INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY SHIBPUR

B.E. 8th Semester (Aerospace Engineering) End Semester Examination May 2014

Sub. : Introduction to Mechatronics (AE 7800 / 02)

Full Marks : 35 **Time : 2 hrs.**

ANSWER ANY SEVEN (07) QUESTIONS
ALL QUESTIONS CARRY EQUAL MARKS

1.

a. What is mechatronics? Give an appropriate definition of it.

b. How the mechatronics products are classified?

c. Identify the four central components in a mechatronics system and explain the advantage of energetic isolation of these four components. 1+2+2

2.

a. What are the design challenges for mechatronics product design?

b. What are truth model and design model?

c. What do you understand by physical model simplification? Explain with example.

d. What are the steps in deriving mathematical model from a physical model? 1+1+1+2

3.

a. What is a senor? What are the quality parameters of a sensor system?

b. What is transfer function and block diagram?

c. What is the output of a system having the transfer function G (s) = 2 / [(s+3)(s+4)] and subject to a unit impulse? 2+1+2

4.

a. A condenser of capacity C discharged through an inductance L and resistance R in series and the charge q at time t satisfies the equation

$$L(d^2q/dt^2) + R(dq/dt) + (q/c) = 0$$

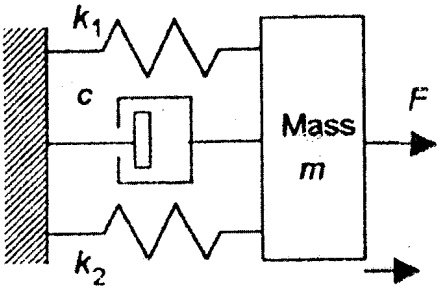
Given that L=0.24 H, R=240 Ohms, C = 2×10^{-6} farad, and that when t=0, charge q = 0.002 couloms and the current dq/dt = 0, obtain the value of q in terms of t.

b. Compare and construct the traditional design of a watch with that of the mechatronics-designed product involving a microprocessor. 3+2

5.

a. What is the difference between a distributed-parameter model and a lumped-parameter model?

b. Derive an equation relating the input, force F, with the output, displacement x, for the systems described below.

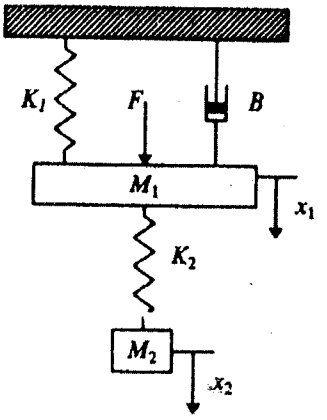


2+3

6.

a. Explain with schematic diagram the basic operation of a modern camera having automatic focusing and exposure.

b. The following mechanical system may be used to measure acceleration. Construct the block diagram model and find the transfer function, x_1 / F, x_2 / F, x_2 / x_1 2+3



7.

a. Name different types of actuators.
b. What are the factors on which selection of actuators depend?
c. State the balance equations and constitutive equations for a cylindrical water tank in horizontal orientation with cross-section A = 1 m^2 and liquid level h = 2m, one inflow valve over the liquid surface and outflow at the bottom. Derive the transfer function for the liquid level as output and the inlet valve position as input (maximum inlet flow 0.2m^3/s) for a flow of 0.1m^3/s. 1+1+3

8.

a. Comment on the difference between using pneumatic fluid power and hydraulic fluid power.
b. Why is hydraulic power especially useful when performing heavy works?
c. What are the primary functions of a hydraulic fluid?
d. Name the basic components required in a hydraulic circuit. 1+1+1+2

9.

a. With a hydraulic circuit explain the principle of operation of a hydraulic cylinder.
b. Name the basic components required in a pneumatic circuit.
c. What is the difference between a single-acting and double-acting hydraulic cylinder?
d. What is a valve? Describe the principle of operation of a solenoid valve. 1+1+1+2

10.

a. State and describe the basic components of an embedded system.
b. Write down the steps for connecting and blinking a led by using ATMEGA 8 microcontroller.
c. What is the function of ADC in an embedded system? What is meant by a 10 bit ADC? 1+2+2

11.

a. What is the relation between RPM and torque of a dc motor? Why motor drivers are required in an embedded system?
b. Mention the steps of digitizing an analog signal? What is meant by resolution of an ADC?
c. Explain how stepper motor works. 2+2+1

12.

a. What are the common techniques of actuation?
b. Write down steps for interfacing a sensor with microcontroller and reading its data.
c. Write and explain characteristics of a dc motor.
d. Why an embedded program is always written inside while loop? 1+2+1+1