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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION 2009/2010

MEX 6333 - MECHATRONICS

DATE : 01ST MARCH 2010
TIME : 0930HRS.-1230 HRS.
DURATION : THREE HOURS

READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE ANSWERING THE QUESTION PAPER

The question paper has **six** questions.

Answer **four** questions only. Question **one is compulsory** and answers three others.

Question 01 *Spend approximately one hour* *[40 marks]*

Today's fiercely competitive market enforces industries to rapidly deliver quality products to meet the societal demand. Many of the production cells in industry have already been equipped with automated machineries and systems. Out of many machine types, spindle machines draw attention and are commonly employed in the processes. For instance, in order to improve productivity, high-speed spindle systems (HSSS) are used in the production cells. Especially, they are employed for machining, micromachining, milling, drilling, data reading and recording applications, aerospace, heavy industry, consumer industry, and in many manufacturing sectors. Performance driven state-of-the-art design techniques, methodology and tools must be adopted for building machineries. HSSS have a reputation of not being highly reliable over a period of time due to the effect of decoupling and misalignment, unbalancing and vibration, thermal deformation, centrifugal force-oriented deformation and so on, for which performance profile deteriorates.

Design a high-speed spindle system for a data reading and recording application.

Note: - There is a strong need to investigate the design strategy, since the HSSS are no longer simply the mechanical systems rather they are mechatronic in nature.

Question 02 *[20 marks]*

a) What are the criteria that need to be considered when selecting the size and type of PLC required for a particular task or tasks?
b) Draw the ladder rungs to represent:
   i. Two switches are normally open and both have to be closed for a motor to operate.
   ii. Either of two, normally open, switches have to be closed for a coil to be energised and operate an actuator.
   iii. A motor is switched on by pressing a spring-return push-button start switch, and the motor remains on until another spring-return push-button stop switch is pressed.

Question 03 *[20 marks]*

a) Draw the symbols for
   i. a 2/2 valve which has actuators of a push-button and a spring
   ii. a directional valve.
b) Explain how a sequential valve can be used to initiate an operation only when another operation has been completed.
c) Explain what is meant by the four-bar chain

Question 04 *[20 marks]*

a) Explain the principle of the brushless d.c. permanent magnet motor.
b) A hot object, capacitance C and temperature T, cools in a large room at temperature T_r. If the thermal system has a resistance R derive an equation describing how the temperature of the hot object changes with time and give an electrical analogue of the system.

Question 05 *[20 marks]*

a) Consider a solenoid actuator in which a current passing through the solenoid results in movement of a rod actuator into or out of the solenoid. Propose models for the arrangement which could then be used to develop a differential equation relating the input of current to the output of displacement.
b) A first-order system has a time constant of 4 s and a steady-state transfer function of 6. What is the form of the differential equation for this system?

Question 06 *[20 marks]*

a) Describe and compare the characteristics of
   i. Proportional (P) control
   ii. Proportional plus integrate (PI) control
   iii. Proportional plus integrate plus derivative (PID) control.
b) Discuss the advantages of "soft" computing methodologies as compared to "hard" computing and explain how they are more appropriate for handling real-world problems. Explain the operating principle of a fuzzy logic washing machine which is an example in the application of soft computing methodology.

End