

**THE NATIONAL COUNCIL OF EXAMINERS FOR ENGINEERING AND SURVEYING
PRINCIPLES AND PRACTICE OF ENGINEERING EXAMINATION**

CONTROL SYSTEMS

EFFECTIVE October 2003

Approximate
Percentage of
the Examination

I. Measurement

24%

1. Sensor technologies applicable to the desired type of measurement (e.g., flow, pressure, level, temperature, analytical, counters, motion, vision)
2. Sensor characteristics (e.g., rangeability, accuracy and precision, temperature effects, response times, reliability, repeatability)
3. Material compatibility
4. Calculations involved in: Pressure drop
5. Calculations involved in: Flow element sizing
6. Calculations involved in: Level, differential pressure
7. Calculations involved in: Unit conversions
8. Calculations involved in: Velocity
9. Calculations involved in: Linearization
10. Installation details (e.g., process, pneumatic, electrical)

II. Signals and Transmission

12.5%

A. Signals

11.25%

1. Pneumatic, electronic, optical, hydraulic, digital, analog
2. Transducers (e.g., analog/digital [A/D], digital/analog [D/A], current/pneumatic [I/P] conversion)
3. Intrinsically Safe (IS) barriers
4. Grounding, shielding, segregation, AC coupling
5. Basic signal circuit design (e.g., two-wire, four-wire, isolated outputs, loop powering)
6. Calculations: Circuit (voltage, current, impedance)
7. Calculations: Unit conversions

B. Transmission

1.25%

1. Different communications systems architecture and protocols (e.g., fiber optics, coaxial cable, wireless, paired conductors, fieldbus, Transmission Control Protocol/Internet Protocol [TCP/IP], OLE Process Control [OPC])
2. Distance considerations versus transmission medium

III. Final Control Elements	20%
<ul style="list-style-type: none"> A. Valves 12.5% <ul style="list-style-type: none"> 1. Types (e.g., globe, ball, butterfly) 2. Characteristics (e.g., linear, low noise, equal percentage, shutoff class) 3. Calculation (e.g., sizing, split range, noise, actuator, speed, pressure drop, air/gas consumption) 4. Applications of fluid dynamics (e.g., cavitation, flashing, choked flow, Joule-Thompson effects, two-phase) 5. Material selection based on process characteristics (e.g., erosion, corrosion, plugged, extreme pressure, temperature) 6. Accessories (e.g., limit switches, solenoid valves, positioners, transducers, air regulators) 7. Environmental constraints (e.g., fugitive emissions, packing, special sealing) 8. Installation practices (e.g., vertical, horizontal, bypasses, troubleshooting) B. Pressure Relieving Devices 5% <ul style="list-style-type: none"> 1. Pressure relieving valves: Types (e.g., conventional spring, balanced bellows, pilot operated) 2. Pressure relieving valves: Characteristics (e.g., modulating, pop action) 3. Pressure relieving valves: Calculations (e.g., sizing considering inlet pressure drop, back pressure, multiple valves) 4. Pressure relieving devices: Material selection based on process characteristics 5. Pressure relieving valves: Installation practices (e.g., linking valves, sparing the valves, accessibility for testing, car sealing inlet valves, piping installation) 6. Rupture discs (types, characteristics, application, calculations) C. Other Final Control Elements 2.5% <ul style="list-style-type: none"> 1. Motor controls 2. Solenoid valves 3. On-off devices/relays 4. Self-regulating devices 	
IV. Control Systems Analysis	16%
<ul style="list-style-type: none"> A. Documentation 7.5% <ul style="list-style-type: none"> 1. Drawings (e.g., PFD, P&ID, loop diagrams, ladder diagrams, logic drawings, cause and effects drawings, SAFE charts) B. Theory 6% <ul style="list-style-type: none"> 1. Basic processes (e.g., compression, combustion, distillation, hydraulics) 2. Process dynamics (e.g., loop response, P-V-T relationships, simulations) 3. Basic control (e.g., regulatory control, feedback, feed forward, cascade, ratio, PID, split-range) 4. Discrete control (e.g., relay logic, Boolean algebra) 5. Sequential control (e.g., batch) C. Safety 2.5% <ul style="list-style-type: none"> 1. Safety system design (e.g., Safety Instrumented System [SIS], Safety Requirements Specification [SRS], application of OSHA 1910) 	

V. Control Systems Implementation

20%

1. HMI (e.g., graphics, alarm management, trending, historical data)
2. Ergonomics (e.g., human factors engineering, physical control room arrangement, panel layout)
3. Configuration and programming (e.g., PLC, DCS, hybrid systems, SQL, ladder logic, sequential function chart, structured text, function block programming, database management, specialized controllers)
4. System comparisons and compatibilities (e.g., advantages and disadvantages of system architecture)
5. Installation requirements (e.g., shielding, constructability, input/output termination, environmental, heat load calculations, power load requirements, purging, lighting)
6. Commissioning (e.g., performance tuning, loop checkout)
7. Safety Instrumented System [SIS] model validation calculations (e.g., Safety Integrity Level [SIL], reliability, availability)
8. Troubleshooting (e.g., root cause failure analysis and correction)

VI. Codes, Standards, and Regulations

7.5%

1. Working knowledge of applicable codes, standards, and regulations: American National Standards Institute (ANSI)
2. Working knowledge of applicable codes, standards, and regulations: Institute of Electrical & Electronics Engineers (IEEE)
3. Working knowledge of applicable codes, standards, and regulations: Instrumentation, Systems & Automation Society (ISA)
4. Working knowledge of applicable codes, standards, and regulations: National Electrical Code (NEC)
5. Working knowledge of applicable codes, standards, and regulations: National Electrical Manufacturers Association (NEMA)
6. Working knowledge of applicable codes, standards, and regulations: National Fire Protection Association (NFPA)
7. Working knowledge of applicable codes, standards, and regulations: Occupational Safety and Health Administration (OSHA)

Total

100%

Notes:

The knowledge areas specified as 1., 2., 3., ... etc., are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.

This examination contains 80 multiple-choice questions. Examinee works all questions.