# NCEES_Principles_and_Practice_of_Engineering_Examination

## CONTROL SYSTEMS

| DAY | Topic/ Number of Questions | Knowledge Area | √ | DAY | Topic/ Number of Questions | Knowledge Area | √ |
|---|---|---|---|---|---|---|---|
| 1 | I. Measurement 20 A. Sensors 10 | 1. Sensor technologies applicable to general measurement (e.g., flow, pressure, level, temperature, counters, motion) | | 51 | III. Final Control Elements 16 A. Valves 8 | 8. Environmental constraints (e.g., fugitive emissions, packing, special sealing, fire rating) | |
| 2 | | 2. Sensor technologies applicable to general analytical instruments and sampling systems (e.g., pH, ORP, density, O2, conductivity, effects of sampling systems, GC) | | 52 | | 9. Installation practices (e.g., vertical, horizontal, bypasses, location, flow direction) | |
| 3 | | 3. Sensor technologies applicable to fire and gas detection | | 53 | III. Final Control Elements 16 B. Pressure Relieving Devices 3 | 1. Pressure relieving valve types (e.g., conventional spring, balanced bellows, pilot operated) | |
| 4 | | 4. Sensor technologies applicable to machinery monitoring and protection (e.g., vibration, bearing temperature, lube oil pressures, thrust, speed) | | 54 | Rest | Rest | |
| 5 | | 5. Sensor characteristics (e.g., rangeability, accuracy and precision, temperature effects, response times, reliability, repeatability, maintenance, calibration) | | 55 | III. Final Control Elements 16 B. Pressure Relieving Devices 3 | 2. Pressure relieving valve characteristics (e.g., modulating, pop action) | |
| 6 | Rest | Rest | | 56 | | 3. Pressure relieving valve calculations (e.g., sizing considering inlet pressure drop, back pressure, multiple valves) | |
| 7 | I. Measurement 20 A. Sensors 10 | 6. Sensor selection (e.g., plugging service, process severity, environmental effects and constraints, costs) | | 57 | | 4. Material selection based on process characteristics | |
| 8 | | 7. Material compatibility | | 58 | | 5. Pressure relieving valve installation practices (e.g., linking valves, sparing the valves, accessibility for testing, car sealing inlet valves, piping installation, combination devices) | |
| 9 | | 8. Installation details (e.g., process, pneumatic, electrical, location, maintenance, calibration) | | 59 | | 6. Rupture discs and buckling pin valves (e.g., types, characteristics, application, calculations) | |
| 10 | I. Measurement 20 B. Flow, Level, and Pressure Calculations 8 | 1. Flow (e.g., element sizing, pressure-temperature compensation, mass/volume) | | 60 | Rest | Rest | |
| 11 | | 2. Level | | 61 | III. Final Control Elements 16 C. Motor Controls 3 | 1. Types (e.g., motor starters, variable-speed drives) | |
| 12 | Rest | Rest | | 62 | | 2. Applications (e.g., speed control, soft starters, motor-operated valve actuators) | |
| 13 | I. Measurement 20 B. Flow, Level, and Pressure Calculations 8 | 3. Pressure drop | | 63 | | 3. Calculations (e.g., sizing, tuning, location) | |
| 14 | I. Measurement 20 C. General Calculations 2 | 1. Unit conversions | | 64 | | 4. Accessories (e.g., encoders, positioners, relays, limit switches) | |
| 15 | | 2. Velocity | | 65 | III. Final Control Elements 16 D. Other Final Control Elements 2 | 1. Motion (e.g., damper controls, types, orientation, actuators, servos, encoders) | |
| 16 | | 3. Square root extraction and interpolation | | 66 | Rest | Rest | |
| 17 | | 4. Variables involved in wake frequency calculations (e.g., thermowell length/ diameter, velocity, natural frequency, wake frequency) | | 67 | III. Final Control Elements 16 D. Other Final Control Elements 2 | 2. Solenoid valves (e.g., types, sizing) | |
| 18 | Rest | Rest | | 68 | | 3. On-off devices/relays (e.g., types, applications, energize and de-energize to trip) | |
| 19 | II. Control Systems 20 A. Drawings 3 | 1. Drawings (e.g., process flow diagrams, P&IDs, loop diagrams, ladder diagrams, logic drawings, cause and effects drawings, electrical drawings, schematics, wiring diagrams) | | 69 | | 4. Self-regulating devices (e.g., types, sizing, pressure, temperature, level, and flow regulators) | |
| 20 | II. Control Systems 20 B. Theory 8 | 1. Basic control of processes (e.g., pumps, compression, combustion, evaporation, distillation, hydraulics, reaction, dehydration, heat exchangers, crystallization, filtration, refrigeration, fluidization) | | 70 | IV. Signals, Transmission, and Networking 12 A. Signals 6 | 1. Pneumatic, electronic, optical, hydraulic, digital, analog, buses, wireless, thermocouple | |
| 21 | | 2. Process dynamics (e.g., loop response, pressure-volume-temperature relationships, simulations) | | 71 | | 2. Transducers (e.g., analog/digital [A/D], digital/analog [D/A], current/ pneumatic [I/P] conversion, current/current [I/I], splitters, filters) | |
| 22 | | 3. Basic control (e.g., regulatory control, feedback, feedforward, cascade, ratio, PID, split-range, gap control) | | 72 | Rest | Rest | |
| 23 | | 4. Discrete control (e.g., relay logic, Boolean algebra, aliasing) | | 73 | IV. Signals, Transmission, and Networking 12 A. Signals 6 | 3. Hazardous area classification and instrument installation techniques (e.g., intrinsically safe [IS] barriers, cabinet purges, non-incendive) | |
| 24 | Rest | Rest | | 74 | | 4. Grounding, shielding, segregation, electromagnetic interference | |
| 25 | II. Control Systems 20 B. Theory 8 | 5. Sequential control (e.g., batch, assembly, conveying, CNC, state machine, sequential function chart) | | 75 | | 5. Basic signal circuit design (e.g., two-wire, four-wire, isolated outputs, loop powering, buses) | |
| 26 | II. Control Systems 20 C. Implementation 7 | 1. HMI (e.g., graphics, alarm management, trending, historical data, operator panels) | | 76 | | 6. Circuit calculations (voltage, current, impedance, power) | |
| 27 | | 2. Equipment layout (e.g., human factors engineering, physical control room arrangement, panel layout) | | 77 | | 7. Unit conversion calculations | |
| 28 | | 3. Limited variability programming languages for DCS and PLC (e.g., IEC 61131-3 languages/ladder diagrams, function blocks, sequential function charts, structured text, instruction list) | | 78 | Rest | Rest | |
| 29 | | 4. System design comparisons and compatibilities (e.g., advantages and disadvantages of system architecture, distributed architecture, remote I/O, buses, wireless) | | 79 | IV. Signals, Transmission, and Networking 12 B. Transmission 4 | 1. Different communication systems architecture and protocols (e.g., fiber optics, coaxial cable, wireless, paired conductors, buses, transmission control protocol/internet protocol [TCP/IP], OPC) | |
| 30 | Rest | Rest | | 80 | | 2. Distance considerations versus transmission medium (e.g., data rates, sample rates) | |
| 31 | II. Control Systems 20 C. Implementation 7 | 5. Installation requirements (e.g., shielding, constructability, I/O termination, environmental, heat load calculations, power load requirements, purging, lighting, maintainability) | | 81 | IV. Signals, Transmission, and Networking 12 C. Networking 2 | 1. Routers, bridges, switches, firewalls, gateways, network loading, error checking, bandwidth, crosstalk, parity, hubs | |
| 32 | | 6. System testing (e.g., factory acceptance test, integrated system test, site acceptance test) | | 82 | V. Safety Systems 12 A. Documentation 1 | 1. Basic documentation required (e.g., process hazards analysis, safety requirements specification [SRS], logic diagrams/narratives, test procedures, SIL selection report, SIL verification report, safety lifecycle plan) | |

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| 33 | | 7. Commissioning (e.g., performance tuning, loop checkout) | | 83 | V. Safety Systems 12 B. Theory 5 | 1. Reliability and availability (e.g., bathtub curve, failure rates types, voting, proof test intervals, common cause and diversity) | |
| 34 | | 8. Performance evaluation (e.g., troubleshooting, root cause failure analysis and correction) | | 84 | Rest | Rest | |
| 35 | II. Control Systems 20 D. Security of Industrial Automation and Control Systems 2 | 1. Security (e.g., physical, cyber, network, firewalls, routers, switches, protocols, hubs, segregation, access controls) | | 85 | V. Safety Systems 12 B. Theory 5 | 2. SIL selection (e.g., safety layer matrix, risk graph, LOPA) | |
| 36 | Rest | Rest | | 86 | V. Safety Systems 12 C. Implementation 3 | 1. Safety system design (e.g., SRS, I/O assignments, redundancy, segregation, logic design, failure direction) | |
| 37 | | 2. Security lifecycle (e.g., assessment, controls, audit, management of change) | | 87 | | 2. SIL verification calculations (e.g., failure rates types, voting, proof test intervals, common cause and diversity) | |
| 38 | | 3. Requirements for a security management system | | 88 | | 3. Installation, commissioning, and validation (e.g., methods, procedures, test records) | |
| 39 | II. Control Systems 20 D. Security of Industrial Automation and Control Systems 2 | 4. Security risk assessment and system design | | 89 | V. Safety Systems 12 D. Safety Lifecycle Management 3 | 1. Modifications (e.g., management of change, scope of change, impact of change, documentation) | |
| 40 | | 5. Product development and requirements | | 90 | Rest | Rest | |
| 41 | | 6. Verification of security levels (e.g., level 1, level 2) | | 91 | V. Safety Systems 12 D. Safety Lifecycle Management 3 | 2. Operations and maintenance (e.g., methods, procedures, test records, partial stroke testing, demand tracking, bypass and override management, failure analysis, validation of design assumptions) | |
| 42 | Rest | Rest | | 92 | Rest | Rest | |
| 43 | III. Final Control Elements 16 A. Valves 8 | 1. Types (e.g., globe, ball, butterfly) | | 93 | Test,Review | Test,Review | |
| 44 | | 2. Trim characteristics (e.g., linear, low noise, equal percentage, seat leakage class) | | 94 | | Test,Review | |
| 45 | | 3. Calculation (e.g., sizing, split range, noise, actuator, response time, pressure drop, air/gas consumption) | | 95 | | Test,Review | |
| 46 | | 4. Selection of motive power and failure mode (e.g., hydraulic, pneumatic, electric, spring) | | 96 | | Test,Review | |
| 47 | | 5. Applications of fluid dynamics (e.g., cavitation, flashing, choked flow, Joule-Thompson effects, two-phase) | | 97 | | Test,Review | |
| 48 | Rest | Rest | | 98 | Rest | Rest | |
| 49 | III. Final Control Elements 16 A. Valves 8 | 6. Material selection based on process characteristics (e.g., erosion, corrosion, plug, extreme pressure, temperature, material compatibility) | | 99 | Exam | Exam | |
| 50 | | 7. Accessories (e.g., limit switches, solenoid valves, positioners, transducers, air regulators, servo amp, boosters, quick exhaust) | | | | | |