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Final test

Topics: Transformers, Synchronous motors, Servomotors

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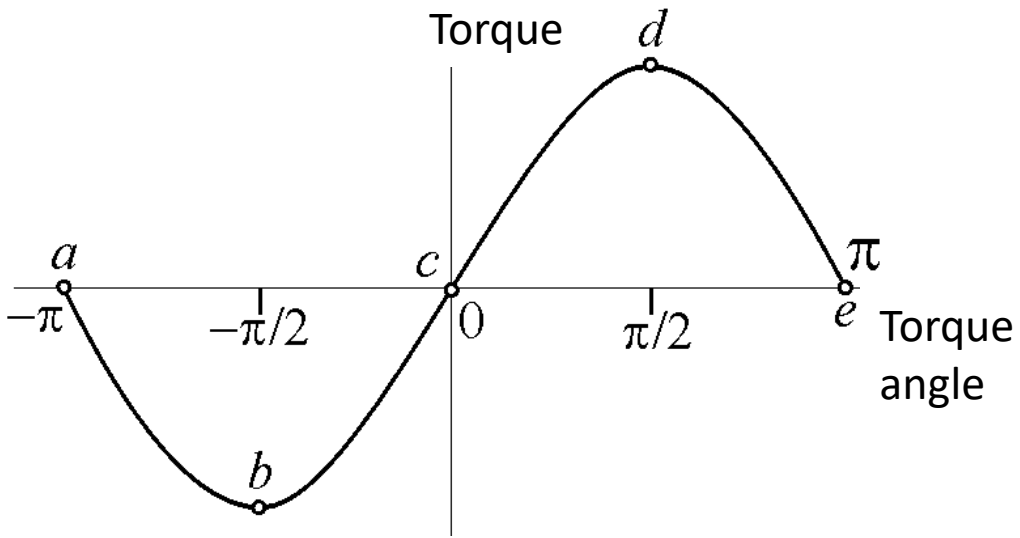
1. Specify the section corresponding to the stable operation of a synchronous machine in motor mode



a) bd

b) ab

c) bc

d) cd

e) de

f) ac

j) ce

2. Consider the servo that operates with constant tracking error if input signal is constant. What is performance type of the servo?

a) type 0

b) type 1

c) type 2

d) type 1 or type 2

3. Consider 60 Hz, 240/110 V ideal transformer. The primary side coil has 650 turns.

Determine the maximum flux in the magnetic core of the transformer (in mWb).

a) 0.635

b) 1.386

c) 1.164

d) 2.772

4. What equation corresponds to the torque of the PMSM in d/q rotating reference frame (p – number of poles)?

a) $T_e = \frac{3p}{2}\left[\phi_f i_{qs}^r + \left(L_{ds} - L_{qs}\right) i_{ds}^r i_{qs}^r\right]$

b) $T_e = \left[\phi_f i_{qs}^r + \left(L_{ds} - L_{qs}\right) i_{ds}^r i_{qs}^r\right]$

c) $T_e = p\frac{3}{4}\left[\phi_f i_{qs}^r + \left(L_{ds} - L_{qs}\right) i_{ds}^r i_{qs}^r\right]$

d) $T_e = \frac{p}{2}\frac{3}{2}\left[\phi_f i_{ds}^r + \left(L_{qs} - L_{ds}\right) i_{ds}^r i_{qs}^r\right]$

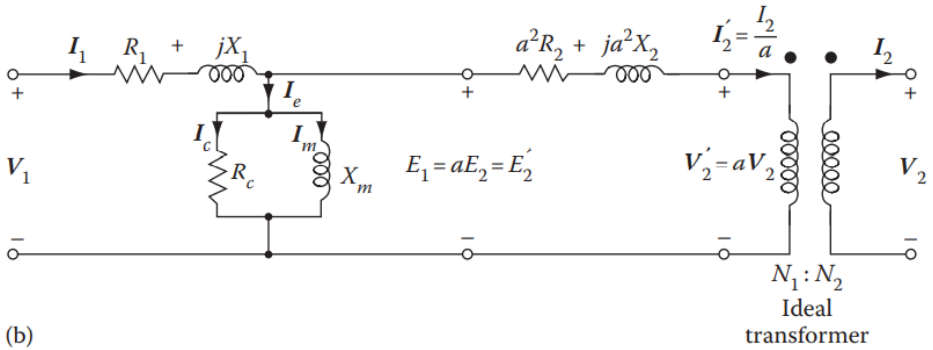
5. Consider the equivalent circuit of the real transformer. What element corresponds to losses in core of the transformer.

a) R_1

b) R_c

c) R_2

d) X_m



6. Consider the servomotor based on PMSM with 4 pole pairs. The encoder has $2*10^6$ units. How many encoder's units do we have per 1 electrical degree of the motor?

a) 221

b) 694

c) 5556

d) 1389

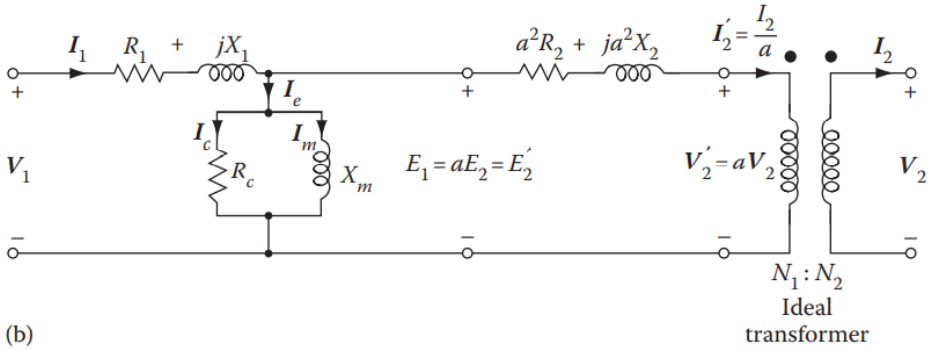
7. Consider the equivalent circuit of the real transformer. What element corresponds to the leakage inductance of the secondary winding of the transformer.

a) X_1

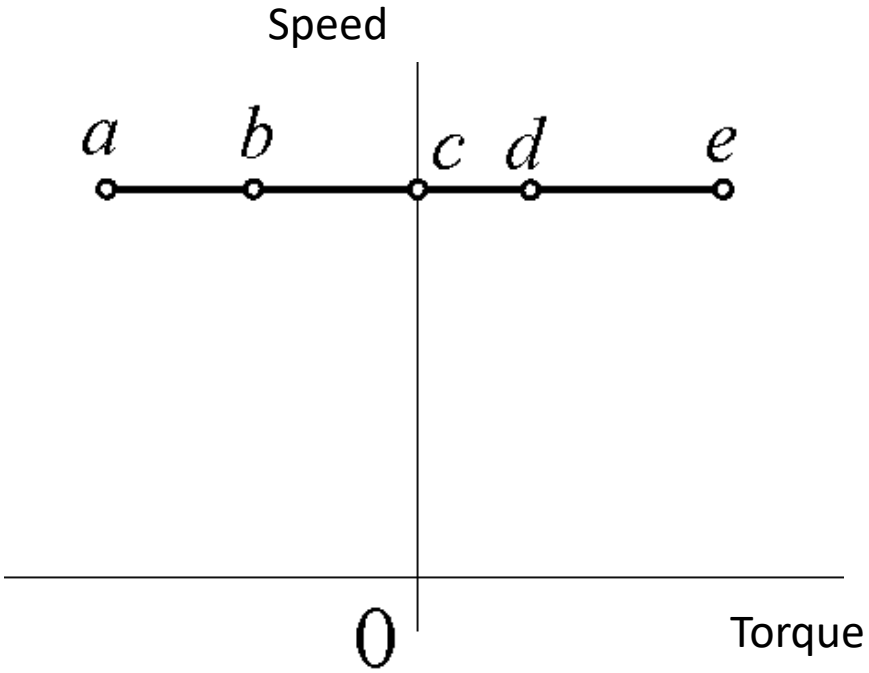
b) X_m

c) R_2

d) X_2



8. Specify the section corresponding to the operation of a synchronous machine in motor mode



a) bd
b) ab
c) bc
d) cd
e) de
f) ac
j) ce

9. What equations correspond to the currents of the PMSM in d/q rotating reference frame?

a)

$$\frac{di_{qs}^r}{dt} = \frac{v_{qs}^r}{L_{qs}} - \frac{R_s i_{qs}^r}{L_{qs}} - \frac{\omega L_{ds} i_{ds}^r}{L_{qs}} - \frac{\omega \phi_f}{L_{qs}}$$

$$\frac{di_{ds}^r}{dt} = \frac{v_{ds}^r}{L_{ds}} - \frac{R_s i_{ds}^r}{L_{ds}} + \frac{\omega L_{qs} i_{qs}^r}{L_{ds}}$$

b)

$$\frac{di_{ds}^r}{dt} = \frac{v_{ds}^r}{L_{ds}} - \frac{R_s i_{ds}^r}{L_{ds}} - \frac{\omega L_{qs} i_{qs}^r}{L_{ds}}$$

$$\frac{di_{qs}^r}{dt} = \frac{v_{qs}^r}{L_{qs}} - \frac{R_s i_{qs}^r}{L_{qs}} - \frac{\omega L_{ds} i_{ds}^r}{L_{qs}} + \frac{\omega \phi_f}{L_{qs}}$$

c)

$$\frac{di_{ds}^r}{dt} = \frac{v_{ds}^r}{L_{qs}} - \frac{R_s i_{ds}^r}{L_{qs}} + \frac{\omega L_{ds} i_{qs}^r}{L_{qs}}$$

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d)

$$\frac{di_{ds}^r}{dt} = \frac{v_{ds}^r}{L_{ds}} - \frac{R_s i_{ds}^r}{L_{ds}} + \frac{\omega L_{qs} i_{qs}^r}{L_{ds}} + \frac{\omega \phi_f}{L_{ds}}$$

$$\frac{di_{qs}^r}{dt} = \frac{v_{qs}^r}{L_{qs}} - \frac{R_s i_{qs}^r}{L_{qs}} - \frac{\omega L_{ds} i_{ds}^r}{L_{qs}}$$

10. Which type of electrical motor isn’t usually used as servomotor (motor + position sensor)?

a) Induction motor

b) PMSM

c) DC-motor

d) BLDC

e) Stepper motor

f) All these types are used

11. Which of these constructions corresponds to IPMSM with perpendicular magnets construction? How many pole pairs does it have?

a) - A), 2

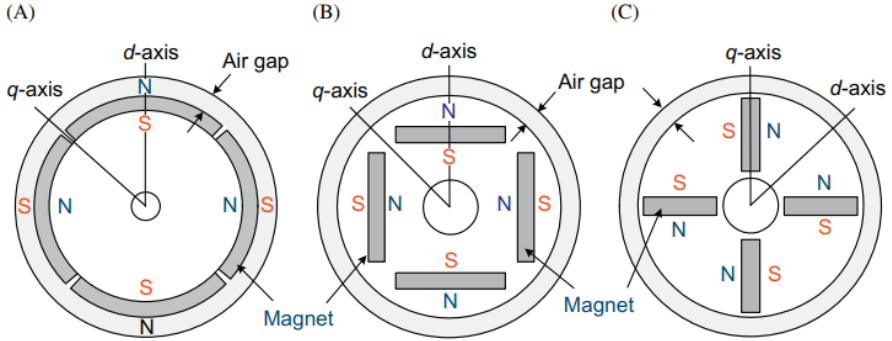
b) - B), 2

c) - C), 2

d) - A), 4

e) - B), 4

f) - C), 4



12. Consider salient pole synchronous motor with 2 poles.

The excitation voltage E_f is 32 V. The stator terminals voltage V_s is 48 V.

L_d = 0.01 H, L_q = 0.008 H. The motor speed is 240 rpm, load angle is 80 deg.

Find the maximum value of an electromagnetic torque of the motor.

a) 718 Nm

b) 730 Nm

c) 912 Nm

d) 1459 Nm

13. Consider salient pole synchronous motor with 2 poles.

The excitation voltage E_f is 32 V. The stator terminals voltage V_s is 48 V.

L_d = 0.01 H, L_q = 0.008 H. The motor speed is 240 rpm, load angle is 80 deg.

Find the reluctance torque of the motor.

a) 134 Nm

b) 94 Nm

c) 137 Nm

d) 47 Nm

14. Consider a 25 kVA, 2400/240 V, 60 Hz distribution transformer.

Assume that the open-circuit and short-circuit tests were performed on the primary side of the transformer and that the following data were obtained:

Voc = 2400 V, Ioc = 1.2 A, Poc = 600 W, Vsc = 180 V, Isc = 10.42 A,

Psc = 800 W. Determine Rc.

Enter the answer in ohms.

15. Consider a 25 kVA, 2400/240 V, 60 Hz distribution transformer.

Assume that the open-circuit and short-circuit tests were performed on the primary side of the transformer and that the following data were obtained:

Voc = 2400 V, Ioc = 1.2 A, Poc = 600 W, Vsc = 180 V, Isc = 10.42 A,

Psc = 800 W. Determine the percent voltage regulation at full load if the load power factor is 0.75 lagging.

Enter the answer in %

Thank you!

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