HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)
CHENNAI

B.TECH. MECHANICAL ENGINEERING

SYLLABUS AND CURRICULUM

OF

HONOURS IN INDUSTRIAL DESIGN

B. Tech. Mechanical Curriculum with Honours

SEMESTER - V									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	MAA4301	Optimization Techniques	3	1	0	4	0	4
2	PC	MEB4301	Design of Machine Elements	3	0	0	3	2	3
3	PC	MEB4302	Mechanics of Machines	3	0	0	3	1	3
4	PC	MEB4303	Gas Dynamics and Jet Propulsion	3	0	0	3	1	3
5	PC	MEB4304	Mechatronics and Pneumatics	3	0	0	3	1	3
6	DE	****	Department Elective-III	3	0	0	3	0	3
7	NE	****	Non Department Elective-III	2	0	0	2	0	2
8	PC	MEB4331	Dynamics Lab	0	0	2	1	0	2
9	PC	MEB4332	Thermal Engineering Lab –II	0	0	2	1	0	2
10	PC	MEB4333	Mechatronics and Pneumatics Lab	0	0	2	1	0	2
11	PC	MEB4334	Design Project-III	0	0	2	1	0	2
Total				**20**	**1**	**8**	**25**	**5**	**29**
12	***H***	***MEH4361***	***Computer Aided Design for Additive Manufacturing***	***3***	***0***	***0***	***3***	***2***	***3***
13	***H***	***MEH4362***	***Integrated Product Design and Development***	***3***	***0***	***0***	***3***	***2***	***3***
Total				**26**	**1**	**8**	**31**	**9**	**35**

SEMESTER - VI									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	MEB4316	Computer Aided Design and Manufacturing	3	0	0	3	2	3
2	PC	MEB4317	Design of Mechanical Transmission System	3	0	0	3	2	3
3	PC	MEB4318	Composites and Smart Materials	3	0	0	3	2	3
4	PC	MEB4319	Nano Technology	3	0	0	3	2	3
5	BS	GEA4304	Business Economics	2	0	0	2	1	2
6	DE	****	Department Elective-IV	3	0	0	3	0	3
7	NE	****	Non Department Elective–IV	2	0	0	2	0	2
8	PC	MEB4341	Computer Aided Design and Manufacturing Lab	0	0	2	1	0	2
9	PC	MEB4342	Composites and Smart Materials Lab	0	0	2	1	0	2
10	PC	MEB4343	Design Project-IV	0	0	2	1	0	2
11	PC	MEB4344	Comprehension	1	0	0	1	0	1
Total				**20**	**0**	**6**	**23**	**9**	**26**
12	***H***	***MEH4376***	***Product Design and Manufacturing***	***3***	***0***	***0***	***3***	***2***	***3***
13	***H***	***MEH4377***	***Industrial Piping Design and Stress Analysis***	***3***	***0***	***0***	***3***	***2***	***3***
Total				**26**	**0**	**6**	**29**	**13**	**32**

COURSE TITLE	COMPUTER AIDED DESIGN FOR ADDITIVE MANUFACTURING			CREDITS	3
COURSE CODE	MEH4361	COURSE CATEGORY	H	L-T-P-S	3-0-0-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Additive Manufacturing (AM) is a process of manufacturing parts from 3D model data, usually layer up on layer, as opposed to subtractive manufacturing methodologies employed in traditional machining. This course focuses on the Generative Design Concepts adopted for part consolidation and Additive Manufacturing.
Course Objective	1. Emphasis the importance of computer aided design (CAD) for additive manufacturing 2. Enumerate the different various methods of 3D geometry creation 3. Illustrate generative design concepts for Additive Manufacturing 4. Implement the generative design concepts for Additive Manufacturing 5. Explore the generative workflow using Autodesk Fusion 360 tools
Course Outcome	Upon completion of this course, the students will be able to 1. Utilize Generative Design Concept and Methodology for additive manufacturing 2. Perform generative design of engineering components 3. Analyze complex assemblies 4. Post process an outcome to finalize a design 5. Apply generative design to optimize product design for additive manufacturing.

Prerequisites: Basics in Engineering Drawing, Mechanical components and assemblies

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO-1	3	1	1	1	2	1	-	-	1	2	-	1	1	-
CO-2	3	1	2	2	3	-	-	2	1	2	-	2	2	-
CO-3	2	1	3	3	2	-	2	-	2	1	2	1	1	-
CO-4	3	2	3	3	3	1	-	2	1	2	-	2	2	-
CO-5	3	2	3	3	2	1	-	-	1	2	-	1	2	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO GENERATIVE DESIGN	(9L)
Generative Design, Comparing Shape Optimization to Generative Design, The Fusion 360 User Interface, Basics of sketching, creating solid bodies from sketches, Understanding Bodies and Components, how to collaborate and comment on designs, reviewing a traditional design, Creating Obstacle Geometry for Walls, Creating Obstacle Geometry for Shelf and Hardware, Changing the appearance of a component or body. Generative Design workspace overview, Generative Design Study Settings, Selecting Study Materials, Defining Generative Objectives, Using the Edit Model Workspace to mirror geometry, Defining Obstacle Regions, Defining Preserve Regions, setting up the first load case, picking a manufacturing method, Using the Previewer, solving a Generative Study, Viewing a Generative Outcome Live. **Suggested Activity:** Practice few exercises in Fusion 360	**CO-1** **BTL-2**
MODULE 2: GENERATIVE SETUP AND GENERATIVE DESIGN OUTCOME	**(9L)**
Learning the Explore User Interface, Options when viewing Outcomes, Selecting an Outcome Iteration, Creating a 3D Design, Viewing and editing a design, Creating a distributed design, Viewing an Export Mesh Design, Invite a user to collaborate, Creating a box primitive, Using Edit Form, Creasing and Uncreasing edges, Freeze and Unfreeze, Additional form tools, Exploring a design timeline, Unfreezing and editing geometry, Manipulating a form with erase and fill, Manually patching a form body, Changing the display of a form body, Adding design comments for manufacturing, Exporting an STL. **Suggested Activity:** Practice exercises in Fusion 360	**CO-2** **BTL-2**
MODULE 3: ANALYSIS OF COMPLEX ASSEMBLY	**(9L)**
Open and explore a design, Create design comments, Isolating critical areas in the edit model workspace. Creating new components inside edit model, Copying and moving bodies and components, Changing the color of a body or component, Creating an obstacle for moving geometry, Create obstacles using the connector obstacle tool, Cloning and creating generative models, Editing an obstacle region. Adjust Generative Study Resolution, Select Generative Design materials, Selecting a manufacturing method. Setting generative objectives, Create real world loading conditions, Cloning load cases, Create a fully defined generative study **Suggested Activity:** Practice exercises in Fusion 360	**CO-3** **BTL-3**
MODULE 4: POST PROCESSING	**(9L)**
Viewing and filtering outcomes, identifying potential outcomes, Selecting a final outcome for a design. Creating a 3D design from an iteration, review a created design, Edit existing geometry with direct modelling, adding a Generative Outcome to an Assembly, Measure and inspect geometry, Add comments to a design, View designs on the web, Use A360 Markup tools **Suggested Activity:** Practice exercises in Fusion 360	**CO-4** **BTL-4**
MODULE 5: DESIGN REVIEWS AND VALIDATION	**(9L)**
Setting up a buckling simulation, Reviewing a buckling simulation. Setting up a modal frequency simulation, reviewing a modal frequency simulation, setting up a thermal stress simulation, Reviewing a thermal stress simulation, Mesh Manipulation of a lifting bracket. Mesh display options, exporting a mesh file, Setting up a 2-axis generative manufacturing method. Reviewing generative outcomes for 2-axis cutting, Exploring exported 2-axis and unrestricted designs **Suggested Activity:** Practice exercises in Fusion 360	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Olaf Diegel, Axel Nordin, Damien Motte, (2019), "A Practical Guide to Design for Additive Manufacturing" published by Springer Series in Advanced Manufacturing, 1 Edition.
2	Martin Leary, (2019), "Design for Additive Manufacturing", Elsevier, 1 Edition.
MOOC	
1	https://www.coursera.org/learn/generative-design-additive-manufacturing
2	https://www.coursera.org/learn/generative-design-part-consolidation

COURSE TITLE	INTEGRATED PRODUCT DESIGN AND DEVELOPMENT			CREDITS	3
COURSE CODE	MEH4362	COURSE CATEGORY	H	L-T-P-S	3-0-0-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course focuses on the design of innovative products, emphasizing the balance between the interest of users, industry, society and the environment. It covers the whole design process, integrating all aspects relevant to product development - technology, management, aesthetics, sustainability, ergonomics, marketing, business and design methods.
Course Objective	1. Describe the concept of integrated product design 2. Enumerate the various steps involved in the integrated product design 3. Illustrate the methods of concept generation and selection 4. implement of concept and to achieve a new product design 5. Apply the product life cycle management (PLM) concept adopted in integrated product design
Course Outcome	Upon completion of this course, the students will be able to 1. Summarize the various trends affecting product decision. 2. Identify the requirements to create new product 3. Compare different techniques involved in design creation and design testing 4. Rephrase the methods of model creation and integration between software and hardware. 5. Illustrate the need of end of product life and patenting

Prerequisites: Basics in Engineering Materials and Engineering Design Practices

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO-1	3	1	1	1	1	-	-	-	2	2	-	2	1	-
CO-2	2	1	2	2	1	1	-	1	3	2	-	1	2	-
CO-3	3	1	1	3	1	-	-	-	2	1	-	2	2	-
CO-4	2	1	2	2	1	-	2	2	3	3	-	1	1	-
CO-5	3	1	2	3	1	2	-	-	2	1	-	2	2	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNDAMENTALS OF PRODUCT DEVELOPMENT	(9L)
Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement. Global Trends Analysis and Product decision: Types of various trends affecting product decision - Social Trends-Technical Trends- Economic Trends- Environmental Trends. Types of Product Development- Overview of Product Development methodologies - Product Life Cycle - Product Development Planning and Management. **Suggested Activity:** Reading on Consumer durables vs. Engineering products	**CO-1** **BTL-2**
MODULE 2: CONCEPT GENERATION, SELECTION AND TESTING	**(9L)**
Plan and establish product specifications. Task - Structured approaches - clarification - search-externally and internally - Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance – manufacturability. Concept Testing Methodologies. Product Testing standards, Certification and Documentation. **Suggested Activity:** Reading on Creative thinking concepts for product design	**CO-2** **BTL-2**
MODULE 3: IMPLEMENTATION & INTEGRATION	**(9L)**
Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design. Prototyping: Introduction to Rapid Prototyping and Rapid Manufacturing. **Suggested Activity:** Softwares and their capabilities for CAD, CAM & CAE	**CO-3** **BTL-3**
MODULE 4: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT	**(9L)**
Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution. **Suggested Activity:** Reading of Value Analysis Concepts	**CO-4** **BTL-4**
MODULE 5: INTERATED PRODUCT DESIGN AND BUSINESS DYNAMICS	**(9L)**
Enhancements Product End of Life (EoL): Obsolescence Management-Configuration Management- EoL Disposal. The Industry - Engineering Services Industry overview- Product development in Industry. Introduction to vertical specific product development processes- Product Development Trade-offs- Intellectual Property Rights and Confidentiality- Security and configuration management. **Suggested Activity:** Strategic plans adopted for product development in organizations	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., (2018), "Integrated Product and Process Design and Development: The Product Realization Process", CRC Press, 2nd Edition
2	Eppinger, S. and Ulrich, K., (2020), "Product design and development", McGraw-Hill Higher Education, 7th Edition.
MOOC	

1	https://www.coursera.org/learn/creative-design-prototyping-testing
2	https://www.coursera.org/learn/new-product-development
3	https://www.coursera.org/learn/design-strategy

COURSE TITLE	PRODUCT DESIGN AND MANUFACTURING			CREDITS	3
COURSE CODE	MEH4376	COURSE CATEGORY	H	L-T-P-S	3-0-0-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course presents an overview of the product design and development process, along with the manufacturing systems aspects. The concepts Design for Manufacturing, Assembly, and Environment, and analytical tools for development, costing and manufacturing would help the students and practitioners learn to conceptualize, design, and manufacture competitively-priced quality products.
Course Objective	1. Demonstrate product development functions and innovative manufacturing techniques 2. Implement the Design for Manufacture (DFM) techniques adopted in industrial design 3. Illustrate the environmental and quality factors influencing the product design 4. Implement the reverse engineering concepts adopted in industrial product design 5. Emphasis the rapid prototype techniques associated with product design
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the customer requirements in product design 2. Identify the functional and aesthetic requirements of a new product 3. Formulate the DFM guidelines while developing a product 4. Apply the environmental and quality related factors to finalize a design 5. Apply reverse engineering practices in product design and development

Prerequisites: Basics in engineering design and manufacturing methods

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO-1	3	1	1	1	2	1	2	3	1	2	-	1	1	-
CO-2	3	1	2	2	3	1	2	3	1	1	-	2	2	-
CO-3	2	1	3	3	3	1	2	2	1	2	-	1	1	-
CO-4	3	2	2	3	2	2	3	3	1	1	-	2	2	-
CO-5	3	2	3	3	3	2	3	2	1	2	-	1	2	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION (9L)

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets. Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management **Suggested Activity:** Reading on market research for product development	**CO-1** **BTL-2**
MODULE 2: PRODUCT DESIGN MORPHOLOGY	**(9L)**
Product development process, the role and nature of design, project brief, project plan, types of design organization, information and literature search, patents, standards and codes, The New Product Development Process, Proactive new product development - Product Appraisal: Functional analysis, manufacturing analysis, economical analysis, aesthetic and ergonomic considerations, environment and safety, installation, service and maintenance Product Life Cycle Management (PLM): Need for PLM, Implementing PLM, Responsibilities of PLM, Components of PLM, Product Data and Product workflow: Developing a PLM Strateg. **Suggested Activity:** PLM Softwares	**CO-2** **BTL-2**
MODULE 3: DESIGN FOR MANUFACTURING, ASSEMBLY AND MAINTENANCE	**(9L)**
Structural product analysis- End use behavior- Effect of tooling in product design -Design for joining and assembling- Design for live hinges- Snap fits, design of corners, bushes and ribs- Design considerations- New product design Methods of Decoration- Bonding and cementing techniques- Thermal Bonding Machining of Plastics-Parameters and effect- Case studies in material selection with relevance to product design and development. **Suggested Activity:** DFM Case studies	**CO-3** **BTL-3**
MODULE 4: DESIGN FOR ENVIRONMENT AND QUALITY	**(9L)**
Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact. Design for Quality: Quality Function Deployment - Objectives – Stakeholders - Identification of control factors, noise factors, and performance metrics - developing the experimental plan-experimental design concepts –Conducting the analysis. Reliability-Survival and Failure-Series and parallel systems - Mean time between failure. Failure mode effect analysis (FEMA) concepts. **Suggested Activity:** Reading practical cases of environment critical products	**CO-4** **BTL-4**
MODULE 5: REVERSE ENGINEERING	**(9L)**
Scope and tasks of RE - Domain analysis – Functionality - Developing technical data - digitizing techniques - construction of surface model - solid-part material- Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation - Characteristics evaluation -software and application. **Suggested Activity:** Case study in Reverse Engineering	**CO-5** **BTL-4**

TEXT BOOKS	
1	Kenneth B. Kahn, Mayoor Mohan (2020), “Innovation and New Product Planning”, Routledge.
2	Eppinger, S. and Ulrich, K., (2020), “Product design and development”, McGraw-Hill Higher Education, 7th Edition.
3	Anoop Desai, Anil Mital, (2020), “Sustainable Product Design and Development”, CRC Press.
MOOC	
1	https://onlinecourses.nptel.ac.in/noc20_me12/preview

COURSE TITLE	INDUSTRIAL PIPING DESIGN AND STRESS ANALYSIS			CREDITS	3
COURSE CODE	MEH4377	COURSE CATEGORY	H	L-T-P-S	3-0-0-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course is structured to raise the level of expertise in piping design and to improve the competitiveness in the global markets. This course provides various piping system designs, development skills and knowledge of current trends of plant layout.
Course Objective	1. Familiarize with process plant and other industrial piping components 2. Demonstrate the piping isometrics drawing and other process flow diagrams (P&ID) 3. Enumerate the thickness calculation for different pressure rating as per ASME B31.3 code 4. Awareness on pipe support engineering concepts 5. Apply piping stress analysis and flexibility analysis for different piping networks
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of pipeline engineering practice adopted in Industry 2. Identify the various piping components and their functions in a piping layout 3. Illustrate process flow diagrams – Piping Isometrics and P&IDs of a piping layout and interpret the function of different components 4. Perform pipe wall thickness calculation for different pressure rating as per ASME code 5. Perform piping stress analysis for simple real time cases

Prerequisites: Basics on Strength of Materials and Engineering Design fundamentals

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO-1	3	1	1	1	1	2	-	1	1	2	-	2	1	-
CO-2	3	1	2	2	2	-	-	-	1	2	-	1	2	-
CO-3	1	1	3	2	3	1	-	-	1	1	-	3	2	-
CO-4	2	2	3	1	3	-	1	2	1	2	-	3	1	-
CO-5	3	2	3	2	3	2	-	-	1	2	-	2	2	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNDAMENTALS OF PIPING DESIGN AND ENGINEERING (9L)

Fundamentals of piping - Classification of pipe - Piping Material Specifications - Standards property of piping materials - Piping materials and selection - Manufacturing methods - Pipe dimensioning - Schedule numbers - Common piping abbreviations - Major organizations for standards - American code in piping ASME/ANSI - Common abbreviations etc. **Suggested Activity:** Reading of ASME B31.3 standard for piping	**CO-1** **BTL-2**
MODULE 2: PIPING COMPONENTS AND CONNECTED EQUIPMENTS	**(9L)**
Basic Piping components: Type of Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socket welded fittings, Pipe nipples, flanged fittings and use of fittings. Type Flange -Types, P-T ratings and facings. Gaskets, bolts and nuts. Major Valves - Types, Materials operations, applicability, codes and specifications. Equipment connected in pipelines: Horizontal vessels/accumulators - fractionation columns, pumps - heat exchangers - re-boiler - air cooled heat exchanger - cooling towers - heaters/boilers - storage tanks -fractional distillation process and vendor data drawings - Prepare layout of Different type lights. **Suggested Activity:** Survey of various piping components and their specifications	**CO-2** **BTL-2**
MODULE 3: PIPING ISOMETRICS AND P&ID DIAGRAMS	**(9L)**
Uses of flow diagrams, process flow diagrams - mechanical flow diagrams, utility flow diagrams - piping symbols - line symbols - valve symbols - piping isometrics - general arrangement drawings - sections/elevations/ detail drawings - Nplot plan procedures – Process system: Purpose of P&ID'S - study of P&ID'S - stages of development of P&ID'S - process and instrumentation diagrams - process equipments - symbols usage according to industrial practices - Purpose of P&ID in process industrial/plants. **Suggested Activity:** Reading of few Piping Isometrics and P&IDs of process pipelines	**CO-3** **BTL-3**
MODULE 4: PIPING SYSTEMS DESIGN & CALCULATIONS	**(9L)**
Design of process piping requirements per ASME B31.3 - Design pressure integrity - operating pressure - design pressure - operating & design temperature - max allowable operating pressure Typical wall thickness calculation for Oil and Gas, Petrochemical, Refinery piping system **Hydraulic Design of Piping Systems** - Design Calculations of Piping sizing - Pump Calculations Piping. **Pipe Support Engineering**: Types of supports - pipe guides – pipe hanger rods - spring hangers - pick-up pipe supports Determination types of Pipe Support and Maximum Allowable Span. **Suggested Activity:** Typical pipe wall thickness calculation for oil & gas pipelines as per ASME B31.3	**CO-4** **BTL-4**
MODULE 5: PIPE STRESS ANALYSIS	**(9L)**
Introduction to Pipe Stress Analysis. Classification of loads- sustained load & occasional load. Requirements of ASME B31.3 code for process piping, stress intensification factors, thermal analysis. Piping stress, causes, impacts, stress categories like- thermal stress, longitudinal stress, hoop stress and allowable stresses. Pipe Flexibility Analysis per ASME B31.3 - Calculation of Pipe Stresses by Thermal Expansion Stress / Sustained Loads - Design Calculations of Occasional Loads. **Suggested Activity:** Pipe Stress Analysis using CAESER II software	**CO-5** **BTL-4**
TEXT BOOKS	

1.	Liang-Chuan Peng, (2009), “Pipe Stress Engineering”, American Society of Mechanical Engineers, USA.
2	M W Kellogg Company, (2009), “Design of Piping Systems”, Martino Fine Books.
3	Sam Kannappan, (2008), “Introduction to Pipe Stress Analysis”, Abi Enterprises Inc,
MOOC	
1	http://www.piping-engineering.com
2	http://www.pipingstudy.com
3	https://www.whatispiping.com