

QUESTION BANK

PLCs & SCADA

Diploma in Electronics & Communication Engineering

Based on the supplied Haryana State Board of Technical Education syllabus

Syllabus Coverage

- Unit I – PLC Overview: relays and their limitations, advantages of PLCs, operation, architecture, building blocks and functions, programming languages, applications, manufacturers and selection criteria.
- Unit II – Numeric Systems and Logic Concepts: number systems and conversions, binary arithmetic and codes, Boolean algebra, logic gates, ladder logic, basic components and symbols, ladder logic functions, Boolean logic and relay logic.
- Unit III – File Structure and Addressing Formats: input/output data files, status file, bit data file, timer data file, counter data file, control data file, integer data file and floating-point data file.
- Unit IV – Ladder Programming Instructions: bit, timer, counter, reset, data-handling, comparison and sequencer instructions.
- Unit V – SCADA: project and tag creation, visibility and text animation, numeric display/input, string display/input, labels, arrows, vertical/horizontal sliders, animation of colour/fill/position/height/width/touch, alarming and data logging.

Section A – Multiple-Choice Questions (50)

Choose the most appropriate option. The correct answer is given after each question.

1. A PLC is primarily used for:

- A. Industrial automation
- B. Word processing
- C. Image editing
- D. Audio recording

Answer: A. Industrial automation

2. PLC stands for:

- A. Power Line Circuit
- B. Programmable Logic Controller
- C. Programmed Load Computer
- D. Process Level Converter

Answer: B. Programmable Logic Controller

3. Which device commonly uses a PLC?

- A. Automatic conveyor
- B. Paper notebook
- C. Mechanical pencil
- D. Passive book shelf

Answer: A. Automatic conveyor

4. A major limitation of conventional relay control is:

- A. Easy software modification
- B. Mechanical wear of contacts
- C. No moving parts
- D. Unlimited logic flexibility

Answer: B. Mechanical wear of contacts

5. Which PLC unit executes the user program?

- A. CPU
- B. Fuse
- C. Push button
- D. Terminal block

Answer: A. CPU

6. The input module receives signals from:

- A. Sensors and switches
- B. Only printers
- C. Only displays
- D. Only output lamps

Answer: A. Sensors and switches

7. The output module may drive:

- A. Solenoid valves
- B. Input-only sensors
- C. Program comments
- D. Memory addresses only

Answer: A. Solenoid valves

8. The PLC scan cycle generally includes reading inputs, program execution and:

- A. Updating outputs
- B. Printing documents
- C. Charging a phone
- D. Compiling a website

Answer: A. Updating outputs

9. Which is a common PLC programming language?

- A. Ladder Diagram
- B. HTML only
- C. CSS only
- D. SQL only

Answer: A. Ladder Diagram

10. Ladder logic was designed to resemble:

- A. Relay control circuits
- B. Geographic maps
- C. Spreadsheet charts
- D. Audio waveforms

Answer: A. Relay control circuits

11. A PLC memory stores:

- A. Program and data
- B. Only mechanical parts
- C. Only external wiring
- D. Only sensor bodies

Answer: A. Program and data

12. Which is a typical PLC selection criterion?

- A. Number and type of I/O points
- B. Colour of the cabinet only
- C. Operator's handwriting
- D. Screen wallpaper

Answer: A. Number and type of I/O points

13. Which is an example of a discrete input?

- A. Limit switch ON/OFF
- B. Temperature as a continuous value
- C. Pressure as a continuous value
- D. Analog flow signal

Answer: A. Limit switch ON/OFF

14. Which of the following is a PLC application?

- A. Motor sequencing
- B. Handwritten letter writing
- C. Book binding by hand only
- D. Manual painting only

Answer: A. Motor sequencing

15. A modular PLC generally allows:

- A. Modules to be added or replaced
- B. No expansion
- C. Only one fixed input
- D. Operation without a power supply

Answer: A. Modules to be added or replaced

16. The binary number system has base:

- A. 2
- B. 8
- C. 10
- D. 16

Answer: A. 2

17. The decimal equivalent of binary 1010 is:

- A. 8
- B. 9
- C. 10

D. 12

Answer: C. 10

18. The binary equivalent of decimal 5 is:

A. 101

B. 110

C. 111

D. 100

Answer: A. 101

19. The hexadecimal digit A represents decimal:

A. 8

B. 9

C. 10

D. 11

Answer: C. 10

20. The octal number system has base:

A. 2

B. 8

C. 10

D. 16

Answer: B. 8

21. In binary arithmetic, $1 + 1$ equals:

A. 0 with carry 1

B. 1 with no carry

C. 2 in one binary digit

D. 10 with no carry

Answer: A. 0 with carry 1

22. Which code is commonly used to represent decimal digits in binary-coded form?

A. BCD

B. ASCII only

C. Gray only

D. Excess-3 only

Answer: A. BCD

23. A logic gate performs:

A. A Boolean operation

B. Mechanical amplification only

C. Fluid filtration

D. Temperature measurement only

Answer: A. A Boolean operation

24. The output of an AND gate is 1 when:

A. All inputs are 1

B. Any input is 1

C. All inputs are 0

D. Inputs are unequal

Answer: A. All inputs are 1

25. The output of an OR gate is 0 when:

A. All inputs are 0

B. Any input is 1

C. All inputs are 1

D. Inputs are unequal

Answer: A. All inputs are 0

26. A NOT gate produces:

A. The complement of its input

B. The same input always

C. The sum of inputs

D. A stored count

Answer: A. The complement of its input

27. Which gate gives output 1 when its inputs differ?

A. XOR

- B. AND
- C. NOR
- D. XNOR

Answer: A. XOR

28. Boolean expression for a two-input AND gate is:

- A. $Y = A \cdot B$
- B. $Y = A + B$
- C. $Y = \bar{A}$
- D. $Y = A \oplus B$

Answer: A. $Y = A \cdot B$

29. A normally open ladder contact is logically true when its addressed bit is:

- A. 1/on
- B. 0/off only
- C. Undefined
- D. Always false

Answer: A. 1/on

30. An output coil in ladder logic is used to:

- A. Control an output bit
- B. Convert decimal to octal
- C. Store a paper document
- D. Measure resistance directly

Answer: A. Control an output bit

31. Which file commonly represents physical input status in PLC addressing?

- A. Input data file
- B. Timer data file only
- C. Floating-point file only
- D. Comment file

Answer: A. Input data file

32. An output data file represents:

- A. Output states or commands
- B. Only elapsed time
- C. Only analog temperature units
- D. Only program titles

Answer: A. Output states or commands

33. A status file commonly stores:

- A. Controller operating/status information
- B. Only motor shaft speed
- C. Only external wiring
- D. Only alarm sound

Answer: A. Controller operating/status information

34. A bit data file stores:

- A. Individual binary bits
- B. Only long paragraphs
- C. Only physical sensors
- D. Only floating-point values

Answer: A. Individual binary bits

35. A timer instruction is used to:

- A. Measure or create time delays
- B. Compare text fonts
- C. Convert AC to DC physically
- D. Record video

Answer: A. Measure or create time delays

36. A counter instruction is commonly used to:

- A. Count events or transitions
- B. Measure wire diameter
- C. Generate a printed report only
- D. Set screen brightness

Answer: A. Count events or transitions

37. A reset instruction typically:

- A. Clears or resets selected data/state
- B. Increases every value
- C. Deletes all wiring
- D. Converts analog to digital without hardware

Answer: A. Clears or resets selected data/state

38. A comparison instruction checks whether:

- A. Values satisfy a relationship
- B. A cable is coloured
- C. A sensor is physically clean
- D. A program has a title

Answer: A. Values satisfy a relationship

39. A sequencer instruction is useful for:

- A. Step-by-step control sequences
- B. Freehand drawing only
- C. Changing a document font
- D. Manual soldering

Answer: A. Step-by-step control sequences

40. A data-handling instruction may:

- A. Move or copy data
- B. Replace a sensor physically
- C. Change a motor's bearing
- D. Measure room humidity without a sensor

Answer: A. Move or copy data

41. SCADA stands for:

- A. Supervisory Control and Data Acquisition
- B. System Control and Digital Automation
- C. Sequential Computer Access and Display
- D. Sensor Coding and Data Arrangement

Answer: A. Supervisory Control and Data Acquisition

42. A SCADA system is mainly used for:

- A. Supervisory monitoring and control
- B. Word processing
- C. Offline photo editing
- D. Manual filing

Answer: A. Supervisory monitoring and control

43. A SCADA tag is generally:

- A. A named data point/variable
- B. A physical label only with no data link
- C. A type of fuse
- D. A network cable connector

Answer: A. A named data point/variable

44. An HMI provides:

- A. Human-machine interaction
- B. Hydraulic motor insulation
- C. High-voltage mains input only
- D. Hardware memory integration only

Answer: A. Human-machine interaction

45. A numeric display in SCADA shows:

- A. A numerical process value
- B. Only a photograph
- C. Only an audio signal
- D. Only a paragraph

Answer: A. A numerical process value

46. A slider object is often used to:

- A. Adjust or represent a value graphically
- B. Count PLC scan cycles mechanically
- C. Replace a PLC CPU

D. Create a binary code automatically in all cases

Answer: A. Adjust or represent a value graphically

47. An alarm in SCADA alerts an operator to:

A. An abnormal or configured condition

B. A normal font change only

C. A file name

D. A screen saver

Answer: A. An abnormal or configured condition

48. Data logging is used to:

A. Record process values over time

B. Erase all measurements

C. Disable all alarms

D. Convert every tag into a switch

Answer: A. Record process values over time

49. Colour animation can be used to indicate:

A. Machine or process state

B. The PLC manufacturer only

C. The operator's age

D. A file extension only

Answer: A. Machine or process state

50. Before selecting a SCADA/PLC solution, an engineer should consider:

A. Process needs, I/O, communications and expansion

B. Only the colour of the enclosure

C. Only the logo

D. Only the keyboard layout

Answer: A. Process needs, I/O, communications and expansion

Section B – Very Short Answer Questions (50)

This section includes definitions, true/false statements and full forms. Answers are provided for revision.

- 1. Define PLC.** Answer: A Programmable Logic Controller is an industrial digital controller that monitors inputs, executes a stored program and controls outputs.
- 2. Define SCADA.** Answer: Supervisory Control and Data Acquisition is a system used to monitor and supervise processes, acquire data and support remote control.
- 3. Define a relay.** Answer: An electrically operated switch that opens or closes contacts in response to an energising signal.
- 4. State one limitation of electromechanical relay logic.** Answer: Contacts wear mechanically and switching may be slower than solid-state control.
- 5. What is a PLC scan cycle?** Answer: The repeating process of reading inputs, executing the program and updating outputs, along with controller housekeeping.
- 6. Define CPU in a PLC.** Answer: The central processing unit that executes the control program and manages controller operations.
- 7. What is an input module?** Answer: A module that receives field signals and converts/conditions them for the PLC controller.
- 8. What is an output module?** Answer: A module that interfaces PLC control signals to field devices such as lamps, contactors or solenoids.
- 9. Name any two PLC programming languages.** Answer: Ladder Diagram (LD) and Function Block Diagram (FBD).
- 10. What is a discrete signal?** Answer: A signal with distinct states, commonly ON/OFF or 1/0.
- 11. Define number system.** Answer: A method of representing numbers using a set of digits and a base/radix.
- 12. What is the radix of the binary system?** Answer: 2.
- 13. Convert binary 1100 to decimal.** Answer: 12.
- 14. Convert decimal 7 to binary.** Answer: 111.
- 15. What is BCD?** Answer: Binary-Coded Decimal; each decimal digit is represented by a four-bit binary code.
- 16. Define Boolean algebra.** Answer: A mathematical system for expressing and simplifying logic relationships using binary variables.
- 17. What is a logic gate?** Answer: A digital circuit that performs a Boolean operation on one or more inputs.
- 18. What is the function of an AND gate?** Answer: Its output is 1 only when all inputs are 1.
- 19. What is the function of a NOT gate?** Answer: It produces the complement of the input.
- 20. What is ladder logic?** Answer: A graphical PLC programming language that represents control logic using rails, contacts, coils and function instructions.
- 21. What is a normally open ladder contact?** Answer: A contact instruction that is true when its addressed bit is ON/1.
- 22. What is an output coil?** Answer: A ladder instruction that writes or controls the state of an output bit.
- 23. Define addressing format.** Answer: The convention used to identify a PLC data location, file, element or bit.

- 24. What is an input data file?** Answer: A data area containing input status information from input points or modules.
- 25. What is an output data file?** Answer: A data area containing output states or commands for output points or modules.
- 26. What is a status file?** Answer: A data area containing controller status, diagnostic and operating information.
- 27. What is a bit data file?** Answer: A file or data area used to store individual binary bits.
- 28. What is a timer instruction used for?** Answer: To create or measure time-dependent conditions in a control program.
- 29. What is a counter instruction used for?** Answer: To count events, pulses or transitions.
- 30. What is a reset instruction?** Answer: An instruction that clears or resets the accumulated value or state of a specified element, as defined by the controller.
- 31. Define comparison instruction.** Answer: An instruction that compares data values and makes a condition true when the specified relationship is met.
- 32. What is a sequencer instruction?** Answer: An instruction used to control or track a series of steps in a defined sequence.
- 33. Define data-handling instruction.** Answer: An instruction used to move, copy, mask, convert or otherwise manipulate data.
- 34. What is a floating-point value?** Answer: A numerical representation that can include a fractional part and a wide range of magnitudes.
- 35. What is a control data file?** Answer: A data structure that stores control information used by particular instructions, such as sequencing or file operations.
- 36. Expand PLC.** Answer: Programmable Logic Controller.
- 37. Expand SCADA.** Answer: Supervisory Control and Data Acquisition.
- 38. Expand CPU.** Answer: Central Processing Unit.
- 39. Expand I/O.** Answer: Input/Output.
- 40. Expand HMI.** Answer: Human-Machine Interface.
- 41. Expand LD in PLC programming.** Answer: Ladder Diagram.
- 42. Expand FBD.** Answer: Function Block Diagram.
- 43. Expand IL (traditional PLC language abbreviation).** Answer: Instruction List.
- 44. Expand ST in PLC programming.** Answer: Structured Text.
- 45. Expand BCD.** Answer: Binary-Coded Decimal.
- 46. Expand ASCII.** Answer: American Standard Code for Information Interchange.
- 47. True or False: A PLC can be reprogrammed without rewiring every logic connection.** Answer: True.
- 48. True or False: The binary number system uses ten digits, 0 through 9.** Answer: False — it uses only 0 and 1.

49. True or False: An OR gate output is 1 if at least one input is 1. Answer: True.

50. True or False: A timer instruction is intended only to count physical objects. Answer: False — counting objects is typically a counter function.

51. True or False: SCADA can display alarms and historical process values. Answer: True.

Section C – Long Answer Questions (30)

Write structured answers with labelled diagrams, tables or examples wherever appropriate.

1. Explain the need for industrial automation. Discuss the limitations of electromagnetic relay-based control and the advantages of PLCs.
2. Draw and explain the block diagram of a PLC, including power supply, CPU, memory, input modules, output modules and programming device.
3. Describe the PLC scan cycle with a neat flowchart. Explain how input sampling and output updating affect control operation.
4. Discuss the major PLC programming languages and compare Ladder Diagram, Function Block Diagram and Structured Text.
5. Explain the important factors considered while selecting a PLC for an industrial application.
6. Describe common PLC applications in manufacturing, material handling, process control and utilities, giving suitable examples.
7. Explain binary, octal, decimal and hexadecimal number systems. Convert suitable examples from one base to another.
8. Explain binary addition and subtraction with worked examples, including carry and borrow.
9. Describe BCD, ASCII and Gray code. State one application or advantage of each.
10. State and explain the basic laws and identities of Boolean algebra with examples.
11. Draw the symbols and prepare truth tables for AND, OR, NOT, NAND, NOR, XOR and XNOR gates.
12. Explain how relay logic is represented in ladder diagrams. Draw a simple start-stop motor control ladder diagram and explain its operation.
13. Explain the functions of normally open contacts, normally closed contacts, output coils and internal bits in ladder programming.
14. Explain input, output and status data files and show how they relate to physical I/O and controller diagnostics.
15. Discuss bit, timer, counter, control, integer and floating-point data files and their typical uses.
16. Explain PLC addressing formats, including file, element and bit-level addressing, using suitable illustrative examples.
17. Describe on-delay, off-delay and retentive timer concepts. Compare their behaviour and typical applications.
18. Explain up-counter and down-counter operation. Discuss preset, accumulated value and reset behaviour.

19. Explain bit instructions used in ladder programming, including examine-if-closed/open and output energise instructions.
20. Describe reset and data-handling instructions with examples of how data may be cleared, moved or copied.
21. Explain comparison instructions and illustrate equal-to, not-equal-to, greater-than and less-than comparisons.
22. Explain sequencer instructions and develop a sample step-by-step sequence for an industrial process.
23. Draw the basic architecture of a SCADA system and explain the roles of field devices, PLC/RTU, communication network, server and operator station.
24. Explain the concept of a SCADA project and tags. Describe the general steps in creating and assigning tags to process objects.
25. Explain visibility animation, text animation and colour animation in SCADA, with suitable process examples.
26. Describe numeric display, numeric input, string display and string input objects in a SCADA HMI.
27. Explain the use of labels, arrows, horizontal sliders and vertical sliders in an operator interface.
28. Discuss fill, horizontal/vertical position, height, width and touch animation, explaining how each can represent process status.
29. Explain alarm management in SCADA, including alarm limits, priorities, acknowledgement and event review.
30. Explain data logging in SCADA. Discuss historical trends, sampling intervals, storage and the value of logged data in troubleshooting.

Section D – Very Long Answer Questions (20)

Develop comprehensive answers. Include block diagrams, ladder diagrams, truth tables, addressing examples, HMI sketches and applications wherever relevant.

1. With a neat labelled diagram, explain the complete architecture and operation of a PLC. Discuss the function of every major hardware block, the scan cycle, memory, diagnostics and the relationship between field inputs and outputs.
2. Compare relay-based control and PLC-based control in detail under wiring, flexibility, reliability, maintenance, speed, troubleshooting, expansion and cost. Recommend a suitable approach for a changing production line and justify your answer.
3. Design and explain a PLC-based automatic conveyor system that starts and stops using push buttons, detects objects using a sensor, counts products and stops at a preset count. State assumptions and provide a clearly labelled ladder-logic sequence.
4. Explain PLC programming languages in detail. Compare their syntax, strengths, limitations and applications, and recommend an appropriate language for discrete machine control, process control and complex calculations.
5. Explain number systems and binary arithmetic in detail. Demonstrate conversions among binary, octal, decimal and hexadecimal, and discuss BCD, ASCII and Gray code with worked examples and applications.
6. Develop a detailed explanation of Boolean algebra and logic gates. Include truth tables, symbols, Boolean expressions, De Morgan's theorems and simplification of representative logic expressions.

7. Design a ladder-logic control circuit for a motor with start/stop push buttons, seal-in logic and an overload interlock. Explain each rung and discuss fail-safe considerations.
8. Explain PLC file structure and addressing in detail. Discuss input, output, status, bit, timer, counter, control, integer and floating-point data areas, illustrating how an address identifies a data element or bit.
9. Discuss timer and counter instructions in detail. Compare common timer types, explain preset and accumulated values, describe counter operation and reset behaviour, and provide practical timing and counting examples.
10. Explain bit, reset, data-handling, comparison and sequencer instructions in detail. Provide representative ladder-logic examples and describe the role of each instruction in a complete control task.
11. Design a PLC sequence for a tank-filling system with low-level and high-level sensors, a pump, an alarm and a manual stop. Explain the sequence of operation, interlocks, abnormal conditions and suitable ladder-logic strategy.
12. Draw and explain a complete SCADA system for a water-treatment or pumping station. Include field instrumentation, PLC/RTU, communications, SCADA server, HMI clients, alarms and historical data storage.
13. Describe the full workflow for creating a SCADA project, from defining tags and connecting data sources to building screens, configuring object properties, testing animations and deploying the application.
14. Design an HMI screen for a motor-and-tank process. Explain how you would use labels, numeric display/input, string display/input, arrows, sliders and visibility/colour/fill animation to make the interface clear and usable.
15. Explain SCADA animation properties—visibility, text, colour, fill, position, height, width and touch—in detail. Give a practical example of how each property can represent a real process condition.
16. Explain alarm management in a SCADA system. Discuss alarm conditions, thresholds, priorities, acknowledgement, alarm history, operator response and ways to avoid alarm overload.
17. Explain SCADA data logging and historical trending. Describe tag selection, sampling, timestamps, storage, retrieval, trend interpretation and the use of historical data for fault diagnosis and process improvement.
18. Prepare a comparative account of PLC and SCADA, explaining their objectives, architecture, functions, strengths, limitations and relationship in a modern industrial automation system.
19. Propose an integrated PLC-SCADA solution for a packaging line that detects products, counts batches, controls actuators, displays production status, generates alarms and logs production data. Include a system block diagram and explain the data flow.
20. Discuss PLC/SCADA system commissioning and troubleshooting. Cover I/O checks, program verification, communication checks, tag validation, alarm testing, safety interlocks, backup, documentation and preventive maintenance.

Suggested Answer-Writing Guidelines

- For diagram-based questions, draw neat labelled block diagrams, ladder diagrams, truth tables or HMI sketches.
- For programming questions, state assumptions, define inputs and outputs, and explain each rung or instruction.
- For comparison questions, use a table with clear technical criteria.
- For SCADA questions, distinguish tags, screen objects, animations, alarms and logged historical data.
- PLC addressing syntax varies by manufacturer and model. Use the notation taught in your laboratory/manual and state the controller family when giving specific address examples.

150 Short Questions with Answers

Wireless & Mobile Communication • Units I–V

Revision note: These concise answers are prepared from the topics visible in the supplied syllabus photo. Unit I's heading is partly cropped, so its questions cover introductory wireless-communication themes. Use your teacher's prescribed notes for exact syllabus wording.

UNIT I — Fundamentals of Wireless / Mobile Communication

1. What is wireless communication?

Answer: Transfer of information between devices without a physical cable, usually through electromagnetic waves.

2. What is mobile communication?

Answer: Communication in which a user can communicate while moving between locations.

3. What is a cellular system?

Answer: A network divided into small geographic areas called cells, each served by a base station.

4. What is a cell?

Answer: A geographic coverage area served by a particular base station or sector.

5. What is a base station?

Answer: Radio equipment that connects mobile users to the cellular network.

6. What is a mobile station?

Answer: A user device, such as a mobile phone, that communicates with the network.

7. What is a radio channel?

Answer: A portion of radio resources used to carry communication signals.

8. What is the radio-frequency spectrum?

Answer: The range of electromagnetic frequencies used for radio communication.

9. What is frequency?

Answer: The number of cycles of a periodic signal per second, measured in hertz (Hz).

10. What is wavelength?

Answer: The distance a wave travels during one complete cycle.

11. State the relation between frequency and wavelength.

Answer: Wavelength $\lambda = c/f$, where c is the speed of light and f is frequency.

12. What are electromagnetic waves?

Answer: Waves of electric and magnetic fields that carry energy through space.

13. What is bandwidth?

Answer: The width of a frequency range occupied or allocated to a signal.

14. What is a carrier wave?

Answer: A high-frequency signal modified to carry information.

15. What is modulation?

Answer: Changing a carrier's property according to the information signal.

16. Name two common digital modulation methods.

Answer: BPSK and QPSK; QAM is also widely used.

17. What is propagation?

Answer: The way radio waves travel from a transmitter to a receiver.

18. Name the main radio propagation mechanisms.

Answer: Reflection, diffraction, scattering, and transmission/penetration.

19. What is reflection?

Answer: Bouncing of a radio wave from a surface.

20. What is diffraction?

Answer: Bending of waves around edges or obstacles.

21. What is scattering?

Answer: Redistribution of radio-wave energy by small objects or rough surfaces.

22. What is line-of-sight propagation?

Answer: Propagation along a relatively unobstructed direct path between antennas.

23. What is path loss?

Answer: Reduction in received signal power as the wave travels through space and surroundings.

24. What is fading?

Answer: Variation in received signal strength caused by changing propagation paths or surroundings.

25. What is multipath propagation?

Answer: Reception of multiple copies of a signal arriving along different paths.

26. What is Doppler shift?

Answer: A change in observed frequency caused by relative motion between transmitter and receiver.

27. What is a handoff or handover?

Answer: Transfer of an active connection from one cell or base station to another.

28. Why is frequency reuse used?

Answer: To use limited spectrum efficiently by reusing frequencies in sufficiently separated cells.

29. What is interference?

Answer: Unwanted signal energy that degrades reception of the desired signal.

30. What is SNR?

Answer: Signal-to-noise ratio: desired signal power divided by noise power.

UNIT II — Cellular Concepts

31. What is the main idea of cellular coverage?

Answer: Divide a large service area into cells to provide coverage with manageable transmit power.

32. Why are hexagons used in cellular diagrams?

Answer: They approximate circular coverage and tessellate without gaps; real cells are irregular.

33. What is frequency reuse?

Answer: Using the same frequency channels in different, sufficiently separated cells.

34. What is a cluster?

Answer: A group of cells in which each available frequency channel is assigned once.

35. What is cluster size?

Answer: The number of cells in one frequency-reuse cluster.

36. What is co-channel interference?

Answer: Interference between cells using the same frequency channel.

37. What is adjacent-channel interference?

Answer: Interference from a nearby frequency channel due to imperfect filtering or receiver selectivity.

38. How can co-channel interference be reduced?

Answer: Increase reuse distance, improve antenna patterns, control power, or use interference coordination.

39. What is a cell site?

Answer: A physical location containing antennas and radio equipment for cellular service.

40. What is cell splitting?

Answer: Dividing a congested cell into smaller cells to increase capacity.

41. What is sectoring?

Answer: Dividing a cell into sectors using directional antennas.

42. What is the purpose of sectoring?

Answer: To reduce interference and improve frequency reuse and capacity.

43. What is a microcell?

Answer: A small cell generally used in dense areas or streets to provide local capacity.

44. What is a picocell?

Answer: A very small cell commonly used indoors or in localized high-traffic areas.

45. What is a femtocell?

Answer: A low-power, user-premises cellular access point, often for homes or small offices.

46. What is cell breathing?

Answer: In some systems, coverage changes with load or interference, shrinking as load increases.

47. What is trunking?

Answer: Sharing a pool of channels among many users to improve resource utilization.

48. What is blocking probability?

Answer: The probability that a new call cannot be served because no resource is available.

49. What is Grade of Service (GoS)?

Answer: A measure of service quality, often expressed as the probability of call blocking.

50. What is handoff margin?

Answer: A signal-level difference used to help decide when to transfer a connection.

51. What is hard handoff?

Answer: A break-before-make transfer in which the old connection is released before the new one is established.

52. What is soft handoff?

Answer: A make-before-break transfer in which a device can connect to multiple base stations temporarily.

53. What is power control?

Answer: Adjusting transmit power to maintain link quality while limiting interference.

54. Why is power control important?

Answer: It improves battery life and reduces interference to other users.

55. What is cell capacity?

Answer: The number of users or traffic that a cell can support at a given quality level.

56. How can cellular capacity be increased?

Answer: Use smaller cells, sectoring, efficient radio access, more spectrum, or improved scheduling.

57. What is Erlang?

Answer: A unit of traffic intensity; one Erlang represents one channel occupied continuously.

58. What is traffic intensity?

Answer: The average amount of communication resource occupancy over a period.

59. What is a location area?

Answer: A group of cells used to manage a mobile device's location for paging.

60. What is paging?

Answer: Broadcasting a request in an area to find a mobile device for incoming service.

UNIT III — Multiple Access Techniques for Wireless Communication

61. What is multiple access?

Answer: A method allowing multiple users to share a common communication system.

62. Why are multiple-access techniques needed?

Answer: They organize shared spectrum and reduce collisions or interference between users.

63. What is FDMA?

Answer: Frequency Division Multiple Access; users are assigned separate frequency bands.

64. What is the key feature of FDMA?

Answer: Users transmit on different frequency channels, often with guard bands between them.

65. What is a guard band?

Answer: Unused frequency space separating channels to reduce adjacent-channel interference.

66. What is TDMA?

Answer: Time Division Multiple Access; users share a frequency by transmitting in different time slots.

67. What is a time slot?

Answer: A defined interval allocated to a user or transmission in a repeating frame.

68. What is a TDMA frame?

Answer: A repeating group of time slots used to organize transmissions.

69. What is CDMA?

Answer: Code Division Multiple Access; users share time and frequency resources using different spreading codes.

70. What is a spreading code?

Answer: A code sequence used to spread a signal and help distinguish users in CDMA.

71. What is the near-far problem?

Answer: A strong nearby transmitter can overwhelm a weaker distant user at a receiver.

72. How does power control help CDMA?

Answer: It keeps received user powers reasonably balanced and limits interference.

73. What is spread spectrum?

Answer: A technique that spreads a signal over a bandwidth wider than the minimum required.

74. Name two spread-spectrum approaches.

Answer: Direct-sequence spread spectrum (DSSS) and frequency hopping (FHSS).

75. What is OFDMA?

Answer: Orthogonal Frequency Division Multiple Access; users receive groups of orthogonal subcarriers.

76. What is an OFDM subcarrier?

Answer: A narrowband carrier that is orthogonal to other subcarriers in an OFDM signal.

77. Why is OFDM useful?

Answer: It handles frequency-selective channels well and supports efficient high-rate transmission.

78. What is orthogonality in OFDM?

Answer: Subcarriers are mathematically arranged so they do not interfere at ideal sampling points.

79. What is SC-FDMA?

Answer: Single-Carrier FDMA, a DFT-spread multicarrier method used for LTE uplink.

80. Why was SC-FDMA selected for LTE uplink?

Answer: It generally has lower peak-to-average power ratio than conventional OFDM.

81. What is NOMA?

Answer: Non-Orthogonal Multiple Access, where users can share resources with distinguishable power levels or codes.

82. What is SDMA?

Answer: Space Division Multiple Access; spatial separation or antenna beams distinguish users.

83. What is beamforming?

Answer: Controlling antenna phases and amplitudes to direct signal energy toward a target direction.

84. What is MIMO?

Answer: Multiple-Input Multiple-Output; using multiple transmit and receive antennas.

85. What is spatial multiplexing?

Answer: Sending independent data streams over multiple spatial paths to increase throughput.

86. What is diversity gain?

Answer: Improved reliability from receiving independently faded versions of a signal.

87. What is a collision in random access?

Answer: Two or more devices transmit in a way that causes their packets to interfere.

88. What is the purpose of a random-access channel?

Answer: It lets devices request access or send initial signaling to the network.

89. Give one difference between FDMA and TDMA.

Answer: FDMA separates users by frequency; TDMA separates users by time.

90. What is frequency hopping?

Answer: A spread-spectrum method that rapidly changes the carrier among a set of frequencies according to a known sequence.

UNIT IV — Mobile Communication Systems

91. What is a mobile communication system?

Answer: A system that provides voice or data connectivity to users through radio access and a core network.

92. What does GSM stand for?

Answer: Global System for Mobile Communications.

93. Name the major GSM network elements.

Answer: Mobile Station, BTS, BSC, MSC, HLR, VLR, AuC, and EIR.

94. What is BTS in GSM?

Answer: Base Transceiver Station; it transmits and receives radio signals to and from mobiles.

95. What is BSC in GSM?

Answer: Base Station Controller; it manages multiple BTSs and radio resources.

96. What is MSC?

Answer: Mobile Switching Centre; it switches calls and coordinates mobility-related functions.

97. What is HLR?

Answer: Home Location Register; a database of subscriber profiles and service information.

98. What is VLR?

Answer: Visitor Location Register; temporary information about subscribers in an MSC area.

99. What is AuC?

Answer: Authentication Centre; it supports subscriber authentication and security.

100. What is EIR?

Answer: Equipment Identity Register; a database used to check mobile equipment identities.

101. What is a SIM card?

Answer: A subscriber identity module that stores subscriber credentials and related data.

102. What is a cell identity?

Answer: An identifier used to distinguish a cell within a mobile network.

103. What is roaming?

Answer: Using mobile service through a network other than the subscriber's home network.

104. What is location updating?

Answer: A procedure by which a mobile device informs the network of its current location area.

105. What is authentication in mobile networks?

Answer: Checking that a subscriber or device is legitimate before granting service.

106. What is encryption in mobile communication?

Answer: Protecting transmitted information by encoding it so unauthorized parties cannot readily read it.

107. What is GPRS?

Answer: General Packet Radio Service, a packet-data service introduced for GSM networks.

108. What is EDGE?

Answer: Enhanced Data rates for GSM Evolution, a technology that improves GSM-family data rates.

109. What is Bluetooth?

Answer: A short-range wireless technology for connecting nearby devices.

110. What is Wi-Fi?

Answer: A family of wireless local-area networking technologies based on IEEE 802.11.

111. How does Bluetooth differ from Wi-Fi?

Answer: Bluetooth usually targets short-range device links; Wi-Fi commonly provides local-network and internet access.

112. What is a mobile core network?

Answer: The network functions that manage subscriber access, mobility, routing, and services beyond the radio link.

113. What is a radio access network (RAN)?

Answer: The part of a mobile network connecting user devices to the core through radio equipment.

114. What is SMS?

Answer: Short Message Service for sending text messages over mobile networks.

115. What is circuit switching?

Answer: A communication method that reserves a dedicated path or resources for a session.

116. What is packet switching?

Answer: A method that divides information into packets routed over shared network resources.

117. What is a mobile data session?

Answer: A logical connection that enables a device to exchange data through the network.

118. What is latency?

Answer: The time taken for data to travel from source to destination.

119. What is throughput?

Answer: The amount of useful data successfully delivered per unit time.

120. What is a network protocol?

Answer: A set of rules that devices follow to exchange information.

UNIT V — Introduction to 3G, 4G and 5G

121. What does 3G mean?

Answer: Third-generation mobile communication technology, designed to improve voice and mobile data services.

122. What is UMTS?

Answer: Universal Mobile Telecommunications System, a 3G mobile system associated with WCDMA radio access.

123. What is WCDMA?

Answer: Wideband Code Division Multiple Access, a radio interface used by UMTS.

124. What is HSPA?

Answer: High-Speed Packet Access, an enhancement to UMTS for faster packet data.

125. What is 4G?

Answer: Fourth-generation mobile technology emphasizing high-speed IP-based broadband services.

126. What is LTE?

Answer: Long-Term Evolution, a widely deployed 4G radio-access technology.

127. What is LTE-Advanced?

Answer: An enhanced LTE standard adding capabilities such as carrier aggregation and advanced MIMO.

128. What is carrier aggregation?

Answer: Combining multiple frequency carriers to increase available bandwidth and data rate.

129. What is an all-IP network?

Answer: A network that carries services using Internet Protocol rather than relying on dedicated circuit paths.

130. What is packet-switched voice?

Answer: Voice carried as IP data packets, as in Voice over LTE (VoLTE).

131. What is VoLTE?

Answer: Voice over LTE; a service that carries voice calls over an LTE packet network.

132. What is 5G?

Answer: Fifth-generation mobile technology designed for high data rates, low latency, and diverse connected devices.

133. What is 5G NR?

Answer: New Radio, the radio-access technology specified for 5G.

134. Name the three broad 5G service categories.

Answer: Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low-Latency Communications (URLLC), and massive Machine-Type Communications (mMTC).

135. What is eMBB?

Answer: A 5G service category focused on high-capacity, high-speed broadband.

136. What is URLLC?

Answer: Ultra-Reliable Low-Latency Communications for applications needing dependable, fast communication.

137. What is mMTC?

Answer: Massive Machine-Type Communications supporting very large numbers of connected devices.

138. What is network slicing?

Answer: Creating logically separate network instances tailored to different service requirements.

139. What is small-cell deployment in 5G?

Answer: Using low-power cells to add capacity and coverage, especially in dense areas.

140. What is millimetre-wave communication?

Answer: Use of high radio frequencies, commonly around 24 GHz and above, offering wide bandwidth but shorter practical range.

141. What is massive MIMO?

Answer: Using a large number of antenna elements to serve users efficiently through spatial processing.

142. What is beam steering?

Answer: Changing the direction of an antenna beam electronically or through signal processing.

143. What is edge computing?

Answer: Processing data close to users or devices to reduce delay and backhaul traffic.

144. What is IoT?

Answer: Internet of Things: connected physical devices that sense, communicate, or act.

145. How does 5G support IoT?

Answer: It supports varied device types and service profiles, including low-power and high-density connectivity.

146. Give one advantage of 4G over 3G.

Answer: Generally higher data rates and more efficient all-IP broadband service.

147. Give one advantage of 5G over 4G.

Answer: Potentially higher capacity, lower latency, and better support for dense device deployments.

148. What is handover in 4G/5G?

Answer: Moving a device's connection between cells or access points while maintaining service.

149. What is QoS?

Answer: Quality of Service; performance requirements such as delay, loss, reliability, and throughput.

150. What is the difference between 4G and 5G?

Answer: 5G adds a more flexible radio/core architecture and targets higher capacity, lower latency, and more service types.

Instrumentation - Multiple Choice Questions

Comprehensive Question Bank for Diploma in Electronics & Communication Engineering (HSBTE / Technical Education)

5 Units

125 Total MCQs

Answer Keys & Explanations Included

UNIT I: Measurements & Transducers (25 MCQs)

Q1. What is the primary purpose of measurement in industrial control systems?

- (A) Visual decoration of control panels
- (B) Quantifying physical variables for monitoring and control
- (C) Increasing energy consumption
- (D) Replacing electrical power sources

Answer: (B) Quantifying physical variables for monitoring and control

Q2. A basic measuring system typically consists of which primary functional elements?

- (A) Primary sensing element, signal conditioning, data presentation
- (B) Motor, generator, transformer
- (C) Battery, resistor, capacitor
- (D) Input valve, pipeline, output tap

Answer: (A) Primary sensing element, signal conditioning element, and data presentation element

Q3. Which element of a measuring system converts the non-electrical physical quantity into an electrical signal?

- (A) Display unit
- (B) Primary sensing element / Transducer
- (C) Recorder
- (D) Microcontroller

Answer: (B) Primary sensing element / Transducer

Q4. What is a major advantage of electrical measuring systems over purely mechanical measuring systems?

- (A) High mechanical friction
- (B) Fast response, remote indication, and ease of signal processing
- (C) Heavy weight and bulky size
- (D) Requirement of high mechanical force to operate

Answer: (B) Fast response, remote indication, and ease of signal processing

Q5. What is a potential limitation of electrical measuring systems?

- (A) High sensitivity
- (B) Susceptibility to electromagnetic interference (EMI) and temperature drift
- (C) Inability to measure dynamic signals
- (D) Low resolution

Answer: (B) Susceptibility to electromagnetic interference (EMI) and temperature drift

Q6. An active transducer is defined as a transducer that:

- (A) Requires an external auxiliary power source
- (B) Develops its own output voltage or current without external power
- (C) Only measures static quantities
- (D) Operates solely on digital signals

Answer: (B) Develops its own output voltage or current without external power

Q7. Which of the following is an example of an active transducer?

- (A) Thermistor
- (B) Resistance Temperature Detector (RTD)
- (C) Piezoelectric crystal
- (D) Strain gauge

Answer: (C) Piezoelectric crystal (generates charge under mechanical stress)

Q8. A passive transducer is one which:

- (A) Generates voltage on its own
- (B) Requires an external electrical source to operate
- (C) Does not change resistance or capacitance
- (D) Is used only in power plants

Answer: (B) Requires an external electrical source to operate

Q9. The working principle of a resistive transducer depends on variation of resistance given by $R = \rho L/A$. Resistance changes if:

- (A) Length L changes
- (B) Area A changes
- (C) Resistivity ρ changes
- (D) Any of the above changes

Answer: (D) Any of the above changes

Q10. Inductive transducers work on the principle of variation of self-inductance or mutual inductance caused by changes in:

- (A) Reluctance of the magnetic path
- (B) Dielectric constant of air
- (C) Piezoelectric charge
- (D) Optical wavelength

Answer: (A) Reluctance of the magnetic path

Q11. A capacitive transducer measures displacement based on the capacitance formula $C = \epsilon A / d$. Capacitance can be varied by changing:

- (A) Overlapping area of plates A
- (B) Distance between plates d
- (C) Permittivity of dielectric ϵ
- (D) Any of the above

Answer: (D) Any of the above

Q12. What dielectric change is used in capacitive transducers for humidity measurement?

- (A) Change in plate area
- (B) Change in permittivity ϵ due to moisture absorption
- (C) Change in plate thickness
- (D) Change in supply frequency

Answer: (B) Change in permittivity ϵ due to moisture absorption

Q13. An electromagnetic transducer operates on which fundamental physics law?

- (A) Faraday's Law of Electromagnetic Induction
- (B) Ohm's Law
- (C) Hooke's Law
- (D) Stefan-Boltzmann Law

Answer: (A) Faraday's Law of Electromagnetic Induction

Q14. The piezoelectric effect refers to the generation of electrical charge across certain materials when subjected to:

- (A) Magnetic field
- (B) Mechanical stress/force
- (C) Light radiation
- (D) Chemical reaction

Answer: (B) Mechanical stress/force

Q15. Which material is widely used as a natural piezoelectric material?

- (A) Copper
- (B) Quartz crystal
- (C) Silicon
- (D) Soft iron

Answer: (B) Quartz crystal

Q16. Piezoelectric transducers are NOT suitable for measuring:

- (A) High-frequency dynamic pressure
- (B) Static (DC) displacement or force
- (C) Rapid vibrations
- (D) Transient acoustic waves

Answer: (B) Static (DC) displacement or force (due to charge leakage across internal resistance)

Q17. Synthetic ceramic materials showing strong piezoelectric properties include:

- (A) Barium Titanate and PZT
- (B) Aluminum Oxide
- (C) Carbon Composition
- (D) Constantan alloy

Answer: (A) Barium Titanate and PZT (Lead Zirconate Titanate)

Q18. Sensitivity of a transducer is defined as the ratio of:

- (A) Input change to output change
- (B) Output change to input change
- (C) Maximum range to minimum range
- (D) Error to full-scale output

Answer: (B) Output change to input change ($S = \Delta V_{out} / \Delta Input$)

Q19. Inverse transducer is a device that converts:

- (A) Electrical quantity into non-electrical quantity
- (B) Non-electrical quantity into electrical quantity
- (C) Mechanical energy into thermal energy
- (D) AC signal into DC signal

Answer: (A) Electrical quantity into non-electrical quantity (e.g. Piezoelectric crystal used as actuator)

Q20. Which of the following is a primary transducer in a Bourdon tube pressure measurement system?

- (A) LVDT connected to the tip
- (B) Bourdon tube itself
- (C) Signal amplifier
- (D) Digital Voltmeter

Answer: (B) Bourdon tube itself (converts pressure to mechanical displacement)

Q21. Secondary transducers receive output from a primary transducer and convert it into:

- (A) Mechanical movement
- (B) Electrical output signal
- (C) Thermal heat
- (D) Fluid pressure

Answer: (B) Electrical output signal

Q22. Linearity of a transducer refers to:

- (A) Direct proportionality between input and output
- (B) Time required to reach steady state
- (C) Smallest detectable change in input
- (D) Ability to produce identical output under same conditions

Answer: (A) Direct proportionality between input and output

Q23. Resolution of a measuring system is:

- (A) Maximum measurable quantity
- (B) Smallest incremental change in input that produces a detectable output change
- (C) Ratio of full scale error
- (D) Time delay of instrument response

Answer: (B) Smallest incremental change in input that produces a detectable output change

Q24. Which parameter represents the closeness of agreement among repeated measurements of the same quantity?

- (A) Accuracy
- (B) Precision
- (C) Sensitivity
- (D) Hysteresis

Answer: (B) Precision

Q25. Hysteresis in a transducer is defined as:

- (A) Error due to high frequency
- (B) Difference in output for the same input value when approached from increasing and decreasing directions
- (C) Total power consumed
- (D) Drift over time

Answer: (B) Difference in output for the same input value when approached from increasing and decreasing directions

UNIT II: Measurement of Displacement and Strain (25 MCQs)

Q26. A wire wound potentiometer measures displacement by converting linear/angular position into a change in:

- (A) Capacitance
- (B) Electrical resistance
- (C) Inductive reactance
- (D) Frequency

Answer: (B) Electrical resistance

Q27. LVDT stands for:

- (A) Linear Variable Differential Transformer
- (B) Low Voltage Differential Transducer
- (C) Linear Variable Displacement Thermistor
- (D) Light Variable Digital Transmitter

Answer: (A) Linear Variable Differential Transformer

Q28. How many primary and secondary windings does an LVDT possess?

- (A) 2 Primary, 1 Secondary
- (B) 1 Primary, 2 Secondary windings connected in series opposition
- (C) 2 Primary, 2 Secondary windings in parallel
- (D) 1 Primary, 1 Secondary winding

Answer: (B) 1 Primary, 2 Secondary windings connected in series opposition

Q29. In an LVDT, when the magnetic core is at the central (null) position, the output voltage is ideally:

- (A) Maximum positive
- (B) Maximum negative
- (C) Zero
- (D) Equal to input supply voltage

Answer: (C) Zero

Q30. The phase of the AC output voltage of an LVDT depends on:

- (A) Core displacement direction from null position
- (B) Primary coil resistance
- (C) Temperature of surrounding air
- (D) Supply frequency only

Answer: (A) Core displacement direction from null position

Q31. Which core material is used inside an LVDT to couple magnetic flux between windings?

- (A) Copper rod
- (B) High permeability soft iron / nickel-iron core
- (C) Aluminum rod
- (D) Plastic core

Answer: (B) High permeability soft iron / nickel-iron core

Q32. Electrical strain gauges convert mechanical strain into:

- (A) Change in magnetic field
- (B) Change in electrical resistance
- (C) Change in light intensity
- (D) Change in fluid level

Answer: (B) Change in electrical resistance

Q33. Gauge Factor (GF) of a strain gauge is defined as the ratio of:

- (A) Per-unit change in resistance to strain ($(\Delta R/R) / \epsilon$)
- (B) Strain to stress
- (C) Voltage output to current input
- (D) Length change to area change

Answer: (A) Per-unit change in resistance to strain ($GF = (\Delta R/R) / (\Delta L/L)$)

Q34. The expression for Gauge Factor in terms of Poisson's ratio ν and piezoresistive effect is:

- (A) $GF = 1 + 2\nu + (\Delta\rho/\rho) / \epsilon$
- (B) $GF = 1 - \nu$
- (C) $GF = 2 + \nu$
- (D) $GF = 1 / (1 + \nu)$

Answer: (A) $GF = 1 + 2\nu + (\Delta\rho/\rho) / \epsilon$

Q35. Metallic wire/foil strain gauges typically have a Gauge Factor of approximately:

- (A) 0.1 to 0.5
- (B) 2.0 to 2.2
- (C) 100 to 200
- (D) 1000

Answer: (B) 2.0 to 2.2

Q36. Semiconductor strain gauges have very high Gauge Factors (around 100 to 200) mainly due to:

- (A) Large dimensional expansion
- (B) Strong piezoresistive effect
- (C) High magnetic permeability
- (D) Low thermal conductivity

Answer: (B) Strong piezoresistive effect

Q37. Common alloy used for manufacturing metal foil strain gauges is:

- (A) Constantan (Copper-Nickel alloy)
- (B) Pure Gold
- (C) Aluminum
- (D) Lead

Answer: (A) Constantan (Copper-Nickel alloy)

Q38. To measure small fractional changes in strain gauge resistance, which circuit arrangement is used?

- (A) Series voltage divider
- (B) Wheatstone bridge circuit
- (C) LC resonant circuit
- (D) Transformer coupled circuit

Answer: (B) Wheatstone bridge circuit

Q39. In a strain gauge Wheatstone bridge, a dummy gauge is used for:

- (A) Increasing sensitivity
- (B) Temperature compensation
- (C) Increasing bridge voltage
- (D) Measuring cross-axis strain

Answer: (B) Temperature compensation

Q40. A full-bridge strain gauge configuration uses how many active strain gauges?

- (A) 1 active gauge
- (B) 2 active gauges
- (C) 4 active gauges
- (D) 3 active gauges

Answer: (C) 4 active gauges (provides 4 times the sensitivity of a quarter bridge)

Q41. Proximity switches are designed to detect:

- (A) Presence or absence of an object without physical contact
- (B) Temperature variations
- (C) Internal pipe pressure
- (D) Chemical concentration

Answer: (A) Presence or absence of an object without physical contact

Q42. Inductive proximity sensors are specifically used to detect target objects made of:

- (A) Plastics
- (B) Metallic / Ferrous materials
- (C) Glass
- (D) Wood

Answer: (B) Metallic / Ferrous materials

Q43. Capacitive proximity switches can detect:

- (A) Metallic targets only
- (B) Both metallic and non-metallic targets (liquid, plastic, glass)
- (C) Magnetic fields only
- (D) Light signals only

Answer: (B) Both metallic and non-metallic targets (liquid, plastic, glass)

Q44. Which proximity switch utilizes the Hall Effect to detect magnetic targets?

- (A) Photoelectric sensor
- (B) Magnetic / Hall effect proximity sensor
- (C) Ultrasonic sensor
- (D) Resistive potentiometer

Answer: (B) Magnetic / Hall effect proximity sensor

Q45. An inductive displacement transducer measures variation in displacement using:

- (A) Change in inductance of a coil due to core motion
- (B) Change in resistance of a heating element
- (C) Change in light wavelength
- (D) Piezoelectric charge output

Answer: (A) Change in inductance of a coil due to core motion

Q46. Main advantage of LVDT over potentiometer is:

- (A) High friction and mechanical wear
- (B) Contactless operation, high reliability, and long life
- (C) Low sensitivity
- (D) Requires DC excitation only

Answer: (B) Contactless operation, high reliability, and long life

Q47. The strain gauge rosette is used to measure:

- (A) Uniaxial strain only
- (B) Multi-directional / complex strain states at a surface point
- (C) Temperature variations only
- (D) Magnetic flux density

Answer: (B) Multi-directional / complex strain states at a surface point

Q48. Standard nominal resistance of commercial foil strain gauges is usually:

- (A) 120 Ω or 350 Ω
- (B) 10 k Ω
- (C) 1 M Ω
- (D) 0.5 Ω

Answer: (A) 120 Ω or 350 Ω

Q49. A linear potentiometer exhibits non-linearity if:

- (A) It is operated under no-load conditions
- (B) Connected load resistance is not significantly higher than potentiometer resistance
- (C) Input voltage is constant DC
- (D) Wiper is stationary

Answer: (B) Connected load resistance is not significantly higher than potentiometer resistance

Q50. Optical proximity switches operate based on:

- (A) Emission and detection of light (IR LED and phototransistor)
- (B) High voltage arc generation
- (C) Acoustic sound absorption
- (D) Electromagnetic flux leakage

Answer: (A) Emission and detection of light (IR LED and phototransistor)

UNIT III: Force, Torque and Speed Measurement (25 MCQs)

Q51. Which mechanical element is used as an elastic transducer for force measurement?

- (A) Proving ring and cantilever beam
- (B) Orifice plate
- (C) Thermocouple junction
- (D) Rotameter tube

Answer: (A) Proving ring and cantilever beam

Q52. A strain gauge load cell converts force or weight into an electrical signal using:

- (A) Strain gauges bonded to an elastic structural member
- (B) Variable capacitance plates
- (C) Optical gratings
- (D) Thermal expansion of mercury

Answer: (A) Strain gauges bonded to an elastic structural member

Q53. In a compression load cell, strain gauges are mounted such that:

- (A) All gauges experience tension
- (B) Two gauges experience tension and two experience compression
- (C) Gauges do not experience any strain
- (D) All gauges experience shear stress only

Answer: (B) Two gauges experience tension and two experience compression

Q54. Hydraulic load cells measure heavy loads based on the principle of:

- (A) Pascal's Law (pressure increase in enclosed fluid)
- (B) Faraday's Law
- (C) Ohm's Law
- (D) Seebeck Effect

Answer: (A) Pascal's Law (pressure increase in enclosed fluid)

Q55. Pneumatic load cells operate using:

- (A) Compressed air pressure balanced against applied force
- (B) Liquid nitrogen expansion
- (C) High electrical voltage generation
- (D) Vacuum pressure only

Answer: (A) Compressed air pressure balanced against applied force

Q56. Torque is defined as:

- (A) Force per unit area
- (B) Turning moment produced by force ($T = F \times r$)
- (C) Rate of change of momentum
- (D) Mass per unit volume

Answer: (B) Turning moment produced by force ($T = F \times r$)

Q57. How are strain gauges arranged on a rotating shaft to measure torque?

- (A) Parallel to shaft axis
- (B) Mounted at 45° angle to the shaft axis
- (C) Perpendicular to shaft axis
- (D) Encircled around shaft diameter

Answer: (B) Mounted at 45° angle to the shaft axis (to align with principal shear stress directions)

Q58. To transmit strain gauge signals from a rotating torque shaft to stationary indicators, we use:

- (A) Slip rings and brushes or wireless telemetry
- (B) Rigid copper pipes
- (C) Solid steel couplings
- (D) Optical lenses

Answer: (A) Slip rings and brushes or wireless telemetry

Q59. Inductive torque transducers measure torque by sensing:

- (A) Torsional twist / angular deflection of shaft via variable reluctance/inductance
- (B) Temperature rise of bearings
- (C) Speed variation of shaft
- (D) Acoustic noise output

Answer: (A) Torsional twist / angular deflection of shaft via variable reluctance/inductance

Q60. A revolution counter used for speed measurement measures:

- (A) Total number of revolutions over a measured time interval
- (B) Instantaneous acceleration
- (C) Torsional stress
- (D) Fluid velocity

Answer: (A) Total number of revolutions over a measured time interval

Q61. A DC tachometer generator produces an output voltage that is:

- (A) Inversely proportional to shaft speed
- (B) Directly proportional to rotational shaft speed
- (C) Independent of shaft speed
- (D) Proportional to square of speed

Answer: (B) Directly proportional to rotational shaft speed

Q62. An AC tachometer generator operates like an induction motor and produces an AC voltage whose amplitude and frequency are proportional to:

- (A) Shaft speed
- (B) Temperature
- (C) Supply phase angle
- (D) Load torque

Answer: (A) Shaft speed

Q63. Stroboscopic method for speed measurement is a:

- (A) Direct mechanical contact method
- (B) Non-contact optical method using flashing light
- (C) Hydraulic fluid method
- (D) Magnetic absorption method

Answer: (B) Non-contact optical method using flashing light

Q64. In a stroboscope, a rotating object appears stationary when the flashing frequency of light is:

- (A) Equal to or an exact integer submultiple of shaft rotational speed
- (B) Half the room temperature
- (C) Much higher than speed of light
- (D) Zero

Answer: (A) Equal to or an exact integer submultiple of shaft rotational speed

Q65. Photoelectric tachometers measure speed by counting:

- (A) Light pulses reflected or interrupted by a slotted disk attached to shaft
- (B) Thermal pulses from friction
- (C) Electrical sparks across contacts
- (D) Magnetic hysteresis losses

Answer: (A) Light pulses reflected or interrupted by a slotted disk attached to shaft

Q66. Variable reluctance tachometer pulse pickup generates pulses when teeth of a metallic gear pass by a:

- (A) Permanent magnet wrapped with a coil
- (B) Piezoelectric ceramic strip
- (C) Optical fiber bundle
- (D) Carbon resistor

Answer: (A) Permanent magnet wrapped with a coil

Q67. The relationship between force F , mass m , and acceleration a used in acceleration/force transducers is:

- (A) $F = m \times a$
- (B) $F = m / a$
- (C) $F = a / m$
- (D) $F = m + a$

Answer: (A) $F = m \times a$

Q68. Which dynamic torque measurement device absorbs power supplied by a motor?

- (A) Absorption dynamometer (e.g. Prony brake / Eddy current brake)
- (B) Transmission dynamometer
- (C) Tachometer generator
- (D) Piezoelectric accelerometer

Answer: (A) Absorption dynamometer (e.g. Prony brake / Eddy current brake)

Q69. Transmission dynamometers measure torque and power:

- (A) Without absorbing or wasting the energy being transmitted
- (B) By absorbing all output power into heat
- (C) By stopping the machine completely
- (D) By converting power to light energy

Answer: (A) Without absorbing or wasting the energy being transmitted

Q70. Main disadvantage of DC tachometer generator is:

- (A) Commutator brush noise and maintenance requirement
- (B) Inability to determine direction of rotation
- (C) Output is non-linear
- (D) Low output voltage

Answer: (A) Commutator brush noise and maintenance requirement

Q71. Magnetostrictive torque sensors utilize change in magnetic permeability caused by:

- (A) Applied mechanical shear stress
- (B) Temperature change
- (C) High optical frequency
- (D) Chemical reaction

Answer: (A) Applied mechanical shear stress

Q72. A centrifugal tachometer measures speed using the principle of:

- (A) Centrifugal force acting on rotating flyweights
- (B) Electrical resistance change in copper
- (C) Light interference pattern
- (D) Variable capacitance

Answer: (A) Centrifugal force acting on rotating flyweights

Q73. In digital speed measurement using a slotted disc with N slots, if pulse frequency is f Hz, shaft speed in RPM is:

- (A) $RPM = (60 \times f) / N$
- (B) $RPM = f / (60 \times N)$
- (C) $RPM = (f \times N) / 60$
- (D) $RPM = 60 / (f \times N)$

Answer: (A) $RPM = (60 \times f) / N$

Q74. Elastic displacement in force sensors is often measured using which secondary transducer?

- (A) LVDT
- (B) Thermocouple
- (C) Pyrometer
- (D) Psychrometer

Answer: (A) LVDT

Q75. Calibration of load cell is usually done using:

- (A) Standard dead weights / dead weight tester
- (B) Hot air blower
- (C) Oscilloscope grid
- (D) Variable autotransformer

Answer: (A) Standard dead weights / dead weight tester

UNIT IV: Pressure Measurement & Flow Measurement (25 MCQs)

Q76. Bourdon tubes are available in various shapes including:

- (A) C-type, Spiral, and Helical
- (B) Circular, Rectangular, Triangular
- (C) Parabolic, Hyperbolic, Spherical
- (D) Flat plate only

Answer: (A) C-type, Spiral, and Helical

Q77. Cross-section of a C-type Bourdon tube is typically:

- (A) Elliptical or flattened circular
- (B) Perfectly square
- (C) Triangular
- (D) Hexagonal

Answer: (A) Elliptical or flattened circular

Q78. When fluid pressure is applied inside a Bourdon tube, its free tip moves because the tube section tends to become:

- (A) More circular in cross-section
- (B) Flat like a ribbon
- (C) Twisted axially
- (D) Compressed in length

Answer: (A) More circular in cross-section

Q79. A pressure cell using strain gauges measures pressure by converting pressure into:

- (A) Diaphragm deflection and strain in attached gauges
- (B) Optical color change
- (C) Acoustic sound frequency
- (D) Magnetic flux rotation

Answer: (A) Diaphragm deflection and strain in attached gauges

Q80. Electrical pressure pickups include which transducer combinations with diaphragms or bellows?

- (A) LVDT, Capacitive, Piezoelectric, and Strain gauge pickups
- (B) Mercury bulb and capillary tube
- (C) Mechanical lever and gears only
- (D) Rotameter glass tube

Answer: (A) LVDT, Capacitive, Piezoelectric, and Strain gauge pickups

Q81. Capacitive pressure transducers operate by measuring capacitance change caused by:

- (A) Deflection of a sensing diaphragm acting as one capacitor plate
- (B) Change in ambient light intensity
- (C) Heating of the dielectric material
- (D) Fluid color change

Answer: (A) Deflection of a sensing diaphragm acting as one capacitor plate

Q82. LVDT pressure pickup connects the tip of a Bourdon tube or diaphragm to the:

- (A) Movable magnetic core of the LVDT
- (B) Primary coil of transformer
- (C) Power supply ground
- (D) Digital display LED

Answer: (A) Movable magnetic core of the LVDT

Q83. Electromagnetic flow meter basic working principle is based on:

- (A) Faraday's Law of Electromagnetic Induction
- (B) Bernoulli's Principle
- (C) Doppler effect
- (D) Venturi effect

Answer: (A) Faraday's Law of Electromagnetic Induction

Q84. Induced voltage E in an electromagnetic flow meter is given by:

- (A) $E = B \times L \times v$
- (B) $E = B / (L \times v)$
- (C) $E = v / (B \times L)$
- (D) $E = B + L + v$

Answer: (A) $E = B \times L \times v$ (where B = magnetic field, L = conductor length/pipe diameter, v = fluid velocity)

Q85. Electromagnetic flow meters require the flowing fluid to be:

- (A) Electrically conductive
- (B) Highly viscous oil
- (C) Completely dry gas
- (D) Non-conducting distilled water

Answer: (A) Electrically conductive

Q86. Major advantage of electromagnetic flow meter is that it is:

- (A) Non-intrusive with zero pressure drop across pipe
- (B) Very low cost compared to mechanical meters
- (C) Suitable for non-conductive gases
- (D) Dependent on fluid density and viscosity

Answer: (A) Non-intrusive with zero pressure drop across pipe

Q87. Ultrasonic flow meters measure flow velocity using ultrasonic sound waves based on:

- (A) Transit-time difference or Doppler frequency shift
- (B) Faraday's law of induction
- (C) Seebeck thermoelectric effect
- (D) Resistance variation in wire

Answer: (A) Transit-time difference or Doppler frequency shift

Q88. Transit-time ultrasonic flow meters work best with:

- (A) Clean fluids with no suspended solids or gas bubbles
- (B) Heavy slurries and mud
- (C) Highly aerated liquids
- (D) Liquids containing solid particulates only

Answer: (A) Clean fluids with no suspended solids or gas bubbles

Q89. Doppler ultrasonic flow meters rely on acoustic reflection from:

- (A) Suspended particles or gas bubbles inside moving fluid
- (B) Smooth pipe outer wall
- (C) Stationary liquid in pipe
- (D) External electronic display

Answer: (A) Suspended particles or gas bubbles inside moving fluid

Q90. Absolute pressure is defined as:

- (A) Gauge pressure + Atmospheric pressure
- (B) Gauge pressure - Atmospheric pressure
- (C) Atmospheric pressure - Vacuum pressure
- (D) Differential pressure $\times 2$

Answer: (A) Gauge pressure + Atmospheric pressure

Q91. Atmospheric pressure at sea level under standard conditions is equal to:

- (A) 760 mm Hg (101.325 kPa / 1.013 bar)
- (B) 100 mm Hg
- (C) 1 bar exactly
- (D) 14.7 bar

Answer: (A) 760 mm Hg (101.325 kPa / 1.013 bar)

Q92. Bellows pressure element consists of:

- (A) A thin-walled metallic tube with deep convolutions
- (B) A solid heavy steel rod
- (C) A coiled spring only
- (D) A glass U-tube containing water

Answer: (A) A thin-walled metallic tube with deep convolutions

Q93. Which transducer is ideal for measuring rapidly changing transient pressures?

['(C) Liquid-in-glass thermometer', '(D) Mercury barometer']

- (A) Piezoelectric pressure pickup
- (B) U-tube manometer

Answer: (A) Piezoelectric pressure pickup

Q94. Pirani gauge is used to measure:

- (A) Very low pressure / High vacuum
- (B) High hydraulic force
- (C) High fluid flow rate
- (D) High temperature in boilers

Answer: (A) Very low pressure / High vacuum

Q95. Pirani gauge operates based on variation of:

- (A) Thermal conductivity of gas with pressure
- (B) Fluid density with depth
- (C) Magnetic flux with distance
- (D) Optical refractive index

Answer: (A) Thermal conductivity of gas with pressure

Q96. Differential pressure flow meters (like Orifice and Venturi) calculate flow rate using:

- (A) Bernoulli's equation ($Q \propto \sqrt{\Delta P}$)
- (B) Ohm's law
- (C) Hooke's law
- (D) Newton's law of cooling

Answer: (A) Bernoulli's equation ($Q \propto \sqrt{\Delta P}$)

Q97. Rotameter is classified as a:

- (A) Variable area flow meter
- (B) Variable head flow meter
- (C) Electromagnetic flow meter
- (D) Ultrasonic flow meter

Answer: (A) Variable area flow meter

Q98. In a Rotameter, fluid flows upwards through a tapered vertical tube causing a float to reach position where:

- (A) Upward fluid drag and buoyancy force balance downward weight of float
- (B) Float touches top cap
- (C) Fluid stops flowing completely
- (D) Pressure drops to zero

Answer: (A) Upward fluid drag and buoyancy force balance downward weight of float

Q99. Smart pressure transmitters incorporate microprocessors to provide:

- (A) Digital communication (HART/Modbus), auto-zero, and temperature compensation
- (B) High mechanical friction
- (C) Direct hydraulic power
- (D) Mercury column balance

Answer: (A) Digital communication (HART/Modbus), auto-zero, and temperature compensation

Q100. Clamp-on ultrasonic flow meters have the advantage that:

- (A) Transducers are attached outside the pipe without cutting or stopping process
- (B) They require hole drilling into pipe
- (C) They work only on open channel flumes
- (D) They consume high AC power

Answer: (A) Transducers are attached outside the pipe without cutting or stopping process

UNIT V: Temperature and Humidity Measurement (25 MCQs)

Q101. RTD stands for:

- (A) Resistance Temperature Detector
- (B) Rotational Temperature Device
- (C) Reluctance Thermal Diode
- (D) Radiation Temperature Detector

Answer: (A) Resistance Temperature Detector

Q102. RTDs are made of metals that exhibit a:

- (A) Positive Temperature Coefficient (PTC) of resistance
- (B) Negative Temperature Coefficient (NTC)
- (C) Zero temperature coefficient
- (D) Variable non-linear step coefficient

Answer: (A) Positive Temperature Coefficient (PTC) of resistance

Q103. The most common metal used for industrial RTD sensing elements (e.g. Pt100) is:

- (A) Platinum
- (B) Copper
- (C) Aluminum
- (D) Silver

Answer: (A) Platinum

Q104. What does "Pt100" mean in temperature instrumentation?

- (A) Platinum RTD with 100 Ω resistance at 0 °C
- (B) Platinum sensor with 100 °C range
- (C) Power transducer of 100 Watts
- (D) Platinum wire 100 meters long

Answer: (A) Platinum RTD with 100 Ω resistance at 0 °C

Q105. Thermistors are semiconductor sensors that typically possess:

- (A) Highly sensitive Negative Temperature Coefficient (NTC)
- (B) Linear resistance change over 1000 °C
- (C) Zero electrical resistance
- (D) Infinite response time

Answer: (A) Highly sensitive Negative Temperature Coefficient (NTC)

Q106. Thermocouples operate on the principle of:

- (A) Seebeck Effect
- (B) Peltier Effect only
- (C) Thomson Effect only
- (D) Hall Effect

Answer: (A) Seebeck Effect

Q107. Seebeck effect states that an EMF is generated in a closed circuit consisting of two dissimilar metals when:

- (A) Their two junctions are maintained at different temperatures
- (B) A magnetic field is applied across them
- (C) High current passes through them
- (D) They are submerged in oil

Answer: (A) Their two junctions are maintained at different temperatures

Q108. Type K thermocouple is composed of which combination of materials?

- (A) Chromel and Alumel
- (B) Iron and Constantan
- (C) Copper and Constantan
- (D) Platinum and Rhodium

Answer: (A) Chromel and Alumel

Q109. In thermocouple measurement, cold junction compensation (CJC) is necessary to:

- (A) Account for temperature variations at reference junction
- (B) Increase thermocouple current
- (C) Cool down hot junction
- (D) Prevent short circuits

Answer: (A) Account for temperature variations at reference junction

Q110. Pyrometers are temperature measuring devices used for:

- (A) Non-contact measurement of high temperatures via thermal radiation
- (B) Measuring cryogenic liquid nitrogen temperature
- (C) Measuring body temperature in water
- (D) Direct contact oil temperature measurement

Answer: (A) Non-contact measurement of high temperatures via thermal radiation

Q111. Optical pyrometers measure temperature by comparing:

- (A) Brightness of a glowing target with a calibrated internal lamp filament
- (B) Resistance of a platinum wire
- (C) Voltage across thermocouple junction
- (D) Speed of sound in hot air

Answer: (A) Brightness of a glowing target with a calibrated internal lamp filament

Q112. Total radiation pyrometer operates according to which physical radiation law?

- (A) Stefan-Boltzmann Law ($E = \epsilon \sigma T^4$)
- (B) Ohm's Law
- (C) Hooke's Law
- (D) Faraday's Law

Answer: (A) Stefan-Boltzmann Law ($E = \epsilon \sigma T^4$)

Q113. Relative Humidity (RH) is defined as the ratio of:

- (A) Actual water vapor pressure to saturation water vapor pressure at same temperature
- (B) Mass of air to mass of water
- (C) Ambient temperature to dew point temperature
- (D) Total air pressure to vapor pressure

Answer: (A) Actual water vapor pressure to saturation water vapor pressure at same temperature

Q114. A Psychrometer consists of two thermometers known as:

- (A) Dry-bulb thermometer and Wet-bulb thermometer
- (B) High-range and Low-range thermometers
- (C) Mercury and Alcohol thermometers
- (D) Primary and Secondary thermometers

Answer: (A) Dry-bulb thermometer and Wet-bulb thermometer

Q115. On a psychrometer, wet-bulb depression is defined as:

- (A) Difference between dry-bulb temperature and wet-bulb temperature
- (B) Sum of dry-bulb and wet-bulb temperatures
- (C) Ratio of wet-bulb to dry-bulb temperature
- (D) Temperature of water bath

Answer: (A) Difference between dry-bulb temperature and wet-bulb temperature

Q116. Hair hygrometer operates on the principle that human/animal hair:

- (A) Expands/elongates with increase in relative humidity
- (B) Changes electrical resistance
- (C) Changes color with humidity
- (D) Generates electrical voltage

Answer: (A) Expands/elongates with increase in relative humidity

Q117. Electrical resistive hygrometer (e.g. Dunmore sensor) uses hygroscopic salt (like Lithium Chloride) whose resistance:

- (A) Decreases as humidity increases
- (B) Increases as humidity increases
- (C) Remains constant
- (D) Changes with magnetic field only

Answer: (A) Decreases as humidity increases (absorbs moisture and conducts current)

Q118. Modern capacitive humidity sensors measure relative humidity using thin polymer dielectric whose permittivity changes when:

- (A) Moisture molecules are absorbed
- (B) Temperature drops below zero
- (C) Pressure drops to vacuum
- (D) Light falls on it

Answer: (A) Moisture molecules are absorbed

Q119. Dew point temperature is the temperature at which:

- (A) Air becomes fully saturated with water vapor and condensation begins
- (B) Water starts boiling
- (C) Ice melts completely
- (D) Relative humidity becomes zero

Answer: (A) Air becomes fully saturated with water vapor and condensation begins

Q120. A bimetallic strip used in bimetallic thermometers consists of two metals with different:

- (A) Coefficients of thermal expansion
- (B) Electrical resistivities
- (C) Magnetic permeabilities
- (D) Densities

Answer: (A) Coefficients of thermal expansion

Q121. Thermistor material is generally made of:

- (A) Sintered metallic oxides of manganese, nickel, cobalt, copper
- (B) Pure noble metals like gold and platinum
- (C) Synthetic plastics
- (D) Glass fibers

Answer: (A) Sintered metallic oxides of manganese, nickel, cobalt, copper

Q122. To eliminate lead wire resistance error in industrial RTD measurements, which lead configuration is used?

- (A) 3-wire or 4-wire RTD bridge configuration
- (B) 1-wire single ground configuration
- (C) High resistance coaxial cable
- (D) Fiber optic patch cord

Answer: (A) 3-wire or 4-wire RTD bridge configuration

Q123. Infra-red (IR) thermometers measure body temperature from a distance based on:

- (A) Infra-red thermal radiation emitted by object
- (B) Echo time of ultrasound wave
- (C) Magnetic flux reflection
- (D) Radio frequency interference

Answer: (A) Infra-red thermal radiation emitted by object

Q124. Sling psychrometer measures humidity by:

- (A) Whirling dry and wet bulb thermometers rapidly in air
- (B) Heating air to 100 °C
- (C) Passing electrical current through air sample
- (D) Measuring sound speed

Answer: (A) Whirling dry and wet bulb thermometers rapidly in air

Q125. Which device is best suited for point measurement of temperature inside miniature electronic circuits?

- (A) Bead thermistor or micro-thermocouple
- (B) Large Bourdon tube gauge
- (C) Mercury-in-glass thermometer
- (D) Sling psychrometer

Answer: (A) Bead thermistor or micro-thermocouple

Optical Fibre Communication

Question Bank: 100 Short Answer Questions + 50 MCQs (Units I-V)
Diploma in Electronics and Communication Engineering, HSBTE

UNIT I: Introduction

Part A: Short Answer Questions (20)

Q1. What is optical fibre communication?

Ans: A communication system that sends information as pulses of light through a thin glass or plastic fibre.

Q2. Name the main blocks of an optical fibre communication system.

Ans: Transmitter (driver and optical source), optical fibre channel (with connectors, splices, repeaters) and receiver (photodetector, amplifier and decision circuit).

Q3. Why has optical fibre replaced copper cable in many links?

Ans: It offers much larger bandwidth, very low loss, immunity to interference and small size.

Q4. Which part of the electromagnetic spectrum is used in optical fibre communication?

Ans: The near-infrared region, about 800 nm to 1600 nm, just beyond visible light (400-700 nm).

Q5. State four advantages of optical fibre communication.

Ans: Huge bandwidth, low attenuation, immunity to EMI, light weight and small size, and good security.

Q6. State three disadvantages of optical fibre communication.

Ans: Costly installation and equipment, difficult jointing and splicing, and fragility (cannot be bent sharply or pulled hard).

Q7. List four applications of optical fibres.

Ans: Telephone trunk lines, internet backbone, cable TV, computer networks (LAN) and medical endoscopy.

Q8. Define refraction of light.

Ans: The bending of a light ray when it passes from one medium to another because its speed changes.

Q9. Define refractive index.

Ans: The ratio of the speed of light in vacuum to the speed of light in the medium: $n = c/v$.

Q10. State Snell's law.

Ans: $n_1 \sin(i) = n_2 \sin(r)$, where i is the angle of incidence and r the angle of refraction.

Q11. State the law of reflection.

Ans: The angle of incidence equals the angle of reflection, and both rays lie in the same plane with the normal.

Q12. What is total internal reflection (TIR)?

Ans: When light travels from a denser to a rarer medium at an angle above the critical angle, it is completely reflected back into the denser medium.

Q13. State the conditions for TIR.

Ans: (1) Light must go from a denser to a rarer medium. (2) The angle of incidence must be greater than the critical angle.

Q14. Define critical angle.

Ans: The angle of incidence in the denser medium for which the refracted ray grazes the boundary (90 degrees). $\sin(\text{critical angle}) = n_2/n_1$.

Q15. Why must the cladding have a lower refractive index than the core?

Ans: So that light undergoes total internal reflection at the core-cladding boundary and stays guided in the core.

Q16. Why is optical fibre immune to electromagnetic interference?

Ans: The fibre is a dielectric and carries light, not electric current, so external EM fields do not induce noise.

Q17. Why is optical fibre communication considered secure?

Ans: Light does not radiate out of the fibre, and tapping it disturbs the signal so it can be detected.

Q18. Name the three low-loss optical windows.

Ans: About 850 nm, 1310 nm and 1550 nm (1550 nm has the lowest loss).

Q19. Differentiate between the carriers in electrical and optical communication.

Ans: Electrical communication uses electrons in a conductor; optical communication uses photons guided in a fibre.

Q20. Who proposed low-loss glass fibre for communication?

Ans: Charles Kao and George Hockham proposed it in 1966; John Tyndall had earlier (1870) shown that light can be guided in a water jet.

Part B: Multiple Choice Questions (10)

1. Optical fibre works on the principle of:

- (A) Diffraction
- (B) Polarisation
- (C) Total internal reflection
- (D) Interference

2. Optical fibre communication mainly uses:

- (A) Ultraviolet
- (B) Near-infrared
- (C) X-rays
- (D) Microwaves

3. Refractive index is given by:

- (A) v/c
- (B) c/v
- (C) $c \times v$
- (D) $1/(c \times v)$

4. The cladding refractive index is _____ the core.

- (A) Equal to
- (B) Higher than
- (C) Lower than
- (D) Zero compared to

5. Which is NOT an advantage of optical fibre?

- (A) Large bandwidth
- (B) Low loss
- (C) Immunity to EMI
- (D) Easy splicing

6. Snell's law is:

- (A) $n_1 \sin(i) = n_2 \sin(r)$
- (B) $n_1 \cos(i) = n_2 \cos(r)$
- (C) $n_1 / n_2 = i / r$
- (D) $n_1 + n_2 = \sin(i)$

7. TIR needs the angle of incidence to be:

- (A) Less than critical angle
- (B) Equal to zero
- (C) Greater than critical angle
- (D) Equal to 45 degrees only

8. The lowest-loss window of silica fibre is at:

- (A) 850 nm
- (B) 1310 nm
- (C) 1550 nm
- (D) 650 nm

9. The information carrier in optical communication is:

- (A) Electron
- (B) Photon
- (C) Proton
- (D) Neutron

10. Critical angle formula is:

- (A) $\sin = n_1/n_2$
- (B) $\sin = n_2/n_1$
- (C) $\tan = n_2/n_1$
- (D) $\cos = n_1/n_2$

UNIT II: Optical Fibres and Cables

Part A: Short Answer Questions (20)

Q1. Describe the basic structure of an optical fibre.

Ans: Core (guides light), cladding (lower index, confines light), buffer coating (protection) and outer jacket.

Q2. What is the function of the core?

Ans: The core is the central glass region with higher refractive index through which light travels.

Q3. What is the function of the cladding?

Ans: It has a lower refractive index than the core, causes TIR, reduces scattering loss and protects the core.

Q4. What is a step-index fibre?

Ans: A fibre whose core has a uniform refractive index that changes abruptly to a lower value at the cladding.

Q5. What is a graded-index fibre?

Ans: A fibre whose core refractive index decreases gradually (parabolically) from the centre to the cladding, reducing modal dispersion.

Q6. What is a single-mode fibre?

Ans: A fibre with a very small core (about 8-10 μm) that supports only one mode; used for long-distance, high-speed links.

Q7. What is a multimode fibre?

Ans: A fibre with a larger core (50 or 62.5 μm) that supports many modes; used for short-distance links such as LANs.

Q8. Define acceptance angle.

Ans: The maximum angle at which light can enter the fibre core and still be guided by TIR.

Q9. Define numerical aperture (NA).

Ans: A measure of the light-gathering ability of a fibre: $NA = \sqrt{n_1^2 - n_2^2} = \sin(\text{acceptance angle})$ in air.

Q10. Name the types of optical fibre cables.

Ans: Loose-tube, tight-buffered and ribbon cables; by installation they are aerial, duct, direct-buried and submarine cables.

Q11. Why is a strength member (such as Kevlar) used in a cable?

Ans: It takes the pulling load so the fragile glass fibre is not stressed during installation.

Q12. Name four types of optical fibre connectors.

Ans: ST, SC, FC and LC connectors.

Q13. What is fusion splicing?

Ans: A permanent joint made by aligning two fibre ends and fusing them with an electric arc.

Q14. What is mechanical splicing?

Ans: Joining two fibre ends by aligning them in a sleeve or V-groove and holding them with index-matching gel or clamps.

Q15. Define attenuation in an optical fibre.

Ans: The loss of optical power as light travels along the fibre, measured in dB/km.

Q16. What is absorption loss?

Ans: Loss due to the fibre material (and impurities such as OH ions) absorbing light and converting it to heat.

Q17. What is scattering loss?

Ans: Loss caused by light being scattered in other directions by microscopic density variations in glass (Rayleigh scattering).

Q18. Name the types of bending loss.

Ans: Macrobending (large-radius bends) and microbending (tiny random bends in the fibre axis).

Q19. What is connector loss?

Ans: Power lost at a joint because of misalignment, end gap, end-face roughness or core mismatch.

Q20. What is dispersion and how does it affect data rate?

Ans: Dispersion is the spreading of light pulses as they travel (intermodal and chromatic types). Overlapping pulses limit the maximum data rate and distance.

Part B: Multiple Choice Questions (10)

1. The outermost layer of an optical cable is the:

- (A) Core
- (B) Cladding
- (C) Jacket
- (D) Buffer

2. Numerical aperture is:

- (A) $\sqrt{n_1 + n_2}$
- (B) $\sqrt{n_1^2 - n_2^2}$
- (C) n_1 / n_2
- (D) $n_1 \times n_2$

3. Core diameter of a typical graded-index multimode fibre is:

- (A) 9 μm
- (B) 50 μm
- (C) 500 μm
- (D) 1 mm

4. Rayleigh scattering is caused by:

- (A) Impurity ions
- (B) Sharp bends
- (C) Microscopic density variations in glass
- (D) Connector gaps

5. Kevlar in a fibre cable is used as:

- (A) Optical source
- (B) Strength member
- (C) Detector
- (D) Core material

6. Which of these is a fibre connector?

- (A) BNC
- (B) SC
- (C) RJ-11
- (D) SMA-coax

7. Dispersion causes:

- (A) Pulse broadening
- (B) Pulse amplification
- (C) Higher power
- (D) Lower noise

8. The highest bandwidth is offered by:

- (A) Multimode step-index
- (B) Multimode graded-index
- (C) Single-mode fibre
- (D) Plastic fibre

9. Attenuation in fibre is measured in:

- (A) dB/km
- (B) A/W
- (C) Hz/m
- (D) V/m

10. Macrobending loss increases when bend radius:

- (A) Increases
- (B) Decreases
- (C) Is infinite
- (D) Does not matter

UNIT III: Optical Sources

Part A: Short Answer Questions (20)

Q1. What is the function of an optical source?

Ans: It converts the electrical signal into light that is launched into the fibre.

Q2. Name the two main optical sources used in fibre communication.

Ans: Light Emitting Diode (LED) and Injection Laser Diode (ILD).

Q3. List the requirements of a good optical source.

Ans: Suitable wavelength, high output power, narrow spectral width, fast response, small size matching the fibre, long life and low cost.

Q4. State the principle of an LED.

Ans: Electron-hole recombination in a forward-biased p-n junction emits photons by spontaneous emission.

Q5. What is spontaneous emission?

Ans: Random emission of photons when excited electrons fall to a lower energy level without any external trigger.

Q6. What is stimulated emission?

Ans: Emission of a photon triggered by an incident photon; the new photon has the same phase, frequency and direction.

Q7. What is population inversion?

Ans: A condition in which more electrons are in the higher energy state than in the lower state; it is necessary for LASER action.

Q8. State the principle of LASER.

Ans: Light Amplification by Stimulated Emission of Radiation: stimulated emission with population inversion inside a resonant cavity.

Q9. Describe a surface-emitting (Burros) LED.

Ans: Light is emitted perpendicular to the junction plane through a well etched in the substrate, with the fibre placed directly in the well.

Q10. Describe an edge-emitting LED.

Ans: Light is emitted from the edge of the active layer, giving a narrower beam and better coupling into the fibre.

Q11. Differentiate between homojunction and heterojunction.

Ans: A homojunction uses the same semiconductor on both sides; a heterojunction uses different materials, which confines carriers and light better.

Q12. Why are heterostructure LEDs and lasers preferred?

Ans: They confine charge carriers and light in a thin active layer, giving higher efficiency and lower threshold current.

Q13. What is the resonant cavity in an ILD?

Ans: A Fabry-Perot cavity formed by two parallel cleaved facets that reflect light back and forth to build up stimulated emission.

Q14. Define threshold current of a laser diode.

Ans: The minimum forward current above which stimulated emission dominates and laser output begins.

Q15. Name materials used for optical sources.

Ans: GaAs/AlGaAs for 800-900 nm and InGaAsP/InP for 1300-1600 nm.

Q16. What do you mean by coherent light?

Ans: Light waves with a fixed phase relationship, same frequency and the same direction; LASER output is coherent.

Q17. Compare spectral widths of LED and ILD.

Ans: An LED has a wide spectral width (tens of nm) while an ILD has a very narrow one (a few nm or less).

Q18. Compare LED and ILD in power and speed.

Ans: LED: low power, slower response, simple and cheap. ILD: high power, faster response, costlier and more complex.

Q19. Why does an ILD need temperature control?

Ans: Its threshold current rises with temperature, causing output power drift, so a cooler and feedback circuit are used.

Q20. Where is an LED preferred over a laser diode?

Ans: In short-distance, low-speed links such as LANs because it is cheap, reliable and needs no threshold or complex control.

Part B: Multiple Choice Questions (10)

1. An LED works on the principle of:

- (A) Stimulated emission
- (B) Spontaneous emission
- (C) Avalanche effect
- (D) Photoelectric effect

2. Population inversion is needed in:

- (A) LED
- (B) Photodiode
- (C) LASER
- (D) Resistor

3. Which material is used for 1300 nm sources?

- (A) GaAs
- (B) Silicon
- (C) InGaAsP
- (D) Germanium

4. Beam divergence is larger for:

- (A) ILD
- (B) LED
- (C) Both equally
- (D) Neither

5. A Fabry-Perot cavity is used in:

- (A) LED
- (B) PIN diode
- (C) ILD
- (D) APD

6. Threshold current of an ILD with temperature:

- (A) Decreases
- (B) Increases
- (C) Stays constant
- (D) Becomes zero

7. A Burrus LED is a:

- (A) Edge-emitting LED
- (B) Surface-emitting LED
- (C) Laser
- (D) Detector

8. A heterojunction gives better:

- (A) Carrier and light confinement
- (B) Resistance
- (C) Absorption loss
- (D) Dispersion

9. The modulation speed of ILD compared to LED is:

- (A) Lower
- (B) Higher
- (C) Same
- (D) Zero

10. Light from an LED is:

- (A) Coherent
- (B) Incoherent
- (C) Monochromatic
- (D) Polarised

UNIT IV: Optical Detectors

Part A: Short Answer Questions (20)

Q1. What is the function of a photodetector?

Ans: It converts the received optical signal into an electrical signal.

Q2. List the requirements of a good photodetector.

Ans: High sensitivity, fast response, low noise, small size, stable operation, low bias voltage and low cost.

Q3. Name the photodetectors used in optical communication.

Ans: PIN photodiode and Avalanche Photodiode (APD).

Q4. State the principle of a photodiode.

Ans: Photons with enough energy create electron-hole pairs in a reverse-biased junction, producing a photocurrent.

Q5. Describe the structure of a PIN diode.

Ans: A lightly doped intrinsic (I) layer is sandwiched between heavily doped p and n layers.

Q6. Why is a photodiode operated in reverse bias?

Ans: Reverse bias widens the depletion region and gives a strong field that sweeps carriers quickly, improving speed and efficiency.

Q7. Why is the intrinsic layer added in a PIN diode?

Ans: It widens the depletion region so more photons are absorbed there, and it reduces junction capacitance for faster response.

Q8. Define responsivity.

Ans: The ratio of output photocurrent to incident optical power, in A/W.

Q9. Define quantum efficiency.

Ans: The ratio of the number of electron-hole pairs generated to the number of incident photons.

Q10. What is response time of a detector?

Ans: The time taken for the output to rise from 10% to 90% of its final value after an optical pulse (rise time).

Q11. What is dark current?

Ans: The small current that flows in a photodiode even when no light is incident; it adds noise.

Q12. State the principle of an APD.

Ans: At high reverse bias, photo-generated carriers gain energy and create more carriers by impact ionisation, giving internal gain.

Q13. What is impact ionisation?

Ans: A fast carrier collides with the lattice and knocks out a new electron-hole pair.

Q14. Define avalanche multiplication factor.

Ans: The ratio of the total output photocurrent of the APD to the primary photocurrent before multiplication.

Q15. Compare PIN diode and APD.

Ans: PIN: no gain, low bias voltage, lower noise, cheaper. APD: internal gain, high bias, more sensitive, higher noise, costlier.

Q16. Name the types of noise in optical detectors.

Ans: Shot (quantum) noise, dark-current noise and thermal (Johnson) noise.

Q17. What is shot noise?

Ans: Noise caused by the random generation and arrival of electron-hole pairs.

Q18. What is thermal noise?

Ans: Noise due to random motion of electrons in the load resistor of the receiver; also called Johnson noise.

Q19. Define signal-to-noise ratio (SNR) of a receiver.

Ans: The ratio of signal power to noise power at the detector output.

Q20. Name the materials used for photodetectors and their ranges.

Ans: Silicon (800-900 nm), germanium (800-1600 nm) and InGaAs (1000-1700 nm).

Part B: Multiple Choice Questions (10)

1. A photodiode is normally operated in:

- (A) Forward bias
- (B) Reverse bias
- (C) No bias only
- (D) Breakdown only in PIN

2. Unit of responsivity is:

- (A) V/m
- (B) A/W
- (C) W/A
- (D) Hz

3. Quantum efficiency is the ratio of:

- (A) Photons to current
- (B) Electron-hole pairs to incident photons
- (C) Power to voltage
- (D) Voltage to current

4. Internal gain in an APD is due to:

- (A) Impact ionisation
- (B) Thermal motion
- (C) Diffraction
- (D) Reflection

5. Silicon detectors work best near:

- (A) 850 nm
- (B) 1550 nm
- (C) 10 μm
- (D) 2000 nm

6. InGaAs detectors are used for:

- (A) 300-400 nm
- (B) 1000-1700 nm
- (C) 5-10 μm
- (D) Gamma rays

7. Shot noise arises from:

- (A) Resistor heating
- (B) Random carrier generation
- (C) Poor connectors
- (D) Dispersion

8. Which detector needs a high bias voltage?

- (A) PIN
- (B) APD
- (C) LED
- (D) Solar cell

9. Dark current increases with:

- (A) Temperature
- (B) Wavelength
- (C) Core size
- (D) Fibre length

10. Thermal noise is also called:

- (A) Flicker noise
- (B) Johnson noise
- (C) Quantum noise
- (D) Burst noise

UNIT V: Optical Amplifiers

Part A: Short Answer Questions (20)

Q1. Why are optical amplifiers needed?

Ans: Attenuation weakens the signal over long links, so amplifiers boost it to extend distance.

Q2. What is an optical amplifier?

Ans: A device that amplifies the optical signal directly, without converting it to an electrical signal.

Q3. Name the main types of optical amplifiers.

Ans: Semiconductor Optical Amplifier (SOA), Erbium-Doped Fibre Amplifier (EDFA) and Raman amplifier.

Q4. State the working principle of optical amplifiers.

Ans: A gain medium is pumped to create population inversion; the incoming signal photons then cause stimulated emission and are amplified.

Q5. What is pumping?

Ans: Supplying energy (optical or electrical) to the gain medium to achieve population inversion.

Q6. What does EDFA stand for?

Ans: Erbium-Doped Fibre Amplifier.

Q7. Name the main components of an EDFA.

Ans: Erbium-doped fibre, pump laser, WDM coupler to combine pump and signal, and optical isolators.

Q8. What are the usual pump wavelengths of an EDFA?

Ans: 980 nm and 1480 nm.

Q9. In which wavelength band does an EDFA operate?

Ans: Around 1550 nm (C-band, about 1530-1565 nm), the lowest-loss window.

Q10. Why are isolators used in an EDFA?

Ans: They allow light in one direction only, preventing reflections that cause noise and instability.

Q11. What is an SOA?

Ans: A Semiconductor Optical Amplifier, basically a laser diode with anti-reflection coated facets, so that it amplifies light in a single pass.

Q12. State two advantages of an SOA.

Ans: Compact size and low cost, and it can be integrated with other optical devices.

Q13. State two disadvantages of an SOA.

Ans: Higher noise and crosstalk between channels, and polarisation sensitivity.

Q14. State the principle of a Raman amplifier.

Ans: Stimulated Raman scattering transfers power from a strong pump to the signal at a longer wavelength within the transmission fibre.

Q15. What is a distributed amplifier?

Ans: An amplifier in which the transmission fibre itself acts as the gain medium over a long length, as in Raman amplification.

Q16. Compare an optical amplifier with a regenerative repeater.

Ans: An amplifier boosts light directly, is independent of bit rate and format, but also amplifies noise. A repeater converts to electrical form (O-E-O), regenerates the signal, but depends on bit rate.

Q17. What is amplified spontaneous emission (ASE)?

Ans: Spontaneously emitted photons that get amplified in the gain medium; they are the main noise source in optical amplifiers.

Q18. What is noise figure of an optical amplifier?

Ans: The ratio of input SNR to output SNR; it measures the noise added by the amplifier.

Q19. Name the three positions where amplifiers are used in a link.

Ans: Booster (after the transmitter), in-line (along the link) and pre-amplifier (before the receiver).

Q20. List four advantages of an EDFA.

Ans: High gain (about 30-40 dB), low noise, polarisation insensitive, easy coupling to fibre, and it amplifies many wavelengths at once.

Part B: Multiple Choice Questions (10)

1. EDFA operates mainly near:

- (A) 850 nm
- (B) 1310 nm
- (C) 1550 nm
- (D) 650 nm

2. A common EDFA pump wavelength is:

- (A) 980 nm
- (B) 550 nm
- (C) 2500 nm
- (D) 300 nm

3. The dopant used in an EDFA is:

- (A) Erbium
- (B) Silicon
- (C) Gallium
- (D) Phosphorus

4. A Raman amplifier uses:

- (A) Avalanche effect
- (B) Stimulated Raman scattering
- (C) Photoelectric effect
- (D) Diffraction

5. An SOA is basically a:

- (A) PIN diode with gain
- (B) Laser diode with anti-reflection coated facets
- (C) LED array
- (D) Connector

6. Main noise in optical amplifiers is:

- (A) ASE
- (B) Johnson noise
- (C) Crosstalk only
- (D) Dark current only

7. A pre-amplifier is placed:

- (A) After the transmitter
- (B) Midway in the link
- (C) Just before the receiver
- (D) Inside the source

8. An optical amplifier works without:

- (A) Pump energy
- (B) O-E-O conversion
- (C) Gain medium
- (D) Fibre

9. A booster amplifier is placed at the:

- (A) Receiver input
- (B) Transmitter output
- (C) Middle of the span only
- (D) Detector output

10. Gain saturation means gain:

- (A) Rises with input power
- (B) Reduces at high input power
- (C) Is always zero
- (D) Is independent of pump

MCQ Answer Key

UNIT I: 1-C 2-B 3-B 4-C 5-D 6-A 7-C 8-C 9-B 10-B

UNIT II: 1-C 2-B 3-B 4-C 5-B 6-B 7-A 8-C 9-A 10-B

UNIT III: 1-B 2-C 3-C 4-B 5-C 6-B 7-B 8-A 9-B 10-B

UNIT IV: 1-B 2-B 3-B 4-A 5-A 6-B 7-B 8-B 9-A 10-B

UNIT V: 1-C 2-A 3-A 4-B 5-B 6-A 7-C 8-B 9-B 10-B