MINISTRY OF SCIENCE AND TECHNOLOGY
MANDALAY TECHNOLOGICAL UNIVERSITY
Department of Mechatronic Engineering
2019-2020 Academic Year

Fifth Year **Second Semester Examination**

McE-52066 Sensors for Mechatronic System

Date: 24.3.2022(THU) **Time: 9:00 to 12:00 noon**

……...

Attempt ALL Questions.

Attempt **ALL** questions.

1. (a.) Fill in the blanks in the following sentences. **(5.Marks)**

i. An incremental encoder measures displacement as a----------and it measures velocity as a ----------.

ii. ----------, the net induced voltage is zero when the core is centered between the two secondary winding segments.

iii. One of the main limitations of resolver is ----------limited by supply frequency.

iv. The transducer disk is made of an ---------- in sliding contact encoder.

v. Sensors are used in control system to measure ----------for system monitoring, diagnosis, evaluation, parameters adjustment, and supervisory control.

1. (b.) Choose the **correct answer** from the following sentences**.** **(15.Marks)**

i. Which sensor can detect the present of nearby object without any physical contact?

(1.) Proximity Sensor

(2.) Humidity Sensor

(3.) Touch Sensor

(4.) Temperature sensor

ii. The noise that affects pulse code modulation

(1.) Transition noise

(2.) Quantizing noise

(3.) Transient noise

(4.) Both 1 and 2 are correct

iii. In a Linear Variable Differential Transformer (LVDT), the two secondary voltages

(1.) Are independent of the core position

(2.) Vary unequally depending on the core position

(3.) Vary equally depending on the core position

(4.) Are always in phase quadrature

iv. The sensors are classified on the basis of

(1.) Functions

(2.) Performance

(3.) Output

(4.) All of the above

v. When the temperature rises, resistance of negative temperature coefficient thermistor

(1.) Increase

(2.) Decrease

(3.) Zero

(4.) Infinity

vi. The principle of operation of variable resistance transducer is

(1.) Deformation leads to change in resistance

(2.) Displacement of a contact slider on a resistance

(3.) Coupling of two coils changes with displacement

(4.) All of the above

vii. The transducers which requires an external power and their output is a measure of some variation such as resistance, inductance, capacitance etc., are called as

(1.) Active transducer

(2.) Primary Sensor

(3.) Passive transducer

(4.) Self generating transducer

viii. Inductive proximity sensors can be effective only when the objectives are of …….. materials.

(1.) Ferromagnetic

(2.) Diamagnetic

(3.) Paramagnetic

(4.) All of the above

ix. The electron reconfiguration produces a voltage, and is known as the ……..

(1.) Phase shift

(2.) Null Voltage

(3.) Seebeck effect

(4.) Magnetizing voltage

x. …….. consists of two different metals connected at two point.

(1.) Thermister

(2.) Resistance Thermometer

(3.) Thermocouple

(4.) Semiconductor based sensor

xi. What is the principle of operation of Linear Variable Differential Transformer (LVDT)?

(1.) Mutual inductance

(2.) Self-inductance,

(3.) Permanence,

(4.) Reluctance

xii. Device which converts an input device state into a binary representation of ones or zeros is termed as

(1.) Encoder

(2.) Decoder

(3.) Multiplexer

(4.) Data selector

xiii. The transducer that converts the input signal into the output signal which is a discrete function of time is known as …….. transducer.

(1.) Active

(2.) Analog

(3.) Digital

(4.) Pulse

xiv. A piezoelectric accelerometer senses …….and converts it into an electric charge.

(1.) rotation

(2.) displacement

(3.) velocity

(4.) Acceleration

xv. Which among the below stated does not belong to the category of analog transducer?

(1.) Shaft encoder

(2.) Linear Variable Differentiate Transformer

(3.) Strain guage

(4.) Thermister

2.(a.) A vibrating system has an effective mass M, an effective stiffness K, and an effective damping constant B in its primary mode of vibration at point A with respect to coordinate y. **Write expressions for the undamped natural frequency, the damped natural frequency, and the damping ratio for this first mode of vibration of the system.**

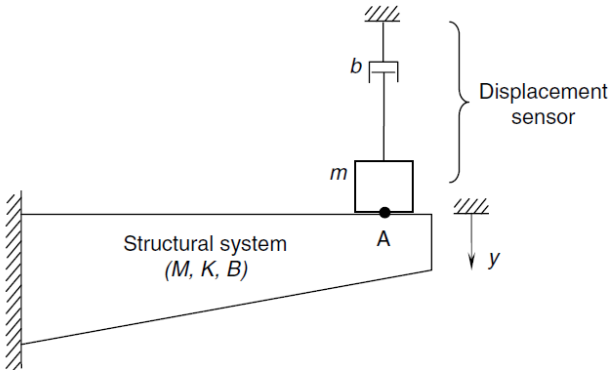

Figure. 2(a.)

Using the model shown in Figure.2(a.), derive expressions for the measured undamped natural frequency and damping ratio. Suppose that M =10 kg, K =10 N=m, and B =2 N/m/s. Consider an LVDT whose core weighs 5 gm and has negligible damping, and a potentiometer whose slider arm weighs 5 gm and has an equivalent viscous damping constant of 0.05 N/m/s. **Estimate the percentage error of the results for the undamped natural frequency and damping ratio, as measured using each of these two displacement sensors**. **(10 .Marks)**

2.(b.) Discuss about digital signals have several advantages in comparison with analog signal. (10 .Marks)

3.(a.) Explain the **signal conditioning method** for the differential transformer **with block diagram**. **(10.Marks)**

3.(b.) Write equations for the amplifier and filter circuits and, using them, give expressions for the voltage signals v_1, v_2, v_3, and vo are shown in Figure 3.(b.). The excitation in the primary coil is $v_p \sin \omega_c t$. **(10.Marks)**

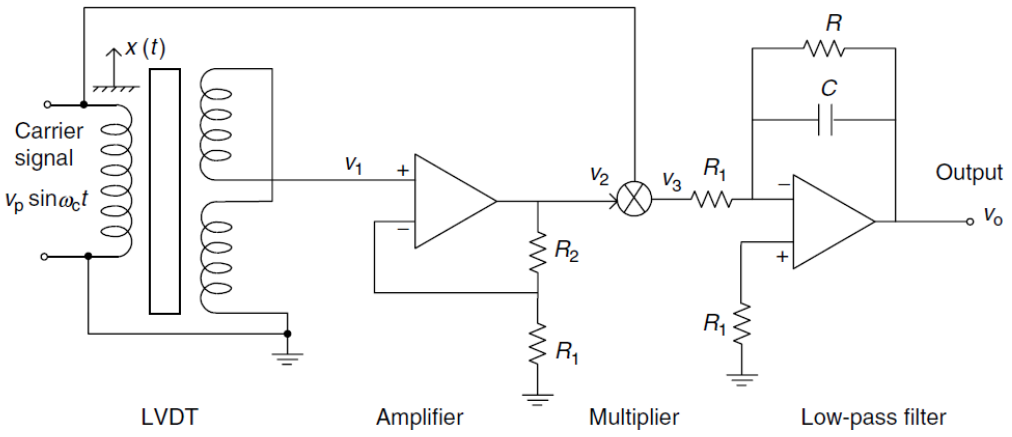

Figure.3.(b)

4.(a.) Consider the two quadrature pulse signals (say, A and B) from an incremental encoder. **Using sketches of these signals, show that in one direction of rotation**, signal B is at a high level during the up-transition of signal A, and in the opposite direction of rotation, signal B is at a low level during the up-transition of signal A. Note that the direction of motion can be determined in this manner, by using level detection of one signal during the up-transition of the other signal. **(10.Marks)**

4.(b.) An incremental encoder with 300 windows in its track is used for speed measurement. Suppose that

i. In the pulse-counting method, the count (in the buffer) is read at the rate of 20 Hz

ii. In the pulse-timing method, a clock of frequency 20 MHz is used.

Determine the percentage resolution for each of these two methods when measuring a speed of 1 rev/s and 100 rev/s. **Discuss the percentage resolution** by using these two methods. **(10.Marks)**

5.(a.) Discuss about the demodulation of the resolver(**support that the carrier (primary) signal is** $\mathbf{v_{ref} = v_a \sin\omega t}$) and primary advantages of resolver. **(10.Marks)**

5.(b.) Sensors can be used in a control system in several ways. Mention four ways of them. **(5.Marks)**

5.(c.) What is the Shaft Encoder? **(5.Marks)**

----------End of the Questions----------