

Jenni Rekola

Programmable calculator allowed
Answers in English or in Finnish allowed

5 questions/ á 6 p

1. Propositions

Answer, if the following propositions are true or not true. Correct answer 1p, wrong answer -1p.

- a) PMSM machine is usually modeled in rotor flux reference frame.
- b) Stator resistance value has a major effect to the accuracy of the speed estimation
- c) Space vector theory is not possible to use if the three-phase voltages are asymmetrical.
- d) Common mode voltage can be reduced by using multilevel converter topology.
- e) The switching frequency of the IGBTs in the converter is constant when DTC is used
- f) Rotor resistance of a slip-ring machine can be changed

2. DC machine

- a) Draw the equivalent circuit of a separately excited DC machine
- b) Draw the control block diagram of separately excited DC machine with position control and shortly explain the figure.
- c) What means electrical time constant of DC machine, how it is defined?
- d) The load torque of the uncontrolled separately excited machine is decreased step-wisely from its nominal value to 0,5*nominal torque in the nominal operating point. How the rotational speed, armature current and magnetizing current change? Why?
- e) The magnetizing voltage of the uncontrolled separately excited DC machine decrease step-wisely from its nominal value to 0,5*nominal voltage when the motor rotates at its nominal speed without the load. How the rotational speed, armature current and magnetizing current change? Why?
- f) How does the rotational speed, armature current and magnetizing current of the uncontrolled separately excited DC machine behave when the supply voltage decreases to be 0,9*nominal?

3. Permanent magnet synchronous machine

- a) What is the difference in the mechanical structure of salient and non-salient PMSM machines?
- b) How the torque production of these two machines differs from each other?
- c) How the control method of these two machines differs from each other?
- d) What is the benefit/benefits of PMSM compared to induction machine?
- e) What is the drawback/drawbacks of PMSM compared to induction machine?
- f) The torque reference of the controlled, non-salient PMSM is decreased step-wisely from its nominal value to 0,1*nominal torque in the nominal operating point. How the rotational speed and stator current (d- and q-component) change? Why?

4. Reluctance machine

- a) Describe shortly the operation principle of reluctance machine
- b) How torque is produced in reluctance machine?
- c) How torque is controlled?
- d) What is the benefit/benefits of reluctance machine?
- e) What is the drawback/drawbacks of reluctance machine?
- f) Why the magnetized assisted reluctance machine is used in electric vehicles instead of conventional reluctance machine?

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5. Induction machine

- Draw the control block diagram of direct vector control (field oriented control) of an induction machine and explain it shortly. (2p)
- Why the flux model is needed in the control system?
- The measured speed and speed reference of an induction machine are shown in Fig. 1. Are the speed control parameters good according to the figure? Why?
- How the discretization of the control system might affect to the control?
- What are the most important un-idealities which might affect to the operation of the real-world motor drive control system, but which are not usually taken into account in the ideal simulation models?

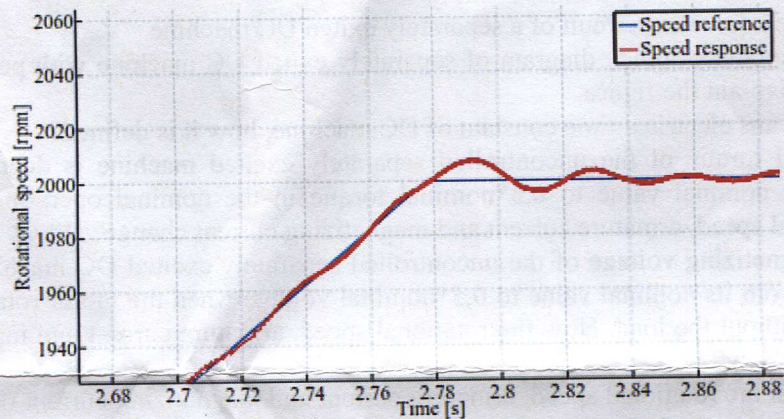


Fig. 1. Measured speed and speed reference

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