

QUESTION BANK

Course Code: ICH501

Course Title: Process Control Instrumentation

Department: Diploma in Instrumentation and Control Engineering

Semester: V.

UNIT I - SIMPLE PROCESS CONTROL SYSTEMS AND TERMINOLOGY

PART A

I. Choose the correct answer

1. A process in which material flows continuously through the system is called
 - A. Batch process
 - B. Continuous process
 - C. Manual process
 - D. Sequential process

Answer: B

2. Which of the following is not a process variable?
 - A. Pressure
 - B. Temperature
 - C. Colour of equipment
 - D. Flow

Answer: C

3. The desired value of the controlled variable is known as
 - A. Error
 - B. Measured value
 - C. Set point
 - D. Controller output

Answer: C

4. The difference between the set point and measured value is called
 - A. Gain
 - B. Offset
 - C. Error
 - D. Sensitivity

Answer: C

5. Which element measures the process variable?

- A. Controller
- B. Control valve
- C. Sensor/Transmitter
- D. Actuator

Answer: C

6. A washing machine is an example of
- A. Continuous process
 - B. Batch process
 - C. Flow process
 - D. Feedback system

Answer: B

7. In the tag PIC-201, the letter P indicates
- A. Pressure
 - B. Position
 - C. Power
 - D. Process

Answer: A

8. Transportation lag is the
- A. Delay due to signal transmission
 - B. Delay caused by movement of material
 - C. Valve hysteresis
 - D. Controller tuning

Answer: B

9. A process which naturally settles after disturbance is called
- A. Oscillatory
 - B. Self-regulation
 - C. Unstable
 - D. Manual

Answer: B

10. P&ID stands for
- A. Plant & Instrument Drawing
 - B. Piping & Instrumentation Diagram
 - C. Pressure & Instrument Diagram
 - D. Process & Instrument Drawing

Answer: B

11. Which instrument compares set point and measured value?

- A. Controller
- B. Comparator
- C. Valve
- D. Sensor

Answer: B

12. The output of the controller is applied to the

- A. Comparator
- B. Final control element
- C. Sensor
- D. Set point

Answer: B

13. A petroleum refinery is an example of

- A. Batch process
- B. Continuous process
- C. Manual process
- D. Discrete process

Answer: B

14. The objective of automatic process control is to

- A. Increase manpower
- B. Maintain process variable
- C. Increase production cost
- D. Reduce sensors

Answer: B

15. A proportional controller is adjusted from a large proportional band to a smaller proportional band. What is the expected effect on the controller action?

- A. Controller gain decreases and response become slower
- B. Controller gain increases and response becomes more sensitive
- C. Offset is completely eliminated
- D. Controller output becomes independent of error

Answer: B

16. Which control mode is used to reduce the effect of sudden changes in the error by responding to the rate of change of error?

- A. Proportional control
- B. Integral control
- C. Derivative control
- D. ON-OFF control

Answer: C

17. Which is an example of a final control element?

- A. Thermocouple
- B. Control valve
- C. Pressure gauge
- D. Indicator

Answer: B

18. The feedback signal is obtained from the

- A. Controller
- B. Measuring element
- C. Valve
- D. Set point

Answer: B

19. ISA standards are mainly used for

- A. Programming
- B. Instrumentation symbols
- C. Pipe sizing
- D. Pump selection

Answer: B

20. Which of the following is mentioned as a difficulty in implementing process control?

- A. High sensitivity towards noise and disturbances
- B. Absence of process variables
- C. Complete absence of time delay
- D. No inter-related variables

Answer: A

21. Error becomes zero when

- A. Set point equals measured value
- B. Valve closes
- C. Controller stops
- D. Process stops

Answer: A

Analytical MCQs (22–30)

22. A food processing plant prepares tomato sauce in separate batches. This type of process is

- A. Continuous process
- B. Batch process
- C. Flow process
- D. Feedback process

Answer: B

23. A water tank is maintained at 4 m. The measured level becomes 3.5 m. The error signal is

- A. 0 m
- B. 0.5 m
- C. 3.5 m
- D. 4.5 m

Answer: B

24. A temperature control system has a long transportation delay between the heater and the temperature sensor. When the heater output is changed, the temperature sensor shows the change only after a certain time. What does this delay represent?

- A. Proportional band
- B. Dead time
- C. Offset
- D. Differential gap

Answer: B

25. A temperature sensor is installed several meters away from a heater. When the heater output is changed, the sensor detects the temperature change only after a certain time. This delay is mainly due to:

- A. Sensor calibration
- B. Transportation lag
- C. Process lag
- D. Valve hysteresis

Answer: B

26. Arrange: Level transmitter, Controller, Control valve, Water tank.

- A. 1→2→3→4

- B. 4→3→2→1
- C. 2→1→3→4
- D. 3→2→1→4

Answer: A

27. LT and LIC in a P&ID represent

- A. LT controls, LIC measures
- B. LT measures level, LIC controls
- C. Both are valves
- D. Both are sensors

Answer: B

28. If the level transmitter fails and sends a constant value,

- A. Controller works correctly
- B. Controller cannot respond to level changes
- C. Valve closes automatically
- D. Set point changes

Answer: B

29. Which instrument directly changes the inlet flow to a tank?

- A. Level transmitter
- B. Comparator
- C. Control valve
- D. Indicator

Answer: C

30. An automation company is designing an automatic water treatment plant.

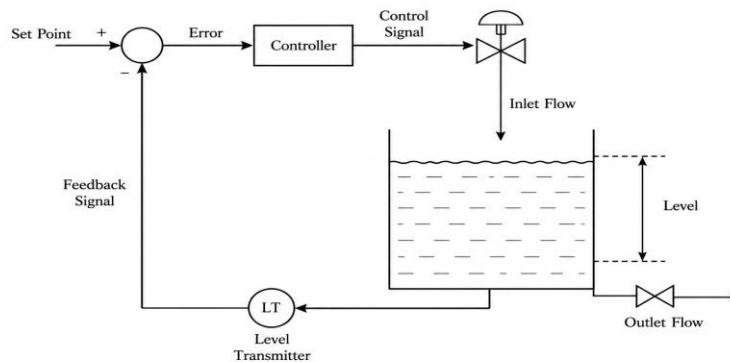
Before developing the control system, the engineers need to understand the process equipment, connections, instruments, and control arrangements involved in the plant. Which document would they primarily use to understand these process operations?

- A. Electrical wiring schedule
- B. Architecture of the plant
- C. Piping and instrumentation diagram
- D. Block diagram of the process

Answer: C

PART B (10 Marks)

1. Explain the functional block diagram of an automatic process control system with a neat sketch. (10 Marks)
 2. Describe a simple temperature control system with process lag.
 3. Explain the working of a liquid level control system with a neat diagram. (10 Marks)
 4. Draw and explain the complete P&ID showing the CSTR, feed line, coolant line, control valves, temperature transmitter, temperature controller, signal lines, cooling jacket, and product/cooling-water outlets. Clearly label all instruments and control elements.
- 5. Analytical Question (10 Marks)**
- A. Identify the controlled variable, manipulated variable, measuring element and final control element. (4 Marks)**



B. State True or False. (2 MARKS)

- a) Temperature, pressure, flow and level are important process variables.
- b) In a continuous process, the material remains stationary at one physical location.
- c) A process in which only one variable is controlled is called a single-variable process.
- d) Process dynamics represents the time response of a process when it is disturbed by load disturbances.

C. Arrange the following steps of a simple temperature control system in the correct sequence. (2 MARKS)

1. Controller compares the measured temperature with the set point.
2. Temperature sensor measures the process temperature.
3. Final control element adjusts the process.
4. Process temperature changes.

D. Select the correct sentence. (2MARKS)

- a. The set point is the actual value measured from the process.
- b. The measured value is the desired value of the process variable.
- c. The error is the difference between the set point and the measured value.
- d. The final control element measures the process variable.

UNIT II – CONTROL PRINCIPLES

PART A

I. Choose the correct answer

1. The primary function of a controller is to
 - A. Measure the process variable
 - B. Compare the measured value with the set point and produce control action
 - C. Increase process pressure
 - D. Reduce pipeline losses

Answer: B

2. A controller whose output increases when the process variable increases is called
 - A. Reverse acting controller
 - B. Direct acting controller
 - C. Two-position controller
 - D. Integral controller

Answer: B

3. In a reverse acting controller,
 - A. Controller output increases with increase in process variable
 - B. Controller output decreases with increase in process variable
 - C. Output remains constant
 - D. Output becomes zero

Answer: B

4. Which controller operates only in two output states?
 - A. P Controller
 - B. PI Controller

- C. ON-OFF Controller
- D. PID Controller

Answer: C

5. The differential gap in an ON-OFF controller is used to
- A. Increase sensitivity
 - B. Eliminate hunting
 - C. Increase gain
 - D. Reduce response speed

Answer: B

6. Proportional controller output is proportional to
- A. Integral of error
 - B. Error
 - C. Rate of change of error
 - D. Process gain

Answer: B

7. Proportional Band PB is expressed in
- A. Volts
 - B. Percentage
 - C. Seconds
 - D. Pascal

Answer: B

8. Increasing proportional band results in
- A. Higher controller gain
 - B. Lower controller gain
 - C. No change in gain
 - D. Infinite gain

Answer: B

9. Offset is eliminated by using
- A. P controller
 - B. D controller
 - C. I controller
 - D. ON-OFF controller

Answer: C

10. Integral controller output depends upon

- A. Present error only
- B. Past history of error
- C. Future error
- D. Controller gain only

Answer: B

11. Derivative controller output depends upon

- A. Error magnitude
- B. Rate of change of error
- C. Integral of error
- D. Set point

Answer: B

12. Derivative control improves

- A. Steady-state error
- B. Stability and response
- C. Offset
- D. Process capacity

Answer: B

13. Which of the following is a possible effect of excessive integral action in a controller?

- A. Elimination of offset only
- B. Faster response without any oscillation
- C. Slow response, overshoot, oscillations and integral wind-up
- D. Complete elimination of process disturbances

Answer: C

14. In a discontinuous controller, the controller output:

- A. Changes continuously with error
- B. Changes only between predetermined values
- C. Is always proportional to error
- D. Is always zero

Answer: B

15. PID controller is mainly used for

- A. Manual control
- B. Industrial process control

- C. Electrical wiring
- D. Signal transmission

Answer: B

16. In electronic controllers, the error signal is generally represented by

- A. Pressure
- B. Voltage
- C. Flow
- D. Temperature

Answer: B

17. The basic element of a pneumatic controller is

- A. Thermocouple
- B. Flapper-Nozzle
- C. Bourdon tube'
- D. Strain gauge

Answer: B

18. Pneumatic relay is mainly used to

- A. Measure pressure
- B. Amplify pneumatic signal
- C. Reduce pressure
- D. Measure flow

Answer: B

19. Which type of controller is commonly used for temperature control in an air conditioner?

- A. ON OFF
- B. PID
- C. P only
- D. D only

Answer: A

20. The equation of a proportional controller contains

- A. Integral term only
- B. Derivative term only
- C. Gain and error
- D. Time constant only

Answer: C

21. Which controller cannot eliminate offset?

- A. Integral
- B. Derivative
- C. Proportional
- D. PI

Answer: C

Analytical MCQs (Q22–Q30)

22. A furnace temperature continues to oscillate because the heater switches ON and OFF repeatedly. Which controller is being used?

- A. PI
- B. ON-OFF
- C. PID
- D. PD

Answer: B

23. A proportional controller leaves a steady-state error after a load disturbance. This error is called

- A. Hysteresis
- B. Offset
- C. Dead time
- D. Gain

Answer: B

24. A controller must eliminate steady-state error in a liquid level system. Which mode should be added?

- A. Derivative
- B. Integral
- C. ON-OFF
- D. Manual

Answer: B

25. A controller reacts immediately to rapid temperature changes before large errors develop. Which control mode provides this action?

- A. Integral
- B. Derivative
- C. ON-OFF
- D. Manual

Answer: B

26.If the proportional band is reduced from 100% to 50%, the controller gain will

- A. Decrease
- B. Double
- C. Become zero
- D. Remain unchanged

Answer: B

27.Which controller is most suitable for a chemical reactor requiring high accuracy and fast response?

- A. ON-OFF
- B. P
- C. PID
- D. D

Answer: C

28.In a pneumatic relay, moving the flapper away from the nozzle causes

- A. Output pressure to decrease
- B. Output pressure to increase
- C. No change
- D. Zero pressure

Answer: A

29.During process start-up, excessive integral action causes

- A. Offset
- B. Integral windup
- C. Dead band
- D. Hunting

Answer: B

30.An instrument is installed inside the control room so that the operator can easily access and monitor it. Which instrument symbol should be used in the P&ID?

- A. Circle with no line
- B. Circle with a solid horizontal line
- C. Circle with a dashed horizontal line
- D. Circle without identifying letters

Answer: B

PART B (10 Marks)

1. Explain the construction and working of an ON-OFF controller with and without differential gap.
2. (a) Explain proportional mode and its characteristics.
(b) Explain the effect of proportional band on controller output.
3. Explain the electronic PID controller with neat circuit diagram and derive its equation.
4. Explain the construction and working of a flapper-nozzle mechanism.

5. Analytical type questions

A. Assertion and Reasoning

Assertion (A): Integral control is used to eliminate offset in a control system.

Reason (R): Integral control continuously responds to the accumulated error.

- A. Both A and R are true, and R is the correct explanation of A.
- B. Both A and R are true, but R is not the correct explanation of A.
- C. A is true, but R is false.
- D. A is false, but R is true.

B. Match the following.

Column I	Column II
A. ON-OFF controller	1. Eliminates offset
B. Proportional controller	2. Provides two-position output
C. Integral controller	3. Produces output proportional to error
D. Derivative controller	4. Responds to rate of change of error

C. State True or False.

- a. An ON-OFF controller is a discontinuous controller.
- b. Increasing the proportional band decreases the proportional controller gain.
- c. Derivative control responds to the rate of change of error.
- d. PID control combines proportional, integral and derivative actions.

D. Select the suitable controller.

A heating process is operating at the desired temperature. When the load changes, the temperature deviates from the set point. The controller brings the

temperature back quickly, but a small difference between the set point and the actual temperature remains. Select the most suitable control action to overcome this problem.

E. Select the correct sentence.

- a. A direct-action controller produces an increase in output when the error increases.
- b. A proportional controller eliminates offset under all operating conditions.
- c. A derivative controller responds to the accumulated error.
- d. An ON-OFF controller produces a continuously varying output.

Unit III – Tuning of Controllers

PART – A

I. Choose the correct answer

1. The process of adjusting the controller parameters to obtain optimum control action is called
- A. Calibration
 - B. Tuning
 - C. Compensation
 - D. Sampling

Answer: B

2. Which of the following is NOT a controller tuning parameter?
- A. K_P
 - B. K_I
 - C. K_D
 - D. K_F

Answer: D

3. Which of the following is a tuning criterion?
- A. Quarter Decay Ratio
 - B. Reynolds Number
 - C. Froude Number
 - D. Mach Number

Answer: A

4. In the Quarter Decay Ratio method, the second peak amplitude is _____ of the first peak.

- A. Equal to
- B. Half of
- C. One-fourth of
- D. Double

Answer: C

5. ISE stands for

- A. Integral of Square Error
- B. Integral of Standard Error
- C. Initial Square Error
- D. Integral of System Error

Answer: A

6. Which time integral performance criterion does not consider the sign (positive or negative) of the error?

- A. ISE
- B. IAE
- C. ITAE
- D. Quarter Decay Ratio

Answer: B

7. ITAE stands for

- A. Integral Time Absolute Error
- B. Integrated Total Absolute Error
- C. Initial Time Average Error
- D. Integral Time Average Error

Answer: A

8. Which performance criterion gives more weight to errors occurring at later times?

- A. ISE
- B. IAE
- C. ITAE
- D. Quarter Decay Ratio

Answer: C

9. In the Process Reaction Curve method, the control loop is operated in

- A. Closed loop
- B. Open loop

- C. Cascade loop
- D. Feedforward loop

Answer: B

10. Which tuning method is also known as the Ultimate Cycle Method?

- A. Process Reaction Curve Method
- B. Ziegler–Nichols Method
- C. Frequency Response Method
- D. Cohen–Coon Method

Answer: B

11. In the Process Reaction Curve method, the tangent is drawn at the

- A. Maximum point
- B. Minimum point
- C. Inflection point
- D. End point

Answer: C

12. A solenoid valve converts _____ into valve movement.

- A. Hydraulic energy
- B. Mechanical energy
- C. Electrical energy
- D. Thermal energy

Answer: C

13. In a linear control valve, equal valve travel produces

- A. Equal percentage change in flow
- B. Equal change in flow rate
- C. Sudden increase in flow
- D. Constant pressure

Answer: B

14. Which performance criterion gives greater penalty to large errors?

- A. IAE
- B. ITAE
- C. ISE
- D. Quarter Decay Ratio

Answer: C

15. In the Ziegler–Nichols method, the controller is initially operated with only _____ action.

- A. Integral
- B. Derivative
- C. Proportional
- D. PI

Answer: C

16. In the Damped Oscillation Method, after obtaining the desired oscillation, the values of T_i and T_d are determined from the measured

- A. Dead time
- B. Process gain
- C. Oscillation period
- D. Steady-state error

Answer: C

17. Knife gate valves are mainly used for

- A. Precise flow control of clean liquids
- B. Slurry and viscous fluids
- C. High-pressure steam control
- D. Gas flow measurement

Answer: B

18. The Damped Oscillation Method aims to obtain a response with a

- A. Half decay ratio
- B. Quarter decay ratio
- C. Zero decay ratio
- D. Unity decay ratio

Answer: B

19. Which tuning method can be used for systems without self-regulation?

- A. Process Reaction Curve Method
- B. Ziegler–Nichols Method
- C. Open Loop Method only
- D. Manual Calibration Method

Answer: B

20. Which of the following is a rotary control valve?

- A. knife valve
- B. Ball valve
- C. Gate valve
- D. Diaphragm valve

Answer: B

Analytical MCQs (22–30)

21. A temperature control loop shows continuous oscillations with constant amplitude after increasing the proportional gain. The engineer notes the gain and oscillation period to determine the controller settings.

Which tuning method is being used?

- A. Process Reaction Curve Method
- B. Damped Oscillation Method
- C. Ziegler–Nichols Ultimate Cycle Method
- D. Frequency Response Method

Answer: C

22. A chemical reactor must reach the set point quickly, but long-lasting errors after the initial disturbance are unacceptable. The engineer chooses a tuning criterion that gives greater weight to errors occurring at later times.

Which performance criterion should be selected?

- A. ISE
- B. IAE
- C. ITAE
- D. Quarter Decay Ratio

Answer: C

23. Two controllers are tested for the same process. Controller A produces a second peak that is one-fourth of the first peak, while Controller B produces a second peak equal to one-half of the first peak.

Which controller satisfies the Quarter Decay Ratio criterion?

- A. Controller A only
- B. Controller B only
- C. Both Controller A and B
- D. Neither Controller A nor B

Answer: A

24. A control valve in a steam line does not reach the exact position commanded by the controller because of friction in the valve stem. To ensure that the valve stem moves precisely to the required position, an additional device is installed between the controller and the actuator.

Which device is most suitable?

- A. I/P Converter
- B. Valve Positioner
- C. Pressure Gauge
- D. Rotameter

Answer: B

25. The function of the LVDT in a P/I converter is to convert

- A. Pressure into displacement
- B. Displacement into an electrical signal
- C. Current into pressure
- D. Voltage into current

Answer: B

26. A storage tank filling system requires a valve that should open completely as soon as the controller sends an ON command. Accurate throttling of flow is not required.

Which valve characteristic is the most suitable?

- A. Linear
- B. Equal Percentage
- C. Quick Opening
- D. Modified Linear

Answer: C

27. A chemical plant requires a control valve in which equal increments in valve travel produce equal increments in flow rate.

Which valve characteristic is most suitable?

- A. Equal percentage
- B. Quick opening
- C. Linear
- D. Modified equal percentage

Answer: C

28. An emergency shutdown system requires a valve that opens immediately when its electrical coil is energized and closes automatically when the power supply fails.

Which valve is best suited for this application?

- A. Globe valve
- B. Butterfly valve
- C. Solenoid valve

D. Needle valve

Answer: C

29. A control valve regulates the flow by moving its valve stem upward and downward in a straight line.

This valve belongs to which type?

A. Rotary valve

B. Linear motion valve

C. Solenoid valve

D. Plug valve

Answer: B

30. Butterfly valves are commonly used for

A. On-off and flow control of large pipelines

B. Measuring pressure

C. Measuring temperature

D. Sampling gases

Answer: A

PART-B

II. Descriptive type questions

1. Explain the Open Loop Response Method for controller tuning with a neat sketch.
2. Explain the Ziegler–Nichols Ultimate Cycle Method with procedure and tuning formulae for P, PI and PID controllers.
3. What is valve positioner? Explain the operation of spring actuator with valve positioner.
4. Explain the operation of I/P converter with neat diagram.

5. Analytical question

A. Assertion and Reason

Assertion (A): A valve positioner improves the accuracy of control valve operation.

Reason (R): A valve positioner ensures that the valve stem reaches the position corresponding to the controller output by overcoming friction and load variations.

1. Both A and R are true, and R is the correct explanation of A.
2. Both A and R are true, but R is not the correct explanation of A.
3. A is true, but R is false.
4. A is false, but R is true.

B. Select the Correct Statement

- a. A butterfly valve is generally used for precise throttling at very low flow rates.
- b. An equal percentage control valve provides equal changes in flow for equal valve travel.
- c. An I/P converter converts a **4–20 mA** signal into a **3–15 psi** pneumatic signal.
- d. A solenoid valve is used only for measuring flow rate.

C. Match the Following

Column A

- a. Globe valve
- b. Butterfly valve
- c. Ball valve
- d. Knife Gate valve

Column B

- 1. Isolation of slurry and pulp
- 2. Precise throttling and flow control
- 3. Large diameter pipelines with low pressure drop
- 4. Quick ON/OFF operation

D. Identify whether the following statements are True or False.

- 1. Signal converters are used to interface electronic controllers with pneumatic control valves.
- 2. The standard output of an I/P converter is 4–20 mA.
- 3. A P/I converter is commonly used to transmit pneumatic signals to electronic controllers or PLCs.
- 4. Both I/P and P/I converters perform the same signal conversion.

E. Arrange the following in the correct order during the operation of a normally closed solenoid valve.

- a. Fluid flows through the valve.
- b. The coil is energized.
- c. The plunger is lifted by the magnetic field.
- d. The valve port opens.
- e. The magnetic field is produced.

UNIT IV – COMPLEX AND DIGITAL CONTROL SYSTEMS
PART A

I. Choose the correct answer

- 1. Feed forward control system acts based on the

- A. Controlled variable
- B. Set point
- C. Measured disturbance
- D. Controller output

Answer: C

2. The main advantage of feed forward control is that it
- A. Eliminates the controller
 - B. Corrects disturbances before they affect the process
 - C. Increases process delay
 - D. Reduces sensor accuracy

Answer: B

3. Feed forward control is commonly used in the control of
- A. Compressor
 - B. Heat exchanger
 - C. Centrifugal pump
 - D. Boiler drum level

Answer: B

4. Which control system reacts only after the process variable deviates from the set point?
- A. Feed forward control
 - B. Cascade control
 - C. Feedback control
 - D. Ratio control

Answer: C

5. Ratio control is used to maintain
- A. Constant pressure
 - B. Constant level
 - C. A fixed ratio between two process variables
 - D. Constant temperature

Answer: C

6. Which of the following is a typical application of ratio control?
- A. Fuel-air ratio control
 - B. pH measurement
 - C. Tank level measurement
 - D. Pressure indication

Answer: A

7. Cascade control uses

- A. One controller
- B. Two controllers
- C. Three controllers
- D. No controller

Answer: B

8. In cascade control, the output of the primary controller becomes the

- A. Manipulated variable
- B. Final control signal
- C. Set point of the secondary controller
- D. Process variable

Answer: C

9. Cascade control improves

- A. Sensor accuracy
- B. Disturbance rejection
- C. Valve size
- D. Instrument range

Answer: B

10. Cascade control of a heat exchanger improves the control of

- A. Outlet temperature
- B. Liquid level
- C. Tank pressure
- D. Flow measurement

Answer: A

11. Cascade control of a distillation column is mainly used to control

- A. Column temperature
- B. Pump speed
- C. Tank level
- D. Motor current

Answer: A

12. DDC stands for

- A. Direct Data Communication
- B. Digital Device Controller

- C. Direct Digital Control
- D. Data Distribution Controller

Answer: C

13. In Direct Digital Control, the controller is a

- A. Pneumatic relay
- B. Hydraulic controller
- C. Digital computer
- D. Mechanical governor

Answer: C

14. The analog signal is converted into a digital signal by using a

- A. D/A converter
- B. A/D converter
- C. Multiplexer
- D. Demultiplexer

Answer: B

15. The computer output is converted into an analog signal by using a

- A. A/D converter
- B. D/A converter
- C. Comparator
- D. Amplifier

Answer: B

16. The control algorithm in a DDC system is stored in the

- A. Sensor
- B. Computer memory
- C. Final control element
- D. Control valve

Answer: B

17. In a multiple-loop DDC system, a single A/D converter serves several measured variables through a

- A. Relay
- B. Multiplexer
- C. Oscillator
- D. Encoder

Answer: B

18. Multiple-loop DDC enables a digital computer to control

- A. One process loop only
- B. Several process loops simultaneously
- C. Temperature only
- D. Pressure only

Answer: B

19. Which control strategy measures the disturbance before it affects the controlled variable?

- A. Feedback control
- B. Feed forward control
- C. ON-OFF control
- D. Manual control

Answer: B

20. Which control strategy maintains a constant ratio between fuel and air?

- A. Feedback control
- B. Cascade control
- C. Ratio control
- D. ON-OFF control

Answer: C

21. Which of the following control systems requires both an A/D converter and a D/A converter?

- A. Feed forward control
- B. Ratio control
- C. Cascade control
- D. Direct Digital Control

Answer: D

Analytical MCQs

22. A heat exchanger experiences a sudden decrease in the inlet fluid temperature. Which control strategy can correct the disturbance before it affects the outlet temperature?

- A. Feedback control
- B. Feed forward control
- C. ON-OFF control
- D. Manual control

Answer: B.

23. A combustion furnace requires the fuel flow to change automatically whenever the air flow changes so that efficient combustion is maintained. Which control strategy is most suitable?

- A. Cascade control
- B. Ratio control
- C. Feedback control
- D. Manual control

Answer: B.

24. A temperature control process has a slow response, while the steam flow changes rapidly. Which control strategy provides faster disturbance rejection?

- A. Feed forward control
- B. Ratio control
- C. Cascade control
- D. ON-OFF control

Answer: C.

25. A chemical plant uses a digital computer to control five independent process loops using a single CPU. Which control strategy is being implemented?

- A. Single-loop feedback control
- B. Multiple-loop Direct Digital Control
- C. Ratio control
- D. Feed forward control

Answer: B. Multiple-loop Direct Digital Control

26. A process engineer wants to maintain a constant fuel-to-air ratio even when the fuel flow changes. Which instrument should be used?

- A. Temperature controller
- B. Ratio controller
- C. Pressure switch
- D. Flow indicator

Answer: B.

27. During the operation of a Direct Digital Control system, the process signal from the transmitter must first be converted before entering the computer. Which device performs this conversion?

- A. D/A converter
- B. A/D converter
- C. Multiplexer
- D. Sample-and-hold circuit

Answer: B.

28. A digital computer has calculated the control action, but the final control valve requires an analog signal. Which device is used to convert the computer output?

- A. A/D converter
- B. Multiplexer
- C. D/A converter
- D. Comparator

Answer: C.

29. A process has frequent measurable disturbances that can be detected before they affect the controlled variable. Which control strategy provides the best performance?

- A. Feedback control
- B. Feed forward control
- C. Manual control
- D. ON-OFF control

Answer: B

30. A refinery uses one A/D converter to receive signals from several transmitters one after another before sending them to the digital computer. Which device makes this possible?

- A. Relay
- B. Multiplexer
- C. Demultiplexer
- D. Amplifier

Answer: B.

PART-B

II. Descriptive type questions

1. Describe feed forward control of heat exchanger with neat diagram.
2. Explain ratio control and its configurations with neat diagram.
3. Explain the cascade control of a distillation column with a neat diagram.
4. Explain the Structure of Direct Digital Control system with a neat block diagram.

5 Analytical type question

A. Assertion and Reason (2 marks)

Assertion (A): Cascade control provides faster disturbance rejection than a single-loop feedback control system.

Reason (R): The secondary controller detects and corrects disturbances before they affect the primary controlled variable.

- A. Both A and R are true, and R is the correct explanation of A.
- B. Both A and R are true, but R is not the correct explanation of A.
- C. A is true, but R is false.
- D. A is false, but R is true.

B. Select the correct statement. (2marks)

- a. Feed forward control acts only after the controlled variable deviates from the set point.
- b. Ratio control maintains a fixed relationship between two process variables.
- c. Cascade control uses only one controller.
- d. Direct Digital Control cannot control multiple process loops.

C. Identify the complex control system. (2marks)

In a distillation column, the temperature controller sends its output as the set point to a flow controller, which controls the steam valve. Identify the complex control system used.

D. Arrange the following steps involved in the operation of a Feed Forward Control of a Heat Exchanger. (2marks)

- 1. The controller calculates the corrective action.
- 2. The inlet fluid temperature is measured.
- 3. The steam control valve is adjusted.
- 4. The outlet temperature is maintained at the desired value.
- 5. The disturbance is detected before it affects the process.

E. State True or False. (2marks)

- 1. Feed forward control requires measurement of the disturbance variable.
- 2. Ratio control maintains a constant ratio between two process variables.
- 3. The primary controller directly controls the final control element in a cascade system.
- 4. DDC systems use an Analog-to-Digital (A/D) converter to convert analog process signals into digital data.

I. Choose the correct answer

1. The main components of a Programmable Logic Controller (PLC) include
- A. CPU, power supply, programming device and I/O modules
 - B. Sensor, transmitter, controller and valve
 - C. Motor, pump, compressor and valve
 - D. Display, keyboard, printer and modem

Answer: A

2. The CPU of a PLC is responsible for
- A. Supplying power to the field devices
 - B. Executing the programmed operations
 - C. Measuring process variables
 - D. Converting AC into DC

Answer: B

3. Which module of a PLC receives signals from sensors and switches?
- A. Output module
 - B. Input module
 - C. Power supply
 - D. Programming device

Answer: B

4. The power supply of a PLC converts the available
- A. DC power into AC power
 - B. AC power into the required DC power
 - C. Analog signal into digital signal
 - D. Digital signal into analog signal

Answer: B

5. Which memory provides permanent storage for the operating system of a PLC?
- A. RAM
 - B. ROM
 - C. Cache memory
 - D. Register

Answer: B

6. The first step in the PLC scan cycle is
- A. Program execution
 - B. Output scan

- C. Input scan
- D. Memory scan

Answer: C

7. In ladder logic programming, the output or end device is represented by a

- A. Switch
- B. Relay
- C. Coil
- D. Rung

Answer: C

8. The smallest collection of hardware in a DCS that can perform closed-loop control is called

- A. Field Control Unit
- B. Local Control Unit
- C. High Level Human Interface
- D. Communication Unit

Answer: B

9. The Local Control Unit (LCU) in a DCS

- A. Interfaces directly to the process
- B. Only displays process values
- C. Only stores the user program
- D. Converts AC power into DC power

Answer: A

10. Which interface allows an operator or instrument engineer to interact directly with the Local Control Unit?

- A. HLHI
- B. LLHI
- C. FCU
- D. CPU

Answer: B

11. The High Level Human Interface (HLHI) provides

- A. Only power supply to the LCU
- B. Increased capability and user friendliness
- C. Direct measurement of process variables
- D. Only field-level control

Answer: B

12.Which of the following is an advantage of a Distributed Control System?

- A. Low flexibility
- B. High level redundancy
- C. Centralized wiring of all devices
- D. Difficult fault diagnosis

Answer: B

13.DCS is widely used in

- A. Chemical and petrochemical plants
- B. Domestic electrical circuits
- C. Personal computers
- D. Simple household appliances

Answer: A

14.Fieldbus is a

- A. Unidirectional communication protocol
- B. Bidirectional communication protocol
- C. Mechanical communication system
- D. Pneumatic communication system

Answer: B

15.The communication speed of Fieldbus mentioned in the study material is

- A. 9.6 kbps
- B. 19.2 kbps
- C. 31.25 kbps
- D. 64 kbps

Answer: C

16.Profibus is also known as

- A. Process Field Bus
- B. Process Feedback Bus
- C. Programmable Field Bus
- D. Process Flow Bus

Answer: A

17.Profibus uses a hybrid access method combining

- A. Master-slave and token passing
- B. Star and ring topology

- C. Analog and pneumatic signals
- D. RTU and ASCII modes

Answer: A

18. Modbus is a

- A. Request-response protocol
- B. Token passing protocol
- C. Analog-only protocol
- D. Pneumatic protocol

Answer: A

19. In Modbus communication, one master can have up to

- A. 15 slaves
- B. 32 slaves
- C. 127 slaves
- D. 247 slaves

Answer: D

20. Which transmission mode of Modbus is compact and faster for normal operation?

- A. ASCII
- B. RTU
- C. HART
- D. Fieldbus

Answer: B

21. Which communication protocol transmits both analog and digital information through a 4–20 mA current loop?

- A. Modbus
- B. Profibus
- C. HART
- D. Fieldbus

Answer: C

Analytical MCQs

22. A manufacturing process uses sensors and switches as inputs and operates motors and other devices according to a programmed sequence. Which system is most suitable for this application?

- A. DCS
- B. PLC

- C. HART
- D. Modbus

Answer: B

23. During PLC operation, the processor has already received the input signals and now determines the required output according to the programmed ladder logic. Which stage is being performed?

- A. Input scan
- B. Program execution
- C. Output scan
- D. Self-test

Answer: B

24. A large chemical plant has several decentralized controllers that communicate through a network, while operators monitor the entire process from a control room. Which system is being used?

- A. PLC
- B. DCS
- C. Modbus
- D. HART

Answer: B

25. An instrument engineer needs to directly change set points and control configuration of a Local Control Unit. Which interface should be used?

- A. HLHI
- B. LLHI
- C. FCU
- D. Fieldbus

Answer: B

26. A manufacturing plant wants to connect instruments from different manufacturers on the same industrial network while reducing the amount of cabling required. Which communication protocol is appropriate?

- A. HART
- B. Modbus
- C. Fieldbus
- D. Profibus

Answer: C

27. An industrial communication system uses a centralized master-slave system together with decentralized token passing. Which protocol is being used?

- A. Fieldbus
- B. Profibus
- C. Modbus
- D. HART

Answer: B

28. A process plant requires a request-response communication system in which one master exchanges messages with several slave devices. Which protocol is most suitable?

- A. HART
- B. Fieldbus
- C. Profibus
- D. Modbus

Answer: D

29. A technician wants to communicate with a smart field instrument while transmitting analog and digital information together through the same 4–20 mA current loop. Which protocol should be selected?

- A. Profibus
- B. Modbus
- C. HART
- D. Fieldbus

Answer: C

30. A plant requires a communication protocol that can connect up to 15 devices in multidrop fashion and can also support point-to-point communication. Which protocol is suitable?

- A. Modbus
- B. Profibus
- C. Fieldbus
- D. HART

Answer: D

PART-B

II. Descriptive type questions

1. Explain the architecture of a Programmable Logic Controller with a neat block diagram.
2. Develop a ladder logic program for On- Off control of level process.

3. Explain the architecture and components of a Distributed Control System with a neat block diagram.
4. Explain Modbus and HART communication protocol.

5. Analytical Questions

A. Assertion and Reason

Assertion (A): A PLC can control an industrial process automatically using programmed ladder logic.

Reason (R): The PLC receives signals from input devices, executes the programmed logic and sends signals to output devices.

- A. Both A and R are true, and R is the correct explanation of A.
- B. Both A and R are true, but R is not the correct explanation of A.
- C. A is true, but R is false.
- D. A is false, but R is true.

B. Select the correct statement.

- a. The LCU in a DCS interface directly to the process.
- b. HLHI can interface directly with the process only through field sensors.
- c. Fieldbus is a unidirectional communication protocol.
- d. Modbus does not use a master-slave relationship.

C. Match the following:

Column I	Column II
A. CPU	1. Stores the user program
B. RAM	2. Receives signals from field devices
C. Input Module	3. Executes programmed operations
D. Scan Time	4. Time required to complete one PLC cycle

D. Identify the logic gate and draw the ladder logic.

A PLC receives signals from two input switches and operates an output device only when both switches are ON. Identify the logic operation and draw the corresponding ladder logic.

E. State True or False.

- a. The CPU of a PLC executes the programmed operations.
- b. The input scan is performed before the program execution stage.
- c. The Local Control Unit (LCU) in a DCS interface directly to the process.
- d. Modbus communication uses a request-response method with a master-slave relationship.

