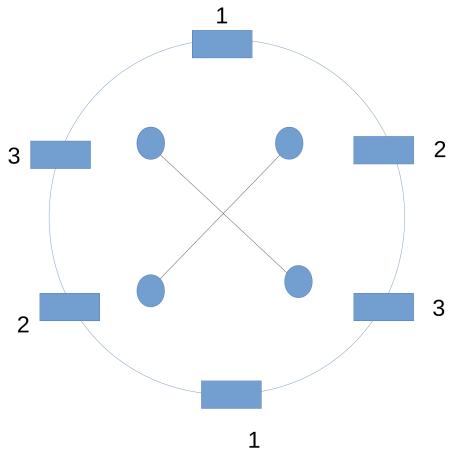
Sensing, Computing, Actuating
Lecture 5 - Stepper Motors

This instruction exercise consists of three questions that show example questions related to the lectures on stepper motors. In preparation for the exam you should of course not only study these questions, but also the examples shown on the lecture slides.

Exercise 1: Stepper motors

(a) Draw a diagram that shows the physical construction of a three-phase four-pole permanent magnet step motor.



Answer:

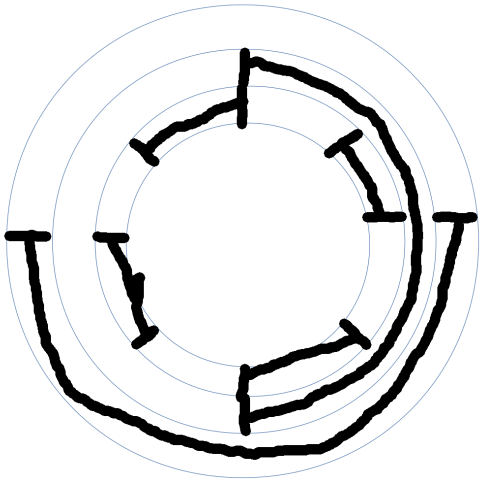
(b) What is the full step angle of a three-phase four-pole permanent magnet step motor?

Answer: Stator pitch $\Theta_s = 360°/6 = 60°$
Rotor pitch $\Theta_r = 360°/4 = 90°$
Full step angle $\Theta_{fs} = |\Theta_s - \Theta_r| = |60° - 90°| = 30°$

(c) For an application it is important that the step motor remains in its position even when the motor is not energized. Can you use a variable reluctance step motor for this application? (Explain your answer)

Answer: No a variable reluctance stepper motor provides no holding torque. A permanent magnet stepper motor should be used instead.

(d) Draw a disc that can be used in a absolute position encoder to encode angles of 45° in a 3-bit value?



Answer:

(e) A displacement can be sensed using a Hall effect sensor. Explain the operation of a Hall effect sensor. Clearly indicate in your answer how you can use the sensor to measure a displacement.

Answer: External field causes electrons to no longer follow straight path through sensor (Lorentz force). This causes different number of charge carriers on two sides of the device (i.e., generating the Hall effect voltage). To use the device to measure a displacement the object should modify the magnetic field passing through the sensor.

(f) The internal resistance of a semiconductor-based Hall effect sensor has a PTC temperature coefficient. Can an NTC thermistor be used to compensate this temperature dependency in the Hall effect sensor. (Explain your answer and provide a circuit that shows how the two devices need to be connected.)

Answer: Yes, the change in resistance of both devices is opposite (PTC / NTC). By putting them in series (and adjusting the temperature sensitivity of one of them with an additional resistor) you can achieve a circuit that is not sensitive to temperature change.