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Electrical Machines, EE 0973373 2^{nd} *Exam.*

Student Name(Arabic):————————————,Student, ID ——

Problem1 [6 marks] Use Fig.1(a)to explain the concept of rotating magnetic field and show the resultant magnetic force and location of poles at instants of time, $T_o, and\ T_1$. Use Fig1.(b) to determine the instants of time $T_2, and\ T_3$ on the time domain plot of the flux density.

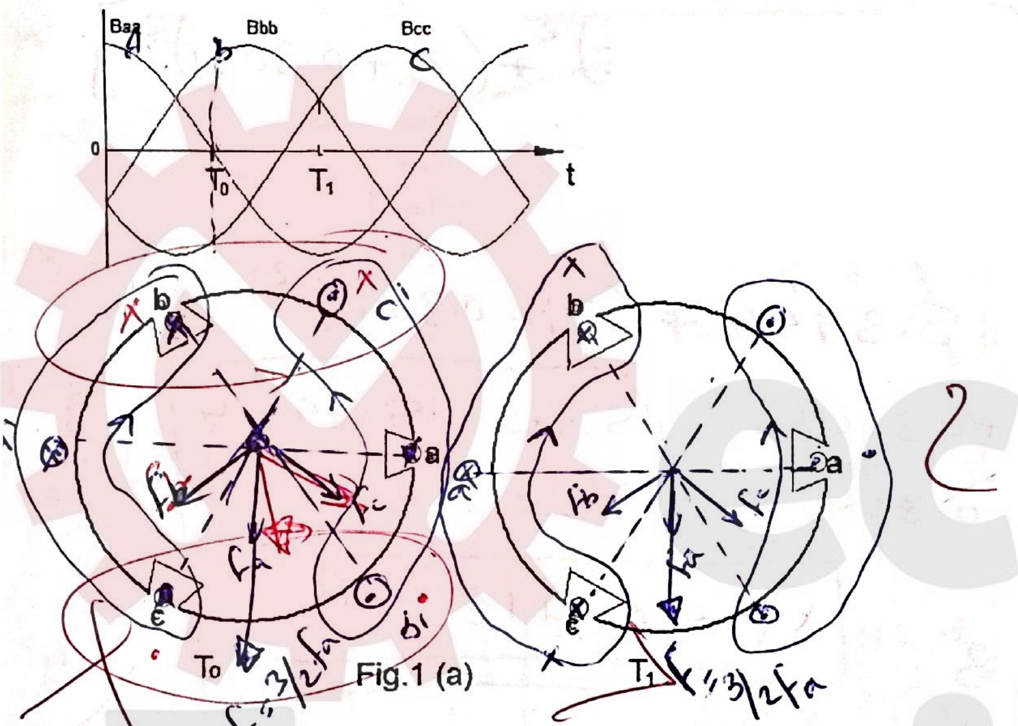
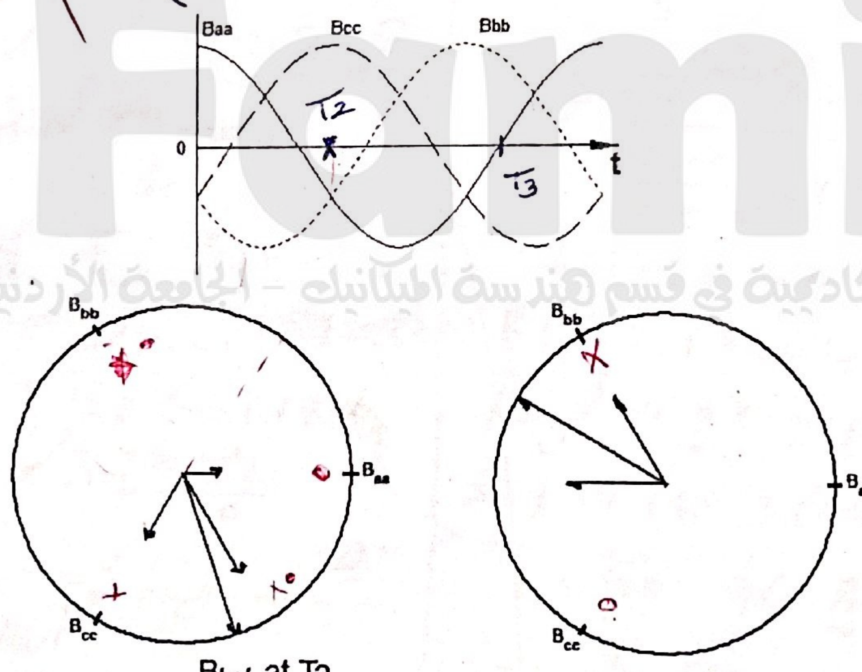


Fig.1 (a)



Btot at T2

Btot at T3

Fig.1 (b)

$\cancel{\text{P}}$ Q 2 part 2 باقي حل السؤال 2.

$$\left(\frac{V\phi}{I_1}\right)^2 = \left[(R_1 + R_f)^2 + (X_1 + X_f)^2\right]$$

$$\left(\frac{400/\sqrt{3}}{94.96}\right)^2 = \left[(2.1726 + 0.15)^2 + (X_1 + 0.3041)^2\right]$$

$\cancel{2.431}$ =

$$5.914 = 5.3944 + (X_1 + 0.3041)^2$$

$$\therefore X_1 + 0.3041 = \sqrt{5.914 - 5.3944}$$

$$X_1 + 0.304 = 0.7207\ \Omega$$

$$\therefore \boxed{X_1 = 0.4167\ \Omega}$$

3ϕ P

Problem2: [8 marks] A three-phase 400 V, 50 Hz, 4-pole, Y-connected, induction motor. The torque speed curve is given in Figure (1). Neglect rotational, core, friction and windage losses except the load losses (stator and rotor). It has the following constants: $R_1 = 0.15\ \Omega$, $R_2' = 0.45\ \Omega$, $X_2' = j\ 0.21\ \Omega$; $X_m = j\ 50; \Omega$. If the motor runs at full load speed of 1192 r.p.m. Find Line current I_A and X_1. Note: *do not assume that* $X_1 = X_2$

interpolation

2.2 500

192

0.62 50

0.3 ?

6

$n = 1192$

$T_{induced} = 374.2\ \underline{N.m}$

$P_{ag} = T_{ind.}\,\omega_{syn}$

ω_{syn}.

$n_{sy} = \dfrac{120 f}{P}$

$= \dfrac{120(50)}{4} = 1500\,rpm$

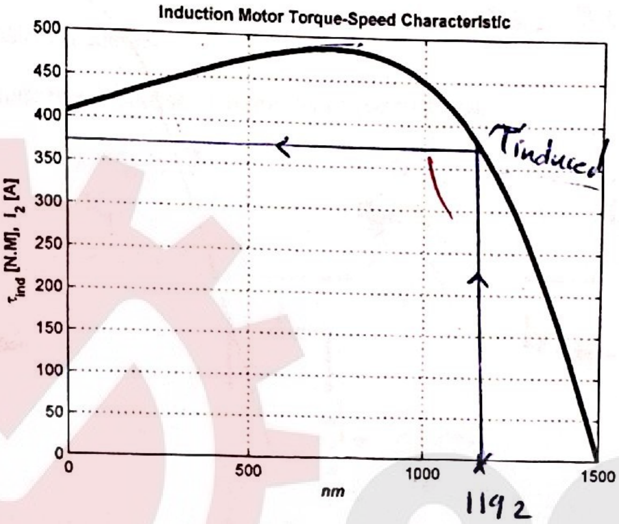


Figure 1

$S = \dfrac{n_s - n_m}{n_s} = \dfrac{1500-1192}{1500}$

$= \underline{0.205}$

$\omega_{syn} = \dfrac{2\pi n_{sy}}{60} = 157.07$

$\therefore P_{ag} = T_{ind}\,\omega_{syn}$

$= 374.2(157.07)$

$= 58779.19\,\underline{w}$

$P_{ag} = 3 I_2^2 \dfrac{R_2}{S}$

$58779.1 = 3 I_2^2 \dfrac{0.45}{0.205}$

$\underline{I_2 = 94.47\ A}$

$Z_f = \dfrac{jX_m \cdot (R_2/s + jX_2)}{\frac{R_2}{s} + j(X_m + X_2)} = R_f + X_f j$

$= \dfrac{50j(0.45/0.205 + 0.21j)}{\frac{0.45}{0.205} + (50.21)j}$

$= 2.1726 + 0.3041j$

$\therefore R_f = 2.1726\,\Omega$, $X_f = 0.3041\,\Omega$

$P_{ag} = 3 I_1^2 R_f$

$58779.19 = 3(I_1)^2(2.1726)$

$I_1 = 94.96\ A$; To check.

$I_2 = \dfrac{I_1 X_m}{\sqrt{(X_m + X_2)^2 + (\frac{R_2}{S})^2}} = 94.47 = I_1(0.994)$

$\rightarrow I_1 = \dfrac{94.47}{0.994}$

$= 94.957\,A$

← الحل . النتيجة ←

Problem3: [7 marks] Problem1. The following test result were obtained when testing a three phase, 400-V, 50-Hz, 4 pole Y-connected, induction motor:

	V, V	I, A	P, kW	F, Hz
No-load test	400	30	4	50
Blocked-rotor test	100	100	9.6	25
Dc Test	3	10	-	0

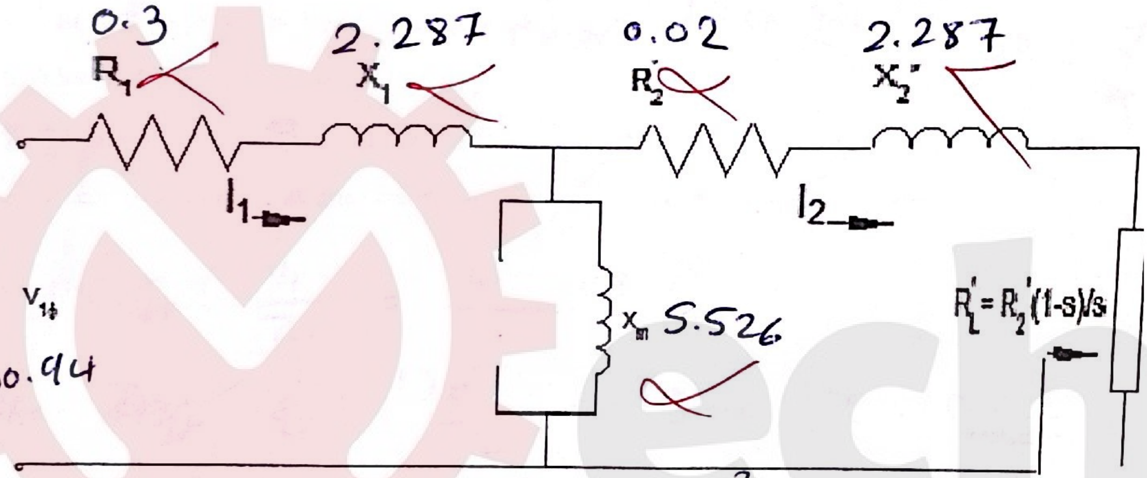
$P = 4$

$f = 50\ hz$

$V = 400V \quad V_1 = 400/\sqrt{3} = 230.94$

1. Find the No-load rotational losses.

2. Find and write all constants calculated from tests carried out.



$P_{Rot} = P_{NL} - 3I_1^2 R_1$

$R_1 = \frac{V}{I} = \frac{3}{10} = 0.3\ \Omega$

$P_{Rot} = 4000 - 3(30)^2(0.3)$

$= 3190\ w \Rightarrow 3.19\ kw$

$Z_{NL} = \frac{230.94}{30} = 7.69\ \Omega$

$R_{NL} = 4000/3(30)^2 = 1.481\ \Omega$

$X_{NL} = X_1 + X_m = (Z_{NL}^2 - R_{NL}^2)^{1/2}$

$X_1 + X_m = (7.554)\ \Omega$

$R_{BL} = P_{BL}/3I_1^2$

$= 9600/3(100)^2 = 0.32\ \Omega$

$Z_{BL} = \frac{V_1}{I_1} = \frac{230.94}{100} = 2.3094\ \Omega$

$X_{BL} = (Z_{BL}^2 - R_{BL}^2)^{1/2} = 2.287$

$X_{BL} = 2.287 * \frac{50}{25} = 4.574\ \Omega$

$= X_1 + X_2'$

assume $X_1 = X_2' = \frac{4.574}{2} = 2.287$

$\therefore 7.554 = X_1 + X_m = 2.287 + X_m$

$\therefore X_m = 5.526\ \Omega$

$R_2' = R_{BL} - R_1 = 0.32 - 0.3$

$= 0.02\ \Omega$

$I_2 = \frac{V_{th}}{R_{th} + \frac{R_2}{S} + jX_{th} + jX_2}$

$V_{th} = \frac{X_m V_1}{(R_1^2 + (X_1 + X_m)^2)^{1/2}} = 151.9\ V$

$Z_{th} = 0.149 + 1.62i$

$\therefore R_{th} = 0.149, \ X_{th} = 1.62$

$I_2 =$

Problem4: [9 marks]A three-phase 415 V, 50 Hz, 4-pole, Wye connected, induction motor. Its full load speed is 1425 r.p.m. It has the following parameters:
$R_1 = 0.25\Omega$, $R_2' = 0.5\Omega, X_1' = 0.6\Omega; X_2' = 1.8\ \Omega;\ X_m = 50\ \Omega$. The rotational losses = 1 kW, find:

R_1

1. The line current withdrawn from the source $I_1 =$ ....
2. The power in air gap $P_{ag} =$ 15193.86
3. Power converted from electrical to mechanical form $P_{conv} =$ ...14434.17
4. Induced torque in the motor $\tau_{ind} =$ 96.77
5. The output power of this motor $p_{out} =$ ~~14443~~ 134 34.17
6. The load torque $\tau_{Load} =$ ....
7. Efficiency $\eta =$ ......~~7~~... 85.37
8. Torque and current at starting $\tau_{st} =$ ...., $I_{st} =$ ....

2

$Q = 72.1$

$$I_1 = \frac{V_1}{Z_1} = \frac{415/\sqrt{3}}{}$$

~~Zero~~ ~~Ray~~ $n_{sy} = \frac{120(50)}{4} = 1500$, $S = 0.05$

$$\omega_{syn} = \frac{2\pi(1500)}{60} = \cancel{157}\ 157$$

$V_{th} = 236.75$

$$Z_{th} = \underbrace{0.2441}_{R_{th}} + \underbrace{0.594J}_{X_{th}} = R_{th} + X_{th}J$$

$\therefore T_{mech} = \cancel{3}.\ 96.77$

$P_{ag} = T \cdot \omega_{sy}$.

$1000 =$