

## (ME 511) PRESSURE VESSEL DESIGN (ELECTIVE - I)

### **Objective of the course:**

*Pressure vessel design involves fundamentals of various component designs. This subject provides basic knowledge required for an engineer to design and to analyze the behaviour of pressure vessels.*

### **UNIT - I**

Introduction: Material-shapes of Vessels-stresses in cylindrical, spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load, bending and torque-relation of pressure vessels-conical and tetrahedral vessels.

### **UNIT - II**

Cylinders and plates: Shrink fit stresses in built up cylinders-auto fretting of thick cylinders. Thermal stresses in Pressure Vessels. Plates subjected to pure bending with different edge conditions. Circular plates with simply supported and clamped ends subjected to concentrated and uniformly distributed loads, stresses, Design of dome bends, shell connections, flat heads and cone openings.

### **UNIT - III**

Discontinuity stresses in pressure vessels: Introduction, beam on an elastic foundation, infinitely long beam, semi infinite beam, cylindrical vessel under axially symmetrical loading, extent and significance of load deformations on pressure vessels, discontinuity stress in vessels, stress in a bimetallic joints, deformation and stress in flanges. Pressure vessel materials, ductile material tensile tests, structure and strength of steel, Leuder's lines, determination of stress patterns from plastic flow observations, behaviour of steel beyond the yield point, effect of cold work or strain hardening on the physical properties of pressure vessel steels.

### **UNIT - IV**

**Fatigue of metals:** fatigue crack growth, fatigue life prediction, cumulative fatigue damage, stress theory of failure of vessels subject to steady state and fatigue conditions. Influence of surface effects on fatigue, effect of the environment and other factors on fatigue life, thermal stress fatigue, creep and rupture of metals at elevated temperatures, hydrogen embrittlement of pressure vessel steels, brittle fracture, effect of environment on fracture toughness, fracture toughness relationships, criteria for design with defects, significance of fracture mechanics evaluations, effect of warm prestressing on the ambient temperature toughness of pressure vessel steels.

### **UNIT - V**

**Design features:** Localized stresses and their significance, stress concentration at a variable thickness transition section in a cylindrical vessel, stress concentration about a circular hole in a plate subjected to tension, elliptical openings, stress concentration factors for position, dynamic and thermal transient conditions, theory of reinforced openings, reinforcement, placement and shape, fatigue and stress concentration.

### **TEXT BOOKS:**

1. John F. Harvey, "Theory and Design of Modern Pressure Vessels", 3<sup>rd</sup> Edition, Van Nostrand Reinhold Company, New York, 1997.
2. Timoshenko & Winowsky, "Theory of Plates and Shells", 2<sup>nd</sup> Edition, Tata Mc Graw Hill, 1964.

### **REFERENCE BOOKS:**

1. Bickell M.B., C. Ruiz, "Pressure Vessel Design and Analysis", 1<sup>st</sup> Edition, Mac Millan / St. Martins, 1967.
2. Brownell & Edwin H Young, "Process Equipment Design", 2<sup>nd</sup> Edition, Wiley & Sons Co., 2009.
3. Indian standard code for unfired Pressure vessels IS: 2825.
4. Henry H. Bednar, "Pressure Vessel Design Hand Book", 2<sup>nd</sup> Edition, Krieger Publishing Co., 1991.