



KENYATTA UNIVERSITY
UNIVERSITY EXAMINATIONS 2010/2011
FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE
IN COMPUTER ENGINEERING

SCE 320: MEASUREMENT AND INSTRUMENTATION

DATE: Friday 26th November, 2010

TIME: 2.00 p.m. – 4.00 p.m.

INSTRUCTIONS

Attempt Question ONE and any other TWO questions.

Q 1 (a) (i) Explain the meaning of the term transducer. (2 Marks)

(ii) Some of the performance characteristics used in specifying transducers are given below. Explain the meaning of each.

I) Accuracy

II) Sensitivity

III) Resolution

IV) Systematic error (4 Marks)

(b) Any instrumentation system having a transfer function expressed in the form:

$$\frac{y(s)}{u(s)} = \frac{wn^2}{s^2 + 2\zeta w_n s + w_n^2}$$

Is known as a second order system where the damping ratio and ω is

Is the system natural, undamped frequency of vibration?

Determine the time response of the second order system subjected to a unit step input on $U(S)$. Assume that $\xi \ll 1.0$. (6 Marks)

- (c) A measurement system can be analyzed by utilizing analogy between the mechanical and electrical quantities. Describe the force voltage and force current analogous systems and show for each system the electrical analogy for the common mechanical, thermal and fluidic quantities. (6 Marks)
- (d) (i) Explain the principle of operation of a moving coil instrument. (2 Marks)
- (ii) A moving coil instrument gives full scale deflection with 15mA and has a resistance of 5. Calculate the resistance of the necessary components in order that the instrument may be used as an ammeter and a 100V voltmeter. (4 Marks)
- (e) (i) Explain the functions of the essential components of a CRO. (3 Marks)
- (ii) An oscilloscope is used to display a sinusoidal alternating voltage. The display shows a sine wave of amplitude 5.0cm and Y-amplifier sensitivity is set at 10v/cm. Calculate the R.M.S value of the voltage. (3 Marks)

- Q2 (a) An electrical thermometer using a thermistor as the temperature sensitive element is shown in Fig Q 2 (a). Describe the factors which would determine the choice of the circuit parameters. (8 Marks)
- (b) A thermistor of 2000Ω and having a characteristic constant $\beta = 2600$ at 20°C has a internal temperature rise of 0.2°C per mill watt of power dissipation. Sketch a typical graph of thermistor voltage against current. Determine the maximum thermistor current before thermal instability occurs when the thermometer is used at an ambient temperature of 20°C . (12 Marks)

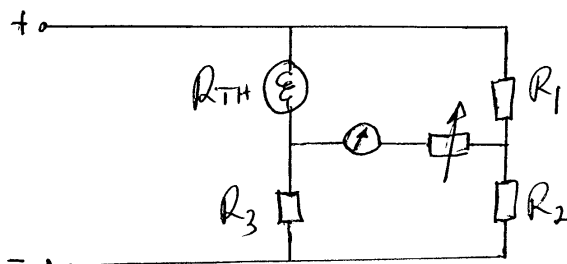
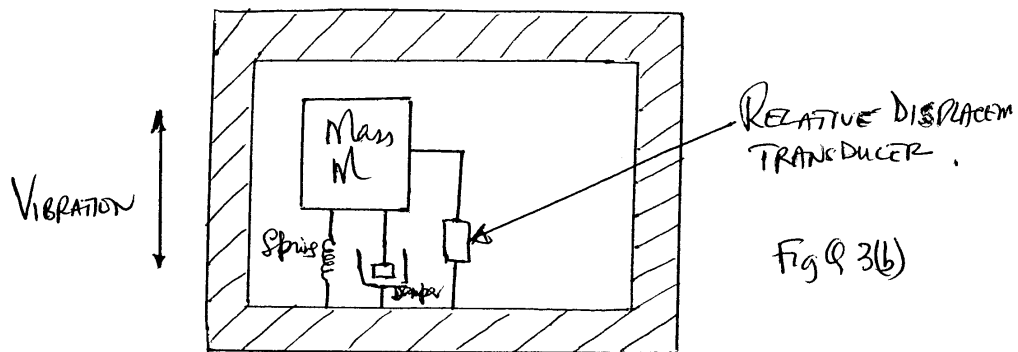


Fig Q 2(a)

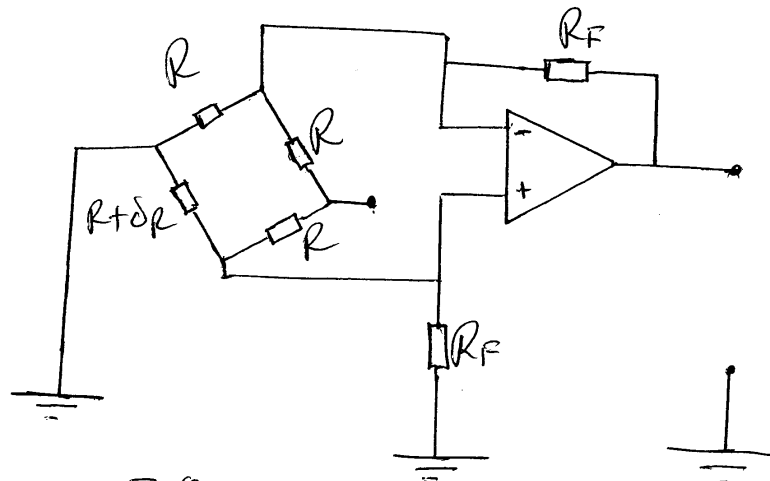
Q3 (a) Describe the problems encountered in multichannel instrumentation systems in deriving a digital signal from transducer output in analogue form. (8 Marks)

(b) Fig Q3(b) shows a seismic displacement transducer which is to be used for vibration tests in a system where a fixed reference for displacement measurement is not accessible. The displacement of the seismic mass within the system is indicated by the signal from the relative displacement transducer connected between the mass and the transducer frame. Derive an equation of motion for the system and hence plot a graph showing the magnitude of the system response as a normalized function of frequency, assuming that the system damping has been set to 0.6 (12 Marks)



Q4 (a) Explain the principle of operation of an instrumentation amplifier. (8 Marks)

(b) A differential amplifier is used as a bridge amplifier as shown in Fig Q4(b). The bridge uses one active arm and it can be assumed that $R \gg R$ and that the amplifier gain is very high. Determine the marginal fractional deviation in the strain gauge if the system non-linearity must not exceed 95%. (12 Marks)



- Q5 (a) Explain the basic principle of sampling and show why this process is necessary in a measurement system using data transmission. (8 Marks)
- (b) (i) Describe the various sources of noise signals which may interfere with the measurement of low level signals. (6 Marks)
- (ii) Distinguish between common-mode and differential mode interference. Explain how noise signals of each type may cause interference effects and describe the techniques by which such effects are minimized. (6 Marks)