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) Let us consider three signals $x_1(t)$, $x_2(t)$, $x_3(t)$
(T) the space vector of x_1, x_2, x_3 is a complex number
(F) the space vector of x_1, x_2, x_3 is zero if they are constant
(T) the space vector of x_1, x_2, x_3 is zero if they are equal to each other
2) Under the assumption that the space vector $\bar{x}$ and the zero sequence component x_0 of the signals $x_1(t)$, $x_2(t)$, $x_3(t)$ are assigned, how do we calculate the original signals?
(F) $x_k = \frac{2}{3}\sum_{k=1}^{3} \bar{x} \cdot e^{j\frac{2\pi}{3}(k-1)} + x_0$
(F) $x_k = \sum_{k=1}^{3} \bar{x} \cdot e^{j\frac{2\pi}{3}k} + x_0$
(F) $x_k = \sum_{k=1}^{3} (\bar{x} + x_0) \cdot e^{j\frac{2\pi}{3}(k-1)}$
3) In a reluctance machine,
(F) $L_d > L_q$
(T) $L_d < L_q$
(F) $L_d = L_q$

4) IPM machines are controlled so that the operating point is on the MTPA curve because
(F) the efficiency of the machine is maximum
(T) a smaller inverter can be used (once the machine is given)
(T) the maximum torque can be obtained (once the inverter is given and the current is sufficient).

5) In an IPM machine, the field weakening operation is obtained
(T) if $I_d < 0$
(F) if $I_d > 0$
(F) if $I_d = 0$

6) In an induction machine, controlled according to the principle of field-oriented control,
(F) when $I_{sd} = I_{sq}$, the torque is maximum
(T) when $\varphi_{sd} = \varphi_{sq}$ and the applied voltage is maximum, the operating point is on the MTPV curve
(F) when the operating point is on the MTPV curve, then stator current has the maximum admissible value

7) An UPS fed by batteries
(F) usually supplies the load for hours
(F) is the safest choice in case of frequent faults
(T) requires a room for the batteries in case of high-power installations.

8) In which case can the feed-forward compensation be used to reduce/cancel the steady-state error?
(F) in general-purpose drives, when the set-point is a speed command
(T) in electric drives for automation, when the set-point is a previously-known position command
(T) in a UPS, when the set-point is a sinusoidal output voltage

9) A resonant controller with frequency ω_0
(T) can cancel error harmonics at frequency ω_0
(T) can cancel error harmonics at frequency $-\omega_0$

(F) can cancel error harmonics at frequency $2\omega_0$

10) In an active rectifier
(T) the reactive power is mainly sensitive to the magnitude of the input voltage
(F) the reactive power is mainly sensitive to the displacement angle between input and grid voltages
(F) the reactive power is controlled by I_{sd} (in the rotating reference frame synchronous with the grid voltage)

11) If the sampling frequency is 10 kHz and the number M of samples per period is 600, the repetitive controller can cancel harmonics
(T) at 50 Hz
(F) at 60 Hz
(T) at 300 Hz

12) In the series-hybrid topology,
(F) the combustion engine and the electric machine use the same shaft
(F) the combustion engine drives the wheels
(T) the electric machine drives the wheels.

Open-ended questions (max. 15 pts.)

1) Field weakening of induction machines.

2) Repetitive controller

3) Examples of parallel hybrid topologies for vehicles.

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 SVM
[300/sqrt(3) V]

2) Let us consider the three signals x_1, x_2, x_3, defined as

$x_1=1+\frac{\sqrt{3}}{2}$

$x_2=1$

$x_3=1-\frac{\sqrt{3}}{2}$

Calculate the corresponding zero-sequence component and the space vector.
exp[j(30 degrees)]

3) Suppose that the magnitude of the transfer function of the controlled load is equal to 0.01 (p.u.) at the desired cross-over frequency. Calculate approximately the proportional gain of the PI controller for a current loop under the assumption that the cross-over frequency is very high.

[100]

Notes:

The students is expected to give back all the sheets received by the professor. Calculators can be used (but no smart phones, no PCs and tables)