The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX4271 – Sensors and actuators**
Academic Year	:	2013/14
Date	:	5th August 2014
Time	:	0930hr-1230hr
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper has **eight** questions.
3. Answer **five** questions only.

Q1.

(a) Briefly explain what are sensors and transducers? [6 marks]

(b) What are the parameters you have to consider when selecting sensors? Briefly explain three parameters. [8 marks]

(c) Define the terms, mechanical loading and electrical loading, in the context of motion sensing. [6 marks]

Q2.

(a) What is a Rotary variable differential transformer (RVDT)? Describe briefly how it works. Draw the output wave form of the RVDT. [5 marks]

(b) In an RVDT, 1^0 angular displacement of core corresponds to 10mV produced at the output.

i What will be the voltage produced when core moves 35^0 in clockwise direction? [5 marks]

ii What is the range of RVDT output voltage if core can move to a maximum of 180^0 in anticlockwise direction? [5 marks]

(c) Explain the necessary steps you have to take when a RVDT is connected to a microcontroller. [5 marks]

Q3.

(a) Explain the construction and operation of absolute position encoder and incremental position encoder. [4 marks]

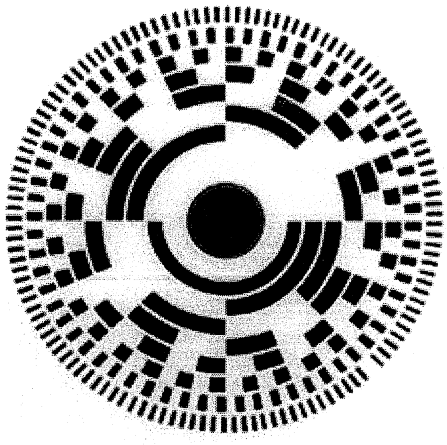
(b) Find the angular resolution of

i the sectored disk encoder shown in figure Q3? [4 marks]

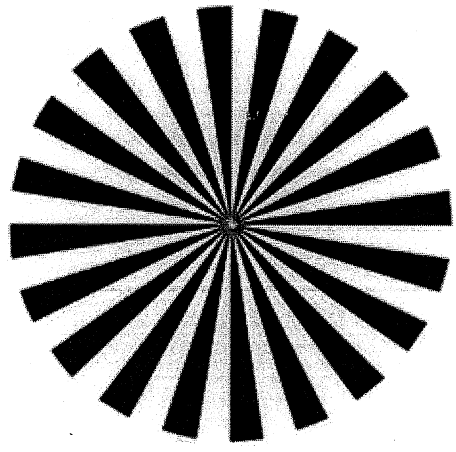
ii the optical shaft encoder shown in figure Q3? [4 marks]

(c) Explain how the angular resolution of the optical shaft encoder can be improved. [4 marks]

(d) Sketch and explain interfacing of slotted disk encoder and optical shaft encoder to a microcontroller. [4 marks]



Optical shaft encoder



Sectored disk encoder (40 divisions)

Figure Q3

Q4.

A car park has a fixed number of parking places, and it is able to accommodate only vehicles less than 2 m high from the ground. The entrance barrier will open if there is a car waiting to enter and a token is released for the driver. The exit barrier will open if there is a car waiting to leave the car park and parking fee is paid at the barrier.

(a) Suggest suitable sensor for each of the following purposes. Discuss how the suggested sensor works, and justify your choice.

i. Detecting the presence of a car. [6 marks]

ii. Ensuring that the vehicle height does not exceed 2 metres high. [6 marks]

(b) Suggest a suitable actuator for operating barrier of the car park. [2 marks]

(c) Sketch the motor drive circuit to open and close the barrier of the car park. [6 marks]

Q5.

A 25kW, 125V separately-excited dc machine is operated at a constant speed of 3000rpm with a constant field current such that the open circuit armature voltage is 125V. The armature resistance is 0.2Ω.
Determine the armature current, input power, electromagnetic power and torque when the input voltage is

(a) 128V, and [10 marks]

(b) 124V. [10 marks]

Q6.

A $220V_{rms}$, 60-Hz three phase wye-connected induction motor draws 30A at a power factor of 75% lagging. For all three phases, the total stator copper losses are 400W, the total rotor copper losses are 150W and the rotational losses are 500W.

Find the,

(a) power crossing the air gap (P_{ag}) [5 marks]

(b) developed power (P_{dev}) [5 marks]

(c) output power (P_{out}) [5 marks]

(d) efficiency [5 marks]

Q7.

(a) Distinguish reluctance stepper motor and permanent magnet stepper motor. [8 marks]

(b) Explain operation of the different types of stepper motor drive modes using switching sequence table. (hint : drive modes are half step drive mode and full step drive mode) [8 marks]

(c) Briefly explain the operation of micro-step drive of stepper motor. [4 marks]

Q8.

(a) Draw the symbols for

i. a pressure relief valve [2 marks]
ii. a 4/2 valve which has actuators of a push-button and spring [2 marks]
iii. a 5/3 valve [2 marks]

(b)

i Name all the components showing in figure Q8. [8 marks]
ii Describe the operation of the pneumatic circuit given in figure Q8. [6 marks]

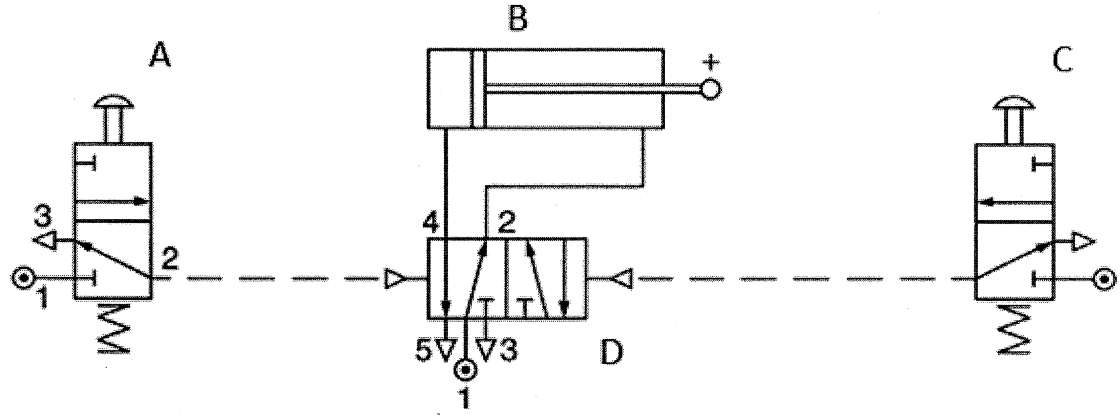


Figure Q8

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