

ELG4112: Home Exam

These questions should be answered briefly. You should always support your answer with figures or block diagram stating the operation of each part

Question

Based on the following applications, categorize the following sensors:

1. Displacement, position and proximity
2. Velocity and motion
3. Force
4. Liquid flow
5. Liquid level
6. Temperature

| Sensor | Application |
|--------------------------|-------------|
| Potentiometer | |
| Incremental encoder | |
| Tachogenerator | |
| Hall effect sensor | |
| Differential transformer | |
| Piezoelectric sensor | |
| Turbine meter | |
| Thermistor | |
| Capacitive element | |
| Thermocouples | |

Question

A sensor gives a maximum output of 5 V. What word length is required for an analog-to-digital converter if there is to be a resolution of 10 mV?

Question

A DC motor is required to have (a) a high torque at low speeds for the movement of large loads, (b) a torque which is almost constant regardless of speed. Suggest a suitable motor and justify your selection.

Question

A major actuator trend in MEMS is based upon piezoactuation. Several companies are investigating both rotary and linear actuation using piezoactuators. Briefly explain this concept and state its application areas.

Question

A second order system is described by the differential equation

$$\frac{d^2x}{dt^2} + c \frac{dx}{dt} + 4x = F$$

What value of damping constant c will be needed if the percentage overshoot is to be less than 9.5%?

Question

What are the transfer functions for systems giving the following input/output relationships?

1. A hydraulic system has an input q and an output h , where

$$q = A \frac{dh}{dt} + \frac{pgh}{R}$$

2. A spring-dashpot-mass system with an input F and an output x , where

$$m \frac{d^2x}{dt^2} + c \frac{dx}{dt} + kx = F$$

3. An RLC circuit with an input v_i and output v_o

$$v_i = RC \frac{dv_o}{dt} + LC \frac{d^2v_o}{dt^2} + v_o$$

Question

Consider a camera which is automatic, auto-focus, and reflex. The camera has interchangeable lenses. There is a main controller in the camera body and another microcontroller in the lens housing, the two communicating with each other when a lens is attached to the camera body. Draw the block diagram of the electronic system.

Question

All modern cars contain many electronic control systems involving microcontrollers. One important feature is the engine control system. Its aim is to ensure that the engine is operating at its optimum settings. The system consists of sensors supplying, after suitable signal conditioning, the input signals to the microcontroller and it provides output signals via drives to actuate actuators. Draw a block diagram of the engine management systems showing the required sensors.

Question

Consider the design of a simple weighting machine. The main requirements are that a person can stand on a platform and the weight of that person will be displayed on some form of readout. The weight should be given with reasonable speed and accuracy and be independent of where in the platform the person stands. Suggest a suitable design for the machine showing the basic details of the system.

Question

Manufacturing processes become more complex in terms of their operation. There is a stronger demand for real-time coordination of multiple process issues and also between levels of control operations. Suggest a methodology of on-line inspection system. Support your suggestion with a block diagram.

Question

You are provided with a coin slot through which people push coins. The bottom of the coin always slides along the bottom of the slot. People feed variety of coins (dimes, nickels, and quarters). Photo sensors are available and can be placed at any height to detect when portions of coins pass through the slot. The output of a sensor is high when its beam is interrupted; otherwise it is low. Design a system that will light a red LED when a dime passes through, a yellow LED when a nickel passes through, and a green LED when a quarter passes.

Question

In monitoring the inputs from a number of thermocouples the following sequence of modules is used for each thermocouple in its interface with a microprocessor. Explain the function of each of the modules:

| Module | Function |
|-----------------------------|-----------------|
| Protection | |
| Cold junction compensation | |
| Amplification | |
| Sample and hold | |
| Analog to digital converter | |
| Buffer | |
| Multiplexer | |

Question

For each of the following applications, what is a good choice for the type of electric motor used? Justify your choice.

| Application | Type of motor | Justification |
|--------------------------|----------------------|----------------------|
| Robot arm joint | | |
| Ceiling fan | | |
| Electric trolley | | |
| Circular saw | | |
| Electric crane | | |
| Disk drive head actuator | | |
| Disk drive motor | | |
| Windshield wiper motor | | |
| Washing machine | | |
| Clothes dryer | | |