Pipeline Engineering Program

Technical University of Leoben

UNILEOBEN.AC.AT

§1 INTRODUCTION

The university's ***Pipeline Engineering*** **ULG** aims to provide comprehensive training for professionals in planning, designing, constructing, operating, and maintaining modern pipeline systems. Graduates will be able to manage pipeline projects, evaluate technical and economic aspects of system design, apply international standards, and implement solutions ensuring pipeline infrastructure's integrity, efficiency, and sustainability. The course is designed for professionals seeking to expand their skills and assume leadership roles in pipeline engineering across diverse industry sectors.

Upon completion of the course, participants will acquire the following qualifications:

(1) Theoretical knowledge and understanding:

- Comprehensive understanding of pipeline system design, hydraulic behavior, and liquid and gas transport optimization principles.
- Knowledge of applicable codes and standards (e.g., ASME B31 series, ISO, EN) governing pipeline safety, construction, and operations.
- Insight into pipeline material properties, mechanical design criteria, and corrosion mechanisms relevant to infrastructure longevity.
- Familiarity with instrumentation, automation systems, and control architectures used in pipeline monitoring and regulation.

(2) Practical skills:

- Ability to perform hydraulic calculations and design pipelines under various fluid properties, terrain, and operational conditions.
- Capability to assess material selection, welding techniques, structural integrity, and corrosion protection systems in pipeline construction.
- Application of geotechnical and civil engineering knowledge for routing, site planning, and foundation design.
- Use of real-world instrumentation and SCADA systems to ensure safe, real-time monitoring and control of pipeline operations.
- Preparation and interpretation of technical documentation, flow diagrams, equipment specifications, and project reports.

(3) Methodological competence:

- Ability to integrate interdisciplinary knowledge from mechanical, civil, electrical, and environmental domains for holistic pipeline planning.
- Competence in applying engineering tools, GIS systems, and modeling software for route selection, stress analysis, and system simulation.
- Familiarity with risk management, environmental impact assessment, and sustainability analysis in pipeline project development.
- Practical experience in applying construction techniques, commissioning procedures, and integrity management strategies.

(4) Interdisciplinary skills:

- Development of leadership and communication skills for managing multidisciplinary teams in pipeline-related projects.
- Problem-solving and decision-making in complex technical, environmental, and regulatory contexts.
- Competence in project planning, stakeholder coordination, and interface management across engineering, business, and policy domains.

After completing the course, graduates will be able to:

- Independently plan, design, and operate pipeline systems that meet technical, economic, and regulatory standards.
- Lead and manage pipeline projects, including construction, commissioning, and integrity maintenance.
- Address emerging challenges such as hydrogen transport, digitalization, and environmental protection in the pipeline sector.
- Act as key technical contacts and decision-makers in engineering firms, operating companies, regulators, and consulting organizations.

Graduates of the course are qualified for positions in:

- Energy and utility companies transport oil, gas, Hydrogen, water, and slurry.
- Engineering, procurement, and construction (EPC) contractors and consulting firms.
- Regulatory authorities and certification bodies are involved in infrastructure compliance and safety.
- Research and development institutions focusing on pipeline technology, energy systems, and infrastructure innovation.

The course aligns with the National Qualifications Framework (NQF) requirements and positions graduates at a professional level that combines technical expertise, practical application, and scientific reasoning. This qualification profile ensures participants are equipped for demanding roles in a dynamic global energy infrastructure environment.

§2 CONTENT AND STRUCTURE OVERVIEW

The “Pipeline Engineering” university program comprises 60 ECTS credits. The content and skills of the program are taught in modules worth 5 ECTS credits each. Modules are teaching and learning content grouped according to a program's didactic and thematic units (Table 1).

Table 1: Core Module

Module Type	ECTS
Core Modules	60
Thesis / Exam	2
Sum	62

§3 CORE MODULES- OVERVIEW

Core modules must be completed to achieve the qualification profile of the university course “Pipeline Engineering.” The core modules are listed in Table 2.

Table 2: Core Module

Micro-credential	Core Modules
MC01	Basics of Pipeline Engineering and Design Fundamentals
MC02	Pipeline Materials and Mechanical Design
MC03	Pipeline System Design
MC04	Pipeline Routing and Civil Design
MC05	General Aspects of Station and Terminal Design and Equipment
MC06	Pipeline Instrumentation and Automation
MC07	Energy Pipeline Systems
MC08	Pipeline Systems for Water Transmission and Similar Fluids
MC09	Special Pipeline System
MC10	Pipeline Construction
MC11	Pipeline Operation, Integrity Management, and Maintenance
MC12	Pipeline Project Management

MC01: BASICS OF PIPELINE ENGINEERING & DESIGN FUNDAMENTALS

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics or engineering fundamentals. No formal prerequisites are required. Participant limit: minimum 12, maximum 20.

Course Description

This introductory course provides a comprehensive overview of pipeline engineering, focusing on its historical development, technological advancements, and industry standards. Participants will explore the evolution of pipeline technology, recent innovations, and the core principles that guide the construction, operation, and maintenance of modern pipeline systems. The course covers different pipeline types—such as transmission, distribution, and flow lines—and the classification of pipelines based on fluid type, operational conditions, and specific mechanical and material considerations.

The economic and strategic significance of pipelines within global energy infrastructure will be addressed, and alternatives to transportation methods will be compared. Participants will also gain insight into the various fluids transported through pipelines, including oil, natural gas, water, Hydrogen, and CO_2, and understand the basic design considerations, operational parameters, and construction techniques. Ethics and responsibilities in engineering will be emphasized, focusing on sustainable, safe, and environmentally conscious solutions. This introductory knowledge, paired with practical insights, provides an essential foundation for anyone new to the field of pipeline engineering.

Course Content

1. **Overview of Pipeline Systems**
    - **Historical Context and Evolution**
        - Development of pipeline technology through the ages
        - Key innovations and milestones in pipeline engineering
    - **Technological Advancements**
        - Recent breakthroughs and modern advancements
        - Emerging technologies and future trends
    - **Current Practices and Industry Standards**
        - Modern construction methods
        - Best practices in pipeline operation and maintenance
2. **Core Concepts of Pipeline Engineering**
    - **Pipeline Types and Functions**
        - Transmission, distribution, and flow lines
        - Characteristics and applications of each pipeline type
    - **Components and Classifications**
        - Essential components: pipeline (liner part), stations, terminals, and supervisory & control system
        - Pipeline classification based on fluid type and operational parameters
3. **Economic and Strategic Importance**
    - **Pipelines as Critical Infrastructure**
        - Economic impact and role in global and local economies
        - Integration with other transportation and energy systems
    - **Comparative Analysis**

        - Pipelines versus rail, road, and maritime transport
        - Comparison of transportation costs
        - Benefits and challenges associated with pipelines
4. **Fluids and Pipeline Design**
    - **Types of Fluids Transported**
        - Overview of fluids: oil, natural gas, water, Hydrogen, CO_2, Ammonia
        - Specific requirements and handling considerations for each fluid
    - **Design Considerations**
        - Factors influencing pipeline design: fluid characteristics, environmental conditions
        - System optimization
    - **Materials and Mechanical Design**
        - Selection of materials based on corrosion resistance, strength, and operational demands
        - Mechanical aspects of pipeline design to ensure safety and longevity
5. **System and Route Design**
    - **System Design (Hydraulics and Stations)**
        - Hydraulic calculations, pressure requirements, and station placement
        - Design of pump stations, compressor stations, and storage facilities
        - Introduction to the system optimization process
    - **Route Design (Environmental and Structural Aspects)**
        - Route selection, crossing methods, and environmental impact assessments
        - Considerations for terrain, habitats, and infrastructure crossings
6. **Engineer's Ethics and Responsibilities**
    - **Professional Standards in Pipeline Engineering**
        - Ethical responsibilities in design and decision-making
        - Commitment to safe, sustainable, and environmentally responsible solutions

Learning Outcomes:

By the end of this course, participants will be able to:

- Describe the development of pipeline systems, emphasizing key technological advancements and the importance of following current construction and maintenance standards.
- Differentiate between pipeline types and components, linking their design principles to operational needs.
- Analyze pipelines' economic and strategic value, comparing them with other transport methods and assessing their broader economic impact.
- Evaluate fluid properties and apply appropriate design and material choices to ensure safe, efficient pipeline operation.
- Develop hydraulic design strategies and address environmental and structural considerations in route planning.
- Promote ethical engineering practices, prioritizing safety, sustainability, and responsible project management.

MC 02: PIPELINE MATERIALS AND MECHANICAL DESIGN

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics or engineering fundamentals. No formal prerequisites are required. Participant limit: minimum 12, maximum 20.

Course Description

This module provides a comprehensive foundation for selecting, designing, and protecting pipeline systems, focusing on materials, manufacturing methods, structural design, and corrosion prevention. Participants will explore the properties and suitability of various pipeline materials—including steel, plastics, concrete, and composites—and gain an understanding of key manufacturing techniques used to produce pipeline components. The course covers essential aspects of structural design, such as determining design pressure, wall thickness, and Maximum Allowable Operating Pressure (MAOP) in line with international codes and standards. In addition, the module examines corrosion mechanisms affecting pipeline integrity and presents industry practices for protection, inspection, and monitoring. Designed for professionals in pipeline engineering, the course equips participants with the technical knowledge and practical skills needed to support safe, efficient, and durable pipeline systems in diverse operating environments.

Course Content

1. Pipeline Materials

1.1 Overview of Common Pipeline Materials
- – Carbon steel, stainless steel, and alloy steel
- – Plastics: PVC, HDPE, PP
- – Concrete and composite materials

1.2 Material Selection Criteria
- – Mechanical strength and toughness
- – Corrosion resistance and durability
- – Cost-efficiency and lifecycle considerations
- – Environmental compatibility and fluid-specific suitability

2. Pipe Manufacturing

2.1 Steel Pipe Manufacturing
- – Seamless and welded pipe production
- – Rolling, forming, and welding processes
- – Inspection and quality control standards

2.2 Plastic and Concrete Pipe Manufacturing
- – Extrusion and molding techniques for plastics
- – Casting methods for concrete pipelines
- – Durability and dimensional control in production

3. Structural Design

3.1 Design Pressure and MAOP
– Internal, external, and transient pressures
– Calculation of design pressure and safety margins
– Maximum Allowable Operating Pressure (MAOP) determination

3.2 Wall Thickness Determination
– Influencing factors: pressure, diameter, material grade
– Corrosion allowance and external loads
– Design codes (e.g., ASME B31.4, ASME B31.8)

3.3 Load and Stress Analysis
– Thermal expansion, soil loads, and environmental forces
– Stress concentrations, fatigue, and buckling resistance
– Flexibility analysis for route and load adjustments

3.4 Design for Safety and Compliance
– Compliance with industry standards and regulations
– Integration of safety factors and design redundancy

4. Corrosion Protection

4.1 Introduction to Corrosion
– Corrosion mechanisms in pipeline systems
– Common types: uniform, pitting, crevice, and stress corrosion cracking

4.2 Corrosion Prevention Techniques
– Protective coatings: types, application, and joint treatment
– Cathodic protection: sacrificial anode and impressed current systems
– Corrosion inhibitors: types, application methods, environmental factors

4.3 Monitoring and Inspection
– Surveillance methods and inspection planning
– In-line inspection (ILI) tools and pigging techniques
– Data interpretation and integration into integrity management

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Based on mechanical, environmental, and economic criteria, understand and evaluate pipeline materials used in engineering applications, including metals, plastics, concrete, and composites.
- Describe and compare steel, plastic, and concrete pipeline manufacturing techniques and assess their impact on pipe quality, durability, and performance.
- Apply structural design principles to determine design pressure, wall thickness, and Maximum Allowable Operating Pressure (MAOP) using relevant industry codes and standards (e.g., ASME B31.4, B31.8).

- Analyze pipeline load and stress conditions, including internal/external pressure, thermal expansion, and soil interaction, and perform basic stress and flexibility assessments.
- Demonstrate knowledge of corrosion mechanisms relevant to pipeline systems and assess their impact on long-term structural integrity.
- Select and evaluate appropriate corrosion protection methods tailored to specific operational and environmental conditions, including coatings, cathodic protection systems, and chemical inhibitors.
- Understand pipeline inspection and monitoring techniques, including in-line inspection (ILI) tools and corrosion surveillance practices, and interpret basic inspection data for integrity management.

MC 03: PIPELINE SYSTEM DESIGN

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics or engineering fundamentals. No formal prerequisites are required. Participant limit: minimum 12, maximum 20.

Course Description

This module offers a comprehensive foundation in pipe system design, integrating hydraulic principles with system optimization strategies. It begins with the fundamentals of fluid mechanics, including fluid properties (Newtonian and non-Newtonian), pressure loss calculations, and thermodynamic considerations. Steady-state hydraulic analysis is addressed for both liquid and gas systems, focusing on flow behavior and pressure profiles. The module introduces methodologies for optimizing pipeline systems by evaluating technical and economic factors such as CAPEX, OPEX, operational safety, sustainability, and public acceptance. The combined coverage of hydraulic analysis and system optimization ensures a coherent understanding of the key parameters influencing efficient and reliable pipeline design.

Course Content

1. Fundamentals of Fluid Mechanics
1.1 Fluid properties: Newtonian and non-Newtonian fluids
1.2 Flow regimes: laminar, turbulent flow, and multiphase
1.3 Thermodynamic principles in pipeline flow systems
1.4 Pressure loss and head loss calculations

2. Steady-State Hydraulic Analysis
2.1 Flow behavior in liquid and gas pipelines
2.2 Pressure profile development and gradient analysis
2.3 Hydraulic simulating techniques for long-distance pipelines
2.4 Design considerations for elevation, terrain, and temperature

3. System Optimization Principles
3.1 Overview of Pipeline System Configuration Strategies
3.2 Preliminary sizing and route evaluation
3.3 Pipeline diameter selection and system balancing
3.4 Modeling approaches for technical and economic comparison

4. Technical and Economic Evaluation
4.1 Capital and operating expenditure (CAPEX and OPEX)
4.2 Operational safety and risk assessment
4.3 Environmental sustainability and emissions impact
4.4 Stakeholder concerns and public acceptance considerations

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Describe and apply the basic fluid mechanics principles relevant to pipeline systems, including fluid behavior, flow regimes, and thermodynamic effects.
- Perform steady-state hydraulic calculations for liquid and gas pipelines, including pressure loss and flow analysis under various operating conditions.
- Analyze and interpret pressure profiles and flow distributions in pipeline networks, accounting for terrain, temperature, and system layout.
- Apply methodologies for pipeline system optimization, including diameter selection, route assessment, and performance evaluation.
- Evaluate pipeline designs based on technical feasibility, economic efficiency (CAPEX/OPEX), safety, and environmental sustainability.
- Integrate engineering, environmental, and stakeholder factors into the decision-making process for designing efficient and reliable pipeline systems.

MC 04: PIPELINE ROUTING AND CIVIL DESIGN

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics or engineering fundamentals. No formal prerequisites are required. Participant limit: minimum 12, maximum 20.

Course Description

This module provides a comprehensive overview of pipeline routing strategies and civil infrastructure design relevant to onshore and offshore pipeline systems. It integrates principles of alignment design, GIS-supported route planning, and geotechnical engineering to equip participants with the skills needed to develop technically safe, environmentally conscious, and regulatory-compliant pipeline routes. Emphasis is placed on practical challenges such as terrain navigation, environmental mitigation, and infrastructure interaction. In the civil design component, participants will explore geotechnical investigation techniques, soil and rock mechanics, foundation systems, and the design of related infrastructure such as stations, tank farms, crossings, and marine facilities. The course supports a multidisciplinary understanding of how routing, civil, and geotechnical considerations collectively influence pipeline systems' design, construction, and long-term performance.

Course Content

1. Pipeline Routing and Alignment Design

1.1 Introduction to routing principles and alignment design
1.2 Route selection criteria: environmental, topographical, socio-economic
1.3 Impact of alignment on system hydraulics and station location
1.4 GIS applications in pipeline planning and route optimization
1.5 Crossings and infrastructure interaction: roads, railways, waterways
1.6 Open-cut and trenchless construction methods (HDD, microtunnels, tunnels)
1.7 Regulatory compliance, mapping, and documentation
1.8 Stakeholder management, permit engineering, and right-of-way acquisition

2. Geotechnical Considerations

2.1 Basics of soil and rock mechanics relevant to pipelines
2.2 Ground investigation methods and interpretation of geotechnical data
2.3 Site-specific challenges: steep slopes, swamps, groundwater, dunes
2.4 Load-bearing assessment and bedding suitability
2.5 Groundwater level evaluation and slope stability checks
2.6 Geotechnical risks: faults, seismic hazards, settlement, liquefaction
2.7 Mitigation Strategies for ground-related risks and construction challenges

3. Civil Design for Pipeline Infrastructure

3.1 Foundations and supports: spread footings, piles, mats
3.2 Civil structures: tank farms, marine facilities, stations, buildings
3.3 Infrastructure crossings and protective measures (e.g., erosion control)
3.4 Equipment foundations and piling techniques

3.5 Compliance with civil and geotechnical engineering standards
3.6 Documentation, reporting, and integration into project execution plans

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Apply routing and alignment principles to design efficient and sustainable pipeline corridors.
- Evaluate environmental, topographical, and infrastructural factors influencing route selection and alignment.
- Use GIS tools and digital mapping for pipeline route planning and optimization.
- Design crossings and coordinate pipeline routes with existing infrastructure using open-cut and trenchless methods.
- Understand soil and rock behavior and assess ground conditions through geotechnical investigation.
- Incorporate geotechnical data into pipeline design, ensuring structural stability and constructability in varied terrains.
- Identify and mitigate geotechnical risks such as slope instability, settlement, and seismic hazards.
- Design civil infrastructure components, including foundations, stations, marine facilities, and erosion protection systems.
- Ensure compliance with relevant regulations, document technical findings, and contribute to permitting and stakeholder engagement processes.

MC 05: PIPELINE SYSTEM DESIGN GENERAL ASPECTS OF STATION AND TERMINAL DESIGN AND EQUIPMENT

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics or engineering fundamentals. No formal prerequisites are required. Participant limit: minimum 12, maximum 20.

Course Description

This module introduces the general principles and considerations of designing stations and terminals in pipeline systems, focusing on equipment selection and integration. It begins with an overview of the functional roles of pumping, compressor, and metering stations and terminals for storage and distribution. Key topics include layout planning, process flow, safety requirements, and regulatory standards. The module also explores the selection criteria for rotating equipment such as pumps, compressors, and drivers, emphasizing performance, reliability, and operational efficiency. In addition, participants will gain insight into other essential equipment used in station and terminal operations, including valves, filters, pressure control devices, and instrumentation. Through practical examples and system-level considerations, the course prepares participants to understand the technical and operational aspects of station and terminal design within the broader context of pipeline infrastructure.

Course Content

1. Introduction to Stations and Terminals

1.1 Functional roles in pipeline systems: pumping, compression, metering, and storage
1.2 Overview of station types: mainline pump stations, compressor stations, metering stations, delivery and receipt terminals
1.3 Role of terminals in distribution networks and storage infrastructure

2. Station and Terminal Layout Planning

2.1 Process flow design and layout optimization
2.2 Plot plans, space allocation, and access considerations
2.3 Safety zones, control buildings, and separation distances
2.4 Integration of facilities within pipeline systems and site-specific constraints

3. Equipment Selection – Rotating Equipment

3.1 Pump types and selection criteria (centrifugal, positive displacement, etc.)
3.2 Compressor types and applications (reciprocating, centrifugal)
3.3 Drivers: electric motors, gas turbines, and engines
3.4 Performance parameters: efficiency, flow range, reliability, NPSH

4. Equipment Selection – Auxiliary and Static Equipment

4.1 Valves and actuators: types, applications, control integration
4.2 Pressure control devices and relief systems

4.3 Filters, strainers, and separators: roles in system protection
4.4 Basic instrumentation for monitoring and control

5. Safety and Compliance

5.1 Applicable design standards and codes (e.g., ASME, API, IEC)
5.2 Safety requirements: overpressure protection, shutdown systems, fire safety
5.3 Regulatory frameworks and permitting considerations
5.4 Documentation, testing, and commissioning requirements

6. Integration and Practical Considerations

6.1 Coordination of mechanical, civil, electrical, and control systems
6.2 Constructability, operability, and maintainability considerations
6.3 Lessons learned from real-world projects and system-level design examples

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Describe the roles and functions of various stations and terminals within a pipeline system.
- Interpret and apply station and terminal layout design principles, considering process flow, safety, and site-specific factors.
- Select appropriate rotating equipment such as pumps, compressors, and drivers based on performance, reliability, and operational requirements.
- Identify and evaluate auxiliary equipment's function and selection, including valves, filters, pressure control devices, and instrumentation.
- Apply relevant industry standards and regulatory requirements to design stations and terminals.
- Understand the integration of mechanical, electrical, civil, and control systems in station and terminal design.
- Analyze system-level considerations for operational efficiency, safety, and maintainability in pipeline infrastructure.

MC 06: PIPELINE INSTRUMENTATION AND AUTOMATION

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics, basics of pipeline engineering, or design fundamentals. Participant limit: minimum 12, maximum 20.

Course Description

This module comprehensively introduces pipeline engineering instrumentation, automation, and control systems, focusing on modern sensor technologies. It covers the principles and practical application of measurement systems, data acquisition, control logic, and automation architecture. Participants will study various sensors (e.g., pressure, temperature, flow, vibration), understand their roles in pipeline monitoring and protection, and learn how to configure data acquisition systems to ensure safe and efficient operation. The module also introduces automation platforms such as Programmable Logic Controllers (PLCs), Distributed Control Systems (DCS), SCADA integration, and cybersecurity practices. Key focus areas include control strategies (PID, MPC), system optimization, communication protocols, and real-time monitoring using dashboard and HMI systems. Designed for professionals and engineers in the pipeline sector, the module prepares learners to plan, implement, and maintain intelligent instrumentation and automation systems for pipeline infrastructure.

Course Content

1. Pipeline Instrumentation and Sensor Technologies

- Introduction to instrumentation in pipeline systems
- Sensor types and principles: pressure, temperature, flow, level, vibration, conductivity
- Installation, calibration, maintenance, and reliability of sensors
- Distributed sensing (e.g., fiber optic, acoustic, strain, temperature systems)
- Measurement chain: signal preconditioning, filtering, A/D conversion, and communication protocols
- Measurement uncertainty and traceability

2. Data Acquisition and Monitoring

- Architecture and components of data acquisition systems
- Sampling, data logging, and visualization techniques
- Signal analysis in time and frequency domains
- Integration of sensor data with operational dashboards
- Instrumentation for safety: ESD, overpressure protection, leak detection
- Enhancing pipeline efficiency through real-time monitoring

3. Pipeline Automation and Control Systems

- Overview of automation components: sensors, actuators, and controllers
- Principles of pipeline process control and automation logic
- Introduction to PLCs and DCS: structure, operation, and configuration
- PLC programming languages: Ladder Logic, Function Block Diagram, Structured Text
- Troubleshooting and maintenance of automation platforms

4. Control Engineering and Optimization

- Basic control theory and pipeline process modeling
- On/Off, PID, and Model Predictive Control (MPC) strategies
- Tuning of control loops for flow, pressure, and temperature regulation
- Safety Integrity Level (SIL) and implementation of safety-critical systems

5. Systems Integration, Communication, and Cybersecurity

- SCADA and telemetry integration with PLC/DCS platforms
- Fieldbus systems and communication protocols
- Human-machine interface (HMI) and dashboard systems for real-time operations
- Data management, anomaly detection, and predictive maintenance
- Cybersecurity considerations for industrial automation and sensor networks

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Explain the role and function of sensors and instrumentation in pipeline systems.
- Select and configure appropriate sensors for monitoring flow, pressure, temperature, and other key parameters.
- Designed and implemented reliable data acquisition systems and signal processing techniques for pipeline applications.
- Develop and deploy PLC- and DCS-based automation systems tailored to pipeline operations.
- Apply and tune control strategies (PID, MPC) to regulate pipeline processes.
- Integrate automation systems with SCADA platforms, field communication networks, and HMI interfaces.
- Utilize real-time data visualization and analytics for performance optimization and predictive maintenance.
- Ensure compliance with safety integrity standards and implement cybersecurity best practices in pipeline control environments.

MC 07: ENERGY PIPELINE SYSTEMS

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics, basics of pipeline engineering, or design fundamentals. No formal prerequisites are required. Participant limit: 12.

Course Description

This module overviews energy pipeline systems, focusing on transporting and storing crude oil, natural gas, and Hydrogen. It covers the design, operation, and safety considerations of crude oil and gas pipelines and associated storage facilities. The module also introduces the specific challenges and technologies related to hydrogen pipelines, including material selection, safety requirements, and storage methods. Additionally, offshore pipeline systems are addressed, emphasizing subsea routing, installation techniques, and environmental and structural factors affecting offshore operations. The module equips participants with a broad understanding of the diverse energy transport systems that form the backbone of global energy infrastructure.

Course Content

1. Crude Oil & Gas Pipelines and Storage
1.1 Overview of crude oil and natural gas transportation systems
1.2 Pipeline design considerations: flow rates, pressures, temperature control
1.3 Operational principles: pumping/compression stations, pigging, leak detection
1.4 Storage facilities: tank types, terminal design, loading/unloading systems
1.5 Health, safety, and environmental standards in oil and gas transport
1.6 Emergency response, risk mitigation, and system integrity management

2. Hydrogen Pipelines and Storage
2.1 Introduction to Hydrogen as an energy carrier and its physical properties
2.2 Pipeline materials and design challenges for Hydrogen (e.g., embrittlement)
2.3 Hydrogen storage options: above-ground tanks, underground storage (salt caverns, lined rock caverns)
2.4 Regulatory standards and best practices for hydrogen infrastructure
2.5 Repurposing of natural gas pipelines for hydrogen service

3. Offshore Pipelines
3.1 Design considerations for offshore and subsea pipelines
3.2 Routing and seabed mapping: bathymetric surveys, geohazard identification
3.3 Installation techniques: S-lay, J-lay, reel-lay, and tow methods
3.4 Structural integrity under pressure, currents, and seabed interaction
3.5 Inspection, maintenance, and intervention in offshore environments
3.6 Regulatory frameworks for offshore pipeline construction and operation

4. System Comparison and Integration
4.1 Economic and strategic roles of each system within the global energy infrastructure
4.2 Case studies illustrating system performance, failures, and innovation

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Describe the design, operation, and safety principles of crude oil and natural gas pipeline systems, including associated storage infrastructure.
- Understand the unique challenges of hydrogen transport, including material compatibility, safety, and storage technologies.
- Analyze offshore pipeline systems regarding routing, installation, environmental factors, and structural integrity.
- Compare and evaluate the technical and regulatory aspects of different energy pipeline systems.
- Assess how emerging technologies and energy transition trends influence the evolution of pipeline infrastructure.
- Apply system-level thinking to identify integration opportunities between oil, gas, Hydrogen, and offshore systems in energy networks.
- Interpret key case studies to gain practical insights into energy pipeline projects' performance, challenges, and best practices.

MC 08 PIPELINES SYSTEMS FOR WATER TRANSMISSION AND SIMILAR FLUIDS

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics, basics of pipeline engineering, or design fundamentals. No formal prerequisites are required. Participant limit: 12.

Course Description

This module explores water, wastewater, and slurry transmission pipeline systems. It covers these systems' design, operation, and management, highlighting each fluid type's specific technical, hydraulic, and material requirements. Participants will gain practical insights into pressure control, flow dynamics, material selection, and safety practices tailored to the characteristics of clean water supply, wastewater conveyance, and solid-liquid mixtures such as slurry. Special attention is given to sedimentation, abrasion, and environmental compliance. Designed for professionals in pipeline engineering, this module equips participants with the knowledge and skills needed to address the unique challenges of non-hydrocarbon fluid transport systems.

Course Content

1. Introduction to specialized pipeline systems
   1.1 Overview of water, wastewater, and slurry pipelines in industrial and municipal contexts
   1.2 System components: pipeline segments, pumps, valves, and storage units
   1.3 Comparison of design and operational demands across the three fluid types
2. Water transmission systems (main focus)
   2.1 Hydraulic calculations, pipeline sizing, surge, and pressure management
   2.2 Pump station design and flow control
   2.3 Friction loss analysis and system balancing techniques
   2.4 Selection of pipes (PVC, HDPE, ductile iron, steel), joints, coatings, and valves
   2.5 Corrosion protection and lifecycle performance
   2.6 Metering, control valves, and system integration
   2.7 Types of storage: tanks, reservoirs, cisterns
   2.8 Design for capacity, structural integrity, and water quality
   2.9 Operational integration with distribution networks
3. Wastewater conveyance systems
   3.1 Flow characteristics in gravity vs. pressurized sewer systems
   3.2 Hydraulic analysis and material selection for corrosive environments
   3.3 Odor and Corrosion Control Strategies
   3.4 Maintenance technologies: inspection, flushing, and rehabilitation
4. Slurry pipeline systems
   4.1 Rheology and flow behavior of solid-liquid mixtures
   4.2 Pipeline sizing and pump selection for abrasive media
   4.3 Materials for wear resistance and abrasion mitigation
   4.4 Handling sedimentation, start-up/shutdown procedures, and blockages
5. Pumping and control systems
   5.1 Pump station layout, redundancy, and energy efficiency
   5.2 Flow and pressure control: valves, regulators, and SCADA systems
   5.3 Automation and monitoring for operational stability

Learning Outcomes

Upon successful completion of this module, participants will be able to:

- Design and evaluate pipeline systems for water, wastewater, and slurry, applying advanced hydraulic analysis
- Select suitable materials and equipment based on fluid properties and operational demands, ensuring durability and efficiency.
- Integrate storage, pumping, and control systems into comprehensive pipeline networks.
- Manage operational and maintenance challenges specific to each fluid type, including abrasion, sedimentation, corrosion, and odor.
- Apply safety, environmental, and regulatory standards in the design and operation of non-hydrocarbon pipeline systems.

MC 09 SPECIAL PIPELINE SYSTEM

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics, basics of pipeline engineering, or design fundamentals. No formal prerequisites are required. Participant limit: 12.

Course Description

This module provides an in-depth overview of special pipeline systems transporting challenging or high-risk fluids. It covers upstream flow lines and gathering systems commonly used in oil and gas production, focusing on multiphase flow, terrain effects, and flow assurance. The module also addresses the design and operation of CO_2 pipelines, highlighting safety considerations, material compatibility, and regulatory aspects specific to carbon capture and storage (CCS) applications. Ammonia (NH_3) pipeline systems are examined with attention to toxicity, pressure containment, and leak prevention strategies. Additionally, the module covers the transport of hot fluids, emphasizing thermal management, insulation, and material selection. Participants comprehensively understand the engineering challenges and design solutions associated with specialized pipeline systems in complex operating environments through these four sections.

Course Content

1. Upstream Flow Lines and Gathering Systems
   1.1 Characteristics of multiphase flow (oil, gas, water, sand)
   1.2 Terrain effects: slug flow, elevation-induced surges, and pressure transients
   1.3 Flow assurance strategies: hydrate prevention, wax/paraffin control, sand management
   1.4 Pipeline layout considerations in complex topography
   1.5 Operational aspects: pigging, separation facilities, pressure control
2. CO_2 Pipeline Systems (Carbon Capture and Storage - CCS)
   2.1 Properties of CO_2 in gaseous and supercritical states
   2.2 Material compatibility and corrosion control
   2.3 Fracture control and pressure containment
   2.4 Leak detection, safety zones, and risk management
   2.5 Regulatory and environmental compliance (e.g., ISO, API, EU CCS regulations)
3. Ammonia (NH_3) Transport Pipelines
   3.1 Physical and toxicological properties of Ammonia
   3.2 Pressure design and containment systems
   3.3 Leak prevention and emergency response strategies
   3.4 Selection of compatible materials, gaskets, and seals
   3.5 Regulatory frameworks for toxic and hazardous substances
4. Hot Fluid Transport Pipelines
   4.1 Applications in geothermal, refinery, and process industries
   4.2 Thermal expansion, insulation strategies, and heat loss mitigation
   4.3 Pipe material selection for high-temperature resistance
   4.4 Jointing methods and flexibility analysis
   4.5 Monitoring and maintenance of high-temperature systems

Learning Outcomes

By the end of this module, participants will be able to:

- Analyze and design upstream gathering systems for multiphase flow, addressing flow assurance and terrain-induced operational challenges
- Evaluate and implement best practices in CO_2 pipeline design, focusing on corrosion control, containment, and regulatory compliance in CCS applications.
- Understand and apply safety and design standards for ammonia pipelines, including leak prevention, pressure control, and material compatibility.
- Design and manage hot fluid transport systems, incorporating insulation, thermal expansion, and high-temperature material considerations
- Address technical and safety challenges in specialized pipelines, ensuring reliable operation under demanding physical and environmental conditions.

MC 10 PIPELINE CONSTRUCTION

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics or engineering fundamentals. No formal prerequisites are required. Participant limit: 12.

Course Description

This module comprehensively overviews pipeline construction in onshore and offshore environments. It covers the full construction lifecycle, including new pipeline installations, station and tank farm development, and infrastructure rehabilitation and conversion. Key topics include construction methods, equipment, logistics, environmental and safety considerations, and project execution strategies. Offshore construction elements such as subsea installation techniques, marine operations, and specialized equipment are also addressed. Designed for participants and professionals in pipeline engineering, the module equips learners with the practical knowledge and technical skills required to plan and manage efficient, safe, and compliant pipeline construction projects across diverse terrains and conditions.

Course Content

1. Onshore Pipeline Construction

1.1 Pre-construction planning

- Route endorsement
- Right-of-way acquisition, permitting, and regulatory compliance
- Construction planning, scheduling, and stakeholder coordination

1.2 Site preparation and pipeline laying

- Clearing, grading, trenching, and access road development
- Pipe stringing, bending, and welding
- Lowering-in, padding, and backfilling
- Crossing roads, railways, and rivers (e.g., HDD, boring, casing)

1.3 Testing and commissioning

- Hydrostatic testing, pigging, and cleaning
- Pre-commissioning and commissioning processes
- Quality assurance and documentation

1.4 Safety and environmental management

- Construction HSE planning and monitoring
- Environmental protection and erosion control
- Emergency response planning for land-based projects

1.5 Special conditions

- Construction in mountainous terrain, deserts, wetlands, and cold regions
- Logistics for remote and difficult-access areas

2. Offshore Pipeline Construction

2.1 Marine planning and engineering surveys

- Route selection, bathymetric, and geotechnical studies
- Permitting, maritime regulations, and coordination with port authorities

2.2 Pipeline Installation Methods

- S-lay, J-lay, and reel-lay techniques
- Pipe welding and coating on laying vessels
- Riser installation and tie-ins to platforms or FPSOs

2.3 Subsea crossings and protection

- Rock dumping, trenching, and burial
- Use of mattresses, concrete coating, and stabilization techniques
- Corrosion protection and cathodic systems

2.4 Testing and commissioning

- Pressure testing in deepwater environments
- Leak detection and pipeline integrity testing
- Integration with onshore facilities

2.5 Offshore HSE and operational risk

- Marine safety procedures and contractor coordination
- Environmental protection in sensitive marine ecosystems
- Emergency procedures and contingency plans

Learning Outcomes

By the end of this module, participants will be able to:

- Understand the full lifecycle of onshore and offshore pipeline construction, from planning to commissioning
- Select and apply appropriate construction techniques based on geography, environmental conditions, and project scope
- Manage HSE compliance and risk during construction operations
- Coordinate construction activities across multiple stakeholders and regulatory frameworks
- Solve construction challenges in complex terrains and subsea environments
- Ensure pipeline integrity and quality assurance through proper testing and documentation practices

MC 11 PIPELINE OPERATION, INTEGRITY MANAGEMENT, AND MAINTENANCE

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics, basics of pipeline engineering, or design fundamentals. No formal prerequisites are required. Participant limit: 12.

Course Description

This module provides an in-depth understanding of pipeline systems from operation and integrity management to maintenance and repair practices. It focuses on efficient pipeline operation, advanced monitoring, and control technologies, and emphasizes integrity management through in-line inspection (ILI) and non-destructive testing methods. The module also covers practical maintenance strategies and field repair techniques necessary for ensuring pipeline reliability and safety. Designed for professionals in pipeline engineering, it equips participants with the technical knowledge and operational skills required to manage complex pipeline networks safely and efficiently across various environments.

Course Content

1. Pipeline Operation

- Standard operating procedures and organizational structure
- Real-time monitoring and SCADA systems
- Flow rate, pressure, and temperature control
- Performance optimization and troubleshooting
- Regulatory compliance and safety standards

2. Integrity Management (with Emphasis on In-line Inspection)

- Principles of pipeline integrity assessment
- In-line inspection (ILI): smart pigs, ultrasonic testing, and other NDT techniques
- Corrosion management: coatings, cathodic protection, inhibitors
- Risk assessment and mitigation strategies
- Regulatory frameworks and traceability in inspection processes

3. Pipeline Maintenance and Repair

- Preventive, predictive, and risk-based maintenance planning
- Routine maintenance and emergency response procedures
- Pigging operations and corrosion detection
- Repair technologies: clamps, sleeves, welding, hot tapping, composite wraps
- Safety measures and environmental compliance during repair activities

Learning Outcomes

Upon completion of this module, participants will be able to:

- Operate pipeline systems efficiently using best practices and monitoring technologies
- Implement integrity management techniques to assess, maintain, and enhance pipeline health
- Apply structured maintenance strategies (preventive, predictive, and condition-based)
- Utilize field-proven and innovative repair methods to restore pipeline function
- Ensure compliance with safety and environmental regulations during operations and repair
- Develop and manage emergency response plans for operational incidents

MC 12 PIPELINE PROJECT MANAGEMENT

Participant Limits, Prerequisites: Recommended for participants with prior technical background in fluid mechanics, basics of pipeline engineering, or design fundamentals. No formal prerequisites are required. Participant limit: 12.

Course Description

This course introduces the fundamental principles and practices of project management, specifically tailored for pipeline projects. It covers critical aspects from initiation to closure, including planning, scheduling, cost management, risk analysis, quality control, and stakeholder management. In addition, the course addresses key execution and control aspects, ensuring that projects are completed on time, within budget, and meet the required quality standards. Special emphasis is placed on the unique challenges of pipeline projects, such as regulatory compliance, environmental considerations, and cross-disciplinary coordination.

Course Content

1. **Introduction to Pipeline Project Management**

    - Overview of project management in the context of pipeline projects
    - Key phases of the pipeline project lifecycle: initiation, planning, execution, monitoring, and closure
    - Importance of integrating technical, financial, and environmental considerations in project management
    - Establish a Project Management organization
    - Various options for project execution and the relevant conditions of the contract
    - Development of the Project Execution Plan

2. **Project Planning and Scheduling for Pipeline Projects**

    - Development of project scope and objectives
    - Work Breakdown Structure (WBS) and Gantt charts for pipeline project scheduling
    - Critical Path Method (CPM) and Program Evaluation and Review Technique for pipeline projects
    - Resource allocation and management in pipeline projects

3. **Cost Management and Budgeting**

    - Cost estimation techniques for pipeline projects: direct and indirect costs
    - Budgeting and financial planning for pipeline project phases
    - Cost control techniques: Earned Value Management (EVM) and cost variance analysis
    - Case studies on budget overruns and cost optimization strategies

4. **Risk Management in Pipeline Projects**

    - Identifying potential risks in pipeline projects: technical, environmental, and financial risks
    - Qualitative and quantitative risk analysis methods

- Risk mitigation and contingency planning
- Application of risk management tools and software

5. **Quality Management and Compliance**

    - Quality assurance and quality control (QA/QC) in pipeline projects
    - Design vetting
    - Regulatory compliance and standards for pipeline construction and operation
    - Inspection, testing, and auditing processes to ensure quality
    - Case studies on quality failures and lessons learned

6. **Stakeholder Management and Communication**

    - Identifying and managing stakeholders: internal and external stakeholders
    - Effective communication strategies and conflict resolution
    - Collaboration and coordination across multidisciplinary teams
    - Managing community relations and public perception in pipeline projects

7. **Project Execution, Control, and Reporting**

    - Strategies for effective control during the project execution phase
    - Frameworks and best practices for regular reporting and decision-making
    - Methods to measure progress, including the application of PoC AWP techniques
    - Approaches for managing plant and operational data efficiently
    - Document Management: Best practices for maintaining and controlling project documentation

Learning Outcomes

By the end of this course, participants will be able to:

- Prepare the Project Execution Plan
- Understand the fundamental principles and processes of project management in pipeline projects.
- Develop and manage project schedules, budgets, and resources effectively.
- Perform risk assessments and implement risk management strategies for pipeline projects.
- Ensure quality management and regulatory compliance in all phases of pipeline projects.
- Manage stakeholders and communicate effectively to achieve project objectives.
- Apply execution controlling, reporting, and progress measurement techniques, and manage plant data and project documentation efficiently.

APPENDIX: TIME TABLE OF THE PROGRAM MODULES 2026

Module	Dates
Basics of Pipeline Engineering and Design Fundamentals	March 2 - 6
Pipeline Materials and Mechanical Design	March 9-13 March 16- 20
Pipeline System Design	March 23- 27 March 30- April 3
Pipeline Routing and Civil Design	April 13-17
General Aspects of Station and Terminal Design & Equipment Selection	April 20- 24 April 27- April 30
Pipeline Instrumentation and Automation	May 4 -8 May 11-15
Pipelines Systems for Water Transmission and Similar Fluids	May 18- 22
Energy Pipeline Systems	June 8-12 June 14-19
Special Pipeline System	June 22- 26 June 29- July 3
Pipeline Construction	July 6-10
Pipeline Operation, Integrity Management, and Maintenance	July 13-17 July 20-24
Pipeline Project Management	July 27-31