

Jenni Rekola

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Answers in English or in Finnish allowed

5 questions/ á 6 p

1. Control of separately excited DC machine

- Draw control block diagram of separately excited DC machine operating in four quadrants with speed control and shortly explain the figure.
- The open-loop frequency response of separately excited DC machine is presented in Fig. 1. Are the control parameters well chosen? Why?
- What means the anti-windup of the integrator in the control system? What might happen without the anti-windup?
- How the anti-windup of the integrator can be realized?
- How the discretization of the control system might affect to the control?
- How the un-idealities of the real-world motor drive and its control might differ from the ideal system?

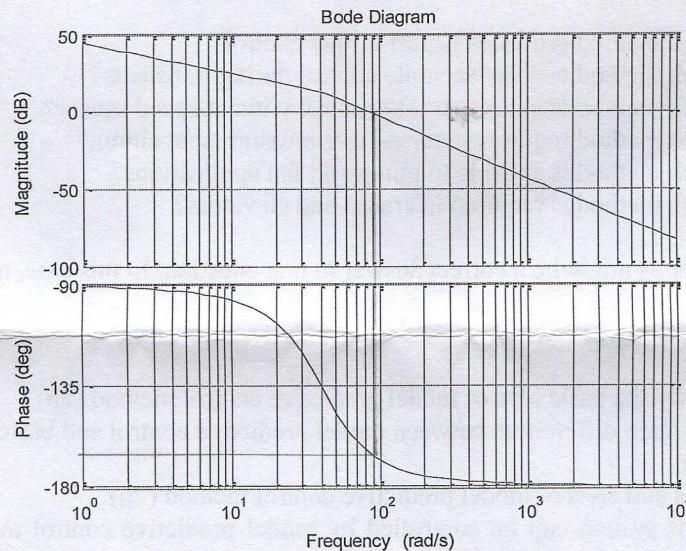


Fig. 1. Open-loop frequency response of separately excited DC machine

2. Control of an induction motor

- Explain briefly the operation principle of scalar control method (Volts/Hz-control, U/f-control)?
- What measurements are required in scalar control method?
- What means IR-compensation and why it is used?
- How the control changes depending on the operation region (constant voltage region or field weakening region)?
- Why the vector control (field oriented control) or DTC are used instead of scalar control?
- How the required magnetizing current of the induction machine varies depending on the operating method of the motor (motor mode or generator mode)?

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3. Control of an induction machine

- Draw the control block diagram of direct vector control (field oriented control) of an induction machine and explain it briefly.
- What reference frame is used in direct vector control (field oriented control) and why?
- Why the flux model is needed in the control system?
- What measurements are required in direct vector control (field oriented control)?
- What measurements are required in direct torque control (DTC)?
- The switching frequency of the IGBTs in the motor inverter is not constant if DTC is used. Mention some advantages/disadvantages caused by non-constant switching frequency.

4. Compare the following control methods: scalar control (Volts/Hz control, U/f-control), vector control (field oriented control), direct torque control (DTC)

- Which method produces fastest torque control?
- Which method enables accurate control during transients?
- Which method enables accurate control without speed sensor?
- Which method requires stator current measurement circuit?
- Which method is suitable to pump and fan applications?
- Which method is required in cranes and elevators?

Multiple control methods might be a correct answer to one question. In this case, mention all of them.

5. Model Predictive Control

- Explain briefly the basic idea of model predictive control method (2p)
- Mention the main differences between model predictive control and basic linear control based on PI-controllers
- Mention pros and cons of model predictive control method (2p)
- What kind of system can be controlled by model predictive control method? Are there some limitations?