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Jamshedpur, India

Step 1: Foundation Piping Design Fundamentals | Step 2: AutoCAD Plant 3D & P&ID | Step 3: Advanced Plant Modeling in SP3D | Step 4: Pipe Stress Analysis with CAESAR II

Build core technical knowledge, design skills, and calculation abilities before moving into software tools.

M1 Introduction to Piping Engineering & Industry Overview

- What is Piping Design? Importance in process plants
- Industry sectors: Oil & Gas, Power, Pharma, Chemicals
- EPC lifecycle: FEED → Detail Engineering → Procurement → Construction
- Career tracks in piping: Design, Modeling, Stress, QA/QC

Activities

- Identify piping applications in different industries
- Map roles in a sample EPC project

Mini Project

- Create a piping workflow diagram for any process industry

M2 Piping Design Codes, Standards & Line Classes

- ASME B31.1, B31.3, API, ASTM, ANSI overview
- Difference between codes, standards, and specs
- Understanding pipe schedule and pressure class
- How to read line specifications
- Practice: Decoding a piping spec sheet

Activities

- Interpret data from actual ASME table
- Match pipe schedule to pressure and temperature conditions

Mini Project

- Prepare a sample line class with materials, pressure rating, and schedule selection

M3 Piping Components & Functional Understanding

- Pipe fittings: elbows, tees, reducers
- Flanges: types, facing, ratings
- Valves: gate, globe, ball, check, butterfly
- Branch connections: weldolet, sockolet, stub-in
- Symbols used in drawings and P&IDs
- Application scenarios and selection logic

Activities

- Rename a list of improperly named files using ISO 19650 naming logic
- Review a simplified BEP sample and identify: EIR, MIDP, and roles sections

Mini Project

- Draw a segment of a piping line using correct components and annotate with symbols

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M4 Piping Materials, MOC, and Corrosion Basics

- Common materials: CS, SS, Duplex, PVC, HDPE
- Selection criteria: temperature, pressure, fluid type
- Corrosion types and protection techniques
- Traceability and Material Test Certificates (MTCs)

Activities

- Compare material properties for different process conditions
- Evaluate a sample MTC

Mini Project

- Develop a basic MOC matrix based on given process conditions

M5 Fluid Flow Basics & Pipe Sizing Calculations

- Flow concepts: velocity, pressure, head
- Continuity, Bernoulli's and Darcy-Weisbach equations
- Pipe sizing using velocity and flow rate
- Frictional pressure drop estimation
- Manual calculation exercises (Water, Steam, Oil lines)

Activities

- Solve sample problems using standard formulas
- Plot velocity vs. pressure drop for different pipe diameters

Mini Project

- Perform full pipe sizing calculation and report for a sample fluid line

M6 Pipe Routing, Layout Rules & Thermal Flexibility

- Routing logic around pumps, vessels, exchangers
- Expansion loops, offsets, and flexibility
- Elevation changes and slope rules
- Pipe support types: guide, anchor, spring
- Avoiding interferences and ensuring maintainability

Activities

- Analyze a routing scenario for thermal expansion
- Identify support placement in sample sketches

Mini Project

- Sketch a routing layout with correct support types and flexibility provisions

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M7 Equipment Layout, Plot Plans & Nozzle Orientation

- Understanding layout drawings and symbols
- Plot plan reading and interpretation
- Nozzle orientation for pumps, vessels, columns
- Clearance, access, and safety zones
- GA and sectional drawing examples

Activities

- Interpret a sample plot plan
- Mark correct nozzle orientations on provided layout

Mini Project

- Prepare a simplified equipment layout with nozzle placement and clearances

M8 Project – Manual Layout & Sizing of a Pump-to-Tank Piping System

- Design a simple pipe system (e.g., pump to tank)
- Hand-sketch layout with correct routing principles
- Perform pipe sizing and thickness calculations
- Annotate valves, fittings, and supports
- Submit report with design basis and assumptions

End-of-Step Outcomes

- Strong foundation in piping systems and calculations
- Familiarity with real project documents and specs
- Readiness for 3D modeling tools in Step 2
- Completed project portfolio piece (manual design)

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Step 1: Foundation Piping Design Fundamentals | **Step 2: AutoCAD Plant 3D & P&ID** | Step 3: Advanced Plant Modeling in SP3D | Step 4: Pipe Stress Analysis with CAESAR II

Apply piping fundamentals to create smart P&IDs, 3D piping models, and complete deliverables using industry-standard tools.

M1 Introduction to AutoCAD P&ID

- Understanding the interface and tool palettes
- Navigating the project manager
- Creating P&IDs using standard libraries
- Adding equipment, lines, and annotations

Activities

- Create a simple P&ID diagram from a given process
- Use standard symbols and annotations

Mini Project

- Prepare a complete P&ID for a basic pump-to-tank system

M2 Intelligent Tagging, Properties & Reports in P&ID

- Component tagging and data linking
- Assigning line numbers and equipment IDs
- Generating component lists and line lists
- Data consistency and audit checks

Activities

- Edit and update tag properties for a given diagram
- Perform error checks using Data Manager

Mini Project

- Generate an intelligent line list and equipment list from your own P&ID

M3 Project Setup in AutoCAD Plant 3D

- Setting up a Plant 3D project
- Understanding the folder structure and spec files
- Importing P&ID data into 3D environment

Activities

- Set up a sample Plant 3D project
- Link existing P&ID data to 3D workspace

Mini Project

- Configure a project and import your P&ID model

M4 Project Setup in AutoCAD Plant 3D

- Creating custom equipment using equipment builder
- Placing standard pumps, vessels, tanks, and exchangers
- Nozzle orientation and alignment

Activities

- Model a vessel and pump in 3D
- Adjust nozzle direction and elevations

Mini Project

- Build an equipment layout for a sample process plant zone

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M5 Piping Routing and Fittings in Plant 3D

- Routing pipelines using spec-driven modeling
- Adding elbows, reducers, valves, flanges
- Using pipe routing preferences and elevation settings

Activities

- Route piping between two equipment in 3D
- Insert valves and fittings with correct orientation

Mini Project

- Model a complete line from pump to tank, using correct spec

M6 Pipe Supports, Isometrics & BOM Generation

- Adding pipe supports and hangers
- Creating isometric drawings and customizing annotations
- Generating Bill of Materials (BOM) and spool drawings

Activities

- Add supports to existing 3D lines
- Generate isometrics for individual lines

Mini Project

- Generate isometric and BOM for a complete line system

M7 Ortho Drawings, Annotations & Sheet Setup

- Creating orthographic views: plan, elevation, section
- Dimensioning, annotation, and title block editing
- Plotting and sheet setup for deliverables

Activities

- Extract ortho views from your plant model
- Apply dimensioning and annotation settings

Mini Project

- Submit a plot-ready ortho sheet for review

M8 Capstone Project – 3D Modeling of a Pump Circulation System

- Model a complete pump circulation loop including pump, suction drum, delivery tank, valves, reducers, flanges, and supports
- Develop intelligent P&ID and link it to Plant 3D
- Route all piping lines with correct specs and elevations
- Generate isometrics, orthographic drawings, BOM, and project data reports

Activities

- Peer review and checklist-based QA of model and drawings

Final Submission

- **Deliverables to include:**
  Linked P&ID and Plant 3D model
  Isometrics and BOM
  Ortho drawings (plan and section)
  Design basis note

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Step 1: Foundation Piping Design Fundamentals | Step 2: AutoCAD Plant 3D & P&ID | **Step 3: Advanced Plant Modeling in SP3D** | Step 4: Pipe Stress Analysis with CAESAR II

Learn Smart Plant 3D for large-scale industrial piping projects, covering modeling, specs, supports, and clash detection workflows used in EPC environments.

M1 Introduction to SP3D & Project Structure

- Overview of SP3D interface and workspace
- Understanding database-driven modeling
- SP3D project structure and environment setup
- Work breakdown, permissions, and admin roles

Activities

- Explore interface and component hierarchy
- Set up a sample SP3D workspace

Mini Project

- Create a new SP3D project and configure the grid and workspace

M2 Equipment & Structural Modeling in SP3D

- Placing equipment: pumps, vessels, exchangers
- Modifying dimensions, orientation, and nozzles
- Basic steel structure modeling for platforms and racks
- Inserting reference planes and setting elevations

Activities

- Model a pump and vertical vessel with nozzles
- Create a steel support frame using structural tools

Mini Project

- Complete a model of a pump skid with platform and vessel

M3 Pipe Routing, Line Properties & Specifications

- Creating pipelines using spec-driven routing
- Inserting elbows, tees, reducers, and custom fittings
- Using pipe hierarchy: systems, runs, and branches
- Assigning specs and insulation layers

Activities

- Route a pipe between pump and vessel
- Apply correct specs and elevation offsets

Mini Project

- Model a full line system for a tank feed loop using SP3D specs

M4 Piping Supports, Hangers & Assemblies

- Using pipe support module
- Inserting supports, spring hangers, and baseplates
- Modifying support types based on line service

Activities

- Insert supports for horizontal and vertical lines
- Configure a custom support assembly

Mini Project

- Apply appropriate supports for a pressure line with elevation changes

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M5 Nozzle Orientation & Equipment Connectivity

- Managing nozzles and connectivity
- Nozzle alignment with pipe routes
- Equipment-to-pipe integration

Activities

- Align nozzle direction for pump suction/discharge
- Fix a disconnected line using the routing tool

Mini Project

- Model a connected loop between pump, vessel, and pipe rack

M6 Clash Detection & Interference Management

- Running clash detection within SP3D
- Managing interferences using filters
- Clash resolution reporting and coordination

Activities

- Run clash check for a modeled plant area
- Generate and interpret clash report

Mini Project

- Resolve interferences in a congested piping area and submit clash-free version

M7 Drawing Extraction – Isometric & Orthographic Views

- Generating isometrics automatically
- Customizing drawing templates and annotations
- Creating ortho drawings: plan, elevation, and sections
- Exporting and publishing deliverables

Activities

- Generate isometric drawings for a selected line
- Create orthographic view with annotations

Mini Project

- Submit isometric and ortho drawing set for a modeled system

M8 Capstone Project – SP3D Modeling of a Compressor Unit with Pipe Rack

- **Model a full compressor unit including:**
  - Centrifugal compressor
  - Suction drum and aftercooler
  - Interconnected piping with routing via a pipe rack
  - Supports, nozzles, valves, and connectivity
- **Include line specs, drawing outputs, and clash-free model**

Activities

- Peer review and validation checklist

Final Submission

- SP3D model, isometrics, ortho sheets, BOM, and clash report

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Step 1: Foundation Piping Design Fundamentals | Step 2: AutoCAD Plant 3D & P&ID | Step 3: Advanced Plant Modeling in SP3D | **Step 4: Pipe Stress Analysis with CAESAR II**

Equip students to perform stress analysis of piping systems using CAESAR II, ensuring flexibility, safety, and compliance with ASME codes.

M1 Introduction to Pipe Stress Engineering

- What is pipe stress and why it matters
- Types of loads: sustained, thermal, occasional
- Failure modes: fatigue, creep, buckling
- Code overview: ASME B31.1, B31.3 stress criteria

Activities

- Identify stress zones in a sample piping layout
- Map loads on a sample pipe routing

Mini Project

- Document stress concerns in a high-temp pump line scenario

M2 Getting Started with CAESAR II

- Interface walkthrough and input setup
- Creating a piping model: nodes, elements, restraints
- Input of material, temperature, pressure, and pipe data
- CAESAR file formats and navigation

Activities

- Apply wind load to a pipe rack system
- Analyze effects of earthquake loading in a riser

Mini Project

- Analyze a vertical column line with wind and seismic loads

M3 Static Stress Analysis & Load Cases

- Understanding primary and secondary stresses
- Load cases: W+P, W+P+T, occasional (wind/seismic)
- Sustained stress and expansion stress checks
- Displacement and stress result interpretation

Activities

- Analyze a modeled line under W+P+T
- Compare output with ASME allowable limits

Mini Project

- Perform complete static analysis of a process line and summarize results

M4 Expansion Loops & Flexibility Analysis

- Why expansion loops are needed
- Expansion stress and displacement limits
- Loop sizing formulas and flexibility checks
- Support configuration: anchor, guide, spring hanger

Activities

- Add an expansion loop to an existing model
- Calculate loop dimensions manually

Mini Project

- Modify a rigid layout into a flexible one and compare results

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M5 Supports & Boundary Conditions in CAESAR II

- Types of supports: fixed, sliding, spring, variable
- Modeling restraints and stiffness
- Guide spacing and anchor loads

Activities

- Apply spring hangers in a vertical riser
- Evaluate support reactions and check overstressed zones

Mini Project

- Add complete support logic to a stress-critical system

M6 Stress Compliance, Reports & Documentation

- Modeling wind and seismic loads
- Using uniform loads and response spectrum
- Hydrotest case setup

Activities

- Build a basic L-shaped pipe model
- Input operating and design conditions

Mini Project

- Model a horizontal line with reducers, bends, and supports

M7 Stress Compliance, Reports & Documentation

- Reviewing code compliance reports
- Generating support load reports and displacement summaries
- Preparing deliverables: stress isometrics, load tables

Activities

- Interpret CAESAR output reports
- Create a compliance checklist based on project specs

Mini Project

- Submit documentation for a completed stress model with findings and design notes

M8 Capstone Project – Stress Analysis of a Steam Header System

- Model a steam distribution line with branches, valves, and elevation changes
- Apply temperature, pressure, and occasional loads
- Add expansion loops, proper supports, and restraints
- Ensure stress compliance with ASME code

Activities

- Peer-review another student's model
- QA checklist verification of model assumptions

Final Submission

- **Deliverables to include:**
  - CAESAR II model file
  - Load case setup and results
  - Stress isometric with support locations
  - Final report with conclusions and recommendations

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