIRCUITO



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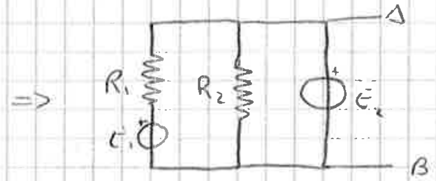
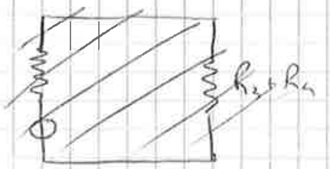
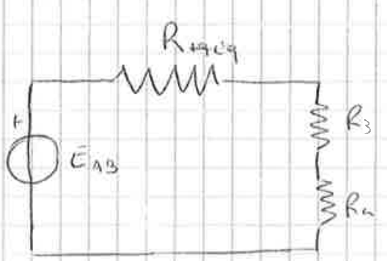


$$E_{AB} = \frac{\frac{E_1}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1,2}{0,1 + 0,083} = 6,55\ V$$

~~$E_{AB} = E_1 +$~~ $R_{eq} = R_1 = 10\ \Omega$

CIRC. THEVENIN





ESERCIZI DAL LIBRO IN PDF.

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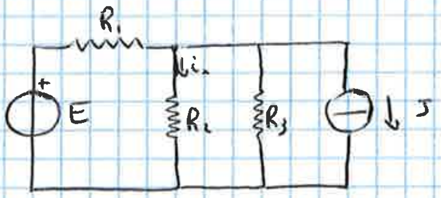
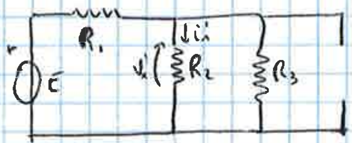


$R_1 = 24\ \Omega$ $R_2 = 20\ \Omega$

$R_3 = 80\ \Omega$ $E = 30V$ $J = 2A$

CALCOLO : P_x : ? i_x : ?

PASSIVO J :



PER IL CALCOLO DI V_x' USO IL PARTITOR DI TENSIONE.

$$V_x' = E \frac{R_2 \| R_3}{R_1 + (R_2 \| R_3)} = 12V$$

DA CUI: $i_x' = \frac{V_x'}{R_2} = 0,6\ A$

PASSIVO E :

PER IL CALCOLO DI i_x'' USO IL PARTITOR DI CORRENTI:

$$i_x'' = -J \frac{R_1 \| R_3}{R_2 + (R_1 \| R_3)} = -0,36A$$

DA CUI:

$$V_x'' = i_x'' \cdot R_2 = -19,2\ V$$

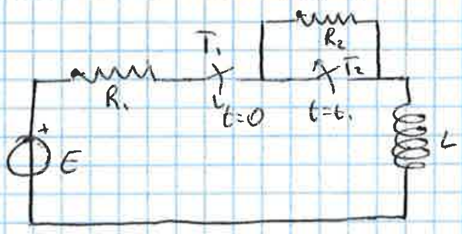
$V_x = V_x' + V_x'' = \overset{12}{\cancel{0,6}} - 19,2 = \cancel{-18,6\ V}\ \underbrace{-7,2\ V}$

$i_x = \cancel{0,8}\ i_x' + i_x'' = \cancel{0,6(-0,36)} = \cancel{0,576\ A} = \underbrace{-0,36\ A}$

$P_x = V_x \cdot i_x = \underbrace{2,592\ W}$ OPPURE $P_x = R_2 i_x^2 = \underbrace{2,592\ W}$

ESERCITAZIONE ELETTROTECNICA 10/4/2013

1) ESERCIZIO SU REGIME TRANSITORIO

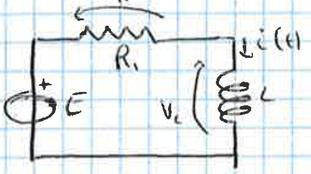


$E = 12V$ $L = 1mH$ $t_1 = \overset{5ms}{\cancel{0{,}5ms}}$

$R_1 = 1\Omega$ $R_2 = 1k\Omega$ $i(0) = 0$

$0 < t < t_1 \Rightarrow$ T_1 CHIUSO T_2 CHIUSO

$R_2 = 0$ (CORTOCIRCUITATA)



$E - V_R - V_L = 0$

$E - Ri - L\frac{di}{dt} = 0$

$$\begin{cases} \frac{di}{dt} + \frac{R_1}{L} i = \frac{E}{L} \\ i(0) = 0 \end{cases} \Rightarrow \text{O.A.: } s + \frac{R}{L} = 0 \Rightarrow s_1 = -\frac{R}{L}$$

$$\Downarrow \quad \tau = \left|\frac{1}{s_1}\right| = \frac{L}{R} = 1ms$$

I.P.: $i_p(t) = H$

$\underset{0}{\cancel{\frac{dH}{dt}}} + \frac{R}{L}H = \frac{E}{L} \Rightarrow H = \frac{E}{R_1}$

$i(t) = K e^{-t/\tau} + \frac{E}{R}$

MA $i(0) = 0$

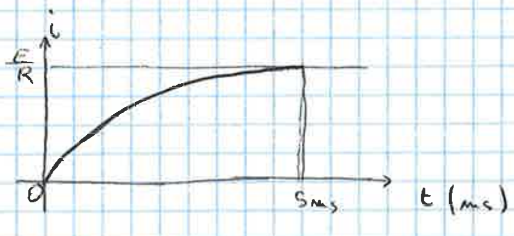
$\Downarrow$

$K = -\frac{E}{R}$

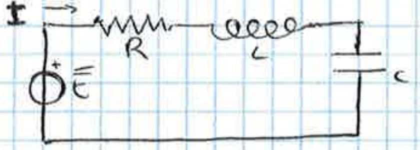
$\Downarrow$

$i(t) = -\frac{E}{R} e^{-t/\tau} + \frac{E}{R} \Rightarrow \boxed{\frac{E}{R}\left(1 - e^{-\frac{t}{\tau}}\right)}$

GRAFICO:



2) ESERCIZIO DI "REGIME SINUSOIDALE"



$\bar{E} = 100$ V R = 50 Ω (f = 50 Hz)

C = 100 μF L = 0,05 H

RICAVARE $\bar{I} = ?$; DIAGRAMMA VETTORIALE

→ FASORE CORRENTE.

NON VIENE RIPORTATO VALORE DI FREQUENZA E PULSAZIONE, QUANDO SUCCEDE QUESTO SI IPOTIZZA f = 50 Hz E QUINDI ω = 2πf = 314 rad/sec

$\bar{Z}_R = \underline{R}$

$\bar{Z}_C = -\frac{J}{\omega C} = -J\frac{1}{\omega C} = -J\frac{1}{314 \cdot 10^{-4}} = -J\frac{1}{0{,}314} = \underline{-J\,31{,}85\ \Omega}$

$\bar{Z}_L = J\omega L = J\,314 \cdot 5 \cdot 10^{-2} = \underline{J\,15{,}7\ \Omega}$

$\bar{Z}_{eq} = \bar{Z}_R + \bar{Z}_C + \bar{Z}_L = 50 - J\,31{,}85 + J\,15{,}7 = \underbrace{50 - J16{,}1\ \Omega}$

$|\bar{Z}_{eq}| = \sqrt{50^2 + 16{,}1^2} = \underbrace{52{,}5\ \Omega}$

$\angle \bar{Z}_{eq} = Tg^{-1} - \frac{16{,}1}{50} = -17{,}4°$

$\bar{I} = \frac{\bar{E}}{\bar{Z}_{eq}} \Rightarrow$ E INF DI FASE $\varphi_E = 0$ ← SUPPONIAMO

$\bar{I} = \frac{100\,e^{J\cdot 0}}{52{,}5\,e^{-J\cdot 17{,}4}} = \boxed{1{,}9\,e^{J\,17{,}4°}\ A}$

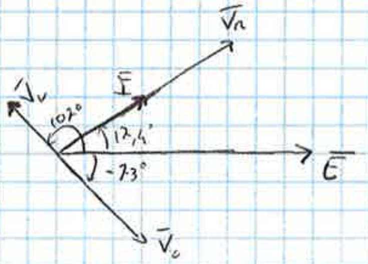
IMPONGO $-J = e^{J\,90°}$

$\bar{V}_R = \bar{Z}_R\,\bar{I} = RI\,e^{J\varphi_I} = \boxed{50 \cdot 1{,}9\,e^{J\,17{,}4}\ V}$

$\bar{V}_L = J\omega L\,\bar{I} = J\,15{,}7 \cdot 1{,}9\,e^{J\,17{,}4°} = 29{,}8\,e^{J(90+17{,}4)} = \boxed{29{,}8\,e^{J(107{,}4)}\ V}$

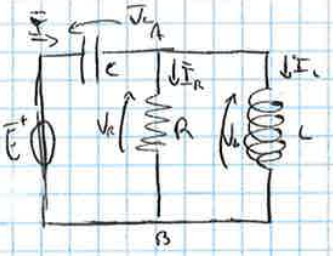
$\bar{V}_C = \bar{Z}_C\,\bar{I} = -J\,31{,}8 \cdot 1{,}9\,e^{J\,17{,}4} = \boxed{60{,}4\,e^{J(-22{,}6°)}\ V}$

- DIAGRAMMA VETTORIALE



$\bar{E} = \bar{V}_R + \bar{V}_C + \bar{V}_L$

2)



$|\bar I_R| = 10\,A$ $R = 10\,\Omega$

$L = 0{,}1\,H$ $C = 50\,\mu F$ $\bar I = ?$ $\bar E = ?$

IN QUESTO CASO DOBBIAMO CERCARE DI CALCOLARE IL POTENZIALE E.

- CALCOLO $\bar V_R$:

$$|\bar V_R| = |R \cdot \bar I_R| = R I_R = 10 \cdot 10 = \underbrace{100\,V}$$

- $\bar V_R = V_R\, e^{j0}$

ESSENDO IN PARALLELO $\bar V_R = \bar V_L \Rightarrow \bar I_L = \dfrac{\bar V_R}{\bar Z_L}$ $\quad Z_L = j314 \cdot 0{,}1 = j31{,}4\,\Omega = 31{,}4\, e^{j90^\circ}\,\Omega$

- $\bar I_L = \dfrac{100\, e^{j0}}{31{,}4\, e^{j90^\circ}} = \underbrace{3{,}2\, e^{-j90^\circ}\,A}$

A QUESTO PUNTO APPLICO LA LKC:

NODO A: $\bar I = \bar I_R + \bar I_L = \boxed{10 - j\,3{,}2\,A}$

$$\|$$

$|\bar I| = \sqrt{10^2 + 3{,}2^2} = 10{,}5\,A$ $\quad \boxed{\bar I = 10{,}5\, e^{j17{,}7^\circ}\,A}$

$\measuredangle \bar I = Tg^{-1}\, \dfrac{-3{,}2}{10} = -17{,}7^\circ$

- CALCOLO E:

$\bar V_C = \bar Z_C \bar I$ $\quad Z_C = \dfrac{-j}{\omega C} = \dfrac{-j}{314 \cdot 5 \cdot 10^{-5}} = \underline{-j\,63{,}7\,\Omega}$

~~$\bar V_C = (-j\,3{,}2)$~~ $V_R =$ $\bar V_C = \bar Z_C \bar I = 63{,}7\, e^{-j90^\circ} \cdot 10{,}5\, e^{j17{,}7} = \underbrace{668{,}8\, e^{-j107^\circ}\,V}$

ORA L.K.T:

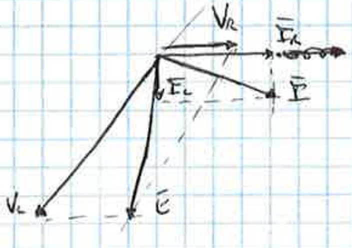
$$\bar E - \bar V_C - \bar V_R = 0 \Rightarrow \bar E = \bar V_C + \bar V_R$$

V_C IN FORMA BINOMIA:

$$\bar V_C = 668{,}8\,(\cos(-107^\circ) + j\sin(-107^\circ)) = \underbrace{-195{,}5 - j\,639{,}6\,V}$$

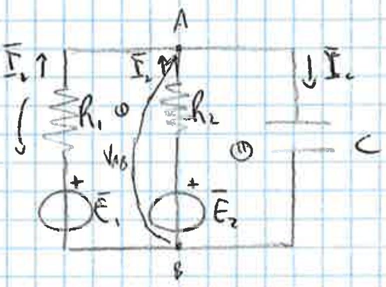
$$\bar E = \bar V_C + \bar V_R = -195{,}5 - j\,639{,}6 + 100 = \boxed{-95{,}5 - j\,639{,}6\,V}$$

$$\boxed{\bar E = 646{,}6\, e^{-j98^\circ}\,V}$$



ESERCITAZIONE 17/4/2013

1) REGIME SINUSOIDALE



$\bar{E}_1 = \bar{E}_2 = 100\ V$ $\quad \varphi_1 = 0°$ $\quad \varphi_2 = 90°$

$R_1 = R_2 = 10\ \Omega$ $\quad C = 50\ \mu F$

CALCOLARE: $\bar{I}_c = ?$ $\quad \bar{I}_1 = ?$ $\quad \bar{I}_2 = ?$

$$Z_c = \frac{-j}{\omega C} = \frac{-j}{314\cdot 5\cdot 10^{-5}} = -j\,63{,}7\ \Omega$$

UTILIZZANDO MILLMAN :

$$V_{AB} = \frac{\frac{\bar{E}_1}{R_1} + \frac{\bar{E}_2}{R_2}}{\frac{1}{R_{1}} + \frac{1}{R_2} + \frac{1}{Z_c}} = \frac{\frac{R_2\bar{E}_1 + R_1\bar{E}_2}{\cancel{R_1R_2}}}{\frac{R_2\bar{Z}_c + R_1\bar{Z}_c + R_1R_2}{\cancel{R_1R_2}\,Z_c}} = \frac{\bar{Z}_c\,(R_2\bar{E}_1 + R_1\bar{E}_2)}{\bar{Z}_c\,(R_1+R_2) + R_1R_2}$$

$$V_{AB} = \frac{-j\,63{,}7\,(10\cdot 100\, e^{j0°} + 10\cdot 100\, e^{j90°})}{-j\,63{,}7\,(10+10) + 100} = \frac{63{,}7\, e^{-j90°}\cdot 1000\sqrt{2}\, e^{j45°}}{100 - j\,1274}$$

MODULO DENOMINATORE $\quad |\bar{D}| = \sqrt{100^2 + 1274^2} = 1277$

FASE " $\quad$: ~~→A~~ $\angle\bar{D} = Tg^{-1}\ \frac{-1274}{100} = -88°$

$$V_{AB} = \frac{63\cdot 10^3\sqrt{2}\, e^{-j45°}}{1277\, e^{-j88°}} = \underline{69{,}7\ e^{j40°}\ V}$$ (TENSIONE AI MORSETTI AB)

$$\bar{I}_c = \frac{\bar{V}_{AB}}{\bar{Z}_c} = \frac{69{,}7\, e^{j40°}}{63{,}7\, e^{-j90}} = \boxed{1{,}09\, e^{j130°}\ A}$$ (CORRENTE I_c)

LKT (1) : $\quad \bar{V}_{AB} + R_1\bar{I}_1 - \bar{E}_1 = 0 \quad \Rightarrow \quad \bar{I}_1 = \frac{\bar{E}_1 - \bar{V}_{AB}}{R_1}$

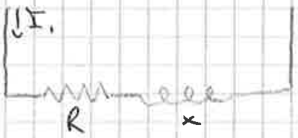
$$\bar{I}_1 = \frac{100\, e^{j0°} - 69{,}7\, e^{j40°}}{10} = \frac{100 - 69{,}7\cos(40°) - j\,69{,}7\sin(40°)}{10}$$

$$= \frac{100 - 53{,}8 - j\,44{,}8}{10} = 4{,}61 - j\,4{,}48 = \boxed{6{,}46\, e^{-j43{,}8°}\ A}$$

LKC : $\quad \bar{I}_1 + \bar{I}_2 - \bar{I}_c = 0 \quad \Rightarrow \quad \underline{\bar{I}_2 = \bar{I}_c - \bar{I}_1}$ ...

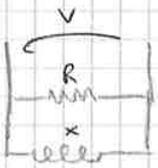
c) e d)

LKC: $\bar{I} = \bar{I}_1 + \bar{I}_2$



$\bar{S}_1 = \bar{V}\bar{I}^* = \bar{Z}_1 \bar{I}_1^2 = (R+jX)\bar{I}_1^2 = \underbrace{\cancel{68}\,6348}_{\text{POTENZA ATTIVA}} + j\underbrace{8464}_{\text{POTENZA REATTIVA}}$ VA (POTENZA COMPLESSA)

$\bar{S}_2 = \bar{Z}_{Eq}\,\bar{I}_2^2$



$\bar{S}_R = \frac{\bar{Z}}{\bar{Z}}\frac{V^2}{Z} = \frac{V^2}{Z}(\cos\varphi + j\sin\varphi)$ $\varphi = 0$ $Z = R$

$\bar{S}_R = \frac{V^2}{R} = \frac{230^2}{\cancel{10}3} = \underbrace{\overset{17633}{\cancel{5290}}\text{ VA}}_{\text{POT ATTIVA}}$ (MA ESSENDO ATTIVA $P_R = \overset{17633}{\cancel{5290}}$ W)

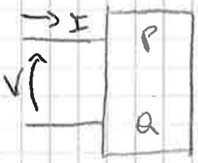
$\bar{S}_X = \frac{V^2}{Z}(\cos\varphi + j\sin\varphi)$ $\varphi = \frac{\pi}{2}$ $Z = X$

$\bar{S}_X = \frac{V^2}{X}(0 + j1) = j\frac{V^2}{X}$ $Q_X = \frac{V^2}{X} = \frac{230^2}{4} = \underbrace{13225\text{ VA}}_{\text{POT REATTIVA}}$

$\bar{S} = \bar{S}_1 + \bar{S}_2 = 6348 + j8464 + 17633 + j13225 =$

$= \boxed{23981 + j21689 \text{ VA}}$

CALCOLO $\bar{I}$:



$S = \sqrt{P^2+Q^2} = \sqrt{23981^2 + 21689^2} = \boxed{32334 \text{ VA}}$

$S = VI \Rightarrow I = \frac{S}{V} = \frac{32334}{230} = 140$ A

$\text{Tg}\,\varphi = \frac{Q}{P} = \frac{21689}{23981} = 0{,}9 \Rightarrow \varphi = 42°$

$\bar{I} = I e^{-j\varphi°} = 140\, e^{-j42°}$

CALCOLO PRIMA $\bar{S}_R$ E POI $\bar{S}_{x_L}$: $\bar{S}_2 = \bar{S}_R + \bar{S}_{x_L}$

$$\bar{S}_R = \frac{V^2}{R}(\cos\varphi + j\sin\varphi) \qquad \varphi = 0°$$

$$\bar{S}_R = \frac{230^2}{4}(1+0) = \frac{230^2}{4} = 13225 \text{ VA } (W)$$ POT ATTIVA

$$\bar{S}_{x_L} = \cancel{230^2}\ \frac{V^2}{RX_L}(\cos\varphi + j\sin\varphi) \qquad \varphi = \frac{\pi}{2}$$

$$\bar{S}_x = \frac{230^2}{3}(0+j) = j\,17633,3 \text{ VA}$$ POT REATTIVA

$$\bar{S}_2 = \bar{S}_R + \bar{S}_{x_L} = \boxed{13225 + j\,17633,3 \text{ VA}}$$

$$\bar{S} = \bar{S}_1 + \bar{S}_2 = 8418 + 13225 + j(-6394 + 17633,3) =$$

$$= \boxed{21643 + j\,11239,3 \text{ VA}}$$

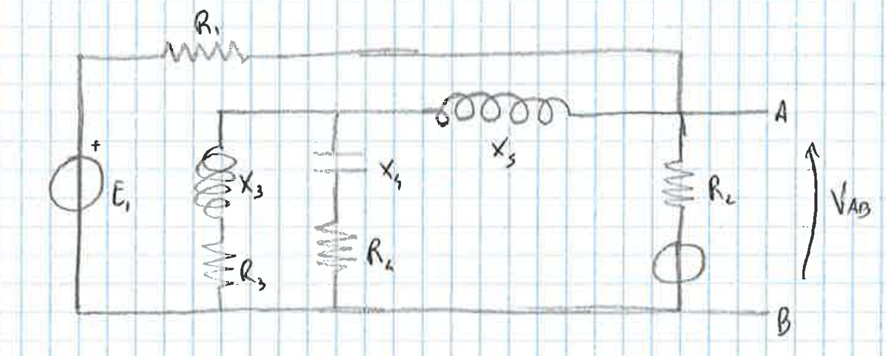
$P = 21643$ VA $\qquad Q = 11239,3$ VA

$$S = \sqrt{P^2 + Q^2} = \sqrt{21643^2 + 11239,3^2} = 24387,3 \text{ VA}$$

$$S = VI \Rightarrow I = \frac{S}{V} = \frac{24387,3}{230} = 106 \text{ A}$$

$$\varphi = Tg^{-1}\ \frac{11239,3}{21643} = 27,44°$$

ESERCIZIO (THEVENIN)



$R_1 = 1\Omega$ $R_3 = 2\Omega$

$R_2 = 1\Omega$ $X_4 = 3\Omega$

$X_3 = 3\Omega$ $X_5 = 2\Omega$

~~X~~ $R_4 = 4\Omega$

CALCOLO LE IMPEDENZE:

$z_1 = R_1 = 1\Omega$; $z_2 = R_2 = 1\Omega$; $z_3 = R_3 + jX_3 = 2 + j3\Omega$;

$z_4 = 4 - j3\ \Omega$; $z_5 = j2\ \Omega$

CALCOLO IMPEDENZA EQUIVALENTE z_{eq}:

$$z_{34} = z_3 \| z_4 = \frac{z_3 z_4}{z_3 + z_4} = 2{,}83 + j\ \Omega$$

$$z_{345} = z_{34} + z_5 = 2{,}83 + j3\ \Omega$$

$$z_{2345} = z_{345} \| z_2 = 0{,}84 + j\,0{,}126\ \Omega$$

$$\boxed{z_{eq} = z_{2345} \| z_1 = 0{,}47 + j\,0{,}037\ \Omega}$$

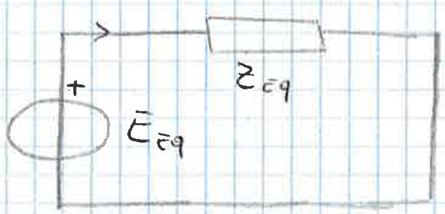
CALCOLO V_{AB}:

MILLMAN:

$$\boxed{V_{AB} = \frac{\dfrac{\bar{E}_1}{R_1} + \dfrac{\bar{E}_2}{R_2}}{\dfrac{1}{z_{345}} + \dfrac{1}{z_1} + \dfrac{1}{z_2}}}$$

SVOLGENDO I CALCOLI AVREMO UN VALORE DI $\bar{E}_{eq}$.

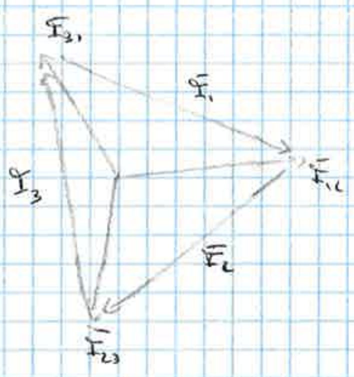
CIRCUITO DI THEVENIN.



b) CALCOLO I_l:

$$\bar{I}_1 + \bar{I}_{31} - \bar{I}_{21} = 0$$

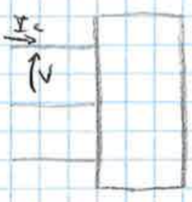
LKC
$$\begin{cases} \bullet\ \bar{I}_1 = \bar{I}_{21} - \bar{I}_{31} \\ \circ\ \bar{I}_2 = \bar{I}_{23} - \bar{I}_{12} \\ \bullet\ \bar{I}_3 = \bar{I}_{31} - \bar{I}_{23} \end{cases}$$



$$|\bar{I}_1| = |\bar{I}_2| = |\bar{I}_3| = I_l$$

$$I_l = \sqrt{3}\, I_f = \sqrt{3} \cdot 18,2 = \boxed{30,\ A}$$

c)



$S = \sqrt{3}\, V I_l$

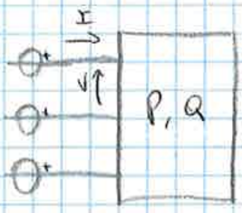
ci serve l'angolo di fase.

$\angle \bar{Z}_\Delta = 25,8° = \varphi$

$$\bar{S} = P + jQ = S(\cos\varphi + j\sin\varphi) = \sqrt{3}\, V I_l\, (\cos\varphi + j\sin\varphi)$$

$$= \sqrt{3}\, 400 \cdot 30\, (\cos(25,8) + j\sin(25,8)) = \underbrace{18706}_{P} + j\, \underbrace{8313}_{Q}\ VA$$

2) METODO DELLE POTENZE



V = 400 V   P = 100 kW   Q = 100 kVA

a) I = ?   b) $\bar{Z}_y$ = ? (IMPEDENZA EQUIVALENTE)

V, I, P, Q, S, φ.   AVENDO ALMENO 3 DI QUESTE GRANDEZZE POSSO CALCOLARLE TUTTE.

a)

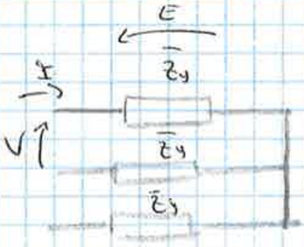
$S = \sqrt{3}\, V I$ MA $S = \sqrt{P^2+Q^2} = \sqrt{10^2+10^2} = 10\sqrt{2}$ kVA

⇓

$$I = \frac{S}{\sqrt{3}\, V} = \frac{10\sqrt{2}\cdot 1000}{\sqrt{3}\; 400} = \boxed{20,6\ A = I}$$

UN ALTRO MODO DI AGIRE ERA CALCOLARE $\boxed{\varphi = Tg^{-1}\frac{Q}{P}}$

b)



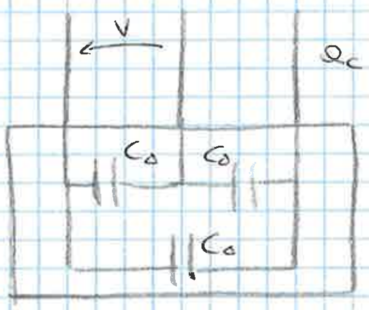
$$E = \frac{V}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230\ V$$

$$Z_y = \frac{E}{I} = \frac{230}{20,6} = 11,2\ \Omega$$

MA $\varphi = Tg^{-1}\frac{Q}{P} = \frac{\pi}{4}$

$$\bar{Z}_y = 11,2\left(\cos\frac{\pi}{4} + j \sin\frac{\pi}{4}\right) = \boxed{7,85 + j7,85\ \Omega = \bar{Z}_y}$$

- COLLEGO A TRIANGOLO



$$Q_c = 3\left(\frac{V^2}{Z_c} \sin \varphi_c\right)$$

$$= 3\,\frac{V^2}{1/\omega C_\Delta}(-1) = -3V^2\omega C_\Delta$$

da cui $\boxed{C_\Delta = \frac{-Q_c}{3V^2\omega}}$

RICAPITOLANDO SI NOTA CHE LA CAPACITÀ IN COLLEGAMENTO A TRIANGOLO È 3 VOLTE + PICCOLA DI QUELLA A STELLA:

$$\boxed{C_y = \frac{-Q_c}{\omega V^2}} \qquad \boxed{C_\Delta = \frac{-Q_c}{3\omega V^2}}$$

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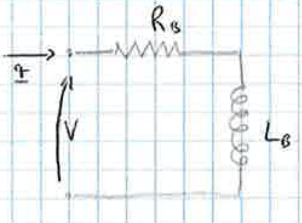
b)

CALCOLO DELLA TENSIONE: $(V = ?)$



$$\underbrace{V = R_B \cdot I} \to \text{EQ. DA RISOLVERE}$$

MA $R_B = \rho \frac{l_{spira} \cdot N}{S_c}$] - 2° OHM $\Rightarrow$ $R_B = 18 \cdot 10^{9} \cdot \frac{0{,}45 \cdot 500}{0{,}4 \cdot 10^{-6}} = \underbrace{10{,}125\ \Omega}$

ORA POSSO CALCOLARE V: $V = R \cdot I = 10{,}125 \cdot 3{,}814 = \boxed{38{,}62\ V}$

c)

L'OGGETTO VARIA:

FORMULA DA RISOLVERE:

$$N I' = H_{Fe}\, l_{Fe}' + H_{Tr}\, l_{Tr}$$

$l_{Fe}' = l_{Fe} - l_{Tr} \Rightarrow l_{Fe}' = 1{,}568\ m$

$l_{Tr} = 0{,}003\ m$

$B_{Fe} = B_{Tr} = \frac{\Phi}{S_{Fe}} = 1{,}47\ T$ CON $H_{Fe} = 1214\ A/m$

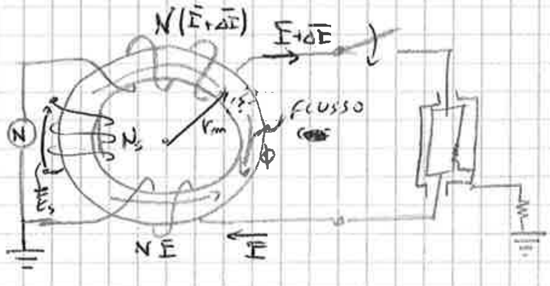
$H_{Tr} = \frac{B_{Tr}}{\mu_0} = \frac{1{,}47}{4\pi\, 10^{-7}} = 1169790\ A/m$

ORA POSSO CALCOLARE I':

$$I' = \frac{H_{Fe}\, l_{Fe}' + H_{Tr}\, l_{Tr}}{N} = \frac{(1214 \cdot 1{,}568) + (1169790 \cdot 0{,}003)}{500}$$

$$\boxed{I' = 10{,}82\ A}$$

2) TEMA D'ESAME



LO SBILANCIO MAGNETO-MOTRICE CREA UN FLUSSO NEL NUCLEO.

IL FLUSSO SI CREA GRAZIE ALLA DIFFERENZA DI CORRENTE. TALE FLUSSO "SOLLECITA" LA SPIRA CHE APRE L'INTERRUTTORE.

DATI: $r_m = 5 cm$ $N = 10 spire$

$S = 5 cm^2$ $\mu_r = 5000$

CALCOLARE: a) $N_s = ?$ CON $f = 50 Hz$

$\hat{E}_{s(EFF)} = 2 V$

$\Delta I_{(EFF)} = 30 mA$

SVOLGIMENTO:

$$e_s = \frac{d\lambda_r}{dt} = \frac{d(N_s \cdot \Phi_a)}{dt}$$

$$E_s = \frac{\omega}{\sqrt{2}} N_s \hat{\Phi}$$

INCOGNITA

RELAZIONE DA RISOLVERE

LEGGE DI HOPKINSON:

$$N(\cancel{\bar{I}} + \Delta\hat{I}) - \cancel{N\bar{I}} = R_N \hat{\Phi}$$

$$\Rightarrow N \Delta\hat{I} = R_N \hat{\Phi} \Rightarrow \hat{\Phi} = \frac{N \Delta\hat{I}}{R_N}$$

$$R_N = \frac{l_N}{\mu_r \mu_0 S} = \frac{2\pi r_m}{\mu_r \mu_0 S} = 100000 H^{-1}$$

$$\hat{\Phi} = \frac{N \cdot (\sqrt{2} \Delta I_{(EFF)})}{R_N} = 4,24 \cdot 10^{-6} Wb$$

$$\boxed{N_s = \frac{\sqrt{2} E_s}{\omega \hat{\Phi}} = 2122 \text{ spire}}$$

→ RISULTATO

b) $M_{21} = \frac{\lambda_{21}}{I_1} = \frac{N_2 \, \Phi_2^*}{I_1}$

AVVOLGIMENTO

CORRENTE

OTTENGO $\Phi_2^* = \Phi_1^* \frac{R_c}{R_c + 2R} = \underbrace{\frac{N_1 I_1}{R_{eq_1}}}\frac{R_c}{R_c + 2R} = \frac{N_1 I_1}{R_{eq}^*}$

$\Phi_1^* = \frac{L_1 I_1}{N_1}$

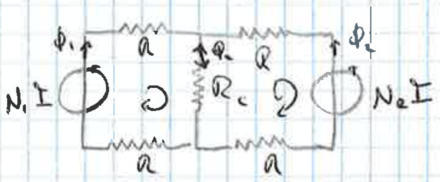
SOSTITUENDO TUTTO:

$M_{21} = -\frac{N_1 N_2}{R_{eq_1}} \cdot \frac{R_c}{R_c + 2R} \Rightarrow \boxed{M_{21} = -0{,}002327 \text{ H}}$

CONNETTO B e D

$L = \frac{\lambda}{I}$ → FLUSSO CONCATENATO

$\lambda = N_1 \Phi_1 + N_2 \Phi_2$ % BISOGNA TROVARE Φ_1 e Φ_2 %



ADOPERO IL METODO DI KIRCHHOFF:

$$\begin{cases} \Phi_1 + \Phi_2 = \Phi_c \\ N_1 I_0 = 2R\,\Phi_1 + R_c \Phi_c \\ N_2 I = 2R\,\Phi_2 + R_c \Phi_c \end{cases}$$

VISTO CHE LA RISOLUZIONE DEL SISTEMA È MOLTO COMPLESSO, POSSO FARE DUE SUPPOSIZIONI:

$\underline{I = 1 \text{ A}}$ ← SUPPOSIZIONE POSSIBILE XKE' IL SISTEMA E' LINEARE.

NE CONSEGUE CHE:

$\Phi_2 = 2{,}8 \cdot 10^{-5}$ Wb

$\Phi_1 = 5{,}816 \cdot 10^{-5}$ Wb

$\Rightarrow L = \frac{N_1 \Phi_1 + N_2 \Phi_2}{I} = \frac{(150)(2{,}8 \cdot 10^{-5}) + (5{,}816 \cdot 10^{-5})(120)}{1}$

$L = 0{,}01383 \text{ H} = \boxed{13{,}83 \text{ mH}}$

⇑

$\boxed{L = L_1 + L_2 + M_{21}}$

ESERCITAZIONE 16/5/2013

MACCHINA A C.C. ECCITAZIONE SEPARATA.

4)

DATI: $P_N = 10\ kW$ $\eta_N = 0,84$ $R_{ecc} = 3,665\ \Omega$

$V_N = 110\ V$ $R_a = 0,07\ \Omega$ $I_{ecc} =$ COSTANTE $\Rightarrow \phi_M = cost$

$n_N = 1000\ rpm$ $V_{ecc} = 50\ V$

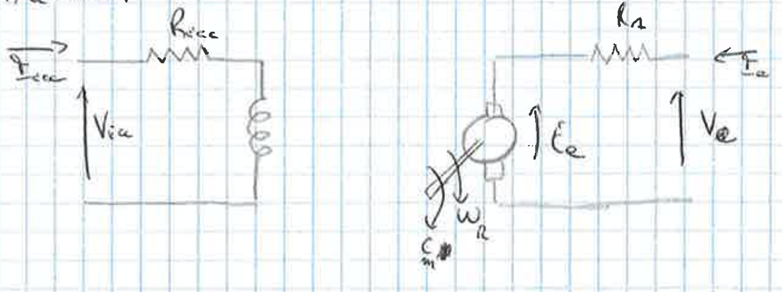
DETERMINARE:

a) $P_{fe} + P_{mecc} = P_0 = ?$

b) $C_0 = ?$

c) $C_{AW} = 2\,(C_0 + C_N)$ $R_{AW} = ?$

SVOLGIMENTO:



a)

$$\eta_N = \frac{P_N}{P_N + \Sigma\ Perdite} \quad \text{con} \quad \Sigma\ Perdite = \left(\frac{1}{\eta_N} - 1\right) P_N = 1905\ W$$

MA $\Sigma\ Perdite = P_0 + P_{Ja} + P_{J\,ecc}$

$$\Sigma\ Perdite_a = \Sigma\ Perdite_{tot} - \underbrace{\Sigma\ Perdite_{ecc}}_{P_{Jecc}} \Rightarrow \Sigma\ Perdite_a = 1905 - \frac{50^2}{3,665} = \underline{1223\ W}$$

$$P_a = P_N + \Sigma\ Perdite_a = 10\,000 + 1223 = \underline{11223\ W}$$

$$I_N = \frac{P_a}{V_N} = \frac{11223}{110} = \underline{102\ A}$$

$$P_0 = \Sigma\ Perdite_a - R_a \cdot I_a^2 = 1223 - 0,07\,(102^2) = \boxed{485\ W}$$

b)

$$C_0 \cong \frac{P_0}{\omega_N} = \frac{485}{\frac{2\pi\ 1000}{60}} = \boxed{4,63\ N \cdot m}$$

5) DATI: $R_a = 1\Omega$ $n_0 = 181$ rpm

$V_N = 210V$ I_0 = TRASCURABILE $\approx 0A$

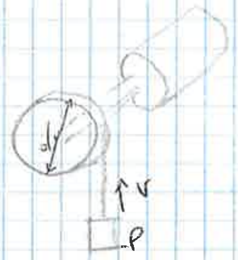
$I_N = 10A$

CALCOLARE: a) $K\Phi_m = K_e = ?$ K_e si usa per i magneti permanenti

b) $C_N = ?$

c) $\eta_N = ?$

II PARTE: DATI (4): Peso = 200kg $v = 0,4$ m/s $d = 10$cm



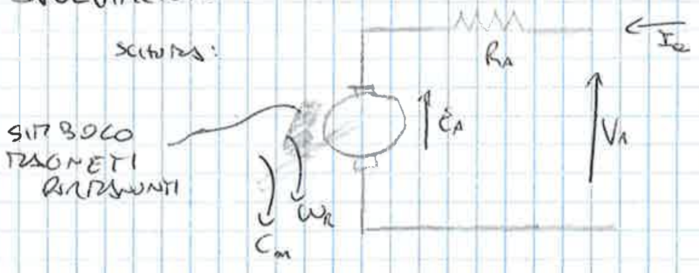
CALCOLARE:

d) $I_a = ?$

e) $V_a = ?$

SVOLGIMENTO:

SCHEMA:



ABBIAMO CHE

a) $I_0 = 0 \Rightarrow E_0 = V_N = K_e\omega$

$~~Ke~~ K_e = \frac{E_0}{\omega_0} = \frac{210}{\frac{2\pi}{60}181} = \boxed{10,5 \frac{V s}{rad}}$

b) $E_N = K_e\omega_N = V_a - R_a I_N \Rightarrow \omega_N = \frac{V_a - R_a I_N}{K_e} = \frac{210 - 10}{10,5} = \boxed{19,05 \ rad/s}$

da cui $\underbrace{n_N = 182 \text{ rpm}}$

$C_N \underset{\overset{\uparrow}{P_0 = 0}}{=} \frac{E_N I_N}{\omega_N} = \boxed{105 \ N \cdot m}$ poteva essere anche $C_N = \underbrace{k\Phi_m}_{K_e} \cdot I_N$

c) $\eta_N = \frac{P_N = C_N \cdot \omega_N}{V_N \cdot I_N} = \boxed{0,952}$ P_N ~~= 2000W~~

7) DATI: $P_N = 10kW$ $\eta = 0,75$

$n = 600 rpm$ $V_a = 110V$ $R_a = 0,1\Omega$ ECCITAZIONE TRASCURABILE

$I_a = 60 A$

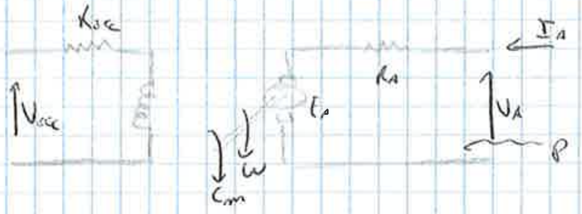
CALCOLARE: a) $P_{ASSE} = ?$

b) $P_{Ja} = ?$

c) $P_0 = P_{MECC} + P_{FE} = ?$

d) $V_a' = ?$ per cui $n' = 2n$ e $I' = 50 A$

SVOLGIMENTO



a) $$\eta = \frac{P_{ASSE}}{V_a \cdot I_a + \cancelto{0}{\frac{V_{ec}^2}{R_{ecc}}}} \Rightarrow P_{ASSE} = \eta V_A \cdot I_a = \boxed{4950 \ W}$$

b) $$P_{Ja} = R_a \cdot I_a^2 = 0,1 \cdot 60^2 = \boxed{360 \ W}$$

c) $$\Sigma P_{PERDITE} = \Sigma P_{PERDITE_a} \Rightarrow \Sigma P_{PERDITE_a} = V_a \cdot I_a - P_{ASSE} = 1650 \ W$$

$$P_0 = \Sigma P_{PERDITE_a} - P_{Ja} = 1650 - 360 = \boxed{1290 \ W}$$

d) $$k\Phi_n = \frac{V_A - R_a I_a}{\omega} = \frac{E_A}{\omega} = \frac{110 - (0,1)(60)}{\frac{2\pi}{60} 600} = 1,66 \ \frac{Vs}{rad}$$

$$V_a' = \underbrace{k\Phi_n \cdot \omega'}_{E_A'} + R_a I_a' = \boxed{213 \ V}$$

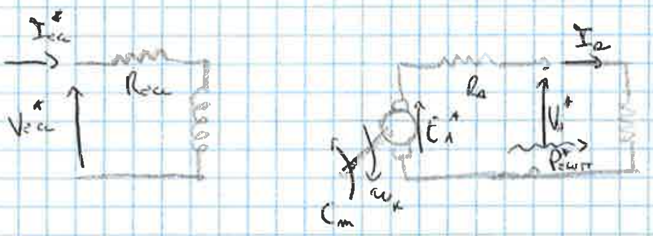
PARTE II

SE IL MOTORE FUNGE DA GENERATORE CON TENSIONE E VELOCITA' NOMINALI

$V_a^* = 1200 V$ $n^* = 1600 rpm$ $P_{elettr}^* = 600 kW$

DETERMINARE: a) $C^* = ?$

b) $V_{ecc}^* = ?$



a) $$C_m^* \cdot \omega_r^* = E_a^* I_a^* = P_{elettr}^* + P_{Ja}^*$$

$P_0 \simeq 0$

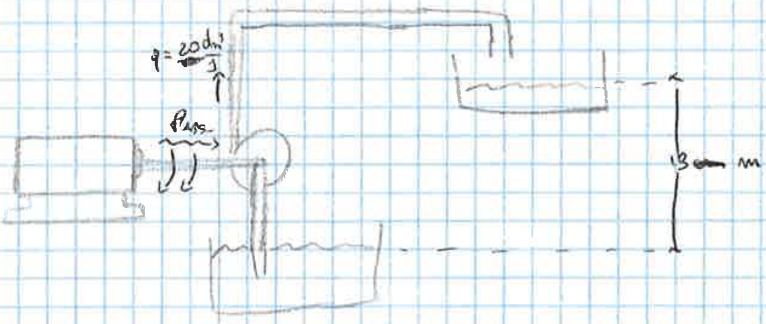
$$I_a^* = \frac{P_{elettr}^*}{V_a^*} = \frac{600\,000}{1200} = 500 \quad A$$

$$C_m^* = \frac{600000 + (0{,}35 \cdot 500^2)}{1600 \cdot \frac{2\pi}{60}} = \boxed{4103 \quad N \cdot m}$$

b) $$K\Phi_m^* = \frac{C_m^*}{I_a^*} = \frac{4103}{500} = 8{,}2 \ \frac{N \cdot m}{A}$$

$$V_{ecc}^* = V_{ecc_N} \cdot \frac{K\Phi_m^*}{K\Phi_{m_N}} = \boxed{242 V}$$

NOTE SUL PROBLEMA 3 : (DA FARE)



- $\Delta L_{TH} = \Delta m \cdot g \cdot h$
- $P_{TH} = \frac{\Delta L_{TH}}{\Delta t} = \underbrace{\frac{\Delta m}{\Delta t}}_{Q \text{ in massa}} g h$
- $Q = 20 \ kg/s$
- $P_{asse} = \frac{P_{TH}}{\eta_{tubi} \cdot \eta_{pompa}} = 2814 W$

TEMA D'ESAME

MOTORE C.C. SERIE

DATI: $n_N = 1220$ rpm $\quad I_N = 440A \quad R_T = 0{,}05\ \Omega$

CARATTERISTICA COPPIA-VELOCITA'

IPOTESI LINEARE ⟵

C (N·m)	2300	1800	1400	1160	980
n (rpm)	1100	1200	1300	1400	1500

DETERMINARE:

a) $C_N = ?$

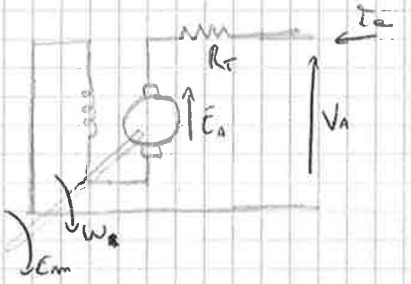
b) $V_N = ?$

c) $\eta_N = ?$

d) $I' = ?$ con $n' = 1450$ rpm

e) $V'' = ?$ con $C''_{avv} = 2\ C_N$

SVOLGIMENTO:



a) $C_N = \{\text{da Tabella}\} =$

$$= \frac{n_N - 1200}{1300-1200} = \frac{C_N - 1800}{1400-1800}$$

$$\hookrightarrow \boxed{C_N = 1720\ N \cdot m}$$

b) $k_T = \dfrac{C_N}{I_N^2} = \dfrac{1720}{440^2} = 8{,}88 \cdot 10^{-3}\ \dfrac{N \cdot m}{A^2}$

$$E_a = \underbrace{k_T I_a}_{K\Phi}\ \omega_R = 8{,}88 \cdot 10^{-3} \cdot 440 \cdot 1220 \cdot \frac{2\pi}{60} =$$

$$V_N = E_a + R_a I_a = \boxed{521{,}4\ V}$$

c) $\eta_N = \dfrac{\overset{\to P_N}{C_N \cdot \omega_N}}{V_N \cdot I_a} = \dfrac{1720 \cdot \frac{2\pi}{60}\ 1120}{521{,}4 \cdot 440} = \boxed{0{,}958}$

ESERCIZIO 4:

DATI: $V_N = 1000\ V$ $C_{AVV} = 7000\ N\cdot m$ $C_N = 3600\ N\cdot m$ ([illegible])

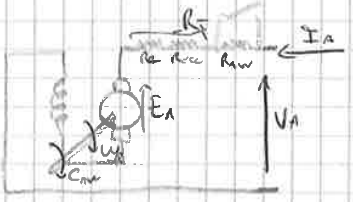
$R_{AVV} = 2{,}2\ \Omega$ 400 A $= I_{AVV}$

CALCOLARE: a) $R_{ecc} = ?$ $R_a = ?$ $k_T = ?$ con $R_{ecc} = R_a$

b) $n_N = ?$

c) $n' = 1{,}1\, n_N$ con $C' = 1{,}1\, C_N$ $V' = ?$

SVOLGIMENTO:



a) $R_T = \dfrac{V_N}{I_{AVV}} - R_{AVV}$

$R_T = \dfrac{1000}{400} - 2{,}2 = 0{,}3\ \Omega$ $R_{ecc} = \dfrac{R_T}{2} = R_a = \boxed{0{,}15\ \Omega}$

$C_{AVV} = k_T I_{AVV}^2 \Rightarrow k_T = \dfrac{C_{AVV}}{I_{AVV}^2} = \dfrac{7000}{400^2} = \boxed{0{,}04375\ \dfrac{N\cdot m}{A}}$

b) $I_N = \sqrt{\dfrac{C_N}{k_T}} = \sqrt{\dfrac{3600}{0{,}04375}} = 286{,}9\ A$

$E_A = V_{N0} - R_T I_N$ ma $E_A = k_T I_N \omega \Rightarrow \omega_N = \dfrac{E_A}{k_T I_N}$

$\omega_N = \dfrac{V_N - R_T I_N}{k_T I_N} = 72{,}81$ rad/sec

$n_N = 72{,}81 \cdot \dfrac{60}{2\pi} = \boxed{695{,}3\ \text{rpm}}$

c) $\omega' = 1{,}1 \cdot \omega_N = 1{,}1 \cdot 72{,}81 = \cancel{82{,}81\ rad/s}\ 80{,}09$ rad/s

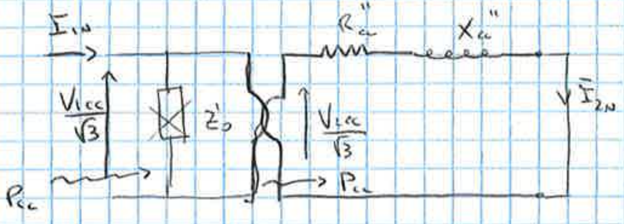
$C' = 1{,}1 \cdot C_N = 1{,}1 \cdot 3600 = 3960\ N\cdot m$

$I_a' = \sqrt{\dfrac{C'}{k_T}} = \sqrt{\dfrac{3960}{0{,}04375}} = 300{,}8\ A$

$E_a' = \dfrac{C'\omega'}{I_a'} = \dfrac{3960 \cdot 80{,}09}{300{,}8} = 1054{,}2\ V$

$V' = E_a' + R_T \cdot I_a' \Rightarrow V' = 1054{,}2 + (0{,}3\ 300{,}8) \Rightarrow \boxed{V' = 1144{,}5\ V}$

ESEGUO LA PROVA IN CTO CTO AL SECONDARIO:



$$V_{2cc} = \frac{V_{1cc}}{t} = \frac{50}{4} = \underline{12,5\ V}$$

$$R_{cc}'' = \frac{P_{cc}}{3 I_{2N}^2} = \frac{250\ W}{3 \cdot 120^2} \Rightarrow \underbrace{R_{cc}'' = 0,01736\ \Omega}$$

$$Z_{cc}'' = \frac{V_{2cc}}{\sqrt{3}\ I_{2N}} = \frac{12,5}{\sqrt{3}120} = \underline{0,06014\ \Omega}$$

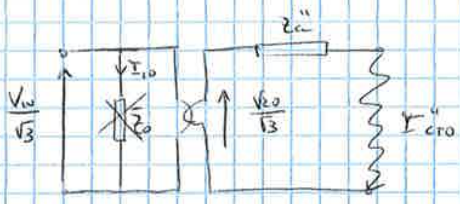
$$X_{cc}'' = \sqrt{Z_{cc}''^2 - R_{cc}''^2} = \cancel{\sqrt{0,016}}\ \sqrt{0,06014^2 - 0,01736^2} = \underbrace{0,05758\ \Omega}$$

$$\underbrace{Z_{cc}'' = 0,01736 + j\ 0,05758\ \Omega}$$ CARTESIANA

$$\underbrace{Z_{cc}'' = 0.06014\ e^{j73,22°}\ \Omega}$$ POLARE

$$\cos \varphi_{cc} = 0,287$$

VOLENDO CALCOLARE LA CORRENTE DI GUASTO A CTO CTOCTO .



$$I_{cto}'' = \frac{V_{20}}{\sqrt{3}\ Z_{cc}''} = \frac{250\ V}{\sqrt{3} \cdot 0,06014}$$

$$\underbrace{I_{cto}'' = 2400\ A}$$

$$I_{cto}' = \frac{I_{cto}''}{t} = \frac{2400}{4} = \underbrace{600\ A}$$

ALTRO ESERCIZIO: 1)

~~Sn~~ DATI: $S_N = 200$ KVA $t = \frac{20\,000\ V}{400\ V}$

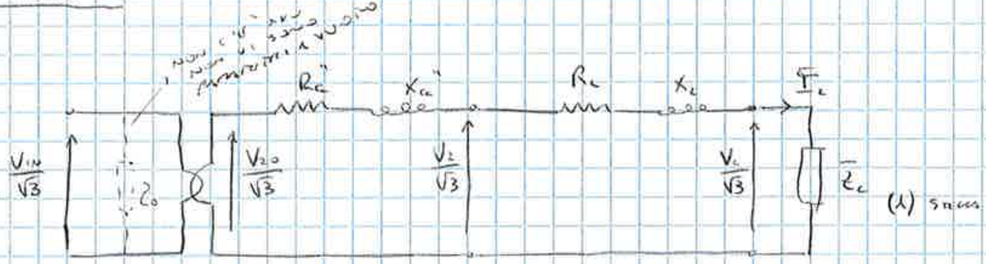
$\frac{V_{1cc\ prova}}{V_{nominale}}$ <= $V_{cc}\% = 5\%$ $\cos\varphi_{cc} = 0,4$

DATI NOMINALI CARICO: $P_{cN} = 100$ KW ; $V_{cN} = 500$ V ; $\cos\varphi_c = 0,85$

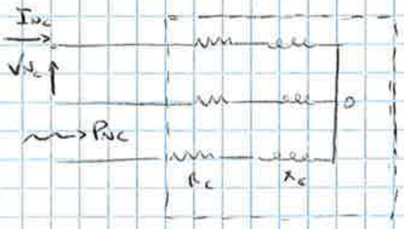
$R_l = 0,1\,\Omega$ $X_l = 0,2\,\Omega$

CALCOLARE: a) $V_c = ?$ b) $I_c = ?$ c) $\eta_c = ?$ d) $\eta_T = ?$ e) $\eta_{impianto} = ?$

SVOLGIMENTO:



CARICO:



$$I_{Nc} = \frac{P_{Nc}}{\sqrt3\ V_{Nc}\ \cos\varphi_c} = \frac{100\,000}{\sqrt3\ 500\ 0,85} =$$

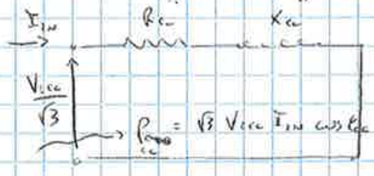
$$I_{Nc} = 135,8\ A$$

$$R_c = \frac{P_{Nc}}{3\,I_{Nc}^2} = \frac{100\,000}{3\cdot 135,8^2} \Rightarrow R_c = \underline{1,809\ \Omega}$$

$$X_c = R_{cc}\ Tg\,\varphi_c = 1,809\ Tg(\cos^{-1} 0,85) = \underline{1,12\ \Omega}$$

D'ORA IN POI I DATI NOMINALI NON SERVONO PIÙ. (SI USANO I DATI DEL PROBLEMA).

PROVA DI CORTO AL SECONDARIO



$$I_{2N} = \frac{S_N}{\sqrt3\,V_{20}} = \frac{200\,000}{\sqrt3\ 400} = 288,7\ A$$

$$V_{cc}\% = \frac{V_{2cc}}{V_{20}}\cdot 100 \qquad V_{2cc} = \frac{V_{cc}\%\cdot V_{20}}{100}$$

$$Z_{cc}'' = \frac{V_{2cc}}{\sqrt3\ I_{2N}} = \frac{20}{\sqrt3\ \cancel{I_{2N}}\ 288,7} = 0,04\ \Omega \qquad V_{2cc} = \frac{5\cdot 400}{100} = \underline{20\ V}$$

$$R_{cc}'' = Z_{cc}''\cos\varphi_{cc} \qquad X_{cc}'' = Z_{cc}''\sin\varphi_{cc}$$

$$R_{cc}'' = 0,016 \qquad X_{cc}'' = 0,0211\ \Omega$$

ESERCIZIO 2:

DATI: $S_N = 100$ kVA

$t = \frac{10000}{400}$ $\frac{V_{1N}}{V_{2N}}$

CORTO
$\begin{cases} V_{cc}\% = 2,5\% \\ P_{cc}\% = 1,3\% \end{cases}$

$P_0\% = 1,2\%$ => 1,2% DI S_N

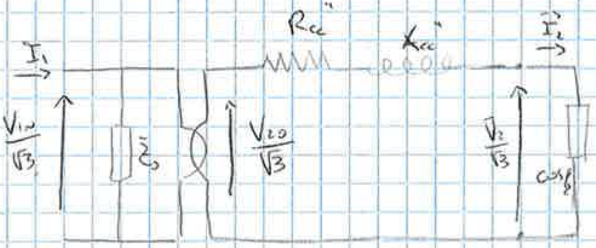
$I_2 = \frac{3}{4} I_{2N}$ $\cos\varphi_2 = 0,8$

CALCOLARE:

a) $\Delta V_{..} = \Delta V_{..} = ?$ b) η_T c) ~~I_{cc}''~~ $I''_{cto} = ?$

$V_2 = ?$

SVOLGIMENTO:



ESEGUO LA PROVA DI CORTO:

CONVERSIONE VALORI PERCENTUALI

$V_{cc}\% = \frac{V_{2cc}}{V_{2N}} \cdot 100 \Rightarrow \underline{V_{2cc}} = \frac{V_{cc}\% \cdot V_{2N}}{100} = 10V$

$P_{cc}\% = \frac{P_{cc}}{S_N} \cdot 100 \Rightarrow \underline{P_{cc}} = \frac{P_{cc}\% \; S_N}{100} = 1300 \text{ W}$

PROVA DI CORTO CIRCUITO

$I_{2N} = \frac{S_N}{\sqrt{3} V_{2N}} = \frac{100000}{400\sqrt{3}} = 144,3$ A

$\underline{R''_{cc}} = \frac{P_{cc}}{3 I_{2N}^2} = \frac{1300}{3 \cdot 144,3^2} = 0,02081 \; \Omega$

$Z''_{cc} = \frac{V_{cc}}{\sqrt{3} I_{2N}} = \frac{10}{144,3\sqrt{3}} = 0,04 \; \Omega$

$\Rightarrow \underline{X''_{cc}} = \sqrt{Z''^2_{cc} - R''^2_{cc}} = 0,03416 \; \Omega$

a)

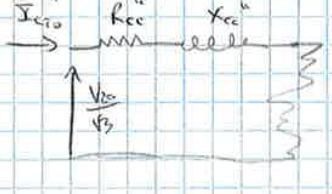
$\Delta V = V_{2N} - V_2 = \sqrt{3} I_2 (R''_{cc} \cos\varphi_2 + X''_{cc} \sin\varphi_2) \Rightarrow$

$\Rightarrow \boxed{\Delta V = 6,965 \text{ V}} \Rightarrow V_2 = V_{2N} - \Delta V = \boxed{393,35 \text{ V}}$

b) $\eta_T = \frac{\sqrt{3} V_2 I_2 \cos\varphi_2}{\sqrt{3} V_2 I_2 \cos\varphi_2 + 3 R''_{cc} I_2^2 + P_{fe}} = \boxed{0,968 = \eta_T}$

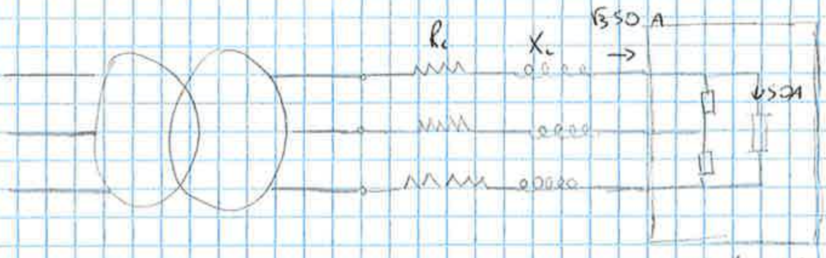
$P_{fe} = P_0 \; (V_1 = V_{1N})$

c)



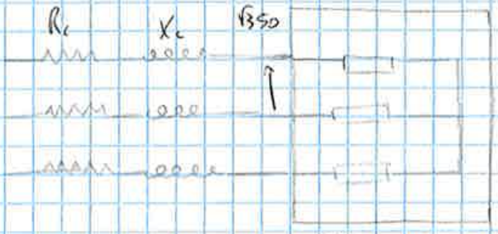
$I''_{cto} = \frac{V_{20}}{\sqrt{3} |\bar{Z}''_{cc}|} = \frac{400}{\sqrt{3} \; 0,04} = \boxed{5773 \text{ A}}$

INTRODUZIONE ALL'ESERCIZIO 5.



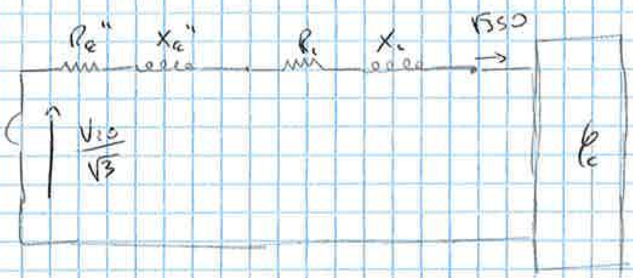
cos φ = 0,7

E LO TRASFORMO IN UN CARICO A STELLA EQUIVALENTE:



cos φ = 0,7

TRACCIO ORA IL GRAFICO DI RISOLUZIONE:



ORA SI RISOLVE NORMALMENTE.

c) $\eta_{TOT} = ?$ POSSIAMO FARE IL PRODOTTO DI RENDIMENTO

$$\eta_{TOT} = \eta_T \cdot \eta_{ROT}$$

POSSO PERÒ ANCHE AGIRE CON BOUCHEROT:

$$\eta_{TOT} = \frac{P_{ASSE}}{P_2 + 3R_{cc}'' I_2' + P_0} \qquad P_0 = \sqrt{3}\, V_{20}\, I_{20} \cos\varphi_0 \quad \underline{\text{NOTO}}$$

LA R_{cc}'' SI TROVA CON LA PROVA DI CORTOCIRCUITO.

AGGIUNGO UNA DOMANDA: (DOMANDINA FINALE)

SAPENDO CHE IL TRASFORMATORE È UN $\Delta y\, 11$, TROVARE IL RAPPORTO SPIRE

$N_{sp} = ?$

$$t \overset{def}{=} \frac{V_{1n}}{V_{20}} = \frac{E_1}{\sqrt{3}\, E_2} \rightarrow m_s \implies t = \frac{m_s}{\sqrt{3}} \implies m_s = t\sqrt{3} \quad \underline{\underline{\text{NOTO}}}$$

$$\boxed{m_s = t \cdot \sqrt{3} = 2{,}5\sqrt{3}}$$

ESERCITAZIONE 30 / 5 / 2013

PARALLELO TRASFORMATORI

1) FUNZIONAMENTO A VUOTO ⇒ $I_{circ} = 0$ $\begin{cases} V_{IN_A} = V_{IN_B} \\ t_A = t_B \\ GR_A = GR_B \end{cases}$

2) FUNZIONAMENTO IN CTO ⇒ $\begin{cases} V_{cc_A}\% = V_{cc}\%_B \\ \varphi_{cc_A} = \varphi_{cc_B} \end{cases}$ (*)

ESERCIZIO 1:

DATI: T_1 ⇒ $S_N = 100\,kVA$ $\frac{10\,kV}{400\,V} = t$

$V_{cc}\% = 4,2\%$

$\cos\varphi_{cc} = 0,35$

T_2 ⇒ $S_N = 120\,kVA$ $\frac{100\,kVA}{400\,V} = t$

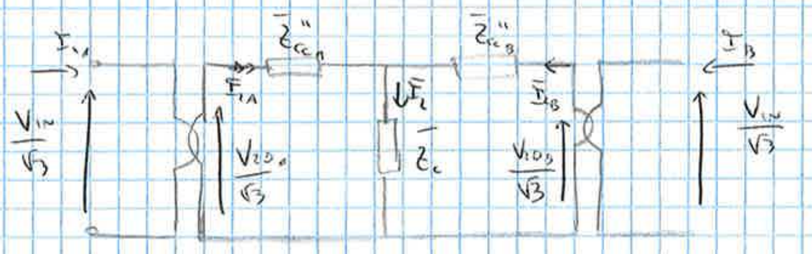
$V_{cc}\% = 4\%$

$\cos\varphi_{cc} = 0,35$

DATI DI TARGA: $P_N = 180\,kW$ $V_{cN} = 400\,V$ $\cos\varphi_c = 0,85$

CALCOLARE: a) $V_2 = ?$ b) $I_{2A} = ?$, $I_{2B} = ?$ c) $I''_{circ} = ?$

SVOLGIMENTO:

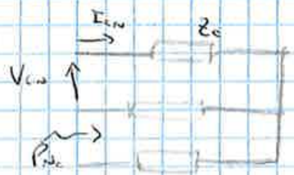


ESEGUENDO LA PROVA IN CTO CTO ⇒ $\bar{Z}''_{cc_A} = \underbrace{0,0235 + j\,0,063\,\Omega} = \underline{0,0672\,e^{j63,51}}$

$\bar{Z}''_{cc_B} = \underbrace{0,0087 + j\,0,05\,\Omega} = \underline{0,0533\,e^{j63,51}}$

CALCOLO $\bar{Z}_c$ (SI USANO I VALORI DI TARGA)

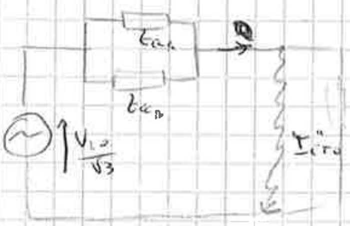
$\bar{Z}_c$ È TRIFASE ⇒



$Z_c = \frac{V_{Nc}}{\sqrt{3}\,I_{Nc}} = 0,756\,\Omega$

$I_{Nc} = \frac{P_{Nc}}{\sqrt{3}\,V_{Nc}\cos\varphi_c} = 305,6\,A$

c) $I''_{cto} = ?$



~~$I_{cto} = \frac{V_{20}}{\sqrt{3}} \cdot 1$~~

$$I''_{cto} = \frac{V_{20}}{\sqrt{3}\ Z_{eq_{11}}} = \boxed{7882\ A}$$

VOLENDO CALCOLARE I RENDIMENTI.

- $\eta_{TA} \Longrightarrow$ $$\eta_{TA} = \frac{\sqrt{3}\ V_2 I_{2A} \cos\varphi}{\sqrt{3} V_2 I_{2A} \cos\varphi_c + 3R'_{cc_A} I^2_{2A} + \underset{0}{\cancel{P_{fe_A}}}}$$

φ : SFASAMENTO TRA V_2 e I_{2A}

$\varphi = \widehat{V_2 I_{2A}} = \varphi_c$

$\underbrace{\varphi = \varphi_c \iff \varphi_{cc_A} = \varphi_{cc_B}}$

- $\eta_{TB} \Longrightarrow$ $$\eta_{TB} = \frac{\sqrt{3}\ V_2 I_{2B} \cos\varphi_c}{\sqrt{3} V_2 I_{2B} \cos\varphi_c + R''_{cc_B} I^2_{2B} + \underset{0}{\cancel{P_{fe_B}}}}$$

- $\eta_{TOT\ (IMPIANTO)} \Longrightarrow \eta_{TOT} \neq \eta_{TA} \cdot \eta_{TB}$

$$\eta_{imp} = \frac{\sqrt{3}\ V_2 I_2 \cos\varphi_2 \ (\text{carico})}{\sqrt{3} V_2 I_2 \cos\varphi_2 + 3R''_{cc_A} I^2_{2A} + 3R''_{cc_A} I^2_{2B} + \underset{0}{\cancel{P_{fe_A}}} + \underset{0}{\cancel{P_{fe_B}}}}$$

$$X_{cc} = X_{d_{TOT}} = \sqrt{Z_{cc}^2 - R_{cc}^2} = \sqrt{2{,}71^2 - 1{,}19^2} = \underline{2{,}43\ \Omega}$$

$$Z_{cc} = \frac{V_{cc}}{\sqrt{3}\ I_N} = \frac{74{,}47}{\sqrt{3}\ 15{,}86} = 2{,}71$$

LA REATTANZA TOTALE È IL DOPPIO DELLE 2 REATTANZE:

$$X_{ds} = X_{dr} = \frac{X_{d_{TOT}}}{2} = \boxed{1{,}215\ \Omega}$$

- PROVA A VUOTO

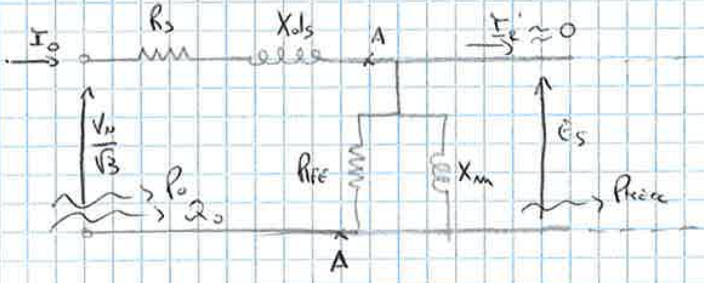
VIENE EFFETTUATA A TENSIONE NOMINALE

$V_N = 380\ V$

V_0 [V]	I_0 [A]	P_0 [W]
$379 \approx V_N$	8,6	423

BISOGNA CALCOLARE SEPARATAMENTE LE PERDITE MECCANICHE. P_{mecc} =? COME LE RICAVO? GRAFICI.

DAL GRAFICO $P_{mecc} = 50\ W$



$P_{AA} = P_0 - 3 R_s I_0^2$ $\qquad Q_{AA} = Q_0 - 3 X_{ds} I_0^2$

CON $Q_0 = P_0\ Tg\ \varphi_0$ MA $\cos\varphi_0 = \frac{P_0}{\sqrt{3}\ V_N I_0} = \frac{423}{\sqrt{3} \cdot 379 \cdot 8{,}6} = 0{,}0749$

$Q_0 = P_0\ Tg(\cos^{-1} 0{,}0749) =$ ~~5671 VAR~~ 5652 VAR

DA CUI: $P_{AA} = 423 - 0{,}442 \cdot 3 \cdot (8{,}6)^2 = \underline{325\ W}$

$Q_{AA} = 5652 - 1{,}215 \cdot 3 \cdot (8{,}6)^2 = \underline{5382\ VA_R}$

$S_{AA} = \sqrt{P_{AA}^2 + Q_{AA}^2} = 5392\ VA_R$

$E_s = \frac{S_{AA}}{\sqrt{3}\ I_0} = 362\ V$ $\qquad$ "$\frac{E_{s\,FASE}^2}{P_{Fe}/3}$" $= R_{Fe} = \frac{E_{s\,CONC}^2}{P_{Fe}} = \frac{362^2}{275} = \boxed{476\ \Omega}$

$P_{Fe} = P_{AA} - P_{mecc} = 275\ W$ $\qquad X_m = \frac{E_{s\,CONC}^2}{Q_{AA}} = \boxed{24{,}25\ \Omega}$

$\frac{E_{s\,FASE}^2}{Q_0/3}$

SE ANDASSI DA VUOTO CALCOLARE LO SCORRIMENTO NOMINALE :

$$s_N = \frac{n_s - n_N}{n_s} \qquad n_s \qquad n_s = \frac{60 f}{p} = 1500 \text{ rpm}$$

$$s_N = \frac{1500 - 1450}{1500} = \frac{50}{1500} = \boxed{0,0333}$$

SE VOGLIO CALCOLARE LA ~~POTENZA~~ FREQUENZA AD UN DIVERSO VALORE DI NUMERO DI GIRI :

$$n_s' = 1750,5 \text{ rpm} \qquad f' = ?$$

$$f' = \frac{p \cdot n_s'}{60} = \frac{2 \cdot 1750.5}{60} = \boxed{58,35 \text{ Hz}}$$

SE VOLESSI CALCOLARE IL FLUSSO NOMINALE : (REGOLAZIONE)

$$\frac{V_s}{f} \approx \frac{E_s}{f} \propto \hat{\Phi}_M \qquad V_s' = V_s \frac{f'}{f} = 443,5 \text{ V}$$

$$\frac{V_s}{f'} = k \Phi_M' \qquad \frac{V_N}{f} = k \Phi_{MN}$$

$$\frac{\Phi_M'}{\Phi_{MN}} = \frac{f}{f'} = \boxed{0,86}$$

$$\cos\varphi_s = \frac{P_s}{S_s} = 0,958$$

d) RENDIMENTO:

$$\eta = \frac{P_{CONV_{ASSE}}}{P_s} = \frac{\cancel{15},12857}{11,376} = \boxed{0,894}$$

RIEPILOGO SUI BILANCI DI POTENZA:

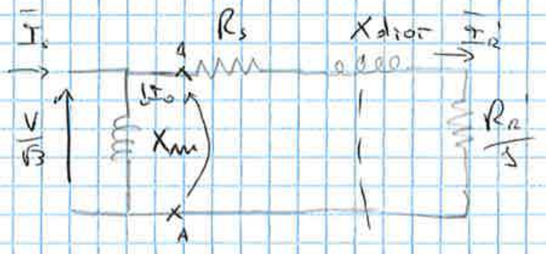
$$P_s = P_{Js} + P_{FE} + P_T$$

$$P_T = P_{JR} + P_{CONV} \qquad P_{CONV} = P_{ASSE} - P_{MECC}$$

$$P_T = C_m \omega_s \qquad C_m = \frac{P_{ASSE}}{\omega_R}$$

$$P_{JR} = s P_T \qquad P_{CONV} = (1-s) P_T$$

- CALCOLO R_S, $X_{d\,rot}$, R_R'



$$P_{T_N} = C_m \cdot \omega_s$$

$\overset{'''}{N}$ ⇝ xké non vi sono [illegible] meccanici.

$$P_{T_N} = 3\,\frac{R_R'}{s_m} \cdot I_R'^{\,2}$$

SAPENDO CHE $\eta_N = \frac{P_N}{P_S} \mapsto P_S = \frac{P_N}{\eta} = 8929\ W$

$$Q_S = \sqrt{S_s^2 - P_s^2} = \sqrt{(\sqrt{3}V_s I_N)^2 - P_s^2} = 4935\ VAR$$

$P_{AA} = P_s$ $\quad Q_{AA} = Q_s - \frac{V_s^2}{X_m} = 650{,}1\ VAR$

$$S_{AA} = \sqrt{P_{AA}^2 + Q_{AA}^2} = \sqrt{3}\,V_s I_R' \Rightarrow I_R' = \frac{S_{AA}}{\sqrt{3}V_s} = 13{,}6\ A$$

- $R_R' = \frac{C_N \cdot \omega_s}{I_R' \cdot 3}\, s_m = \boxed{0{,}465\ \Omega}$

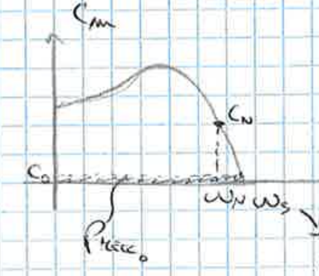
$P_{JS} = P_S - P_T = 1171\ W$ $\qquad$ • $R_S = \frac{P_{JS}}{3 I_R'^2} = 2{,}11\ \Omega$

- $X_{d\,rot} = \frac{Q_{AA}}{3 I_R'^2} = 1{,}17\ \Omega$

$P_{CONV} = P_{ASSE} + P_{MECC}$

$P_{ASSE} = P_{CONV} - P_{MECC} \Rightarrow \boxed{P_{ASSE} = 20095 \text{ W}}$

b)



$C_0 = \frac{P_{MECC}}{\omega_S} = \frac{367}{\frac{2\pi 1000}{60}} = \boxed{3,5 \text{ N·m}}$

xk si trascura lo scorrimento a vuoto.

c) $\eta = \frac{P_N}{P_S} = \frac{20095}{23200} = \boxed{0,866}$

d) $C_N = \frac{P_N}{\omega_R} = \frac{20095}{\frac{2\pi}{60} 960} = \boxed{200 \text{ N·m}}$

TEMA DI ESAME 10.2.09

DATI: $n_{poli} = 2p$ $P_N = 50 kW$ $V_N = 380 V$ $f = 50 Hz$

$\eta = 0,89$ $\cos\varphi = 0,88$ $s\% = 3\%$

CALCOLA: a) $I_N = ?$ b) $C_N = ?$

$V'_s = 300 V$ $\begin{cases} C \propto V^2 \\ \text{tratto stabile} \propto s \end{cases}$

CALCOLA: c) C'_{max} come riduzione della C_{max} a V_s.

d) ω'_e con $C'_m = C_N$

SVOLGIMENTO:

I PARTE

a) $P_s = \frac{P_N}{\eta} = \sqrt{3} V_N I_N \cos\varphi$

$I_N = \frac{P_N}{\eta \sqrt{3} V_N \cos\varphi} = 96,99$ A

b) $C_N = \frac{P_N}{\omega_{mN}}$ $\omega_s = \frac{2\pi f}{p} = \frac{100\pi}{2} = 157,08$ rad/s

~~$C_N = \frac{50000}{157,08}$ 318,3 N·m~~

$\omega_N = (1-s)\,\omega_s = 152,4$ rad/s

$C_N = \frac{50000}{152,4} = \boxed{328,15 \ N\cdot m}$

II PARTE

c) $\left(\frac{300}{380}\right)^2 \cdot 100 = \frac{C'_{max}}{C_{max}} = \boxed{62\%}$