ECE 385 – Fall 2024

Instructor: Michael Abba
TA: Bishal Lamichhane

HW #4

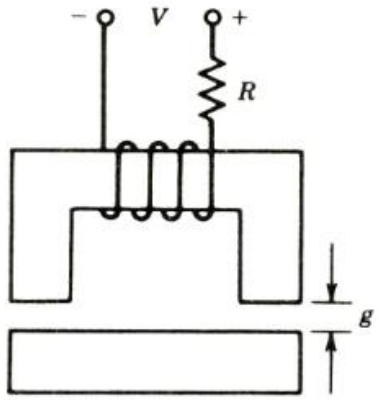
Due Date: Uploaded to D2L by 10 PM Friday October 18, 2024

Problem 1

The electromagnet shown in the figure below can be used to lift a sheet of steel. The coil has 400 turns and a resistance of 5 ohms. The reluctance of the magnetic material is negligible. The magnetic core has a square cross section of 5 cm by 5 cm. When the sheet of steel is fitted to the electro- magnet, air gaps, each of length g=1mm, separate them. An average force of 550 newtons is required to lift the sheet of steel.

(a) For dc supply,
- (i) Determine the dc source voltage.
- (ii) Determine the energy stored in the magnetic field.

(b) For ac supply at 60 Hz, determine the ac source voltage.



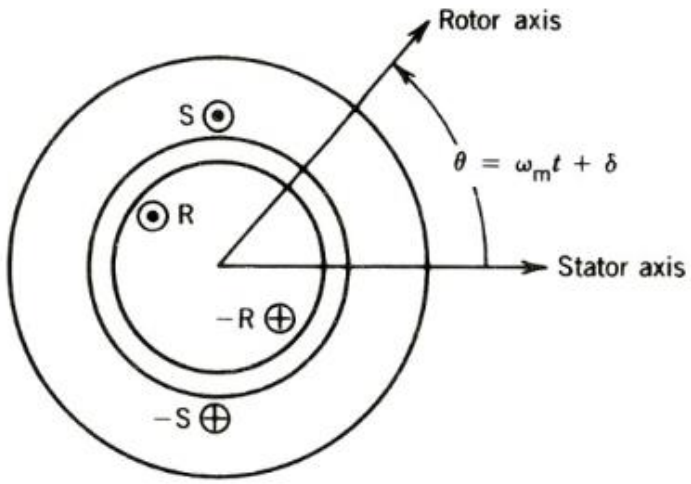
Problem 2

The rotating machine of the figure below has the following parameters.

$$L_{ss} = 0.15\,\text{H}$$
$$L_{rr} = 0.06\,\text{H}$$
$$L_{sr} = 0.08\cos\theta\,\text{H}$$

(a) The rotor is driven at 3600 rpm. If the stator winding carries a current of 5 A (rms) at 60 Hz, determine the instantaneous voltage and rms voltage induced in the rotor coil. Determine the frequency of the rotor induced voltage.

(b) Suppose the stator and rotor coils are connected in series, and a current of 5 A (rms) at 60 Hz is passed through them. Determine the speeds at which the machine will produce an average torque. Also determine the maximum torque that the machine will produce at each speed.



Problem 3

A three-phase, 5 hp, 208 V, 60 Hz induction motor runs at 1746 rpm when it delivers rated output power.

(a) Determine the number of poles of the machine.
(b) Determine the slip at full load.
(c) Determine the frequency of the rotor current.
(d) Determine the speed of the rotor field with respect to the
    (i) Stator.
    (ii) Stator rotating field

Problem 4

A 3φ, 460 V, 100 hp, 60 Hz, six-pole induction machine operates at 3% slip (positive) at full load.

(a) Determine the speeds of the motor and its direction relative to the rotating field.
(b) Determine the rotor frequency. (c)Determine the speed of the stator field.
(c) Determine the speed of the air gap field.
(d) Determine the speed of the rotor field relative to
    (i) the rotor structure.
    (ii) the stator structure.
    (iii) the stator rotating field.