

Electronics and Instrumentation Engg.

EI 1301 INDUSTRIAL INSTRUMENTATION-1

Unit I

1. Define force.

Force may be defined as a cause that produces resistance or obstruction to any moving body or change the motion of a body.

2. Define speed.

Speed is a variable which refers to the revolutions per minute of some piece of rotating equipment.

3. Which is the most frequently used speed measuring instrument?

Tachometer

4. What are the types of tachometer?

a) A.C. tacho generator

b) D.C. tacho generator

5. What are the types of D.C. tacho generator?

a) Permanent magnet type

b) Separately excited field type

6. What are the disadvantages of D.C. tacho generator?

A.C. ripple is present in the output signal. The magnitude of the ripple is 2% of the output D.C. level.

7. Name the types of rotor used in A.C. tacho generators.

a) Drag cup rotor

b) Squirrel cage rotor

8. What are the advantages of Squirrel cage rotor?

*Cheaper

*Occupies less space

9. Give some applications of drag cup tacho generator.

It is commonly used in the speedometers of motor vehicles and as a speed indicator for aeroengines.

10. Give the formula to calculate the shaft speed.

Shaft speed = (disk speed * No. of openings in the disk) / No. of images

11. Define torque.

Torque is defined as the force which tends to change the linear motion or rotation of a body.

12. What is the other name for inline stationary torque sensor?

Relative regular twist torque sensor

13. What are the types of torque transducer?

i) Inline rotating torque sensor

ii) Inline stationary torque sensor

iii) Optical torque sensor

iv) Proximity torque sensor

14. Write the relationship between torque and force.

$$T = F \cdot D$$

where T -> Torque

F -> Force

D -> Perpendicular distance between the axis of rotation of the line of action of the force

15. What are the advantages of optical torque sensor?

Low cost, small physical size

16. Write the formula for determining the actual speed in a stroboscope.

Actual speed, $f_r = f_1 f_n (n-1) / (f_n - f_1)$

f_n is the highest flashing speed

f_1 is the lowest flashing speed

n is the no. of flashing frequencies

17. Define load cell.

Load cell are devices that convert force into pressure, which are then measured.

18. Write down the range, accuracy and resolution in hydrostatic or hydraulic load cell.

Range of force measurement = 0 to 30000 N

Accuracy = 0.1%

Resolution = 0.02%

19. Why magneto elastic load cell is also called piezoelectric load cell?

The degree of change has a direct relationship with the applied stress or force. So it is called piezoelectric load cell.

20. What are the advantages of magneto elastic load cell?

- Extremely robust transducer
- Produces relatively high output signal levels
- Overload ratings are as high as 15 times the rated loads

Unit II

1. What are the advantages of using Baume scale?

It is used for liquids both lighter and heavier than water.

2. Write the abbreviation of API scale.

API - American Petroleum Institute

3. Write the disadvantages of bridge type gas densitometer.

The major disadvantage is that the variations in ambient temperature will introduce errors.

4. Write the formula for determining the height in a pressure head type densitometer.

$H = \text{Span} / (\text{Specific gravity maximum} - \text{Specific gravity minimum})$

5. Give some of the materials which are used for the manufacturing of a float.

Pyrex, Plastic

6. For what purpose accelerometers are used?

- For the measurement of shock & vibration
- For gross measurement of acceleration of vehicles like aircraft, submarines etc.

7. What are the advantages of LVDT?

- It is used for steady state and low frequency vibration measurements.
- Smaller mass, so, it is used for the measurement of vibrations of higher frequencies.

8. Define piezo electric effect.

If the dimension of crystal are changed by the application of a mechanical force, an electrical potential appears across the crystal. This effect is called piezo electric effect.

9. What are the features of piezo electric accelerometers?

- Small in size and weight
- It can be used for vibration and shock measurements.
- High output impedance
- Their response is poor at low frequencies

10. List some of the applications of strain gauge accelerometers.

It is used for the measurement of acceleration and vibration in vehicles, aircrafts, bridges, hoists, cranes & lifts.

11. Seismic instrument can be used as accelerometer & vibrant – True or false.

True

12. What are the two modes of seismic instrument?

- (i) Displacement mode
- (ii) Acceleration mode

13. Define density.

It is defined as the mass per unit volume of a substance under fixed conditions.

14. Define specific gravity.

It is defined as the ratio of density of one substance to the density of another reference substance both obtained at same temperature & pressure.

15. What is the other name for specific gravity?

Relative density.

16. Define viscosity.

It is the property of the fluid which gives the resistance to the flow.

17. What are the units of density?

Kg/m^3 or gm/litre or gm/ml

18. What are the units of viscosity?

Pascal or Nsm^{-2} or kgm^{-1} or poise

19. For what purpose mechanical type vibration instruments are used?

It is used for the measurement of

- (a) Motion of 2 points w.r. to each other (relative motion)
- (b) Motion w.r. to earth (absolute motion)

20. Write down the excitation voltage and accuracy of strain gauge load cell.

Excitation voltage may be a.c. or d.c in the range of 5 to 25 volts.

Accuracy is +0.1% of the full scale output.

UNIT-III

1) What are the main parts of an electrical pressure transducer?

- (a) Pressure sensing element such as a bellow, a diaphragm or a bourdon tube.
- (b) Primary conversion element. e. g resistance or voltage.
- (c) Secondary conversion element.

2) What are the advantages of strain gauge pressure transducer?

- (i) Small & easy to install

- (ii) Good accuracy
 - (iii) More stable
 - (iv) Fast speed response
 - (v) Simple to maintain
- 3) What are the disadvantages of strain gauge pressure transducer?
- (i) High cost
 - (ii) Requires constant voltage supply.
 - (iii) Electrical readout is necessary.
 - (iv) Temperature compensation is required.
- 4) What is the principle of operation of a piezoelectric pressure transducer?
When pressure is applied to a piezoelectric crystal such as quartz, an electrical charge is generated.
- 5) What are the types of thermal conductivity gauges?
- (a) Pirani gauge
 - (b) Thermocouple gauge
- 6) What is the purpose of ionization gauge?
Ionization gauge is used to measure the density of a gas.
- 7) Write down the formula for calculating the pressure in a McLeod gauge?

$$P = KH(H_0 - KH)$$
 K->Constant
 H-> Difference in heights of the two mercury columns.
 H₀->Height of the top of the closed capillary tube above the line marked on the tube.
- 8) What is the function of a dead weight tester?
Dead weight tester is used to calibrate bourdon gauges .It is used as a measuring device and also as a calibration method.
- 9) What are the disadvantages of using thermocouple gauge?
- (i) Easily damaged by organic vapours
 - (ii) The filaments can be coated with a deposit of devapourised vapours which alters the way the filament transfers heat.
- 10) Define thermal conductivity
The ability of the material to carry heat by conduction is called as the thermal conductivity.
- 11) What are the materials used in the construction of piezoelectric pressure transducer?
These devices use piezoelectric characteristic of crystalline and ceramic materials such as quartz.
- 12) What are the main parts in electrical pressure transducer?
- (i)Pressure sensing element such as a bellow, a diaphragm or a bourdon tube.
 - (ii)Primary conversion element
 - (iii)Secondary conversion element.
- 13) What are the advantages of capacitive pressure transducer?
- It gives rapid response to changes in pressure
 - It can withstand a lot of vibration
 - It has a good frequency response and can measure both static & dynamic changes.
- 14) What is a vacuum pressure?

Pressure which are below the atmospheric pressure are called vacuum pressure.

15) What is the purpose of calibrating a pressure measuring instrument?

It is used to adjust the output signal to a known range of pressure. It includes zero, span and linearity adjustment.

16) Write down the applications of ionization gauges?

It is used to measure low vacuum and ultra high vacuum pressure.

17) Determine the range of pressure which can be measured by pirani gauge & thermocouple gauge

In pirani gauge-> Pressure range from 10⁻⁵ torr to 1 torr can be measured.

In thermocouple gauge-> Pressure range from 10⁻⁴ torr can-be measured.

18) What are the disadvantages of LVDT pressure transducer?

- Large core displacement are required for appreciable amount of differential output.
- Temperature affects the performance of the transducer.
- They are sensitive to stray magnetic fields.

19) What is the principle of operation of a capacitive pressure transducer?

It is based on the principle of the familiar capacitance equation of the parallel plate capacitor (ie) $C = \epsilon_0 \epsilon_r A/d$ farad

(ie) capacitance = $\epsilon A/d$

$\epsilon_0 = 8.85 \times 10^{-12} \text{ f/m}^2$

ϵ_r = Dielectric constant

A -> Area of each plate

d-> Distance between two plates.

20) Write the principle of operation of an ionization gauge?

It follows Boyle's law (i.e) at constant temperature, the ratio of pressure of two gases is equal to the ratio of the two densities.

UNIT-IV

1) Define temperature?

The temperature of a substance is a measure of hotness or coldness of that substance.

2) What is the difference between temperature and heat?

Temperature is defined as “degree of heat”.

Heat is used to mean “quantity of heat”.

3) What are the temperature scales?

- Lower fixed point or ice point.
- Upper fixed point or steam point.

4) Give the relationship between Celsius scale & Fahrenheit scale?

$$^{\circ}\text{C}/100 = ^{\circ}\text{F}-32/180$$

5) Write the relationship between Kelvin scale & Rankine scale?

$$\text{R} = ^{\circ}\text{F} + 459.69$$

6) Define triple point?

A particular temperature and pressure at which three different phases of one substance can exist in equilibrium is known as “triple point”.

7) Write some methods of measurement of temperature?

- Expansion Thermometer.
- Filled system Thermometer.
- Electrical Thermometer.
- Pyrometer.

8) What are the different types of filled system Thermometer?

- Gas-filled Thermometer.
- Liquid-filled Thermometer.
- Mercury-filled Thermometer.
- Vapour-filled Thermometer.

9) How radiation error occurs?

It occurs due to the temperature difference between bulb and other solid bodies in filled system Thermometer.

10) Define Seebeck effect?

If two dissimilar metals are joined together to form a closed circuit, there will be two junction where they meet each other. If one of these junctions is heated, then a current flow in the circuit which can be detected by a galvanometer. The amount of current depends on the difference in temperature between the two junctions and on the characteristics of the two metals. This was observed by Seebeck & hence known as Seebeck effect.

11) Which effect is used in thermocouple?

Seebeck effect is used in thermocouple.

12) What are the various types of the thermometers?

Copper-Constantan, Iron-Constantan, Platinum-Rhodium, Chromal-Constantan & Chromal-Alumel.

13) What is the purpose of protecting tube in a thermocouple?

It is used to protect the thermocouple from harmful atmosphere, corrosive fluids and also to prevent from mechanical damage.

14) Explain the principle of operation of thermistor?

They have negative temperature coefficient of resistance i.e. with increase in temperature the resistance decreases and vice-versa.

15) What is the drawback in two wire RTD?

Two wire RTD's will give a large lead wire & hence it is impossible for accurate measurement of temperature.

16) Give some of the temperature instruments?

- Resistance thermometer.
- Thermocouple.
- Thermistor.

17) Define Barometric effect?

The effect due to change in atmospheric pressure is known as Barometric effect.

18) How Barometric error can be minimized?

It can be minimized by keeping the filled system at a pressure sufficiently larger than the atmospheric pressure.

19) What are the advantages of Filled system Thermometer?

- Low cost.
- Less maintenance requirement.

- Rugged construction.
 - Absence of need of electric power.
- 20) List some of the disadvantages of bimetallic thermometers.
- Possibility of calibration change due to rough handling.
 - Limitation to local mainting.
 - Availability of indication type only.

Unit V

1. Define first law of thermocouple.

The thermal emf of a thermocouple with junctions at T1 and T2 is totally unaffected by temperature elsewhere in the circuit if two metals used are each homogenous.

2. What are the two types of signal conditioning?

- a) Analog b) Digital

3. What are the possible ways of signal conditioning?

- A Linearisation b. Conversion c. signal transmission. D. Digital interface.

4. Define heat radiation?

When a body is heated, it emits thermal energy known as heat radiation.

5. Define pyrometry.

Pyrometry is the technic for measuring the body's temperature by measuring it's electromagnetic radiation.

6. What are the two types of pyrometer?

- a. Radiation pyrometer b. optical pyrometer.

7. Give the values of temperature coefficient of resistance in platinum and nickel?

Pt-0.004, Ni - 0.005

8. Define dissipation constant.

It is the power required to raise the RTD temperature by 1 degree centigrade.

9. What is the advantage of optical pyrometer?

It is used to measure high temperature.

10 How the calibration is adjusted in optical pyrometer?

By adjusting the emissivity.

11. What are the errors in total radiation pyrometer?

- a. They are sensitiue to emittance errors.

b. Sensitiue to any obstructions in the line of sight between the pyrometer and the hot body.

12. List some of the applications of total radiation pyrometer?

1. use for moving target.

2. Used in furnaces.

3. used for the temperatures above the practical operating range of thermocouple.

13. What are the advantages of total radiation pyrometer?

1. High temperature measurement.

2. Fast response speed.

3. Moduate cost and high output.

14. What are the advantages of selected radiation pyrometer?
The transmission losses are minimised and accuracy is improved.
15. What are the types of two colour pyrometer?
a) Selected radiation pyrometer
b) broad band pyrometer
c) Chopper broad- band pyrometer
d) Narrow band radiation pyrometer.
16. What is the other name for two colour radiation pyrometer?
Ratio pyrometer.
17. What are the advantages in ratio pyrometer?
1. Less accurate
2. More cost about 50-100% more than other types of pyrometer.
18. What are the disadvantages of total radiation pyrometer?
1. Non linear scale.
2. Emissivity of target material affecting measurement.
3. Errors due to presence of gases and vapours.
19. Give the formula for rate of radiation emitted per second
 $E = KT^4$ T-> Temperature;
K-> Constant
20. Write the formula for rise in temperature of RTD due to self heating effect?
 $T = P/P_d$
P -> power dissipated from RTD circuit
 P_d -> Dissipation constant of RTD in mW/C

Part- B Questions

Unit I

1. Explain in detail the strain gauge type loadcells. What are the advantages of strain gauge load cells?

The different types are (a) Link type load cell
(b) Beam type load cell
(c) Ring type load cell

Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 213-214)
2) Industrial Instrumentation by Krishna swamy (Pages : 155-159)

2. Explain how force measurement is done with hydraulic force meter & Pressductor load cells.

Ref : 1) Industrial Instrumentation & Control by S.K.Singh
(Pages: 208-209,213-214)

3. Describe the construction and working of a) in-line rotating torque sensor
b) in-line stationary torque sensor

- Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 214-217)
4. What are tachometers? Describe with neat sketch, the ac & dc tachogenerator used for speed measurement.
Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 211-213)
5. Explain in detail the mechanical disk type and flash light stroboscope
Ref : 1) A course in Electrical & Electronic Measurements & Instrumentation by J.B.Gupta (Pages :1021-1023)

Unit –II

1. With neat diagram, explain the mechanical behavior of a seismic instrument.
Ref : 1) A course in Electrical & Electronic Measurements & Instrumentation by A.K.Sawhney(Pages :1378-1380)
2. With neat sketches, explain the following:
(a) piezo-electric accelerometer
(b) variable reluctance accelerometer
Ref : a)Industrial Instrumentation by Krishna swamy (Pages : 200-202)
b) Industrial Instrumentation by Krishna swamy (Pages : 208-210)
3. Explain the principle of LVDT accelerometer with neat sketch. Also give its advantages & limitations.
Ref : 1) A course in Electrical & Electronic Measurements & Instrumentation by A.K.Sawhney(Pages :1381)
4. Explain in detail float type densitometers.
Ref : 1) Industrial Instrumentation by Krishna swamy (Pages : 224-226)
5. Explain in detail the ultrasonic type densitometer with neat diagram.
Ref : 1) Industrial Instrumentation by Krishna swamy (Pages : 232-234)

Unit III

1. Explain in detail the different elastic type pressure transducers.
Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 307-312)
2. Explain with a neat sketch a McLeod gauge.
Ref : 1) Industrial Instrumentation by Krishna swamy (Pages : 324-326)
3. With neat sketches, explain the principle and working of the following.
(i) piezoelectric pressure transducer
(ii) pressure head type densitometer

- Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 327-328)
2) Industrial Instrumentation by Krishna swamy (Pages : 227-232)

4.Explain in detail about dead weight tester.

Ref : 1) Principles of Industrial Instrumentation by Patranabis(Pages : 143-145)

5. With neat sketches, explain the different types of manometers.

Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 302-307)

Unit - IV

1. What are the different types of filled system thermometers? Explain the construction and working in detail.

Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 347-353)

2.List the sources of errors in mercury in steel thermometer. Explain any one compensation method used to reduce these errors.

Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 252-253)

3. What are the different electrical methods of temperature measurements? Explain any two methods in detail.

Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 354-366)

4.What are bimetallic thermometers? Explain the construction & working of different bimetallic thermometers?

Ref : 1) Industrial Instrumentation & Control by S.K.Singh (Pages : 343-345)

5.With a neat diagram, explain 2 lead wire, 3 lead wire & 4 lead wire RTD measuring circuits.

Ref : 1) Industrial Instrumentation by Krishna swamy (Pages : 18-22)

Unit V

1. Explain the principle of the thermocouple. Mention its types. What are the ranges of temperature for each.

Ref : 1) Notes

2. Explain in detail the signal conditioning of thermocouple output.

Ref : 1) Notes

3. Explain with a neat sketch, how cold junction compensation is arranged.

Ref : 1) Notes

4.Explain the construction & measuring principle of total & selective radiation pyrometers.

Ref : 1) Measurement & Analysis by B.C.Nakra & K.Kchaudhry
(Pages : 281-283)

5. Explain the constructional features of a two color radiation pyrometer system & explain how it is used for temperature measurement ? What is the prime advantage of this pyrometer in comparison to other pyrometers?

Ref : 1) Measurement & Instrumentation by Alan Morris (Pages : 261)