Test of Electric Drives for Automation M (L. Zarri)

Name/Surname of the student: _____ Student Number: _____

Multiple Response Questions (max. 12 pts.)

Write if the following assertions are true (t) or false (f) (there may be more true or false answers simultaneously).

1) The zero sequence component of three quantities x_1, x_2, x_3
(T) is proportional to the mean value of x_1, x_2, x_3
(F) is zero if the variables x_1, x_2, x_3 are constant
(T) is a real number

2) The space vector $\bar{x}$ is calculated from $x_1(t)$, $x_2(t)$, $x_3(t)$ as $\bar{x} = \frac{2}{3}\sum_{k=1}^{3} x_k e^{j\frac{2\pi}{3}(k-1)}$. The three signals form a symmetric set of sinusoidal quantities whose rms value is X_{RMS}.
(F) The magnitude of $\bar{x}$ is equal to X_{RMS}
(F) The magnitude of $\bar{x}$ is equal to $\frac{X_{RMS}}{\sqrt{2}}$
(F) The magnitude of $\bar{x}$ is equal to $\sqrt{3}X_{RMS}$

3)In a synchronous machine with salient poles,
(T) $L_d > L_q$
(F) $L_d < L_q$
(F) $L_d = L_q$

4) In a synchronous machine with interior magnets,
(T) the reluctance torque is proportional to I_q
(T) the reluctance torque is proportional to I_d
(F) the reluctance torque is proportional to the excitation flux φ_e.

5) A pure reluctance machine, in the low speed range, is controlled in such a way that
(F) I_d is always zero
(F) I_d is equal to I_q
(T) I_d and I_q identify points on the MTPA curve

6) In an induction machine, controlled according to the field-oriented control principle
(T) the torque producing component of the current is Iq
(F) the torque producing component of the current is Id
(F) the flux producing component of the current is Iq

7) In an induction machine
(T) the operating constraint due to the limited inverter voltage can be represented by an ellipse in the Id-Iq plane
(F) the voltage limit due to the limited inverter voltage can be represented by a circle in the Id-Iq plane
(T) the current limit due to the limited drive current can be represented by a circle in the Id-Iq plane

8) According to the time-optimal control scheme (TOS)
(F) the speed set point should be proportional to the maximum braking torque
(T) the speed set point should be proportional to the square root of the position error (absolute value)
(F) the speed set point should be proportional to the speed error

9) In an elastic coupling modeled with two masses
(F) if the shaft stiffness doubles, the locked-rotor frequency doubles

(T) if the load inertia doubles, the locked-rotor frequency reduces
(F) if the motor inertia increases, the natural frequency increases.

10) In an active rectifier (in the rotating reference frame synchronous with the grid voltage)
(F) the reactive power is proportional to Id
(T) the reactive power is proportional to Iq
(T) it is necessary to control Id to adjust the dc-link voltage

11) The shunt active filter
(F) is in series with the load
(F) can compensate the disturbances coming from the grid and the load at the same time
(T) can be coupled with a shunt LC passive filter

12) In an off-line UPS,
(F) the bypass is used only in case of fault of the UPS
(F) the batteries are directly charged by a bi-directional inverter
(T) the efficiency is greater than that of on-line UPS in normal operation.

Open-ended questions (max. 15 pts.)

1) Describe the control scheme of inner permanent magnet machines.

2) Internal model principle: theory and applications

3) Topologies and characteristics of active filters.

Numerical Exercises (max. 6 pts.)

1) The dc-link voltage of a three-phase inverter is 300 V. Calculate the maximum peak value of the output phase voltage that can be applied to a star-connected three-phase load under the assumption that the modulation strategy of the inverter is SPWM
[150 V]

2) An interior-permanent magnet synchronous machine has the following characteristics:
p = 2 (pole pairs)
Ld = 30 mH
Lq = 40 mH
φ_e = 0.03 Wb
Calculate the electromagnetic torque when Id=-10 A and Iq = 20 A
[7.8 Nm]

3) The reference voltage vector of a three-phase inverter is (100 + j30) V. The dc-link voltage is 300 V. Calculate the duty-cycles of the active voltage vectors according to the space vector modulation (SVM).

Notes:

The students is expected to give back all the sheets received by the professor
Phones, books and student notes are not allowed
The duration of the test is 2 hours.