Naan Mudhalvan – Polytechnic – Even Semester 2024-25
4th Semester – Course Curriculum

ABOUT THE COURSE

COURSE NAME:	PIPING DESIGN
TOTAL DURATION:	60 HRS
MODE OF DELIVERY	PHYSICAL CLASSROOM TRAINING AT RESPECTIVE COLLEGES
TRAINER TO STUDENT RATIO:	1:60
TOTAL MARKS:	70 (External) + 30 (Internal) **(Final Assessment shall be done by TNSDC)**

TABLE 1	
OVERALL COURSE OBJECTIVE:	• Perform the pipe stress analysis and recommend the optimum pipe routing.
LEARNING OUTCOMES:	• Determine the induced stresses in a piping system for sustained and thermal loads • Create the piping material library, piping sections library based on the selected pipe material and pipe thickness to suit the given service in CAEPIPE software • Create the library for sustained loads, thermal loads and dynamic loads based on the type of piping system and geographical condition in CAEPIPE software, and Create Simple Pipe Routing and Analysis • Create the geometry of the complex piping system and its preliminary routing using CAEPIPE software • Perform pipe stress analysis, and modify the piping system to bring the enough inherent flexibility in the piping system using CAEPIPE software

TABLE 2: MODULE-WISE COURSE CONTENT AND OUTCOME				
SL. NO	**MODULE NAME**	**MODULE CONTENT**	**MODULE LEARNING OUTCOME**	**DURATION (HRS)**
1.	Loads on Pipe	**Static Load:** Primary Loads – Dead Loads, Live Loads; Secondary	Determine the induced stresses for sustained and	15

		Loads – Thermal Expansion & Contraction Loads **Dynamic Load:** Wind, Seismic, Vibrational, Discharge Loads **Demonstration** of Pipe Flexibility through Examples; **Determination** of Longitudinal stress for Primary Loads **Determination** of Induced Stress for Secondary Loads	thermal loads analytically	
2.	Exploration of Stress Analysis Software & Library Creation	**Software:** Pallets Exploration; Pipe Material Library Creation; Pipe Section Library creation including Pipe Schedule Number	Handle the software effectively using all its features Can create the required libraries to perform the pipe stress analysis	15
3.	Load Library Creation and Simple Pipe Routing	**Software:** Sustained Load Library Creation; Thermal Load Library Creation; Dynamic Load Library Creation; Simple pipe Routing; Stress Analysis Demonstration	Create the geometry of the simple piping system Perform the stress analysis Modify the piping system to enhance its flexibility by reducing its rigidness Bring the inherent flexibility in the piping system	15
4.	Complex Pipe Routing Creation and Stress Analysis	**Software:** Pipe Routing of Complex Piping System; Stress Analysis Demonstration	Create the geometry of the complex piping system Perform the stress analysis and generate the required reports	10
5.	Optimum Pipe Routing	**Software:** Modify the Pipe Routing; Ensure required Inherent Pipe Flexibility	Modify the complex pipe routing Perform the stress analysis and generate the required reports	5

			Recommend the optimum pipe routing	

TABLE 3: OVERALL COURSE LEARNING OUTCOME ASSESSMENT CRITERIA AND USECASES			
LEARNING OUTCOME	**ASSESSMENT CRITERIA**	**PERFORMANCE CRITERIA**	**USECASES**
1. Determine the induced stresses in a piping system for sustained and thermal loads	• Recognition of static loads and dynamic loads to be considered for stress analysis • Determination of Axial Stress arises from axial loads and bending loads	• Possible loads identification • Determination of Axial Stress for individual loads analytically • Determination of Axial Stress for combined loads analytically	**Use Case:** Axial stress determination for a given service and process requirements. **Scenario:** Certain flow rate of Service in piping system for a given process flow parameters. **Task:** Learners must identify the possible loads for the given input process requirements, pipe material and pipe diameter. They should determine the Axial stresses for each load analytically. They should determine the Axial stresses for combined loads analytically.
2. Create the piping material library, piping sections library based on the selected pipe material and pipe thickness to suit the given service in CAEPIPE software	• Software installation based on instructions • Exploring all possible pallets, their importance and functions • Exploring smart-use of the pallets	• Software installation • Software customization to meet the project requirements • Libraries creation	**Use Case:** Exploring the software tool and library creation **Scenario:** Stress Analysis Software installation in the individual machine. Customization of software for the given piping system with its operating and geometrical parameters Pipe material and pipe section libraries creation **Task:** Learners must install the software in individual machine. They must customize the software settings to

	• Smart creation of material and pipe section libraries to meet the process requirements		meet the given project requirements and its execution. Learners must create pipe material and pipe section libraries.
3. Create the library for sustained loads, thermal loads and dynamic loads based on the type of piping system and ***geographical condition*** in CAEPIPE software	• Smart creation of load libraries to meet the process requirements	• Libraries creation	**Use Case:** Load library creation including wind and seismic loads **Scenario:** Sustained load, thermal load, wind load and seismic load libraries creation **Task:** Learners must create pipe load libraries.
4. Create the geometry of the complex piping system and its preliminary routing using CAEPIPE software	• Creation of complex pipe routing in software	• Pipe routing • Placing of supports • Placing of bends • Placing of hangers	**Use Case:** Creation of complex pipe routing for the given process requirements **Scenario:** Preliminary pipe routing with all its supports and hangers **Task:** Learners must create complex pipe routing using proper material, pipe sections and loads in the software.
5. Perform pipe stress analysis, and modify the piping system to bring the enough inherent flexibility in the piping system using CAEPIPE software	• Performance of stress analysis • Report generation • Optimum pipe routing recommendation	• Post processing analysis of results • Report generation • Modification of pipe routing • Post processing analysis of results • Report generation	**Use Case:** Performing the stress analysis, modify the pipe routing to bring inherent flexibility by repeatedly performing the stress analysis using software **Scenario:** Created preliminary pipe routing in software **Task:** Learners must perform stress analysis of complex pipe routing and recommend the optimum pipe routing.

TABLE 4: LIST OF FINAL PROJECTS (20 PROJECTS THAT COMPREHENSIVELY COVER ALL THE LEARNING OUTCOME)	
SL. NO.	**FINAL PROJECT**
1.	Liquid water at a pressure of 30.0bar at sub-cooled temperature is flowing through a piping system connected among a nozzle (N_1) of a vertical water tank to a nozzle (N_2) of a vertical water tank and a nozzle (N_3) of a horizontal water tank as shown in the isometric here. **Perform the stress analysis using CAEPIPE SW.** A sharp-edged orifice plate is placed in between Nodes 5 and 6. No support is provided between nodes 4 – 6. Place suitable support during stress analysis between nodes 4 – 6, if needed. The sub-cooled temperature of the water at 30.0bar operating pressure is, $T_{subcooled}$ = 220°C. The density and dynamic viscosity of the water at 30.0bar operating pressure and sub-cooled temperature 220°C are, ρ = 840.8kg/m^3, and 0.000121kg/m-s, respectively. **Take:** 1. Pipe Material - ASTM A106 2. Valve Material - A182 Grade F1 3. Flange Material - A182 Grade F1 4. Gasket Material - IS 2712 Gr W/2 (Compressed Asbestos Fibre) **Table.1. Line Data**

Nodes	Length (Along the Centre Line of the Pipe) in mm	Remarks
N1 - 1	200	After nozzle Pipe Segment Length
1-2	500	Pipe Segment Length
2-3	229	Gate Valve Length
3-4	5000	Pipe Segment Length (At node 4 Rod Hanger is placed)
4-5	5000	Pipe Segment Length
5-6	5000	Pipe Segment Length (Sharp-Edged Orifice is Placed between 5th node and 6th node)
6-7	500	Pipe Segment Length
7-8	200	Reducer Length
8-9	3000	Pipe Segment Length (at node 9 Hanger is placed -Grinnell)
9-10	4000	Pipe Segment Length
10-11	300	Bellow
11-12	400	Pipe Segment Length
6-13	5000	Pipe Segment Length
13-14	292	Globe Valve Length
14-15	500	Pipe Segment Length

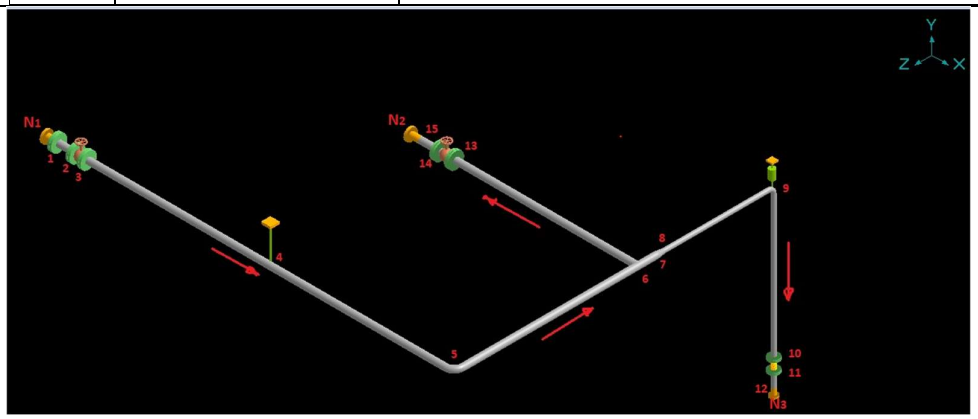

Fig. Pipe Routing

2 to 20.	Perform the flexibility analysis using CAEPIPE Software for a given preliminary pipe routing, service and operating conditions. ***Note:* List of 19** *Problem statements, Required Input Data, Pipe routing/layout, and line data will be provided by L&T EduTech during Project Delivery.*

TABLE 5: COURSE ASSESSMENT RUBRICS (TOTAL MARKS: 70)				
ASSESSMENT CRITERIA	**DESCRIBE THE CRITERIA OF THE BELOW CATEGORY PERFORMANCE**			**TOTAL MARKS**
	FAIR	**GOOD**	**EXCELLENT**	
Recognition of static loads and dynamic loads to be considered for stress analysis	2 - 2.5	2.6 - 3.1	3.2 - 4	4
Determination of Axial Stress arises from axial loads and bending loads	5 - 6.7	6.8 – 8.5	8.6 - 10	10
Software installation based on instructions	2 - 2.5	2.6 - 3.1	3.2 - 4	4
Exploring all possible pallets, their importance and functions and Exploring smart-use of the pallets	2 - 2.5	2.6 - 3.1	3.2 - 4	4
Smart creation of material and pipe section libraries to meet the process requirements	5 - 6.4	6.5 - 7.9	6.5 - 8	8
Smart creation of load libraries to meet the process requirements	3 - 3.8	3.9 - 4.7	4.8 - 6	6
Creation of complex pipe routing in software	10 - 12.8	13 -15.8	16 - 20	20
Performance of stress analysis	1.5 – 1.9	2 - 2.3	2.4 - 3	3
Report generation	1.5 – 1.9	2 - 2.3	2.4 - 3	3
Optimum pipe routing recommendation	4 – 5.1	5.2 – 6.3	6.4 - 8	8
			Total	**70**