EEE4117F: ONLINE QUIZ 4

ELECTRICAL MACHINES AND POWER ELECTRONICS

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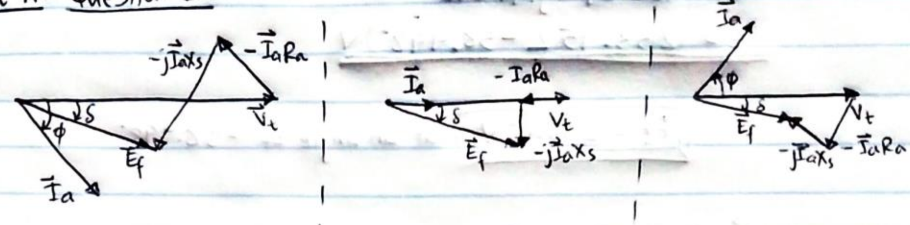
26th June 2020

PART A – ELECTRICAL MACHINES

Question 1:

Part A: Question 1:

1.1>



Lagging p.f | Unity p.f | Leading p.f

1.2> Synchronous motor is NOT self starting because of the inertia of the rotor ~~and~~ as it cannot immediately follow the rotation of stator magnetic field ≪ ie: $n_{motor} \neq n_s$ at start-up ≫

Methods of starting a Synchronous Motor drive:

(a) ~~Start motor as slip ring~~ Using Damper winding

(b) As a slip ring Induction Motor.

Question 2:

PART A : Question 2

2.1> Synchronous speed = $\frac{120f}{P} = \frac{120(60)}{4} = 1800rpm = \underline{188.496\ rad/s}$

For wye-connected; $V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{208}{\sqrt{3}} = \underline{120.09\ V}$

$P_{in} = P_m = \sqrt{3}\, V_\phi I_s \cos\phi$ «where $\cos\phi = 1$ due to unity pf»

$3000 = \sqrt{3}(208)(I_s)$

$\underline{I_s = 8.327A}$

$\vec{E} = \vec{V} - \vec{I_s}(R_s + jX_s)$

$= 120.09 - j8.327(8*3)$

$\vec{E} = 120.09 - j199.848$

$\underline{\vec{E} = (233.15 \angle -58.998^\circ)V}$

$\boxed{E_f = 233.15\ V}$ at an angle of -58.998°

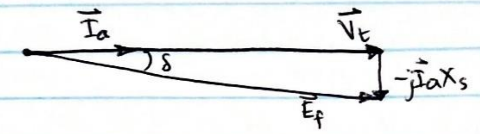
$P_m = \frac{3VE}{X_s} \sin\delta$

$3000 = \frac{3(120.09)(233.15)}{8*3} \sin\delta$

$\sin\delta = 0.8572 \rightarrow \underline{\delta = 59^\circ}$

$\boxed{\delta = 59^\circ}$

2.2>



2.3> $T_{max} = \frac{3 V_t E_f}{\omega_s (X_s)} = \frac{3(120.09)(233.15)}{(188.496)(8*3)} = \underline{18.567\ Nm}$

PART B – POWER ELECTRONICS

Question 1:

EEE4117F Quiz 4:

PART B: Question 1

1.1) Full-bridge inverter is advantageous in high power applications as less paralleling of switches are required due to the output current and switch currents of full-bridge being one-half when compared to half-bridge inverters.

I_o half-bridge $= P/V_{AO}$

I_o full-bridge $= P/2V_{AO}$

1.2) (a) Space Vector PWM generates less harmonic distortion in the output compared to sinusoidal PWM

(b) Space Vector PWM provides more sufficient use of supply voltage compared to sinusoidal PWM.

Question 2:

PART B: Question 2:

2.1) Capacitor can be connected to the input side.

2.2) $m_a = \dfrac{V_{control}}{V_{triangle}} = \dfrac{8V}{10V} = \underline{\underline{0.8}}$

2.3) $m_f = \dfrac{f_{sw}}{f_1} = \dfrac{1050\ Hz}{50\ Hz} = \underline{\underline{21}}$

2.4) $V_1 = m_a V_{dc}$

$V_1 = 0.8(200) = 160V$

$\underline{\underline{V_1 = 160V}}$

2.5) $I_1 = \dfrac{V_1}{Z} = \dfrac{V_1}{\sqrt{R^2 + X_L^2}}$

$X_L = 2\pi f L = 2\pi(50)(10mH) = 3.1415 = \underline{\underline{\pi}}\ \Omega$

$I_1 = \dfrac{160}{\sqrt{10^2 + \pi^2}} = \underline{\underline{15.26\ A}}$

$\boxed{I_1 = 15.26A}$

2.6) $m_f = 21$, harmonics are @ $n = 21$, 19 and 23

$V_{21} = m_a V_{DC} = 0.82(200) = \underline{\underline{164V}}$

$V_{19} = V_{23} = m_a V_{DC} = 0.22(200) = \underline{\underline{44V}}$

Part B:

2.7> $I_{21} = \frac{V_{21}}{Z} = \frac{164}{10.482} = \underline{\underline{15.646\,A}}$

$I_{19} = I_{23} = \frac{44}{10.482} = \underline{\underline{4.198\,A}}$

2.8> $THD = \frac{\sqrt{\sum_{n=2}^{\infty} (I_{n,rms})^2}}{I_{1,rms}} = \frac{\sqrt{\left(\frac{15.646}{\sqrt{2}}\right)^2 + \left(\frac{4.198}{\sqrt{2}}\right)^2 + \left(\frac{4.198}{\sqrt{2}}\right)^2}}{\left(\frac{15.26}{\sqrt{2}}\right)} = \underline{\underline{109.66}}$

$$\boxed{THD = 109.66\%}$$