

**DEPARTMENT OF MECHANICAL ENGINEERING**  
**NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI**

COURSE PLAN – PART I			
<b>Name of the programme and specialization</b>	<b>M.TECH. THERMAL POWER ENGINEERING</b>		
<b>Course Title</b>	<b>ANALYSIS AND DESIGN OF PRESSURE VESSELS</b>		
<b>Course Code</b>	<b>ME 607</b>	<b>No. of Credits</b>	<b>03</b>
<b>Course Code of Pre-requisite subject(s)</b>	<b>NIL</b>		
<b>Session</b>	<b>JANUARY 2021</b>	<b>Section (if, applicable)</b>	<b>NA</b>
<b>Name of Faculty</b>	<b>S.S. ARULAPPAN</b>	<b>Department</b>	<b>MECHANICAL ENGINEERING</b>
<b>Email</b>	<b>sarul@nitt.edu</b>	<b>Telephone No.</b>	<b>8220931901</b>
<b>Course Type</b>	<input checked="" type="checkbox"/> <b>Core course</b> <input type="checkbox"/> <b>Elective course</b>		
<b>Syllabus (approved in BoS)</b>			
<p>Establishment of design conditions – Fracture Mechanics – Heads, Basic shell thickness - Reinforcement of openings – Special components like flange, tube plate, supports.</p> <p>Cylindrical shells – Thick cylinders- Lamé's solution - Theories of breakdown of elastic action – Unrestrained solution – Lateral loading – General loading. Axisymmetric loading - Membrane solutions - Edge bending solutions - Flexibility matrix.</p> <p>Application of general analysis – Flat closure plates –conical heads and reducers – hemispherical and torispherical, ellipsoidal heads.</p> <p>Development of cracks - Fracture mechanics - Corrosion - Selection of working stress for ductile and brittle materials.</p> <p>Finite element analysis for high pressure and high temperature components.</p>			
<b>COURSE OBJECTIVES</b>			
<ol style="list-style-type: none"> <li>1. To give the basic understanding about Radial Stress, Longitudinal stress and Hoop Stress.</li> <li>2. How radial stress and circumferential stress in a pressure vessel becomes a hoop stress and How to derive the equation for Hoop stress.</li> <li>3. Pressure Vessel Safety Devices and Periodical recalibration of safety devices.</li> <li>4. Standards for pressure vessel design ASME VIII comparison with German, British Standards. and BIS</li> </ol>			

<b>COURSE OUTCOMES (CO)</b>			
<b>Course Outcomes</b>			<b>Aligned Programme Outcomes (PO)</b>
<p>1. After finishing this course students will be able understand and design the pressure vessels and understand the existing previous designs and Design Procedures.</p> <p>2. Students will be able to design higher temperature and higher pressure or subzero temperature and vacuum vessels.</p> <p>3. For the particular applications Students will be able to calculate the geometrical dimensions of the vessels and individual elements and components like safety devices, vessels heads and vessel supports with essential knowledge about reinforcement of openings in pressure vessels.</p> <p>4. Students will be able to understand and apply the basic knowledge to do adaptive and some original designs for any particular need.</p>			1, 2, 3, 4, 5
<b>COURSE PLAN – PART II</b>			
<b>COURSE OVERVIEW</b>			
<p>This course involves Understanding, Analysis and Design of Pressure Vessels with respect to Indian and International Standards. Design of Pressure vessels having Cylindrical and Spherical Geometry. Design of all Pressure components having internal or external pressure more or less than the atmospheric pressure and Temperature more or less than atmospheric condition. Material selection from Carbon Steel and Alloy steel including Nonmetallic Cladded Vessels.</p>			
<b>COURSE TEACHING AND LEARNING ACTIVITIES</b>			
<b>Topic No.</b>	<b>Week/Contact Hours</b>	<b>Topic</b>	<b>Mode of Delivery</b>
1	Week 1	Fundamental derivation and calculation of Hoop Stress in cylindrical and spherical pressure vessels, Membrane solution. Thin and thick cylindrical pressure vessels	Online Lecture
2	Week 2	What is Discontinuity stress in Cylinder Hemispherical dome junction	Online Lecture
3	Week 3	Analysis of various types of safety devices in Pressure vessels (a) Dead weight loaded safety device (b) Spring loaded safety device (c) Bursting Disc Safety Device Explanations Using the models	Online Lecture

4	Week 4	Pressure measurement devices Pressure gauges, Dial gauges, Strain Gauges Photo elastic methods using models Explanations and design of Bimetal and metal nonmetal Cladded vessels	Online Lecture
5	Week 5	Comparison of Various types of Pressure vessels in Industrial and Domestic applications. Explanations Using Hydraulic Jack Physical model	Online Lecture
6	Week 6	National and International Codes ASME Section VIII for Design of Pressure Vessel. German and British code of standards.	Online Lecture
7	Week 7	Selection of materials mainly carbon and alloy steel for manufacture of Pressure vessel	Online Lecture
8	Week 8	Reinforcement of openings three different methods (a) Equal area method (b) Nozzle method (c) Increasing the entire wall thickness of the pressure vessel for series of openings in the pressure vessel.	Online Lecture
9	Week 9	Numerical Analysis of Pressure vessel design using Flexibility and Stiffness Matrix.	Online Lecture
10	Week 10	Pressure Vessel Testing Non- Destructive testing methods and Destructive Testing methods with enough safety precautions.	Online Lecture
11	Week 11	Condemning after Prolonged Usage of old Pressure vessels so that failure of the vessel while in use should be avoided. This can be done by measuring the possible excess expansion of the pressure vessel even for the same operating pressure due to reduced vessel wall thickness by corrosion and erosion due to prolonged usage. Ductile material of the pressure vessels can have sudden Brittle fracture and failure of the due to strain hardening.	Online Lecture
12	Week 12	Design of Vessel supports like Saddle supports, Skirt Supports, Sling Supports, Metal Rope supports and Lug supports and vessels on the foundations with provision for expansion of the pressure vessels subjected to pressure and temperature variations. Design of Vessel supports for vessels under	Online Lecture

		transportation.	
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**COURSE ASSESSMENT METHODS (shall range from 4 to 6)**

S.No.	Mode of Assessment	Week / Date of assignment	Duration	% Weightage
1	I- Cycle Test	After 4 Weeks	60 Minutes	30
2	II- Cycle Test	After 8 Weeks	60 Minutes	30
3	Assignment – I	--	--	5
4	Assignment – II	--	--	5
CPA	Compensation Assessment*	Before End semester	60 Minutes	Corresponding weightage
5	Final Assessment *	At the End of Semester	60 Minutes	30

\*mandatory; refer to guidelines on page 4

**COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)**

- Feed Back from students during the class and in class committee meetings.
- End Semester feedback on Total Course Outcomes from the students.

**COURSE POLICY (preferred mode of correspondence with students, compensation assessment policy to be specified)**

All the communication like Schedule of assessment / Design Data Book / all other information regarding this course will be intimated through the class representative.

**MODE OF CORRESPONDENCE (email/ phone etc.)**

Email: [sarul@nitt.edu](mailto:sarul@nitt.edu)

Mobile: 8220931901

**ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)**

- **At least 75% attendance in each course is mandatory.**
- **A maximum of 10% shall be allowed under On Duty (OD) category.**
- Students with **less than 65% of attendance** shall be prevented from writing the final assessment and **shall be awarded 'V' grade.**

## **ACADEMIC DISHONESTY & PLAGIARISM**

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.

The above policy against academic dishonesty shall be applicable for all the programmes.

## **ADDITIONAL INFORMATION**

1. Attendance will be taken by the faculty in all contact classes.
2. Every student should maintain minimum of 75 % physical attendance totally in all those contact periods fulfilling all assessment criteria and attend up to end semester examination.
3. Any student, who could not maintain 75 % overall attendance should appear the compensation assessment (CPA). Students who scores more than 60 % marks in the CPA along with other assessment criteria will alone be eligible and allowed for attending end semester examination.
4. Those students who have attendance lag and also missed any of the cycle tests (CT<sub>s</sub>) can appear for CPA to get eligibility for writing the end semester Examination Their scores in the CPA WILL NOT be taken into account for computing marks for CT.

### **Text Book Reference:**

1. Corresponding Chapter on Design of Pressure vessels from ***Essence of Machine Design*** by S.S.Arulappan SARA Book Publications
2. Theory and Design of Pressure Vessels by John F Harvey.

### References

1. ASME section VIII.
2. Design Data Book
3. Mechanical Engineering Hand Book
4. Refer also relevant Websites and other Course materials.


## **FOR APPROVAL**



**Dr. S. S. ARULAPPAN**  
Course Faculty



**Dr. T. RAMESH**  
CC-Chairperson



**Dr. AR VEERAPPAN**  
HOD

**Guidelines:**

- a) The number of assessments for a course shall range from 4 to 6.
- b) Every course shall have a final assessment on the entire syllabus with at least 30% weightage.**
- c) One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.**
- d) The passing minimum shall be as per the regulations.**

B.Tech. Admitted in				P.G.
2018	2017	2016	2015	
35% or class average/2 whichever is greater.		Peak/3 or class average/2 whichever is lower		40%

- e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.**
- f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.**
- g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.