NCEES
advancing licensure for engineers and surveyors

NCEES Principles and Practice of Engineering Examination
CONTROL SYSTEMS Exam Specifications

Effective Beginning with the October 2011 Examinations

- The exam is an 8-hour open-book exam. It contains 40 multiple-choice questions in the 4-hour morning session, and 40 multiple-choice questions in the 4-hour afternoon session. Examinee works all questions.
- The exam uses both the International System of units (SI) and the US Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.

	Approximate Number of Questions
I. Measurement	**16**
A. Sensor technologies applicable to the desired type of measurement (e.g., flow, pressure, level, temperature, analytical, counters, motion, vision)	
B. Sensor characteristics (e.g., rangeability, accuracy and precision, temperature effects, response times, reliability, repeatability)	
C. Material compatibility	
D. Calculations involved in pressure drop	
E. Calculations involved in flow element sizing	
F. Calculations involved in level, differential pressure	
G. Calculations involved in unit conversions	
H. Calculations involved in velocity	
I. Calculations involved in linearization	
J. Installation details (e.g., process, pneumatic, electrical, location)	
II. Signals, Transmission, and Networking	**12**
A. Signals	4
1. Pneumatic, electronic, optical, hydraulic, digital, analog, buses	
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, buses)	
6. Circuit calculations (voltage, current, impedance)	
7. Unit conversion calculations	

B. Transmission 4

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

C. Networking (e.g., routers, bridges, switches, firewalls, gateways, network loading, error checking, bandwidth, crosstalk, parity) 4

III. Final Control Elements 16

A. Valves 7

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. Selection of motive power (e.g., hydraulic, pneumatic, electric)
5. Applications of fluid dynamics (e.g., cavitation, flashing, choked flow, Joule-Thompson effects, two-phase)
6. Material selection based on process characteristics (e.g., erosion, corrosion, plug, extreme pressure, temperature)
7. Accessories (e.g., limit switches, solenoid valves, positioners, transducers, air regulators, servo amp)
8. Environmental constraints (e.g., fugitive emissions, packing, special sealing)
9. Installation practices (e.g., vertical, horizontal, bypasses, location, troubleshooting)

B. Pressure Relieving Devices 3

1. Pressure relieving valve types (e.g., conventional spring, balanced bellows, pilot operated)
2. Pressure relieving valve characteristics (e.g., modulating, pop action)
3. Pressure relieving valve calculations (e.g., sizing considering inlet pressure drop, back pressure, multiple valves)
4. Pressure relieving device material selections based on process characteristics
5. Pressure relieving valve installation practices (e.g., linking valves, sparing the valves, accessibility for testing, car sealing inlet valves, piping installation)
6. Rupture discs (e.g., types, characteristics, application, calculations)

C. Motor Controls 4

1. Types (e.g., motor starters, variable speed drives)
2. Applications (e.g., speed control, soft starters, valve actuators)
3. Calculations (e.g., sizing, tuning, location)
4. Accessories (e.g., encoders, positioners, relays, limit switches)
5. Troubleshooting (e.g., root cause failure analysis and correction)

D. Other Final Control Elements 2

1. Solenoid valves (e.g., types, sizing)
2. On-off devices/relays (e.g., types, applications)
3. Self-regulating devices (e.g., types, sizing, pressure, temperature, level, and flow regulators)

IV. Control Systems 18

A. Drawings (e.g., process flow diagrams, P&IDs, loop diagrams, ladder diagrams, logic drawings, cause and effects drawings, electrical drawings) 4

B. Theory 6

1. Basic processes (e.g., compression, combustion, evaporation, distillation, hydraulics, reaction, dehydration, heat exchangers, crystallization, filtration)
2. Process dynamics (e.g., loop response, pressure-volume-temperature 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, assembly, conveying, CNC)

C. Implementation 8

1. HMI (e.g., graphics, alarm management, trending, historical data)
2. Configuration and programming (e.g., PLC, DCS, hybrid systems, SQL, ladder logic, sequential function chart, structured text, function block programming, data base management, specialized controllers)
3. System comparisons and compatibilities (e.g., advantages and disadvantages of system architecture, distributed architecture, remote I/O, buses)
4. Installation requirements (e.g., shielding, constructability, input/output termination, environmental, heat load calculations, power load requirements, purging, lighting)
5. Network security (e.g., firewalls, routers, switches, protocols)
6. System testing (e.g., factory acceptance test, integrated system test, site acceptance test)
7. Commissioning (e.g., performance tuning, loop checkout)
8. Troubleshooting (e.g., root cause failure analysis and correction)

V. Safety Systems 12

A. Basic documentation (e.g., safety requirements specification, logic diagrams, test procedures, SIL selection report) 2

B. Theory 4

1. Reliability (e.g., bathtub curve, failure rates)
2. SIL selection (e.g., risk matrix, risk graph, LOPA)

C. Implementation 6

1. Safety system design (e.g., I/O assignments, redundancy, segregation, software design)
2. Safety integrity level (SIL) verification calculations
3. Testing (e.g., methods, procedures, documentation)
4. Management of change (e.g., scope of change, impact of change)

VI. Codes, Standards, and Regulations 6

A. American National Standards Institute (ANSI)

B. American Petroleum Institute (API)

C. American Society of Mechanical Engineers (ASME)

D. International Electrotechnical Commission (IEC)

E. Institute of Electrical & Electronics Engineers (IEEE)

F. International Society of Automation (ISA)

G. National Electrical Code (NEC)

H. National Electrical Manufacturers Association (NEMA)

I. National Fire Protection Association (NFPA)

J. Occupational Safety & Health Administration (OSHA)