

**ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2023
EXAMINATION CATEGORY: TECHNICAL**

PAPER III: SUBJECT SPECIALISATION PAPER FOR METEOROLOGY AND CLIMATE STUDIES

Date	: October 7, 2023
Total Marks	: 100
Writing Time	: 150 minutes (2.5 hours)
Reading Time	: 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
Part II - 4 Short Answer Questions
All questions under SECTION A are **COMPULSORY**.
 - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part on a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **7 printed pages**, including this instruction page.

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SECTION A

PART I: Multiple Choice Questions [30 marks]

1. What is the primary role of an instrumentation engineer?
 - A. To design electrical circuits
 - B. To control industrial processes
 - C. To develop software applications
 - D. To construct buildings

2. What does DCS stand for in the context of industrial automation?
 - A. Digital Control System
 - B. Distributed Control System
 - C. Dynamic Control System
 - D. Direct Control System

3. What is the primary function of a transducer in instrumentation?
 - A. To convert electrical signals into physical parameters
 - B. To convert physical parameters into electrical signals
 - C. To transmit signals over long distances
 - D. To store historical data

4. Which of the following is NOT a common temperature measurement unit?
 - A. Kelvin
 - B. Fahrenheit
 - C. Ampere
 - D. Celsius

5. What does PID stand for in the context of control systems?
 - A. Proportional-Integral-Derivative
 - B. Pressure and Density
 - C. Process Instrumentation Device
 - D. Programmable Integration for Devices

6. What is a PLC (Programmable Logic Controller) primarily used for in industrial automation?
 - A. To measure pressure
 - B. To control processes
 - C. To record historical data
 - D. To design graphical user interfaces

7. Which communication protocol is commonly used for connecting networked sensors in industrial IoT (Internet of Things) applications?
 - A. HTTP
 - B. Modbus
 - C. Bluetooth
 - D. USB

8. What is the primary advantage of using networked sensors in industrial applications?
 - A. Lower cost
 - B. Simplicity of installation
 - C. Enhanced data sharing and communication
 - D. Reduced power consumption

9. What is the primary role of a safety instrumented system (SIS) in industrial processes?
 - A. To increase production efficiency
 - B. To enhance process control
 - C. To ensure process safety
 - D. To monitor environmental conditions

10. In microcontroller programming, what does the term "bit-banging" refer to?
 - A. A method of debugging code by examining individual bits in the microcontroller's memory.
 - B. A technique for programming microcontrollers using binary code.
 - C. The process of manually setting or clearing individual bits in a microcontroller's I/O registers to control external devices.
 - D. A method for overclocking a microcontroller to achieve higher clock speeds.

11. In optimization techniques, what does the term "GA" typically stand for?
 - A. General Algorithm
 - B. Genetic Algorithm
 - C. Gradient Ascent
 - D. Global Adjustment

12. What does HMI stand for in control systems?
 - A. Human-Machine Interaction
 - B. High-Memory Integration
 - C. Hardware Module Interface
 - D. Human-Machine Interface

13. Which of the following signals is not considered a continuous-time signal in the context of signals and systems?
 - A. Sinusoidal signal
 - B. Impulse (Dirac delta) signal
 - C. Square wave signal
 - D. Discrete-time exponential signal

14. In a control system, what is the term for the difference between the desired value and the actual value of the controlled parameter?
 - A. Error
 - B. Setpoint
 - C. Actuator
 - D. Sensor

15. What is the primary purpose of a data logger in instrumentation?
- A. To calibrate sensors
 - B. To archive real-time data
 - C. To control actuators
 - D. To interface with PLCs
16. What is feedforward control in a control system?
- A. A control strategy that uses feedback from sensors to make adjustments
 - B. A control strategy that anticipates disturbances and makes adjustments in advance
 - C. A control strategy that uses proportional control only
 - D. A control strategy that operates in open-loop mode
17. What does the acronym SNR stand for in the context of instrumentation?
- A. Signal-to-Noise Ratio
 - B. Sensor Network Range
 - C. Software Network Routing
 - D. Signal Network Response
18. What is the term for the time it takes a system to return to equilibrium after a disturbance?
- A. Dead time
 - B. Response time
 - C. Settling time
 - D. Delay time
19. What is the primary purpose of a load cell in industrial applications?
- A. To measure temperature
 - B. To measure force or weight
 - C. To measure pressure
 - D. To measure pH
20. In control systems, what is the term for the process variable that the controller is trying to maintain at a specific value?
- A. Error
 - B. Setpoint
 - C. Actuator
 - D. Sensor
21. What is the primary purpose of a proximity sensor in industrial automation?
- A. To measure humidity
 - B. To detect the presence or absence of an object
 - C. To control temperature
 - D. To calibrate instruments
22. In industrial instrumentation, what is the purpose of a safety interlock system?
- A. To calibrate sensors
 - B. To enhance communication between instruments
 - C. To prevent or mitigate hazardous incidents
 - D. To measure flow rates in a process

23. What is the function of the Domain Name System (DNS) in computer communication?
- A. It encrypts data for secure transmission.
 - B. It assigns IP addresses to devices on a network.
 - C. It translates domain names into IP addresses.
 - D. It establishes direct connections between devices.
24. In hydraulic systems, what is the primary function of a hydraulic pump?
- A. To store hydraulic fluid for later use.
 - B. To control the flow of hydraulic fluid.
 - C. To generate pressure and provide the energy to move hydraulic actuators.
 - D. To filter and purify hydraulic fluid.
25. What is the main advantage of using pneumatic systems in industrial applications?
- A. Higher power density compared to hydraulic systems.
 - B. Reduced maintenance requirements and longer lifespan.
 - C. Precision control and accuracy in positioning.
 - D. Compatibility with a wide range of fluids.
26. In power electronics, what is the primary function of an inverter?
- A. To convert DC (Direct Current) into AC (Alternating Current).
 - B. To regulate the voltage supplied to electronic devices.
 - C. To store electrical energy in batteries.
 - D. To condition power quality for sensitive equipment.
27. What is the primary function of switchgear in an electrical distribution system?
- A. To generate electrical power.
 - B. To protect electrical circuits from overloads and faults.
 - C. To measure electrical energy consumption.
 - D. To provide electrical outlets for appliances.
28. What is the purpose of a circuit breaker in electrical control gear?
- A. To measure voltage and current.
 - B. To provide power to electrical loads.
 - C. To disconnect electrical circuits in case of overcurrent or short circuits.
 - D. To control the speed of electric motors.
29. In the context of instrumentation, what does the term "calibration" refer to?
- A. The process of converting analog signals to digital signals.
 - B. Adjusting an instrument to ensure accurate and consistent measurements.
 - C. The maximum measurement range of an instrument.
 - D. The display unit used to visualize measurement values.
30. What is the primary purpose of a digital filter in digital signal processing?
- A. To convert analog signals to digital signals.
 - B. To remove noise and unwanted components from digital signals.
 - C. To increase the sampling rate of a signal.
 - D. To modulate digital signals for transmission.

PART II – Short Answer Questions [20 marks]

This part has 4 short Answer Questions. Answer all the questions. Each question carries 5 marks.

1. What is the role of a Distributed Control System (DCS) in industrial automation? Discuss the advantages and key features of a DCS compared to traditional control systems.
2. Explain the role of a circuit breaker in electrical switchgear, and describe the different types of circuit breakers commonly used in electrical distribution systems.
3. Discuss the concept of feedback control and feedforward control in industrial processes. Provide examples of situations where each control strategy is most effective.
4. Why and how important is calibration and maintenance in instrumentation and control engineering?

SECTION B: Case Study [50 marks]

Choose either Case I or Case II from this section. Each case study carries 50marks. The mark for each question is indicated in the brackets

Case I: Automated Water Treatment Plant

You are working as an instrumentation and control engineer for a municipal water treatment plant. The plant is responsible for treating and distributing clean drinking water to the city's residents. The plant utilizes various instruments, sensors, and control systems to ensure the water treatment process is efficient, safe, and meets regulatory standards.

Recently, the plant has been experiencing challenges with the pH control system. The pH levels of the treated water are fluctuating outside the acceptable range, resulting in potential water quality issues. Your task is to investigate the issue and propose a solution by answering the following questions:

1. What instrumentation and control components are likely to be involved in monitoring and controlling pH levels in the water treatment process? (5 marks)
2. How would you approach diagnosing the problem with the pH control system? (10 marks)
3. What steps would you take to bring the pH control system back within the acceptable range? (15 marks)
4. How can data logging and historical data analysis assist in resolving this issue? (5 marks)
5. What preventive measures can be implemented to avoid similar problems in the future? (15 marks)

Case II : Control System Optimization for a Chemical Plant

You have been assigned as a control engineer to optimize the control system of a chemical manufacturing plant. The plant produces various chemical products, and precise control of temperature, pressure, and flow rates is crucial to ensure product quality and safety. However, the existing control

system is outdated and has limitations. Describe the steps you would take to assess the existing system, propose improvements, and implement the necessary changes to enhance the plant's control capabilities.

Questions:

1. What are the key challenges and limitations of the existing control system in the chemical plant? (5 marks)
2. How would you assess the performance of the current control system and identify areas that need improvement? (10 marks)
3. Outline the steps involved in proposing and implementing control system improvements? (15 marks)
4. What control strategies and technologies would you consider to enhance temperature, pressure, and flow control? (10 marks)
5. What benefits can the chemical plant expect to achieve after the control system optimization is complete? (10 marks)

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