[Total No. of Questions - 8] [Total No. of Printed Pages - 4] (2125)

15401

M. Tech 3rd Semester Examination

Mechatronics (NS)

PE-E19

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt any 05 questions. Each question carries equal marks.

1. (a) "In selecting a sensor for a particular application there are a number of factors that need to be considered" What are these factors? Discuss. (10)

   (b) Suggest a sensor that could be used as a part of a system to control the thickness of rolled sheet by monitoring its thickness as it emerges from rollers. The sheet metal is in continuous motion and measurement needs to be made quickly to enable corrective action to be taken quickly. The measurement system has to supply an electrical signal. Provide a schematic diagram and description in support of your answer. (10)

2. (a) A manufacturer's of high-end home refrigerators wanted to create a 3-D profile of the temperature variations inside its refrigerators. The temperature profile would allow the company to verify the accuracy and consistency of its refrigerators' internal temperature and also allow them to market temperature consistency as a valuable consumer benefit. The manufacturer chose to use Agilent 34970A data acquisition units to conduct the tests. Company test

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engineers then needed to select the best temperature sensors for the sensor array they needed to insert into the refrigerated cavity. The temperature range was fairly narrow, but they needed high accuracy over that range. Thermocouples were not accurate enough and thermistors were found unsuitable. (10)

(i) What are various temperature sensors? State difference between them.

(ii) Suggest the class of sensors that gave the best accuracy in this application.

(iii) Provide the curve between variation of resistance with temperature to support your answer and mathematical relationship, if any.

(b) "A mechatronic system is not just a marriage of electrical and mechanical systems and is more than just a control system; it is a complete integration of all of them". W. Bolton. Provide a figure showing the integration and discuss in detail. (10)

3. (a) A D.C motor is required to have a (i) high torque at low speeds for the movement of large loads (ii) a torque which is almost constant regardless of speed. Suggest suitable form of motors with description and neat sketches. (10)

   (b) Design a 2 bit comparator using logic gates. Describe various types of registers and counters. (10)

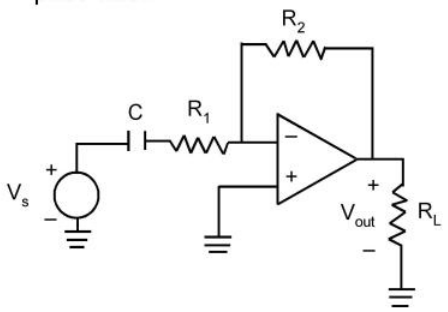
4. (a) Explain the Simulation techniques/ tools for mechatronics design like ACSL, SIMPACK, MATLAB/SIMULINK, and MATRIX-X. (10)

   (b) The op amp circuit shown in Figure below is used as a filter, with component values of C=100μf. R_1=10kΩ, R_2=1505kΩ, R_L=15kΩ

Determine:

(a) the gain Vout/Vs (in dB) in the pass band;

(b) the cut-off frequency: if the circuit is a low- or high-pass filter. (10)



5. (a) A digital to analog converter uses a reference voltage of 10V and has a 6 bit precision. In three successive sampling instants, 0.5 sec apart, the data contained in binary register are the following. Determine

(i) Decoder output values for the three sampling instants.

(ii) Voltage signals between instant 2 and instant 3 for a zero order hold.

(iii) Voltage signals between instant 2 and instant 3 for a First order hold.

Obtain the plot of the values and state which order hold more accurately anticipates the decoder output value and by what percentage?

Instant	Binary Data
1	101000
2	101010
3	101101

(10)

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(b) Is it possible to connect sensors such as thermocouples, strain gauges and accelerometers directly to a digital computer or microprocessor? Explain. (10)

6. (a) Explain Dynamic characteristics of a mechatronics control system. Plot un damped, under damped, and over damped responses for a step input. (10)

(b) For the transfer function determine (a) peak time (b) percentage overshoot (c) settling time (iv) rise time

$$G(s) = \frac{150}{s^2 + 20s + 150}$$ (10)

7. (a) Present the architecture of microprocessors and micro-computers, and define useful terminology with help of a neat sketch. (10)

(b) List popular microcontrollers that have being in great demand for realizing mechatronics systems and explain any one with schematic diagram. (10)

8. (a) Design a switching circuit for a d.c. motor using a pulse width modulated signal input from a microcontroller and a closed-loop system based on an encoder integrated with a rechargeable power supply. (10)

(b) Explain characteristics of (a) PID controller (b) Stepper Motor. (10)