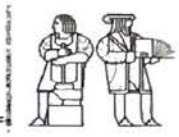


MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

6.622 Power Electronics Assessment #3

Due: Thursday March 16, 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, notes and textbook (Principles of Power Electronics) 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 three-winding transformer is constructed on a three-legged core, as shown in Figure 1. The cross-sectional area of the core is uniform, and the windings have N_1, N_2, and N_3 turns. Winding N_3 is terminated in a resistor of value R. If in-phase sinusoidal voltages with amplitudes V_1 and V_2 are applied to windings N_1 and N_2, respectively, what is the amplitude I_3 of the current i_3 in winding N_3? Assume that no leakage occurs.

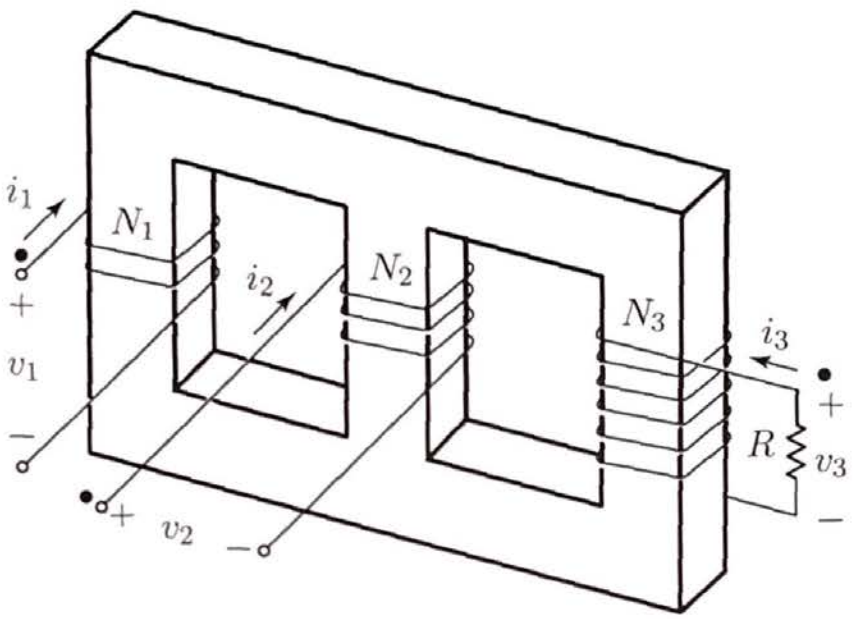
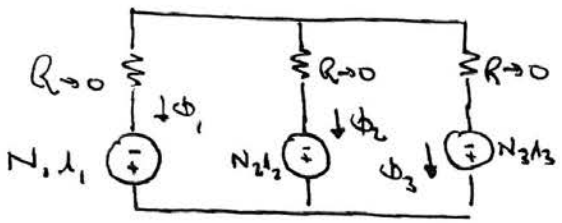


Figure 1 A 3-winding transformer.

Name: Solutions

Consider the magnetic circuit (idealized)



for $R \to 0$ $\boxed{N_1\ell_1 = N_2\ell_2 = N_3\ell_3}$

$\phi_1 + \phi_2 + \phi_3 = 0$

$\therefore \boxed{\frac{v_1}{N_1} + \frac{v_2}{N_2} + \frac{v_3}{N_3} = 0}$

$\therefore v_3 = -\frac{N_3}{N_1} v_1 - \frac{N_3}{N_2} v_2$

$i_3 = -\frac{v_3}{R}$ Note the sign, owing to defined polarities of v_3, i_3

$\therefore \boxed{|i_3| = \frac{N_3}{RN_1} v_1 + \frac{N_3}{RN_2} v_2}$

(~~Additional Work~~)

$$\boxed{I_3 = \frac{1}{R}\frac{N_3}{N_1} V_1 + \frac{1}{R}\frac{N_3}{N_2} V_2}$$

6.622 Power Electronics

Spring 2023