MERCURY

Functional Safety: Safety Engineering Fundamentals

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Introduction:

Functional safety is a critical discipline that ensures systems operate correctly in response to their inputs, even when faults occur. This Functional Safety: Safety Engineering Fundamentals course explores the core principles of safety engineering, providing an overview of hazard analysis, risk assessment, and safety lifecycle management.

Participants will learn how to implement and evaluate safety systems based on international functional safety standards, such as IEC 61508 and IEC 61511. This Functional Safety: Safety Engineering Fundamentals training course will emphasize safety integrity levels SIL, failure modes, and protective instrumentation systems.

With the increasing automation and complexity of processes in various industries, understanding functional safety is crucial for preventing hazards and maintaining compliance. The Functional Safety: Safety Engineering Fundamentals program offers a balanced combination of theoretical foundations and real-world engineering practices for professionals responsible for designing, integrating, verifying, and validating safety systems in high-risk environments.

Targeted Groups:

This Functional Safety: Safety Engineering Fundamentals course targets professionals seeking specialized knowledge and skills:

- Process safety engineers work in manufacturing and processing industries.
- Instrumentation and control engineers are involved in safety system design.
- Maintenance and operations personnel in high-risk facilities.
- Engineering project managers are responsible for safety lifecycle management.
- HSE professionals are involved in risk assessments and hazard control.
- Automation engineers are accountable for safety logic configuration.
- System integrators and consultants in industrial automation.
- Quality assurance and compliance officers monitor safety protocols.
- Technical auditors are performing functional safety assessments.
- Professionals aiming to align with IEC 61508 or IEC 61511 standards.

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Course Objectives:

Participants will achieve the following objectives by completing the Functional Safety: Safety Engineering Fundamentals course:

- Understand the fundamentals of functional safety and its role in engineering.
- Identify common hazards and apply appropriate risk assessment methods.
- Describe the structure and purpose of the safety lifecycle.
- Analyze failure modes and their impact on system reliability.
- Interpret and apply key clauses of IEC 61508 and related standards.
- Calculate and validate Safety Integrity Levels SIL.
- Differentiate between preventive and mitigative safety measures.
- Develop safety requirements, specifications, and documentation.
- Evaluate and verify functional safety systems effectively.
- Apply functional safety in real-world scenarios with critical infrastructure.
- Improve coordination between engineering disciplines for integrated safety.
- Enhance decision-making in system design through functional safety insights.

Targeted Competencies:

Participants will gain the following competencies during the Functional Safety: Safety Engineering Fundamentals program:

- Risk identification and assessment techniques.
- SIL classification and verification methodologies.
- Functional safety lifecycle implementation.
- Technical understanding of safety instrumentation systems.
- Application of international safety standards.
- Safety system performance analysis.
- Cross-functional collaboration in safety engineering.
- Documentation and traceability in safety compliance.
- Diagnostic coverage and system reliability interpretation.
- Preventive control planning and failure management.

Course Content:

Unit 1: Introduction to Functional Safety and Standards:

- Define functional safety and its importance in engineering environments.
- Differentiate functional safety from general safety practices.
- Introduce international standards: IEC 61508, IEC 61511, ISO 26262.
- Discuss industry applications in oil & gas, chemical, and manufacturing.
- Explain the need for systematic and random fault handling.
- Identify roles and responsibilities in safety lifecycle processes.
- Understand legislative and regulatory frameworks.
- Clarify the terminology used in safety engineering contexts.
- Explore the evolution of functional safety in industrial history.

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Unit 2: Hazard and Risk Assessment Techniques:

- Conduct hazard identification using HAZOP and FMEA methods.
- Perform risk analysis based on probability and consequence.
- Introduce Layer of Protection Analysis LOPA.
- Define tolerable risk and safety objectives.
- Discuss qualitative vs. quantitative risk assessment.
- Integrate risk reduction techniques in engineering design.
- Establish criteria for risk acceptability.
- Apply scenario-based analysis for practical understanding.
- Evaluate barriers and safeguards in process safety.

Unit 3: Safety Lifecycle and SIL Determination:

- Break down the phases of the safety lifecycle.
- Define Safety Integrity Levels SIL and their purpose.
- Identify methods to determine SIL using risk graphs and matrices.
- Apply SIL allocation for safety instrumented functions.
- Discuss reliability parameters: PFDavg, PFH, MTTF.
- Introduce tools used for SIL verification and calculations.
- Align design stages with lifecycle requirements.
- Understand the role of redundancy and voting systems in safety.
- Examine SIL compliance challenges and best practices.

Unit 4: Safety Instrumented Systems SIS Design and Engineering:

- Identify components of a Safety Instrumented System SIS.
- Explain sensor, logic solver, and final control element functions.
- Discuss SIS architecture: 1oo1, 1oo2, 2oo3 configurations.
- Design SIS based on safety requirement specifications.
- Integrate diagnostics and fault tolerance in SIS.
- Address systematic capability and hardware fault tolerance.
- Evaluate common cause failures and mitigation strategies.
- Document design assumptions and validation parameters.
- Conduct proof testing and maintenance planning.

Unit 5: Validation, Operation, and Functional Safety Management:

- Plan and execute safety validation and verification activities.
- Implement functional testing and acceptance protocols.
- Monitor system performance during operation.
- Ensure ongoing compliance through safety audits.
- Maintain records for traceability and documentation.
- Manage change within the safety lifecycle framework.
- Train personnel on safe operation and emergency response.
- Establish a functional safety management system.
- Promote continuous improvement in safety performance.

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Final Insights & Key Takeaways:

This course offers a structured pathway to mastering safety engineering fundamentals and best practices. Through practical tools and standards-based frameworks, professionals will be able to design and maintain compliant and reliable safety systems. Functional safety knowledge enhances decision-making and mitigates operational risks in complex environments. Participants will leave the course with applicable skills for engineering roles in high-risk industries.