MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

6.622 Power Electronics Assessment #7

Due: Thursday April 21, 2023 at 11:00 pm (Cambridge time)

YOUR NAME Solutions

YOUR KERBEROS ID

General Instructions:

1. You must complete this assessment on your own with no consultation or discussion with any other person, excepting 6.622 staff, of whom you may ask clarifying questions. Do not discuss your solutions with anyone until the solutions have been released.

2. You may use a calculator and review the course lectures, handouts, notes, textbook (Principles of Power Electronics) and other materials provided for the course on Canvas when completing this assessment. Please do not use other computational tools or reference materials.

3. Please do all of your work in the space provided. In particular, try to do your work for each question within the boundaries of the question, or on the additional pages at the end of the uploaded document, clearly marking those pages to indicate what problem they relate to. Place the answer to each question within the appropriate answer box.

4. The assessment must be completed and uploaded by the indicated date/time to receive credit.

5. Please make sure to show all of your work. This is important both for you to receive credit for a correct answer and to receive partial credit when an answer is wrong or incomplete.

Problem 1

A 3-phase inverter, like that in KPVS Fig. 9.19, is used to drive a 3-phase Y-connected motor. It has a dc-bus voltage $V_{dc} = 600$ V and uses sine-triangle PWM at a modulation index m=1. The motor draws an average (real) power of $P = 75$ kW at a displacement factor $k_\theta = 0.9$ and the motor windings provide sufficient filtering that the winding currents may be considered sinusoidal.

(a) What is peak amplitude do the fundamental (sinusoidal) components of the line-to-neutral voltages have?

(b) What rms value do the fundamental components of the line-to-neutral voltage have?

(c) What is the rms current drawn by each phase of the motor?

(a) @ $m=1$ the ℓ-r voltages have peak amplitudes of $\frac{V_{dc}}{2}$, as do the ℓ-n voltages. $\therefore |V_{\ell n}| = \frac{V_{dc}}{2} = 300\text{V}$

(b) for a sinusoid $V_{rms} = \frac{1}{\sqrt{2}} V_{pk}$. $\therefore V_{\ell n,rms} = 212\text{ V}$

(c) Each phase delivers $P/3 = 25\text{ kW}$

$\therefore V_{\ell n,rms} \cdot I_{\ell,rms} \cdot \cos(\theta) = \frac{P}{3}$

or $V_{\ell n,rms} \cdot I_{\ell,rms} \cdot k_\theta = \frac{P}{3}$

$\Rightarrow I_{\ell,rms} = \frac{P}{3 \cdot k_\theta \cdot V_{\ell n,rms}} = \frac{75000\sqrt{2}}{3(0.9)300} = 131\text{ A}$

 Name:_____

Peak amplitude of fundamental component of line-to-neutral voltages:

300 V

rms of fundamental component of line-to-neutral voltages:

$\approx$ 212 V

rms current drawn by each phase of the motor:

$\approx$ 131 A

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