

UNIT I – COMPARATORS

Part A – 30 MCQ Questions

1. What is the primary purpose of a comparator?

- A) To measure absolute dimensions
- B) To compare a dimension with a standard
- C) To measure temperature
- D) To measure pressure

Answer: B) To compare a dimension with a standard

2. A comparator is mainly used for measuring:

- A) Large dimensions directly
- B) Small deviations from a standard dimension
- C) Temperature variations
- D) Surface colour

Answer: B) Small deviations from a standard dimension

3. Which of the following is NOT a type of comparator?

- A) Mechanical comparator
- B) Optical comparator
- C) Pneumatic comparator
- D) Thermal comparator

Answer: D) Thermal comparator

4. Which comparator uses mechanical amplification?

- A) Optical comparator
- B) Pneumatic comparator
- C) Mechanical comparator
- D) Electrical comparator

Answer: C) Mechanical comparator

5. A dial gauge is an example of:

- A) Mechanical comparator
- B) Optical comparator
- C) Pneumatic comparator
- D) Electrical comparator

Answer: A) Mechanical comparator

6. The main function of a dial gauge is to:

- A) Measure temperature
- B) Indicate small linear displacement
- C) Measure pressure
- D) Measure mass

Answer: B) Indicate small linear displacement

7. In a dial gauge, the linear movement of the spindle is converted into:

- A) Electrical energy
- B) Angular movement of a pointer
- C) Fluid pressure
- D) Optical energy

Answer: B) Angular movement of a pointer

8. Which mechanism is commonly used in a dial indicator?

- A) Gear and pinion mechanism
- B) Hydraulic mechanism
- C) Pneumatic valve
- D) Optical lens only

Answer: A) Gear and pinion mechanism

9. The ratio of output movement to input movement in a comparator is called:

- A) Accuracy
- B) Sensitivity
- C) Magnification
- D) Resolution

Answer: C) Magnification

10. A comparator having high magnification is capable of detecting:

- A) Large temperature changes
- B) Small dimensional variations
- C) Large pressure variations
- D) Colour changes

Answer: B) Small dimensional variations

11. An optical comparator works mainly on the principle of:

- A) Electrical resistance
- B) Pneumatic pressure
- C) Optical magnification
- D) Magnetic induction

Answer: C) Optical magnification

12. Which component is important in an optical comparator?

- A) Lens
- B) Gear train only
- C) Pressure gauge
- D) Bourdon tube

Answer: A) Lens

13. The main advantage of an optical comparator is:

- A) Low magnification
- B) High magnification without mechanical contact between moving parts of the magnifying system
- C) High friction
- D) Large measuring force

Answer: B) High magnification without mechanical contact between moving parts of the magnifying system

14. The Zeiss ultra optimeter is a:

- A) Mechanical comparator
- B) Optical comparator

- C) Pneumatic comparator
- D) Electrical comparator

Answer: B) Optical comparator

15. The Zeiss ultra optimeter is based primarily on:

- A) Optical amplification
- B) Pneumatic amplification
- C) Electrical resistance
- D) Hydraulic amplification

Answer: A) Optical amplification

16. An electrical comparator converts mechanical displacement into:

- A) Fluid pressure
- B) Electrical signal
- C) Optical image only
- D) Temperature

Answer: B) Electrical signal

17. Which device may be used as the sensing element in an electrical comparator?

- A) Strain gauge
- B) Bourdon tube
- C) Thermometer
- D) Float

Answer: A) Strain gauge

18. An electronic comparator generally provides:

- A) Very low sensitivity
- B) High sensitivity and easy signal amplification
- C) Only visual measurement
- D) Pneumatic output

Answer: B) High sensitivity and easy signal amplification

19. One major advantage of electronic comparators is:

- A) High inertia
- B) Easy amplification and electrical signal processing
- C) Large measuring force
- D) No requirement for a sensing element

Answer: B) Easy amplification and electrical signal processing

20. A pneumatic comparator uses variation in:

- A) Electrical resistance
- B) Air pressure or air flow
- C) Light intensity only
- D) Temperature

Answer: B) Air pressure or air flow

21. The basic principle of a pneumatic comparator is based on:

- A) Variation of air flow or pressure due to changes in clearance
- B) Gear rotation
- C) Electrical resistance
- D) Magnetic flux

Answer: A) Variation of air flow or pressure due to changes in clearance

22. The Solex pneumatic comparator is used for:

- A) Measuring temperature
- B) Comparing dimensions accurately
- C) Measuring electrical power
- D) Measuring weight

Answer: B) Comparing dimensions accurately

23. In a pneumatic comparator, the workpiece is generally compared by observing changes in:

- A) Air pressure
- B) Electrical voltage
- C) Gear ratio
- D) Light wavelength

Answer: A) Air pressure

24. In the Solex pneumatic comparator, compressed air is supplied through:

- A) A measuring nozzle
- B) A thermocouple
- C) A gear train
- D) A lens

Answer: A) A measuring nozzle

25. The clearance between the nozzle and the workpiece affects:

- A) Air flow
- B) Temperature only
- C) Electrical resistance only
- D) Gear speed

Answer: A) Air flow

26. A major advantage of pneumatic comparators is:

- A) High measuring force
- B) Non-contact measurement capability
- C) High mechanical friction
- D) Low sensitivity

Answer: B) Non-contact measurement capability

27. Which comparator is particularly suitable for measuring delicate components because of low measuring force?

- A) Pneumatic comparator
- B) Mechanical comparator with high spring force
- C) Heavy-duty dial gauge
- D) Hydraulic comparator

Answer: A) Pneumatic comparator

28. Which of the following is a disadvantage of mechanical comparators?

- A) Simple construction
- B) Mechanical wear and friction
- C) Easy operation
- D) No external power requirement

Answer: B) Mechanical wear and friction

29. Which comparator is generally less affected by mechanical friction in its amplification system?

- A) Optical comparator
- B) Mechanical comparator
- C) Dial gauge
- D) Gear comparator

Answer: A) Optical comparator

30. Which factor is important for selecting a comparator?

- A) Magnification
- B) Accuracy
- C) Sensitivity
- D) All of the above

Answer: D) All of the above

Analytical One-Mark Questions

31. A dial gauge shows a pointer movement of 5 mm when the spindle moves by 0.1 mm. What is the magnification?

- A) 5
- B) 10
- C) 50
- D) 100

Answer: C) 50

32. In a pneumatic comparator, the clearance between the nozzle and workpiece is increased. What will generally happen to the air flow?

- A) Air flow decreases
- B) Air flow increases
- C) Air flow becomes zero
- D) Air flow remains unchanged

Answer: B) Air flow increases

33. A comparator is required to measure very small dimensional variations with minimum mechanical friction. Which type would be most appropriate?

- A) Mechanical comparator
- B) Optical comparator
- C) Dial gauge
- D) Mechanical lever comparator

Answer: B) Optical comparator

34. If the standard component produces zero deviation on a comparator and the test component produces a positive deviation, the test component is:

- A) Smaller than the standard
- B) Equal to the standard
- C) Larger than the standard
- D) Defective necessarily

Answer: C) Larger than the standard

35. Two comparators have magnifications of 50 and 200. For the same input displacement, which comparator produces the larger output movement?

- A) Comparator with magnification 50
- B) Comparator with magnification 200
- C) Both produce the same movement
- D) Cannot be determined

Answer: B) Comparator with magnification 200

Part B (10 marks)

1. Explain the construction and working of an electrical comparator.
2. Explain the working of an electronic comparator with a block diagram.
3. Explain the construction and working principle of Zeiss Ultra Optimeter.
4. Analytical Questions

1. Assertion and Reason

Assertion (A): A comparator is mainly used to compare the dimensions of a component with a standard.

Reason (R): A comparator generally indicates the deviation from the standard size rather than measuring the absolute size directly.

Choose the correct answer:

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (a) Both A and R are true, and R correctly explains A.

2. Fill in the Blanks

A mechanical comparator uses a system of _____ to magnify a small movement.

Answer: levers and linkages

3. Match the Following

Column A

1. Dial gauge
2. Optical comparator
3. Electrical comparator
4. Pneumatic comparator
5. Zeiss Ultra-Optimeter

Column B

- A. Uses air pressure or air flow
- B. Uses optical magnification
- C. Uses electrical transducers/circuits
- D. Uses a pointer and graduated dial
- E. Uses an optical system with a precision measuring arrangement

Answer: 1-D, 2-B, 3-C, 4-A, 5-E

4. Rearrange the Sentence

Rearrange the words to form a correct sentence:

“standard / a / comparator / component / with / compares / a”

Answer: “A comparator compares a component with a standard.”

5. Choose the Correct Answer – Select TWO

Which **TWO** statements are correct about comparators?

- (a) They are mainly used for comparative measurement.
- (b) They always give the absolute dimension directly.
- (c) They can magnify very small dimensional deviations.
- (d) They are used only for measuring temperature.

Answers: (a) and (c)

UNIT II – MEASUREMENT OF VELOCITY AND ACCELERATION

Part A – 30 MCQs

1. Linear velocity is defined as:

- A) Change in displacement per unit time
- B) Change in acceleration per unit time
- C) Change in force per unit time
- D) Change in mass per unit time

Answer: A) Change in displacement per unit time

2. The SI unit of linear velocity is:

- A) m/s
- B) m/s²
- C) rad/s
- D) Hz

Answer: A) m/s

3. The Doppler effect method for velocity measurement is based on the change in:

- A) Amplitude
- B) Frequency
- C) Resistance
- D) Temperature

Answer: B) Frequency

4. In the Doppler effect method, the frequency shift is proportional to:

- A) Velocity of the moving object
- B) Mass of the object
- C) Temperature of the object
- D) Density of the object

Answer: A) Velocity of the moving object

5. A major advantage of the Doppler method is that it can provide:

- A) Non-contact velocity measurement
- B) Only temperature measurement
- C) Direct force measurement
- D) Static pressure measurement

Answer: A) Non-contact velocity measurement

6. A linear encoder is primarily used to measure:

- A) Linear displacement
- B) Temperature
- C) Pressure
- D) Torque

Answer: A) Linear displacement

7. A linear encoder can be used to determine velocity by measuring:

- A) Change in displacement with time
- B) Change in temperature with time
- C) Change in pressure with time
- D) Change in resistance with time

Answer: A) Change in displacement with time

8. Which device is commonly used for accurate digital measurement of linear displacement?

- A) Linear encoder
- B) Drag cup rotor
- C) Accelerometer
- D) Tachogenerator

Answer: A) Linear encoder

9. Angular velocity is generally expressed in:

- A) m/s
- B) m/s^2
- C) rad/s
- D) N/m

Answer: C) rad/s

10. A drag cup rotor is used in:

- A) AC tachogenerator
- B) Linear encoder
- C) Strain gauge accelerometer
- D) LVDT

Answer: A) AC tachogenerator

11. A tachogenerator is primarily used to measure:

- A) Angular velocity
- B) Linear acceleration
- C) Temperature
- D) Pressure

Answer: A) Angular velocity

12. The output voltage of a tachogenerator is generally proportional to:

- A) Angular velocity
- B) Angular acceleration
- C) Temperature
- D) Displacement only

Answer: A) Angular velocity

13. The main function of a drag cup in an AC tachogenerator is to:

- A) Produce an output related to rotational speed
- B) Measure temperature
- C) Measure linear displacement
- D) Store electrical energy

Answer: A) Produce an output related to rotational speed

14. An accelerometer is an instrument used to measure:

- A) Velocity
- B) Acceleration
- C) Displacement only
- D) Pressure

Answer: B) Acceleration

15. The SI unit of acceleration is:

- A) m/s
- B) m/s²
- C) rad/s
- D) N

Answer: B) m/s²

16. A seismic accelerometer works mainly on the principle of:

- A) Relative motion between a seismic mass and its casing
- B) Change in temperature
- C) Change in pressure
- D) Doppler frequency shift

Answer: A) Relative motion between a seismic mass and its casing

17. The seismic mass in an accelerometer is also known as:

- A) Proof mass
- B) Rotor
- C) Armature
- D) Diaphragm

Answer: A) Proof mass

18. In a seismic accelerometer, the proof mass is usually connected to the casing through:

- A) Spring and damping arrangement
- B) Gear train
- C) Lens
- D) Nozzle

Answer: A) Spring and damping arrangement

19. A piezoelectric accelerometer operates based on the:

- A) Piezoelectric effect
- B) Doppler effect
- C) Hall effect
- D) Photoelectric effect

Answer: A) Piezoelectric effect

20. The output of a piezoelectric accelerometer is generated when the piezoelectric material experiences:

- A) Force or stress
- B) Temperature only
- C) Magnetic field only
- D) Light intensity

Answer: A) Force or stress

21. A strain gauge accelerometer measures acceleration by detecting:

- A) Strain produced due to acceleration
- B) Frequency shift
- C) Air pressure
- D) Light intensity

Answer: A) Strain produced due to acceleration

22. The electrical resistance of a strain gauge changes when:

- A) It is strained
- B) Its colour changes
- C) Air pressure decreases
- D) Light falls on it

Answer: A) It is strained

23. LVDT stands for:

- A) Linear Variable Differential Transformer
- B) Linear Voltage Digital Transducer
- C) Linear Variable Digital Transformer
- D) Low Voltage Differential Transducer

Answer: A) Linear Variable Differential Transformer

24. An LVDT accelerometer converts acceleration into:

- A) Displacement and then electrical output
- B) Temperature
- C) Pressure
- D) Frequency only

Answer: A) Displacement and then electrical output

25. The moving element of an LVDT is called:

- A) Core
- B) Rotor
- C) Proof disc
- D) Diaphragm

Answer: A) Core

26. The major advantage of an LVDT accelerometer is:

- A) High sensitivity and good accuracy
- B) High friction
- C) Large mechanical wear
- D) Low repeatability

Answer: A) High sensitivity and good accuracy

27. Which accelerometer is particularly suitable for measuring high-frequency vibration?

- A) Piezoelectric accelerometer
- B) Mercury thermometer
- C) Pneumatic comparator
- D) Tachogenerator

Answer: A) Piezoelectric accelerometer

28. Which accelerometer uses a strain gauge as its sensing element?

- A) Strain gauge accelerometer
- B) Piezoelectric accelerometer
- C) Seismic accelerometer only
- D) Drag cup accelerometer

Answer: A) Strain gauge accelerometer

29. A disadvantage of a piezoelectric accelerometer is that it:

- A) Cannot measure static or very low-frequency acceleration effectively
- B) Has no sensitivity

- C) Requires mechanical gears
- D) Cannot measure vibration

Answer: A) Cannot measure static or very low-frequency acceleration effectively

30. Which of the following is an important characteristic of an accelerometer?

- A) Sensitivity
- B) Frequency response
- C) Natural frequency
- D) All of the above

Answer: D) All of the above

Part B – 5 Analytical One-Mark Questions

31. A vehicle travels 100 m in 5 seconds. What is its average linear velocity?

- A) 5 m/s
- B) 10 m/s
- C) 20 m/s
- D) 50 m/s

Answer: C) 20 m/s

32. An object rotates at 600 rpm. What is its angular velocity approximately?

- A) 31.4 rad/s
- B) 62.8 rad/s
- C) 100 rad/s
- D) 600 rad/s

Answer: B) 62.8 rad/s

33. If the output voltage of a tachogenerator increases as the rotational speed increases, the output voltage is approximately:

- A) Inversely proportional to speed
- B) Directly proportional to speed
- C) Independent of speed
- D) Proportional to acceleration only

Answer: B) Directly proportional to speed

34. An accelerometer has a sensitivity of 100 mV/(m/s²). What output voltage is produced for an acceleration of 5 m/s²?

- A) 0.05 V
- B) 0.5 V
- C) 5 V
- D) 50 V

Answer: B) 0.5 V

35. A piezoelectric accelerometer gives an output only when the applied force changes. Which measurement is it least suitable for?

- A) Vibration
- B) Dynamic acceleration
- C) Shock
- D) Constant static acceleration

Answer: D) Constant static acceleration

Part B (10 marks)

- 1.Explain the Doppler Effect method of linear velocity measurement.
- 2.Explain the construction and working of an angular encoder.
3. Explain the construction and working of a piezoelectric accelerometer and give its advantages.
- 4.Analytical Questions

Q1. Assertion and Reason

Assertion (A): Piezoelectric accelerometer is widely used to measure vibration.

Reason (R): Piezoelectric crystals generate electrical charge when mechanical force is applied.

- (a) Both A and R are true and R explains A
- (b) Both true but R not explanation
- (c) A true R false
- (d) A false R true

Answer: (a)

Q2. Fill in the Blank

A tachometer measures ____of a rotating shaft.

Answer: Rotational speed (RPM)

Q3. Match the Following

- | | |
|-------------------------------|------------------------|
| 1. Doppler Effect | a. Rotational speed |
| 2. Tachometer | b. Digital signal |
| 3. Linear Encoder | c. Change in frequency |
| 4. Strain Gauge Accelerometer | d. Static acceleration |

Answer: 1-c, 2-a, 3-b, 4-d

Q4. Rearrange the Sentence

- (i) Relative displacement occurs
- (ii) Acceleration is applied
- (iii) Mass moves inside the housing
- (iv) Output signal is produced

Answer: ii ,iii,i ,iv

Q5. Choose the Correct Answer (2 correct)

Which of the following are accelerometers?

- (a) Piezoelectric Accelerometer
- (b) Strain Gauge Accelerometer
- (c) Thermometer
- (d) Barometer

Answer: (a) and (b)

UNIT III – MEASUREMENT OF FORCE, TORQUE AND SHAFT POWER

Part A – 30 MCQs

1. Force is defined as:

- A) Rate of change of displacement
- B) Rate of change of momentum
- C) Rate of change of energy
- D) Rate of change of power

Answer: B) Rate of change of momentum

2. The SI unit of force is:

- A) Joule
- B) Watt
- C) Newton
- D) Pascal

Answer: C) Newton

3. A pendulum scale measures force based on:

- A) Electrical resistance
- B) Deflection of a pendulum
- C) Hydraulic pressure
- D) Air pressure

Answer: B) Deflection of a pendulum

4. The main purpose of a load cell is to measure:

- A) Temperature
- B) Force or load
- C) Velocity
- D) Pressure only

Answer: B) Force or load

5. A hydraulic load cell operates based on:

- A) Pascal's law
- B) Hooke's law
- C) Faraday's law
- D) Ohm's law

Answer: A) Pascal's law

6. In a hydraulic load cell, applied force produces a change in:

- A) Fluid pressure
- B) Temperature
- C) Electrical resistance
- D) Frequency

Answer: A) Fluid pressure

7. The major advantage of a hydraulic load cell is:

- A) High load measuring capacity
- B) Very high electrical resistance
- C) No fluid required
- D) Very low sensitivity

Answer: A) High load measuring capacity

8. A pneumatic load cell uses:

- A) Compressed air
- B) Hydraulic oil
- C) Electrical current
- D) Magnetic flux

Answer: A) Compressed air

9. In a pneumatic load cell, applied load is converted into a change in:

- A) Air pressure
- B) Temperature
- C) Resistance
- D) Capacitance

Answer: A) Air pressure

10. A strain gauge load cell works on the principle of change in:

- A) Resistance due to strain
- B) Pressure due to force
- C) Frequency due to velocity
- D) Temperature due to force

Answer: A) Resistance due to strain

11. The strain gauge is generally connected in a:

- A) Wheatstone bridge
- B) Maxwell bridge
- C) Wien bridge
- D) Schering bridge

Answer: A) Wheatstone bridge

12. A major advantage of strain gauge load cells is:

- A) High accuracy
- B) Large mechanical friction
- C) Low sensitivity
- D) No electrical output

Answer: A) High accuracy

13. Torque is the:

- A) Linear force acting on a body
- B) Turning moment of a force
- C) Rate of change of velocity
- D) Product of mass and acceleration

Answer: B) Turning moment of a force

14. The SI unit of torque is:

- A) N
- B) N/m
- C) N·m
- D) W

Answer: C) N·m

15. Torque is mathematically expressed as:

- A) $T = F/r$
- B) $T = F \times r$
- C) $T = F + r$
- D) $T = F - r$

Answer: B) $T = F \times r$

16. An optical torsion meter measures torque by measuring:

- A) Angle of twist
- B) Temperature
- C) Pressure
- D) Current

Answer: A) Angle of twist

17. An electrical torsion meter converts torsional deformation into:

- A) Electrical signal
- B) Hydraulic pressure
- C) Air pressure
- D) Temperature

Answer: A) Electrical signal

18. A strain gauge torsion meter generally uses strain gauges arranged:

- A) Along the shaft axis only
- B) At approximately 45° to the shaft axis
- C) Perpendicular only
- D) Randomly

Answer: B) At approximately 45° to the shaft axis

19. The purpose of a torsion meter is to measure:

- A) Torque
- B) Force only
- C) Temperature
- D) Pressure

Answer: A) Torque

20. Shaft power is the rate at which:

- A) Torque is produced
- B) Work is done by a rotating shaft
- C) Force is applied
- D) Displacement occurs

Answer: B) Work is done by a rotating shaft

21. Shaft power is related to torque and angular velocity by:

- A) $P = T/\omega$
- B) $P = T\omega$
- C) $P = T + \omega$
- D) $P = T - \omega$

Answer: B) $P = T\omega$

22. The Prony brake dynamometer measures:

- A) Shaft power
- B) Temperature
- C) Pressure
- D) Linear velocity

Answer: A) Shaft power

23. A Prony brake dynamometer works on the principle of:

- A) Frictional resistance
- B) Electromagnetic induction
- C) Hydraulic pressure
- D) Pneumatic pressure

Answer: A) Frictional resistance

24. The main function of a brake dynamometer is to determine:

- A) Brake power
- B) Temperature
- C) Torque only
- D) Acceleration

Answer: A) Brake power

25. A rope brake dynamometer uses a rope wrapped around:

- A) A rotating drum
- B) A piston
- C) A shaft bearing
- D) A flywheel only

Answer: A) A rotating drum

26. In a rope brake dynamometer, the difference between rope tensions produces:

- A) Braking torque
- B) Temperature
- C) Electrical voltage
- D) Pressure

Answer: A) Braking torque

27. The brake power of a rotating shaft depends on:

- A) Torque and speed
- B) Temperature only
- C) Pressure only
- D) Mass only

Answer: A) Torque and speed

28. Which device is suitable for measuring high forces?

- A) Hydraulic load cell
- B) Thermocouple
- C) Tachometer
- D) Glass electrode

Answer: A) Hydraulic load cell

29. Which instrument provides an electrical output corresponding to applied force?

- A) Strain gauge load cell
- B) Pendulum scale
- C) Rope brake
- D) Prony brake

Answer: A) Strain gauge load cell

30. Which of the following can be used for torque measurement?

- A) Optical torsion meter
- B) Electrical torsion meter
- C) Strain gauge torsion meter
- D) All of the above

Answer: D) All of the above

Part B – 5 Analytical One-Mark MCQs

31. A force of 100 N acts at a perpendicular distance of 0.5 m from a shaft. What is the torque?

- A) 20 N·m
- B) 50 N·m
- C) 100 N·m
- D) 200 N·m

Answer: B) 50 N·m

32. A shaft develops a torque of 100 N·m and rotates at 10 rad/s. What is the shaft power?

- A) 100 W
- B) 500 W
- C) 1000 W
- D) 10,000 W

Answer: C) 1000 W

33. A strain gauge load cell is subjected to an increasing load. Its resistance changes proportionally with strain. What happens to the bridge output?

- A) It changes according to the applied load
- B) It always remains zero
- C) It becomes independent of load
- D) It becomes mechanical only

Answer: A) It changes according to the applied load

34. A rope brake dynamometer has a rope tension difference of 200 N and drum radius of 0.25 m. What is the braking torque?

- A) 25 N·m
- B) 50 N·m
- C) 100 N·m
- D) 800 N·m

Answer: B) 50 N·m

35. If the speed of a shaft is doubled while its torque remains constant, its power will:

- A) Become half
- B) Remain unchanged
- C) Double
- D) Become four times

Answer: C) Double

PART-B (10 marks)

1. Explain the construction and operation of a pendulum scale with a neat diagram.
2. With a neat diagram, explain the construction and working of a strain gauge load cell.
3. Explain the Electrical Torsion meter with a neat diagram.

4. Analytical Questions

Q1. Assertion and Reason

Assertion (A): A strain gauge load cell measures force by detecting the change in electrical resistance caused by deformation of the strain gauge.

Reason (R): Strain gauges are bonded to an elastic member which deforms proportionally to the applied load.

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is NOT the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Answer: (a) Both A and R are true, and R is the correct explanation of A.

Q2. Fill in the Blanks

The Prony brake dynamometer is used to measure _____(1), and it works based on the principle of _____(2) applied to a rotating shaft.

Answer: (1) shaft power (2) friction / braking

Q3. Match the Following

Match the term with its correct description:

Column A

Column B

1. Pendulum scale
- a. Uses fluid pressure to measure force
2. Hydraulic load cell
3. Optical torsion meter
4. Rope brake dynamometer

Answer: 1 -b, 2- a, 3- c, 4- d

Rearrange the following steps into the correct sequence of torque measurement:

- (i) The torque causes an angular twist in the shaft
- (ii) The twist is measured using a torsion meter
- (iii) Torque is applied to the rotating shaft
- (iv) The measured twist is converted into a torque value

Answer: iii,i, ii, iv

Q5. Choose the Correct Answer

Which of the following are used for measuring shaft power?

- (a) Prony brake dynamometer
- (b) Strain gauge load cell
- (c) Rope brake dynamometer
- (d) Optical torsion meter

Answer: (a) Prony brake dynamometer and (c) Rope brake dynamometer

UNIT IV – MEASUREMENT OF pH AND GAS ANALYSIS

Part A – 30 MCQs

1. pH is a measure of:

- A) Temperature
- B) Hydrogen ion concentration
- C) Oxygen concentration
- D) Pressure

Answer: B) Hydrogen ion concentration

2. The pH of a neutral solution at 25°C is approximately:

- A) 0
- B) 5
- C) 7
- D) 14

Answer: C) 7

3. A solution having pH less than 7 is:

- A) Neutral
- B) Acidic
- C) Alkaline
- D) Saturated

Answer: B) Acidic

4. A solution having pH greater than 7 is:

- A) Acidic
- B) Neutral
- C) Alkaline
- D) Pure

Answer: C) Alkaline

5. The basic equation for pH is:

- A) $\text{pH} = \log[\text{H}^+]$
- B) $\text{pH} = -\log[\text{H}^+]$
- C) $\text{pH} = [\text{H}^+]^2$
- D) $\text{pH} = 1/[\text{H}^+]$

Answer: B) $\text{pH} = -\log[\text{H}^+]$

6. The two main types of electrodes used in pH measurement are:

- A) Anode and cathode
- B) Reference and indicator electrodes
- C) Positive and negative electrodes
- D) Primary and secondary electrodes

Answer: B) Reference and indicator electrodes

7. A reference electrode provides:

- A) Variable potential
- B) Stable and known potential
- C) Zero resistance
- D) Variable temperature

Answer: B) Stable and known potential

8. The hydrogen electrode is also known as:

- A) Standard hydrogen electrode
- B) Glass electrode
- C) Calomel electrode
- D) Platinum electrode only

Answer: A) Standard hydrogen electrode

9. The standard hydrogen electrode uses:

- A) Platinum electrode
- B) Copper electrode
- C) Silver electrode
- D) Glass electrode

Answer: A) Platinum electrode

10. The gas used in the standard hydrogen electrode is:

- A) Oxygen
- B) Nitrogen
- C) Hydrogen
- D) Carbon dioxide

Answer: C) Hydrogen

11. The standard hydrogen electrode is commonly used as:

- A) Reference for electrode potential measurements
- B) Temperature sensor
- C) Pressure sensor
- D) Gas analyser

Answer: A) Reference for electrode potential measurements

12. The calomel electrode contains:

- A) Mercury and mercurous chloride
- B) Copper and zinc
- C) Platinum and hydrogen
- D) Glass and silver

Answer: A) Mercury and mercurous chloride

13. Calomel electrode is generally used as a:

- A) Reference electrode
- B) Indicator electrode only
- C) Temperature electrode
- D) Gas electrode

Answer: A) Reference electrode

14. The electrolyte commonly used in a calomel electrode is:

- A) HCl
- B) KCl
- C) NaOH
- D) H₂SO₄

Answer: B) KCl

15. A glass electrode is primarily used for:

- A) pH measurement
- B) Pressure measurement
- C) Torque measurement
- D) Velocity measurement

Answer: A) pH measurement

16. The sensing element of a glass electrode is:

- A) Glass membrane
- B) Copper wire
- C) Platinum wire only
- D) Rubber diaphragm

Answer: A) Glass membrane

17. The potential developed across the glass membrane depends on:

- A) Hydrogen ion activity
- B) Temperature only
- C) Pressure only
- D) Oxygen concentration only

Answer: A) Hydrogen ion activity

18. A major advantage of the glass electrode is:

- A) It can be used for many types of aqueous solutions
- B) It requires no calibration
- C) It has zero electrical resistance
- D) It measures pressure

Answer: A) It can be used for many types of aqueous solutions

19. A gas analyzer is used to determine:

- A) Composition or concentration of gases
- B) Torque
- C) Velocity
- D) Force

Answer: A) Composition or concentration of gases

20. An oxygen analyzer is used to determine:

- A) Oxygen concentration
- B) Hydrogen concentration only
- C) Water vapour only
- D) Pressure only

Answer: A) Oxygen concentration

21. A paramagnetic oxygen analyzer operates based on the:

- A) Paramagnetic property of oxygen
- B) Electrical resistance of oxygen
- C) Colour of oxygen
- D) Pressure of nitrogen

Answer: A) Paramagnetic property of oxygen

22. Oxygen is:

- A) Diamagnetic
- B) Paramagnetic
- C) Non-magnetic
- D) Ferromagnetic

Answer: B) Paramagnetic

23. A paramagnetic oxygen analyzer is particularly useful because oxygen:

- A) Is strongly attracted by a magnetic field
- B) Has no magnetic properties
- C) Changes colour in a magnetic field
- D) Produces electrical current directly

Answer: A) Is strongly attracted by a magnetic field

24. A CO analyzer is used to measure:

- A) Carbon monoxide
- B) Carbon dioxide only
- C) Oxygen
- D) Sulphur dioxide

Answer: A) Carbon monoxide

25. A common principle used in CO analysis is:

- A) Infrared absorption
- B) Paramagnetism
- C) Piezoelectric effect
- D) Doppler effect

Answer: A) Infrared absorption

26. SO₂ analyzer is used to determine:

- A) Sulphur dioxide concentration
- B) Oxygen concentration
- C) Hydrogen concentration
- D) Carbon monoxide concentration

Answer: A) Sulphur dioxide concentration

27. Infrared gas analyzers work based on:

- A) Absorption of infrared radiation by gases
- B) Magnetic attraction
- C) Mechanical deformation
- D) Fluid pressure

Answer: A) Absorption of infrared radiation by gases

28. Which gas is strongly paramagnetic?

- A) Nitrogen
- B) Oxygen
- C) Carbon dioxide
- D) Sulphur dioxide

Answer: B) Oxygen

29. Calibration of a pH meter is normally carried out using:

- A) Standard buffer solutions
- B) Pure water only
- C) Compressed air
- D) Standard gases

Answer: A) Standard buffer solutions

30. Which of the following is a reference electrode?

- A) Glass electrode
- B) Calomel electrode
- C) Hydrogen electrode only
- D) Copper electrode

Answer: B) Calomel electrode

Part B – 5 Analytical One-Mark MCQs

31. If the hydrogen ion concentration of a solution is 10^{-3} mol/L, its pH is:

- A) 2
- B) 3
- C) 7
- D) 11

Answer: B) 3

32. A solution changes from pH 5 to pH 3. The hydrogen ion concentration has:

- A) Decreased 100 times
- B) Increased 100 times
- C) Increased 2 times
- D) Remained unchanged

Answer: B) Increased 100 times

33. If a pH meter gives an unstable reading, which component should be checked first?

- A) pH electrode
- B) Tachogenerator
- C) Load cell
- D) Dynamometer

Answer: A) pH electrode

34. An oxygen analyzer is exposed to a gas containing a higher percentage of oxygen. In a paramagnetic analyzer, the magnetic response will generally:

- A) Increase
- B) Decrease
- C) Become zero
- D) Remain exactly unchanged

Answer: A) Increase

35. A gas sample contains 2% CO. If the analyzer is calibrated correctly, its output should indicate approximately:

- A) 0.02% CO
- B) 0.2% CO
- C) 2% CO
- D) 20% CO

Answer: C) 2% CO

PART-B (10marks)

1. With a neat diagram explain the operation of Hydrogen electrode.
2. Draw and explain the operation of calomel electrode.
3. With a neat diagram explain the working of Oxygen Analyser.
4. Explain the SO₂ Analyser in detail.

1. Assertion and Reason

Assertion (A): A pH meter requires a very high input impedance amplifier.

Reason (R): The glass electrode has very high internal (electrical) resistance.

- a) Both A and R are true, and R is the correct explanation of A
- b) Both A and R are true, but R is NOT the correct explanation of A
- c) A is true, but R is false
- d) A is false, but R is true

Answer: a) Both A and R are true, and R is the correct explanation of A

2. Match the Following

Column A	Column B
1. CO analyzer	a. Infrared absorption
2. SO ₂ analyzer	b. UV fluorescence
3. Oxygen analyzer	c. Paramagnetism
4. SCE	d. Saturated Calomel Electrode

Answers: 1-a, 2-b, 3-c, 4-d

3. Fill in the Blank

The ___ analyzer works on the principle of paramagnetism.

Answer: Oxygen (paramagnetic oxygen) analyzer

4. Rearrange the Sentence

Arrange the working steps of the NDIR CO analyzer:

- A. CO absorbs infrared radiation at its specific wavelength
- B. Infrared light passes through sample and reference cells
- C. Diaphragm deflects and generates electrical signal
- D. Pressure difference occurs between detector chambers

Answer: B , A ,D ,C

5. Choose the Correct Answers

Which of the following properties describe oxygen used in a paramagnetic oxygen analyzer?

- a) Oxygen is diamagnetic
- b) Oxygen is paramagnetic
- c) Oxygen is attracted into magnetic field
- d) Oxygen absorbs infrared radiation strongly

Answers: b) Oxygen is paramagnetic, c) Oxygen is attracted into magnetic field

UNIT V – CHROMATOGRAPHY AND SPECTRAL METHOD OF ANALYSIS

Part A – 30 MCQ Questions

1. Chromatography is primarily used for:

- A) Measuring temperature
- B) Separation and analysis of components of a mixture
- C) Measuring pressure
- D) Measuring force

Answer: B) Separation and analysis of components of a mixture

2. The basic principle of chromatography is based on the differential distribution of components between:

- A) Two electrodes
- B) Stationary and mobile phases
- C) Two electrical circuits
- D) Two pressure chambers

Answer: B) Stationary and mobile phases

3. The phase that remains fixed in chromatography is called:

- A) Mobile phase
- B) Stationary phase
- C) Carrier phase
- D) Sample phase

Answer: B) Stationary phase

4. The phase that moves through the stationary phase is called:

- A) Stationary phase
- B) Mobile phase
- C) Detector phase
- D) Sample phase

Answer: B) Mobile phase

5. Gas chromatography uses a:

- A) Liquid mobile phase
- B) Gas mobile phase
- C) Solid mobile phase
- D) Water mobile phase

Answer: B) Gas mobile phase

6. The carrier gas in gas chromatography acts as the:

- A) Stationary phase
- B) Mobile phase
- C) Detector
- D) Sample

Answer: B) Mobile phase

7. Which of the following is commonly used as a carrier gas in gas chromatography?

- A) Helium
- B) Oxygen only
- C) Carbon dioxide only
- D) Chlorine

Answer: A) Helium

8. Liquid chromatography uses a:

- A) Gas as mobile phase
- B) Liquid as mobile phase
- C) Solid as mobile phase
- D) Plasma as mobile phase

Answer: B) Liquid as mobile phase

9. The time taken by a component to travel through the chromatographic system and reach the detector is called:

- A) Dead time
- B) Retention time
- C) Response time
- D) Reaction time

Answer: B) Retention time

10. Retention time is usually measured from:

- A) Injection to detector response maximum
- B) Detector to injector
- C) Start of heating to cooling
- D) Sample preparation to injection

Answer: A) Injection to detector response maximum

11. Dead time is the time taken by:

- A) The retained component to reach the detector
- B) An unretained species to reach the detector
- C) The detector to warm up
- D) The column to cool down

Answer: B) An unretained species to reach the detector

12. A chromatogram is a plot of:

- A) Temperature versus pressure
- B) Detector response versus time
- C) Force versus displacement
- D) Voltage versus current

Answer: B) Detector response versus time

13. In a chromatogram, each separated component generally appears as a:

- A) Straight line
- B) Peak
- C) Circle
- D) Rectangle

Answer: B) Peak

14. Retention time is useful for:

- A) Identifying components
- B) Measuring temperature
- C) Measuring pressure
- D) Measuring force

Answer: A) Identifying components

15. The area under a chromatographic peak is generally related to:

- A) Quantity or concentration of the component
- B) Temperature only
- C) Column length only
- D) Carrier gas pressure only

Answer: A) Quantity or concentration of the component

16. TCD stands for:

- A) Thermal Conductivity Detector
- B) Temperature Control Device
- C) Thermal Chemical Detector
- D) Total Conductivity Detector

Answer: A) Thermal Conductivity Detector

17. A TCD detects components based on changes in:

- A) Thermal conductivity
- B) Magnetic field
- C) Electrical resistance only
- D) Pressure only

Answer: A) Thermal conductivity

18. FPD stands for:

- A) Flame Photometric Detector
- B) Flame Pressure Detector
- C) Flow Photometric Device
- D) Flame Power Detector

Answer: A) Flame Photometric Detector

19. FPD is particularly sensitive to compounds containing:

- A) Sulphur and phosphorus
- B) Oxygen and nitrogen only
- C) Hydrogen only
- D) Carbon only

Answer: A) Sulphur and phosphorus

20. ECD stands for:

- A) Electron Capture Detector
- B) Electrical Conductivity Detector
- C) Energy Capture Device
- D) Electron Control Device

Answer: A) Electron Capture Detector

21. ECD is particularly sensitive to compounds containing:

- A) Electronegative atoms or groups such as halogens
- B) Only hydrogen
- C) Only oxygen
- D) Noble gases

Answer: A) Electronegative atoms or groups such as halogens

22. Beer's law relates absorbance to:

- A) Concentration
- B) Pressure only
- C) Temperature only
- D) Velocity

Answer: A) Concentration

23. According to Beer's law, absorbance is proportional to:

- A) Concentration of the absorbing species
- B) Volume only
- C) Temperature only
- D) Pressure only

Answer: A) Concentration of the absorbing species

24. The Beer-Lambert law is expressed as:

- A) $A = \epsilon bc$
- B) $A = \epsilon/bc$
- C) $A = bc/\epsilon$
- D) $A = b + c$

Answer: A) $A = \epsilon bc$

25. In the equation $A = \epsilon bc$, ϵ represents:

- A) Absorptivity
- B) Emission
- C) Energy
- D) Electrical resistance

Answer: A) Absorptivity

26. UV spectroscopy uses radiation primarily in the:

- A) Ultraviolet region
- B) Microwave region

- C) Radio-frequency region
- D) Infrared region only

Answer: A) Ultraviolet region

27. IR spectroscopy is based on the absorption of:

- A) Infrared radiation
- B) X-rays
- C) Gamma rays
- D) Radio waves

Answer: A) Infrared radiation

28. A commonly used source in UV spectrophotometry is:

- A) Deuterium lamp
- B) Tungsten lamp only
- C) Sodium lamp
- D) Neon lamp

Answer: A) Deuterium lamp

29. A commonly used source for the visible/near-IR region is:

- A) Tungsten-halogen lamp
- B) Deuterium lamp only
- C) Mercury electrode
- D) Hydrogen electrode

Answer: A) Tungsten-halogen lamp

30. Spectrophotometry is mainly used to determine:

- A) Concentration of substances based on light absorption
- B) Torque of a shaft
- C) Linear velocity
- D) Mechanical force

Answer: A) Concentration of substances based on light absorption

Part B – 5 Analytical One-Mark MCQs

31. Two compounds in a chromatogram have retention times of 4 min and 7 min. Which compound is retained longer by the column?

- A) Compound at 4 min
- B) Compound at 7 min
- C) Both equally
- D) Cannot be determined

Answer: B) Compound at 7 min

32. If the concentration of a solution is doubled while path length and absorptivity remain constant, according to Beer's law the absorbance will:

- A) Become half
- B) Remain unchanged
- C) Double
- D) Become four times

Answer: C) Double

33. A chromatogram shows two well-separated peaks. This indicates:

- A) Poor separation
- B) Good separation of two components
- C) No components present
- D) Detector failure

Answer: B) Good separation of two components

34. A sample gives an absorbance of 0.8. If its concentration is doubled within the linear Beer-Lambert range, the expected absorbance is:

- A) 0.2
- B) 0.4
- C) 1.6
- D) 2.4

Answer: C) 1.6

35. A chromatographic component has a retention time of 5 min and the dead time is 2 min. The adjusted retention time is:

- A) 2 min
- B) 3 min
- C) 5 min
- D) 7 min

Answer: B) 3 min

Part-B (10 marks)

1. With a neat sketch explain the operation of Liquid Chromatography?
2. Explain the operation of Gas chromatography with a neat sketch?
3. With neat diagram, explain the construction and operation of FID?
4. Explain the working and applications of IR/UV Photometer with neat diagram?
5. Q1. Assertion and Reason

Assertion (A): Retention time is defined as the time taken by a component to travel from the point of injection to the detector.

Reason (R): Retention time depends on the affinity of the component towards the stationary phase.

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is NOT the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Answer: (a) Both A and R are true, and R is the correct explanation of A.

Q2. Fill in the Blanks

The Electron Capture Detector (ECD) is highly sensitive to compounds containing _____ atoms, such as halogens.

Answer: electronegative

Q3. Match the Following

Match the term with its correct description:

Column A

1. Beer's Law

Column B

a. Relates absorbance to concentration and path length

2. UV radiation source

3. IR radiation source

4. Spectrophotometry

Answer: 1 fi a, 2 fi b, 3 fi c, 4 fi d

Q4. Rearrange the Sentence

b. Deuterium / Hydrogen lamp

c. Nernst glower / Globar

d. Technique to measure absorbance of radiation by a sample

Rearrange the following steps into the correct sequence of the chromatographic process:

(i) The mobile phase carries the mixture through the stationary phase

(ii) Different components move at different rates

(iii) The sample mixture is injected into the chromatographic system

(iv) Components get separated and are detected at different times

Answer: iii fi i fi ii fi iv

Q5. Choose the Correct Answer (2 correct)

Which of the following are actual detectors used in chromatography? (Choose TWO)

(a) TCD

(b) FPD

(c) LCD

(d) VCD

Answer: (a) TCD and (b) FP