THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
LEVEL 4
FINAL EXAMINATION 2010/2011
MEX4271 – SENSORS AND ACTUATORS
DATE : 1ST MARCH 2011
TIME : 0930HRS TO 1230HRS
DURATION : THREE HOURS [3 hrs]

> READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE ANSWERING THE
> QUESTION PAPER

- This question paper has eight questions.
- Answer five questions only.

Question 01:
i. Discuss the main differences between the following two types of electronic temperature sensors:
   a. Linear electronic temperature sensors
   b. Thermistors

ii. Describe the operation of a LVDT for measuring displacement. How is its operation dependent on position of the core?
iii. Define the terms, mechanical loading and electrical loading, in the context of motion sensing.

Question 02:
i. What are the parameters you have to consider when selecting sensors, and briefly explain each parameter.
ii. Discuss two methods of linear position encoding. What advantages and disadvantages does each method have?
iii. Distinguish between incremental encoding and absolute position measurement.

Question 03:
i. What is piezoelectric effect? Sketch the basic construction and explain the operating principle of piezoelectric sensor.
ii. Discuss advantages and disadvantages of fibre optic sensor.
iii. Explain the principle operation of the Hall Effect transducer.
iv. Explain the principle operation of the Phyro-Electric transducer.

Question 04:
i. Why are the brushes of a dc machine always placed at the neutral points?
ii. Explain why the armature current of a shunt motor decreases as the motor accelerates.
iii. A shunt motor rotating at 1500rpm is fed by a 120V source. The line current is 51A and shunt-field resistance is 120Ω. If the armature resistance is 0.1Ω, calculate the following
   a. The current in the armature
   b. The counter emf
   c. The mechanical power developed by the motor

Question 05:

i. Explain what happens to the rotor speed and rotor current when the mechanical load on an inductio motor increases.

ii. Give two advantages of a wound-rotor motor over a squirrel-cage motor.

iii. A 3-phase induction motor having a nominal rating of 75kW and a synchronous speed of 1800 rpm connected to a 600V source. The two-wattmeter method shows a total power consumption of 70kW, an an ammeter indicates a line current of 78A. Precise measurements give a rotor speed of 1763rpm. addition the following characteristics are known about the motor.

   Stator iron losses $P_f = 2kW$
   Windage and friction losses $P_v = 1.2kW$
   Resistance between two stator terminals= 0.34Ω

   Determine the following
   a. Power supplied to motor
   b. Rotor I^2R losses
   c. Mechanical power supplied to the load

Question 06:

i. Describe the basic details of
   a. A poppet valve
   b. A shuttle valve

ii. Draw the symbols of following valves
   a. A pressure relief valve
   b. A 2/2 valve which has actuators of a push-button and spring
   c. A 4/2 valve

iii. Design a pneumatic valve circuit to give the following sequence A+, followed by A- and the similarly followed by B+ and B-.

Question 07:

i. What happens to the reluctance of a magnetic path
   a. If its length is doubled
   b. If the cross sectional area is doubled

ii. A Uniform flux density of 1T is perpendicular to the plane of a five-turn circular coil of radius 10cm Find the flux linking the coil and flux linkages. Suppose that the field is decreased to zero at a uniform rate in 1ms. Find the magnitude of the voltage induced in the coil.

iii. The coil resistance of a 24V dc tubular solenoid coil specified as 37Ω at $20\,^{\circ}C$. The coil is constructed by winding 2710 turns of solid copper wires onto the core. Determine
   a. The mmf, amp-turns, of the coil when it is clod($20\,^{\circ}C$)
   b. The mmf, amp-turns, of the coil when it is hot($85\,^{\circ}C$)

Question 08:

i. What is the main use of a stepper motor?

ii. Distinguish reluctance stepper motor and permanent magnet stepper motor.

iii. Explain what is meant by half-step drive, full-step drive and micro-step drive of stepper motor.

-End-