ADVANCED DIPLOMA OF PLANT ENGINEERING INSTRUMENTATION & AUTOMATION
ABOUT SMARTBRAINS

SmartBrains is the global market leader in providing high-level training services to the energy sector (Oil and Gas, Petrochemical, Refinery, LNG, Power Plants, Fiscal, Contracts, Strategy & Finance and Leadership & Management). Operating nation wise over the last 8 years, our courses are widely acknowledged within the energy community for quality and up-to-date information. Our success and distinguished reputation is down to our commitment to the industry, a high-level of expertise, sector knowledge, cultural diversity and experience that comes from organising many courses.

SmartBrains Institute provides premium training courses for energy industry executives and fresh engineering graduates. Programs are designed by experienced high level Engineers/Managers and professionals as an option to broaden their skill sets to include management tools and techniques that are applicable to various profiles in Oil & Gas industry. Our success and distinguished reputation is thanks to our commitment to provide first-class programmes to our clients. Combining leading professionals from across the industry as lecturers and an interactive, practical format, the lessons learnt in a SmartBrains for energy course are directly transferable back to the workplace.

WHY SMARTBRAINS

SmartBrains is the ultimate choice for all the working and non working engineers in energy sector training requirements. Our extensive portfolio of energy training courses are:

- 100% focused on Oil & Gas industry.
- Guided by the industry renowned professionals with unprecedented knowledge of Oil & Gas industry.
- High interactive program with practical and relevant case studies.
- Training by extensively researched self developed cutting edge techniques.
- Skill development techniques with comprehensive set of documentation, practical skills and tools used in the industry.
- Perfect opportunity to develop network and experiences with knowledge sharing.
- Internationally acclaimed engineering qualification.
- Designed for both fresh engineers and working professionals to attain growth in renewably industry.
- One of the finest international faculty.
- Interactive, interesting and motivational training sessions.
- Access to enormous reference books and research materials.

OUR STRATEGIC OBJECTIVES

To be recognized by industry and employers as a highly reputable training organization. Provide dynamic leadership, sound management and excellence in training. Continue to improve our services through quality management processes. Invest in and value our people through professional development activities. Grow our business through innovation and to continue to be financially secure. Be influential in the economic development of the industries we serve nationwise.
SmartBrains engineers and technologist Pvt Ltd. has received recognition, endorsement and affiliation from National Skill Development Corporation of India (NSDC, a PPP initiative developed by Govt. of India) and various Skill Sector Councils of India as an authorized training provider under various trades. SmartBrains is authorized to provide skill based training for engineering/non-engineering candidates as per their interest. SmartBrains as a training institute will provide complete practical knowledge based skill training to the candidates, recognition & certification to the candidates will be provided by NSDC & Sector Skill Councils. Students who successfully complete their certification from SmartBrains may be able to apply for recognition of their qualification within the local education system. In general most countries will recognize that an “Advanced Program” is a qualification that requires high level of knowledge (beyond bachelor's degree). Many countries have a process for recognition of foreign qualification which is used by new residents when they have qualifications earned overseas. You will be awarded by a National level certification approved & provided by National Skill Development Corporation of India (A PPP promoted by Ministry of Skill Development & Entrepreneurship, Govt. of India) which is broadly accepted & recognized across the globe. However, in many cases formal individual recognition within the home country may not be required because the international validity and affiliation of this credential is very sound. This certification is broadly accepted by many national and international firms of various countries like Australia, New Zealand, United States, United Kingdom & many more.

**PROGRAM STRUCTURE**

The certification program is an intensive part-time program, conducted over a period of 6 months (For particular module), unlike other universities or academic institutions, we operate almost all year around.

**The Program is composed of 12 Units:**

1. Introduction of Plant Engineering.
2. Electrical Equipments Technology.
3. Electrical Drawings and documentation.
4. Electrical wires & Cabling.
5. Illumination Design.
7. System Studies and calculations.
10. Operation and Facility Management.
ABOUT PROCESS PLANT ENGINEERING-ELECTRICAL

Since electric plant layouts is about more than formats and outlines, Intergraph gives the most adaptable, versatile, and effective suite of plant designing assets outline for each part of a force vegetation’s cycle. With instruments for beginning outline, development, upkeep, and that’s only the tip of the iceberg, it’s no fortuitous event that more than 60 percent of the plants worked far and wide are composed with Intergraph programming. Characteristics of electrical Process Plant Engineering are:

- 3D Modeling and visualization Solutions.
- Engineering and Schematics.
- Electrical Equipment Operation and Maintenance.
- Engineering, Procurement and Construction.
- Troubleshooting, O & M.
- Risk Management.

WHAT YOU WILL GAIN

- Skills and knowledge in the latest technologies in all aspects of plant engineering.
- Knowledge from the extensive experience of instructors from process plants.
- World-class, globally accepted certification, enabling improved career prospects and income.
- Networking contacts in the industry.
- Excellent training material gathered from industry experts and case study materials.
- Technical, commercial and operational understanding of process plant.
- Understanding of Feasible study, engineering, procurement, construction, installation, operation, management & maintenance of electrical equipments in process industry.

PURPOSE

SmartBrains is the ultimate choice for all the working and non working engineers in energy sector training requirements. Our extensive portfolios of training courses are:

- 100% focused on Plant Engineering Instrumentation & Automation.
- Guided by industry renowned professionals with unprecedented knowledge of process plant industry.
- High interactive program with practical and relevant case studies.
- Training by extensively researched self developed cutting edge techniques.
- Skill development techniques with comprehensive set of documentation, practical skills and tools used in the industry.
- Perfect opportunity to develop network and experiences with knowledge sharing.
- Internationally acclaimed engineering qualification.
- Designed for both fresh engineers and working professionals to attain growth in process plant industry.
- One of the finest international faculties.
- Interactive, interesting and motivational training sessions.
- Access to enormous reference books and research materials. sessions.
### TRAINING METHODOLOGY

Our approach to training combines Oil & Gas industrial experts with practical exercises and action planning that provides real benefits and instills positive change. Our training experts developed best course content based on current need of industry.

### MULTIMEDIA BASED CONTENTS

The program features real-world applications and uses a blended approach involving interactive on-line sessions, simulation software and self-study assignments. For each topic you will have an initial reading assignment (which will be provided to you in E-format). There will be a course work or problems to be submitted and in some cases there will be practical exercises, using simulation software and remote labs that you can easily do from your home or office.

### BOOKS

In order to maximize the value to your training course and to further enhance the skills developed, we provide all participants with a tool-kit to take back to the office. The tool kit includes a set of comprehensive documentation supporting the course programme with notes, slides, recommended further reading and extra material relevant to the course. Some relevant manual titles are listed below:

1. Electrical Drawings and Schematics.
6. Practical Control Valve Sizing, Selection and Maintenance.
7. Practical Programmable Logic Controllers (PLCs) for Automation and Process Control.
10. Best Practice in Process, Electrical and Instrumentation Drawings and Documentation.
11. Practical Process Control.

Students are advised to use reference books as per the inputs received from master trainers at the time of relevant study.

### PRESENTATION

PowerPoint presentations on:

1. Overview of Oil & Gas Industry, EPC Contracts.
3. Instrumentation Standards in Oil & Gas, E & I Drawings and documentation.
5. PLC.
6. SCADA & DCS.
7. Industrial data Communications.
9. HMI, VFD & Panel Design.
10. Safety and Emergency Shutdowns.

### CASE STUDIES

Empirical examples of organizations' challenges and opportunities. These provide genuine insight and learning by questioning how they should respond to these topical issues.

Simulation Exercises: - Some contents of our course require participants to take part in simulation exercises, putting into practice the knowledge gained.

Feedback and Assessment: - Course leaders will provide constructive feedback and offer suggestions for improvement.
Candidates will need to go through for on the job training for successful completion of training, industries are in collaboration with Sector Skill Councils introduce your candidature for 6 months of on the job training in process industries (Working Plants). It will provide you an advantage of live working process with your instructor and fellow students upgrading your skills and refresh your knowledge. It will also provide you a platform to learn for international industry experts interactive sessions will gain valuable insights into international practice. Industry collaboration will add following advantages for the trainee.

- Improved Quality as per industry norms.
- Real life experience through industrial attachment, Hands-On training and field projects.
- Teacher practitioners, faculty attachments to industry.
- Rich pool of industrial workshops and manufacturing plants.
- Immediate feedback on adequency, long term on graduate performance.
- Better employment opportunities for trainees through sustained relationship.
- Technology transfer, innovation to marketplace.

**INDUSTRIAL LINKAGE**

- Dr Solar Systems Pvt. Ltd.
- Gopinath Solar Energy Pvt. Ltd.
- Tracksun Solar Pvt. Ltd.
- Chemitech Engineers Pvt. Ltd.
- Rays Power Experts Pvt. Ltd.
- Rabboni Engineers Pvt. Ltd.
- Tapan Solar Pvt. Ltd.
- Gautam Solar Pvt Ltd
- Blue Bird Solar Pvt. Ltd.
- Primo Tech Energy Solutions Pvt. Ltd.
- SS Gas Labs Pvt. Ltd.

**CLIENTS WE WORK WITH**

- Minda Energy Pvt. Ltd.
- Green Hut Energy Pvt. Ltd.
- Upas Technical Pvt. Ltd.
- Brisanzia Technologies Pvt. Ltd.
- Degremont Technologies Pvt. Ltd.
- Sombansi Enviro Engineers Pvt. Ltd.
- Earth Water Group
- Driplex Water Engineering Pvt. Ltd.
- Technotherm Engineers Pvt. Ltd.
- N S Thermal Energy Pvt. Ltd.
- Offcom Systems

- Sterling And Wilson Pvt. Ltd.
- Alpine Energies
- Hydro Therm Engineers Pvt. Ltd.
- Thermodyne Technologies Pvt. Ltd.
- Urjex Boilers Pvt. Ltd.
- Mishan Energy Solution
- Akar Impex Pvt. Ltd.
- Uem India Pvt. Ltd.
- Triveni Group
- Tapsi Group
- Sarika Enterprises
UNIT 1: INTRODUCTION TO OIL AND GAS INDUSTRY & EPC CONTRACTS

General Industry Overview And Basic Concepts
- Meaning of petroleum.
- Typical oil & gas company objectives.
- Typical oil & gas company activities.
- Industry streams.
- Typical organization chart.
- Company structures.

Oil & Gas Prospecting (Exploration)
- Geological prospecting.
- Geophysical prospecting.
- Seismic (2D and 3D) acquisition.
- Seismic processing.
- Seismic interpretation.
- Offshore and onshore seismic data acquisition.
- The seismic section.
- Stratigraphical cross sections.
- Reservoir mapping.

Oil & Gas Production Facilities
- Typical oil production facilities.
- Artificial lift systems.
- Crude treatment and processing.
- Natural gas processing.
- Typical LNG value chain.
- Gas added value products.
- Offshore facilities.

What is an EPC Contract
- How does the risk allocation on an EPC contract compare to other construction contracts?
- To what extent does an EPC contract guarantee the project essentials: a fixed price, time and quality?
- Why would you choose an EPC contract as opposed to other forms of contract?
- Will the use of an EPC contract mean that the works cost more?
- The bankability of an EPC contract.
- The EPC contract within the overall structure of a project:

The various entities and the other project documents
- Split EPCs: Onshore/Offshore.
- Different models for contract risk allocation.
- Contract jargon: Lump sum, turn-key, EPCM, EPCC, cost-plus, reimbursable.

The Tender & Procurement Process
- The procurement time-line: From inception to contract finalization.
- Procurement options: e.g. one or two stage tendering, preferred bidders.
- The way in which procurement regulations can restrict and limit tendering options.
- Design development in the context of procurement: Incorporating a Front End Engineering and Design (FEED) stage.
- Transparency and comparison between tender figures.
- Structuring the contract price: lump sum stage payments and milestones.

The Scope Of Works
- Ensuring that the scope of works achieves the owner & objectives.
- The reasons why changes are required to the scope of works and what can be done to ensure that the contractor takes the risk of the additional costs.
- Risks associated with the transition from the design to on-site construction.
- The impact of unexpected site conditions on the contractor & ability to construct the scope.
- How should the contractors design responsibilities be defined?
- The need for the owner to approve the contractor’s designs and the degree to which this will lessen the contractors single point responsibility.
- What is the appropriate level of construction and design risk for the contractor to take?
UNIT 2: FUNDAMENTALS OF PROCESS INSTRUMENTATION

- Process measurement fundamentals.
- Process measurement concepts and terminology.
- Basic measurement concepts.
- Definition of terminology.
- Pressure, level, temperature and flow overview.
- Essential safety considerations pneumatic and hydraulic instrumentation systems.
- Pneumatic instrumentation systems.
- Hydraulic instrumentation and controls related hardware and accessories.
- Instrument tubing, fittings and accessories.
- Instrumentation process interface.
- Double block and bleed valves.
- Mono flanges and instrument manifolds.
- Process close coupling techniques.

**Pressure Measurement**
- Pressure measurement concepts.
- Principle of pressure measurement.
- Pressure sources pressure measurement devices and accessories.
- Pressure transducers.
- Load cells.
- Transmitters, gauges, indicators, switches, elements and accessories.
- Specifications overpressure relief devices.
- Overpressure relief valves.
- Rupture discs issues related to pressure measurement.
- Installation considerations.
- Impact on the overall control loop.
- Future technologies.

**Level Measurement**
- Level measurement techniques.
- Visual/optical.
- Capacitance.
- Nucleonic.
- Buoyancy.
- Hydrostatic pressure.
- Differential pressure.
- Radar and microwave.
- Ultrasonic.
- Radiometric.
- Electromechanical.
- Density.
- Bubbler systems level measurement devices and accessories.
- Level transmitters.
- Level switches.

**Temperature Measurement**
- Measurement based on thermolectric effect.
- Thermocouples measurement based on resistance.
- Thermistors.
- Resistance temperature detectors measurement based on radiation.
- Pyrometers measurement based on expansion.
- Liquid filled glass.
- Bimetallic.
- Issues related to temperature measurement.
- Thermowells.
- Natural frequency and vibration checks.
- Installation considerations.
- Impact on the overall control loop.

**Flow Measurement**
- Measurement based on volume flow rate.
- Differential pressure.
- Positive displacement.
- Turbine.
- Variable area (Rota meter) measurement based on mass flow rate.
- Coriolis.
- Thermal dispersion measurement based on flow velocity.
- Magnetic.
- Target.
- Ultrasonic.
- Vortex other types of flow measurement.
- Multiphase flow measurement.
- Wet gas flow measurement.
- Open channel flow measurement.
- Oscillatory flow measurement.

**Process Considerations in Selecting Instrumentation Components**
- Transmitters.
- Noise.
- Materials Of Construction.
Integration of Process Instrumentation Systems
- Tank farm instrumentation.
- Calculation of individual instrument error and total error for the system.
- Integration of pressure, level, temperature and flow systems.
- Integration of new smart subsystems with data communication links.
- Testing and commissioning of subsystems.

Control Valve Essentials and Capabilities
- Introduction to control valve theory.
- Different types of control valves.
- Characteristics.
- High pressure drop applications.

Sizing of Control Valves, Actuation and Essential Accessories
- Use of computer programs for valve sizing.
- Examples of high pressure drop applications.
- Actuators.
- Positioners.
- Pneumatic circuits.

Control Valve Material, Standards, Applications, Maintenance and Installation
- Materials.
- Quality standards.
- Severe service applications.
- Pressure relief valves.
- Installation and maintenance.

UNIT 3: INSTRUMENTATION STANDARDS IN OIL AND GAS, E & I DRAWINGS AND DOCUMENTATION

Drawing Types, Standards and Component Fundamentals
- Plant documentation.
- The role of plant documentation, standards and specifications.
- Drawing types and standards.
- Standards organizations (ISA, IEC, ISO).
- Understanding diagram layouts and formats.
- Cross references.
- ISO 9002 and document control
- API RP14F – Section 12.2 – electronic instrumentation.
- ISA standards library for automation and control
- Specification forms – ISA S20 - specification forms for process measurement.
- Component fundamentals:
  ✓ Relays.
  ✓ Transducers.
  ✓ Switches.
  ✓ Gate logic.
  ✓ Fail safe design.

Plant-Related Diagrams and Documentation
- Piping and Instrument Diagrams (P&ID):
  ✓ Process flow diagrams.
  ✓ An introduction to the PFD, P&ID, UFD, MFD.
  ✓ Control loops on the P&ID.
  ✓ HAZOP.
  ✓ Mass balance.

✓ Functional spec.
✓ Instrumentation Documentation:
  ✓ Document types.
  ✓ Instrument lists.
  ✓ Logic diagrams.
  ✓ Wiring diagrams.
  ✓ Indexes.
  ✓ Schedules and lists.
  ✓ Block diagrams.
  ✓ Data sheets.
  ✓ Loop diagrams.
  ✓ Hands-on circuit function.
  ✓ Fault finding.
  ✓ Standards and symbols.
  ✓ Nomenclature.
✓ Electrical documentation:
  ✓ Electrical standards.
  ✓ Electrical document types.
  ✓ Main circuits.
  ✓ Control circuits.
  ✓ Symbols.
  ✓ Nomenclature.

Pneumatics & Hydraulics, Ladder Logic and Electro-Pneumatic Circuits
- Pneumatics & Hydraulics:
  ✓ Introduction.
  ✓ Standards.
  ✓ Layout and symbols.
Basic circuits.
Deducing principle of operation.

Ladder Logic:
- Introduction and overview.
- Standards and layout.
- Power supply circuits.

Electro-Pneumatic Circuits:
- Overview.
- Truth tables.
- Fault finding.
- Principle of operation.

Instrumentation Acronyms:
- Common acronyms (e.g. P&ID)

Drawings, Symbols & Schematic Diagrams
- Fundamentals of electrical engineering drawings:-
  - Relevance of drawings in engineering.
  - Drawings at the centre of all activities.
  - Types of drawings and application.
  - Standards in drawings.
  - 2 and 3 dimensional representation.
  - Computer aided drafting; an introduction.

CAD, Drawing Layouts and Drawing Management
- Types of Layouts:
  - Cabling and wiring drawings.
  - Layout drawings for different applications.
- Computer Aided Drafting (CAD):
  - CAD drawings for 2D and 3D applications.
  - Features of CAD and benefits.
  - Parametric programming.
- Drawing Management:
  - Revision control and drawing ownership.
  - Drawing process flow.
  - Redlining in CAD drawings.

UNIT 4: PROCESS CONTROL

Process Control Basics
- Reasons for process control.
- Definitions of PV, SP, CV, Gain, Lag and DT.
- Types of feedback control.
- Set point tracking.
- Proportional or gain action of PID control.

Stability, Algorithms and Cascade Control
- Stability.
- Ideal vs Real algorithms.
- Cascade control.
- Integral or reset action of PID control.

Action, Feed forward and the Effects of Dead Time
- Direct vs Indirect action of a controller.
- Derivative or reset action of a controller.
- Feed forward control.
- Combined feed forward and feedback control.
- Effects of dead time on a controlled process.

Process Control Basics
- Objectives of tuning.

Components of an engineering drawing.
Scales and sheet sizes.
Symbols:
- Electro technology symbols.
- Schematic and logic diagrams:
  - Single line and 3 line diagrams for electrical circuits.
  - Control schematics.
  - Logic gates and logic diagrams.

Open loop tuning.
Closed loop tuning.
Tuning with some overshoot.
Tuning with no overshoot

Stability and Control Modes of Closed Loops
- Cause of instability in control loops.
- Change of stability through PID control modes.
- Methods to improve stability.
- Principles of closed loop control tuning.

Ideal PID vs Real PID
- Non-field-interactive or ideal PID.
- Field-interactive or real PID.
- Distinguish between process noise and instability.
- Selection of ideal or real PID.

Cascade Control
- Equation types for cascade control.
- Initialization and PV-tracking.
- Use of multiple outputs in cascade control.
- Tuning procedure for cascade control.
Combined Feedback and Feed forward Control
- Feed forward balance - a control concept.
- Tuning procedure for feed forward control.
- Concept of combined control with incremental algorithms.
- Tuning procedure for combined control.

Long Dead-Time in Closed Loop Control
- The problem of long dead-time in closed loops.
- Use of process simulation for process variable prediction.
- Tuning procedure for control loops with long dead-time.
- Range of control and instrumentation in industrial process control.

Justification of Advanced Control
- Advanced vs classical control.
- Advanced on-line control vs statistical process control.
- Comparison of payback time on real examples.

Fundamentals of Process Control
- Processes, controllers and tuning.
- PID Controllers - P, I and D modes of operation.
- Load disturbances and offset.
- Speed, stability and robustness.
- Gain, dead time and time constants.
- Process noise and feedback controllers.

Fundamentals of Tuning PID Loops
- Open and closed loop tuning.
- Ziegler Nichols.
- Fine tuning for different process types.
- Lambda tuning.
- Ten different rules compared.
- Cascade systems.
- Feedforward control and deadtime.
- Models and disturbances.

Internal Model Control (IMC)
- Open loop model in parallel with the process.
- Control system in two blocks.
- Equivalence with a classical controller.
- Disturbances rejection and control.
- IMC and delays and feed forward.

Model Predictive Control (MPC)
- Single input / output vs multivariable control.
- Example on a binary column Causality graph.
- Constraints and planning ahead.
- Different models.

MPC: Model Representations, Identification, Observers & Control
- State space and transfer function representation.
- Impulse response representation.
- Identification - what and how?
- Black and grey box models.
- Causality graph of the unit.
- Overall formulation and purpose.
- Study of Kalman algorithm.
- Overall formulation.
- Hard constraints on manipulated variables.
- Set values and soft constraints on control variables.
- The notion of Horizon.

Control Formulation Problem
- Quadratic criterion vs geometric control.
- Importance of the horizon length.
- Use of the weight matrix.
- Handling output constraints along the horizon.
- Projection of measured and unmeasured disturbances along the horizon.
- Final quadratic problem formulation and resolution.
- Off-line pre-processing.
- On-line calculations.

MPC Steady State Optimization
- Degrees of freedom and rationale for optimization.
- Economic output submitted to set point.
- Slogans to maximize or minimize.
- Bridge from optimization to control.
- Reachable targets for economic variables.
- Interpretation of the horizon for economic variables.
- Change of the control formulation problem.
UNIT 5: PROGRAMMABLE LOGIC CONTROLLERS

- Overview of PLCs and their applications:
  - A brief history of PLCs.
  - Alternative control systems – where do PLCs fit in.
  - Why PLCs have become so widely accepted.
  - Lingering concerns about PLCs.
- Fundamentals of PLC hardware:
  - Block diagram of typical PLC.
  - PLC processor module – memory organization.
  - Input / output section – module types.
  - Power supplies.
- Fundamentals of PLC Software [18.1.3]:
  - Methods of representing logic.
    - Boolean algebra.
    - Instruction code.
    - Graphical presentation.
    - Functional logic diagrams.
    - Ladder logic.
    - Fundamental ladder logic instruction set.
    - Comparison of different manufacturers.
    - Memory and data representation.
    - Instruction code.
- Using ladder logic for simple digital functions:–
  - The basic rules.
  - Comparison with relay ladder diagrams.
  - The concept of the 'scan' and how to apply it.
  - Infinite fan-out.
  - Contact 'normal' states.
  - Positive and negative logic.
  - Basic Boolean functions.
  - The usefulness of De Morgan's Law.
- Using registers (Words):
  - Number systems.
  - Types of register data.
  - Timers.
  - Counters.
  - Bit shift / rotate.
  - Table functions.
  - Register (matrix) logic functions.

Application Software & Advanced Control

- Good programming habits:
  - Keeping track of addresses and data used.
  - Looking ahead – how will programs be maintained.
  - Practical methods to improve program quality.
- Good Installation Practice:
  - Location of hardware.
  - Good wiring practice.
  - Reducing noise and interference.
  - Screening and shielding.
- Advanced Control With PLCs:
  - The concept of reusable logic.
  - Use of advanced programming functions.
  - Matrix logic.
  - Table functions and indirect addressing.

- Batch processes and sequential control:
  - Remembering the program state.
  - Creating a 'stepper’.
  - Step advance.
  - Fault detection and recovery.
  - Operator intervention.
  - Multiple recipes or alternate paths.
  - Sequential function charts.
- PID Control Issues:
  - The importance of timing and scan time.
  - When PID is not always appropriate.

Safety Controllers, Programming Standards & Communications

- Safety programmable systems:
  - Why regular PLCs should not be used for safety functions.
  - Programmable electronic logic solvers.
  - Safety certification.
  - Certified programming systems.
  - Application examples.
  - Growth of networked safety devices and certified networks.
  - Integrated safety systems.

Data Communications:

- Interface standards: RS-232, RS-422/423, RS-485
- Protocols: Modbus, DH+.
- Local Area Networks: Ethernet.
- Monitoring communication links and simple watchdog timers.

Introduction To IEC 61131-3:

- Concepts.
- Common elements.
- Programming languages: structured text.
- Function block diagrams.
- Ladder diagrams.
- Instruction list.
- Sequential function chart.
- OPC:
  - Functionality.
  - Architecture.

System checkout and testing:

- Development and verification of code.
- Factory acceptance testing.
- Testing procedures.
- Emulating missing hardware.
- Emulating process responses.
UNIT 6: SCADA & DISTRIBUTED CONTROL SYSTEMS

SCADA for monitoring installations across a wide geographic area
- Overview of Wide Area SCADA Systems.
- SCADA system hardware.
- SCADA system software.
- SCADA communication protocols.
- SCADA human machine interface (HMI).

SCADA for process plants
- Overview of process plant SCADA systems.
- Alarm management.
- Network security.
- Historian.
- System installation and commissioning.
- Troubleshooting and maintenance.

Distributed control systems (DCSs)
- DCS vs SCADA and PLCs.
- DCS system elements.
- Data communications.
- DCS controllers.
  - The basic controller.
  - Basic controller configuration.
  - Advanced controllers.
  - Programming uninterrupted operation and security issues.

DCS operator interfacing, control and implementation
- DCS Operator Interfacing.
  - The operator interface.
  - Alarm management.
  - Reporting.
- DCS configuration and control.
  - DCS configuration.
  - Advanced control strategies.
- DCS Implementation Issues.
  - Maintenance considerations.
  - DCS applications.
  - Comparison of offerings from DCS vendors.

UNIT 7: INDUSTRIAL DATA COMMUNICATION

Fundamentals of data communication systems
- General attributes of industrial data communication systems:
  - OSI model.
  - Attributes of typical communication systems.
  - Media.
  - Physical connections.
  - Protocols.
  - Applications.
- Noise and Ingress Protection:
  - Noise.
  - Earthing.
  - Shielding.
  - Ingress protection.
- Copper and Fiber:
  - Cable standards.
  - Cable distribution standards.
  - Connector standards.
  - EMC conformance standards.
  - Splicing.
  - Connector attachment.
  - Drivers and detectors.
  - Grounding/earthing.
  - Termination.
  - Protection against transients.
- Common physical layer standards:
  - RS-232.
  - RS-485.
  - IEC 61158-2.
- Industrial Networks:
  - Industrial ethernet.
  - ASI.
  - Device Net.
  - Profibus.
  - Foundation Fieldbus H1.
  - Modbus Plus.
  - Data Highway Plus.
  - HART.
  - Ethernet/IP.
  - ProfiNet.
  - Foundation Fieldbus HSE.
- Industrial Protocols:
  - TCP/IP.
  - Modbus Serial.
  - Modbus TCP.
  - DNP3.
  - IEC 60870.
- Wireless technologies:
  - VSAT.
  - Wireless LAN.
  - Wireless point-to-point.
Selection and installation methodologies
- Which standards or technologies to use at device, operator, and enterprise level.
- Which standards to use for long-distance SCADA/telemetry links.
- System design, installation, tips, tricks and pitfalls for:
  - Copper cabling and connectors.
  - Fiber cabling and connectors.
  - Wireless.

Commissioning/testing/troubleshooting
- Copper Infrastructure.
- Fiber Infrastructure.
- Wireless Infrastructure.
- Networks:
  - Physical layer issues (OSI Layer 1).
  - Data Link layer issues (OSI Layer 2).
  - Network layer issues (OSI Layer 3).
  - Transport layer issues (OSI Layer 4).
  - Application and 'user' layer issues (OSI Layers 7 and '8').
  - Client/server issues.

Ethernet
- Ethernet frame structure.
- VLANs.
- Half-duplex operation (CSMA/CD).
- Full-duplex operation.
- Auto-negotiation.
- Deterministic Ethernet.

The TCP/IP protocol suite
- IPV4 vs. IPV6.
- IP Addressing.
- Routing.
- ICMP and ARP.
- TCP and UDP.
- TCP/IP utilities.

IEEE802.11 wireless LANs
- Architecture (Ad-hoc vs infrastructure).
- Bridging and roaming.
- Medium Access Control.
- Frame structure.
- Site surveys.
- AP configuration.
- WLAN vulnerabilities.
- WPA2/IEEE 802.11I.
- AES encryption.
- PSK and RADIUS authentication.

Industrial wireless networks
- Wireless HART (IEEE802.15.4).
- ISA 100.11A.

Antennas
- Antenna basics.
- Dipole, Yagi and parabolic reflector antennas.
UNIT 8: CALIBRATION, INSTALLATION AND MAINTENANCE OF INSTRUMENTS

Instrument maintenance and testing
- Maintenance concepts:
  ✓ Corrective, preventative and predictive maintenance
  ✓ Troubleshooting
  ✓ ISO 9000 and 9001
- Electrical Measurements:
  ✓ Use of multi meters and calibrators.
  ✓ Voltage, current and resistance measurement.
  ✓ Analog and digital meters.
  ✓ Oscilloscopes.
  ✓ Current-to-voltage conversion.
  ✓ Multiple loop devices.
  ✓ Diodes and resistors.
  ✓ Soldering and component preparation.
  ✓ Open and short circuits.
  ✓ Testing of diodes, DIACS and TRIACS.
  ✓ Components out-of-tolerance.
  ✓ Isolation and grounding/earthing.
- Instrument Performance:
  ✓ Basic measurement and control concepts.
  ✓ Accuracy, range, hysteresis, linearity, repeatability, response, dead time.
  ✓ Zero/span.
  ✓ Process dynamics.
  ✓ Specifications.
- Instrument Documentation and P&IDs:
  ✓ Control loops on the P&ID.
  ✓ Instrument lists.

✓ Wiring diagrams.
✓ Schedules and lists.
✓ Data sheets.
✓ Loop diagrams.
✓ Standards and symbols.

Calibration and simulation
- Standards, certification, marking and approval:
  ✓ Standards.
  ✓ Authorities.
  ✓ Marking and identification.
  ✓ Apparatus certification.
- Calibration:
  ✓ The basis of transmitter calibration.
  ✓ Standards for calibration.
  ✓ Five point calibration.
  ✓ Charts.
  ✓ Shop calibration.
  ✓ Electro-pneumatic calibrators.
  ✓ In-shop or field calibration.
  ✓ Calibration of RTDs and thermocouples.
- Simulation:
  ✓ The basis of signal simulation.
  ✓ Transmitter simulation.
  ✓ Transducer simulation.
- Field bus and digital transmitters:
  ✓ Configuration.
  ✓ Rearrangement.
  ✓ Digital trimming.

UNIT 9: HMI, VFD & PANEL DESIGN

- Components of an automation system:
- Types of I/Os (Analog, Digital, HS Pulse).
- PLC instructions & programming.
- PLC networking & architecture.
- Peer-to-peer & daisy chain networks.
- Ethernet I/P & industrial networks.
- Uploading & downloading programs.
- Creating SCADA screen & tags.
- Wiring for I/Os, source and sink connections.
- Testing of I/O Terminations (Point Testing).
- HMI screen generating & commissioning.
- Managing component selection & configuration assessment.
- Motors and generators.
- Knowledge of:
  ✓ Slip ring induction motor.
  ✓ Squirrel cage induction motor.
  ✓ DOL starter & star / delta starter.
- Components of a AC Drive system.
- Types of VFD control terminals.
- Managing Wiring for I/Os.
- Components of a soft.
UNIT 10: HAZARDOUS AREAS

Hazardous Areas
- Introduction: explosion consequences.
- Risk assessment.
- Properties of flammable materials.
- Definitions.
- Classification system: sources of release and zoning.
- Classification of apparatus: grouping and temperature.

Protection
- Theory and definitions.
- Practical aspects and limitations of use:
  - Flameproof EX D.
  - Increased Safety EX E.
  - Non-Incendive EX N.
  - Pressurisation EX P.
  - Oil-Immersion EX O.
  - Sand-filling EX Q.
  - Encapsulation EX M.
  - Intrinsic Safety EX I.
  - Special EX S.

Standards
- British standards.
- European.
- North American.
- International.

Certification & approvals
- Marking and identification.
- Notified bodies.
- Authorities.
- IEx, EEx and AEx schemes.
- ATEX directives in Europe.
- Principles of Ex protection.
- Component, apparatus and systems certification.

UNIT 11: SAFETY INSTRUMENTATION AND EMERGENCY SHUTDOWN SYSTEMS FOR PROCESS INDUSTRIES USING IEC 61511 AND IEC 61508

An overview of safety instrumented systems for managers
- The principles of safety-instrumented systems including the concepts of risk reduction, safety integrity levels and the essential design and performance requirements of safety control systems.
- The scope and application of the IEC standards 61508 and 61511 and their principal requirements.
- Essential features of safety PLCs
- The safety life cycle.

Safety requirements specification
- How hazard analysis and risk assessment leads to the safety requirements specification.
- Demand mode and continuous mode methods for risk reduction.
- LOPA and Risk graph methods for determination of SIL targets.

Safety system equipment selection and application software
- Essential features of field devices.
- Instrument selection and issues of certification.
- Safety PLCs and networks.
- Application software activities and tools.

Performance evaluation, testing and maintenance of safety systems
- Basic reliability analysis and how it benefits the end user.
- Diagnostics and proof testing for improved performance.
- The benefits of safety certified and smart instruments.
Time management.
Portfolio of skills.
Communication skills.
Decision making.
Project management: Work breakdown structures.
Project management: Scheduling.
Project management: Qualitative risk analysis.
Project management: Quantitative risk analysis.
Project costing and cash flow modeling.
Discounted cash flow.
Technical writing and specifications.
Group dynamics.
Leadership and professional conduct.
Ethics in engineering.
Responsibilities of the engineering associate.
Engineering standards and codes of practice.
Global and environmental issues.
Sustainable engineering.
Workplace health and safety issues.
Presentation skills.
Technical skills and career planning.
Contract law.
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