Barishal Polytechnic Institute, Barishal.

Design of Machine Element

Subject code: 27071

Mechanical (7th semester)

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- Aims :
- To be able to understand the basic concepts and principles of design of simple machine elements.
- To be able to understand the basic concept, principles and technique of designing of different machine elements.
- To be able to understand the basic concept, principles and technique of selecting safe stress of different machine elements.
- To be able to understand the basic concept, principles and techniques of computing stength equations considering the theories of failures and to be able to determine the size of machine elements.
- To be able to develop knowledge, skill and attitude of designing simple machine elements.

Short description

Stress in machine elements; Causes of failure of machine members; Pressure vessels; Screwed joints; Knuckle joints; Shaft; Keys; Couplings; Power screw; Belt & ropes; Springs; Gears; Clutches and Breakes.

- Detail Description
- Theory:
- 1. Understand the analysis of stresses induced in machine elements & causes of failure of machine elements.

1.1	State machine elements.
1.2	Describe working stress and factor of safety.
1.3	Describe selection of suitable factor of safety for static, dynamic and fatigue loading.
1.4	Describe thermal stress,impact stress, bending stress and torsional shear stress, combine stress.
1.5	Define failures of machine elements.
1.6	Define stress concentration factors.
1.7	Describe stress concentration factors for both static and fatigue loading.

2.Understand pressure vessels.

- 2.1 Define pressure vessels.
- 2.2 Distinguish between thin and thick pressure vessels.
- 2.3 Define hoop stress.
- 2.4 Identify longitudinal and circumferential stresses.
- 2.5 Express the deduction of the equation relating to longitudinal and circumferential stresses for design pressure vesseles.
- 2.6 Solve problems related to the design of thin pressure vessels considering internal pressure.

3.Understand the principle of designing screwed joint.

3.1 State common types of screw fastening and fastener.

3. 2 Describe the designation of screw thread.

3.3 Describe the stress developed in screw fastening.

3.4 Illustrate the formula of axially loaded screwed joints.

3.5 Illustrate the formula of eccentric loaded screwed joints.

3.6 Solve problems related to screwed joints.

4.Understand the principles of designing knuckle joint.

- 4.1 State knuckle joint.
- 4.2 Sketch different types of knuckle joints.
- 4.3 Illustrate the strength equations of knuckle joints.
- 4.4 Solve problems related to the design of different components of knuckle joints.

5.Understand the principles of shaft design.

5.1 Distinguish among spindle, shaft and axle.

5.2 State various types loading of shafts.

5.3 State shock & fatigue factros.

5.4 Formulate the equation of combine torsional and bending stress on shaft.

5.5 Describe the design procedure of shaft.

5.6 Formulate the effect of torque, bending moment, axial thrust, combined torque and bending moment and rigidity.

5.7 Calculate the diameter of a shaft (solid or hollow) subjected to torque,

bending moment, axial thrust combined torque & bending moment and on the basis of rigidity.

5.8 Solve problems related to the design of shafts.

6. Understand the principle of key design.

6.1 Define key.

6.2 Describe different types of key.

6.3 Deduce strength equations for key.

6.4 Solve the problems related to the design of key.

7. Understand the principle of coupling design.

7.1 Define coupling.

7.2 Describe different types of coupling.

7.3 Deduce strength equations for bolt and flange of flangescoupling.

7.4 Describe design procedure of flanged and coupling.

7.5 Solve the problems releting to the flanged coupling.

8. Understand the principle of design power screw.

Chapter No. 2
Pressure Vessel

GO: Students will be able to Understand pressure vessel

SO: will be able to

1. Define pressure vessels.
2. Distinguish between thin and thick pressure vessel
3. Define hoop stress.
4. Identify longitudinal and circumferential stresses.
5. Express the deduction of the equation relating to longitudinal and circumferential stresses for design pressure vesseles.
6. Solve problems related to the design of thin pressure vessels considering internal pressure.

Pressure Vessel

Thin And Thick Wall Pressure vessel

- **Thin Wall Pressure vessel:** For the thin-walled assumption to be valid the vessel must have a wall thickness of no more than about one-tenth (often cited as Diameter / t > 20) of its radius.

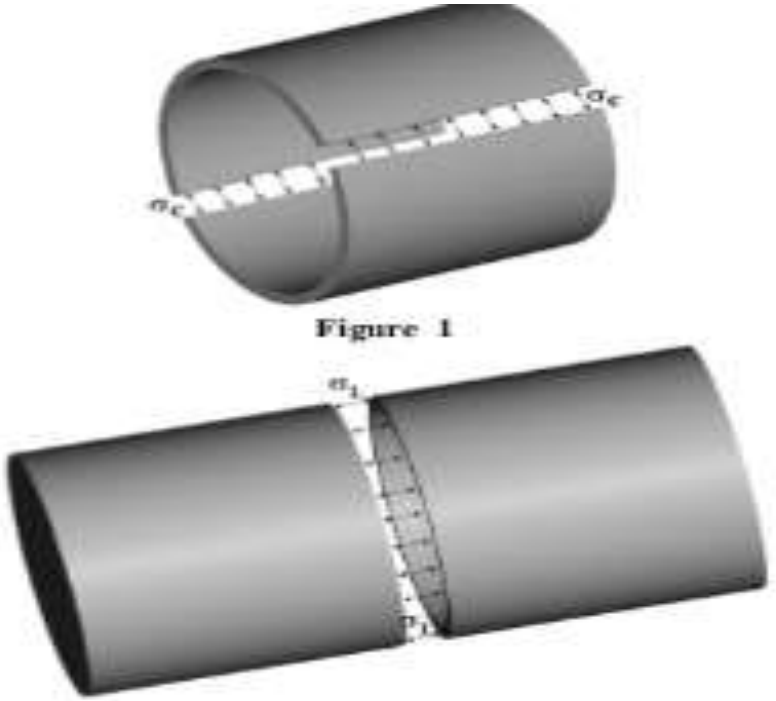
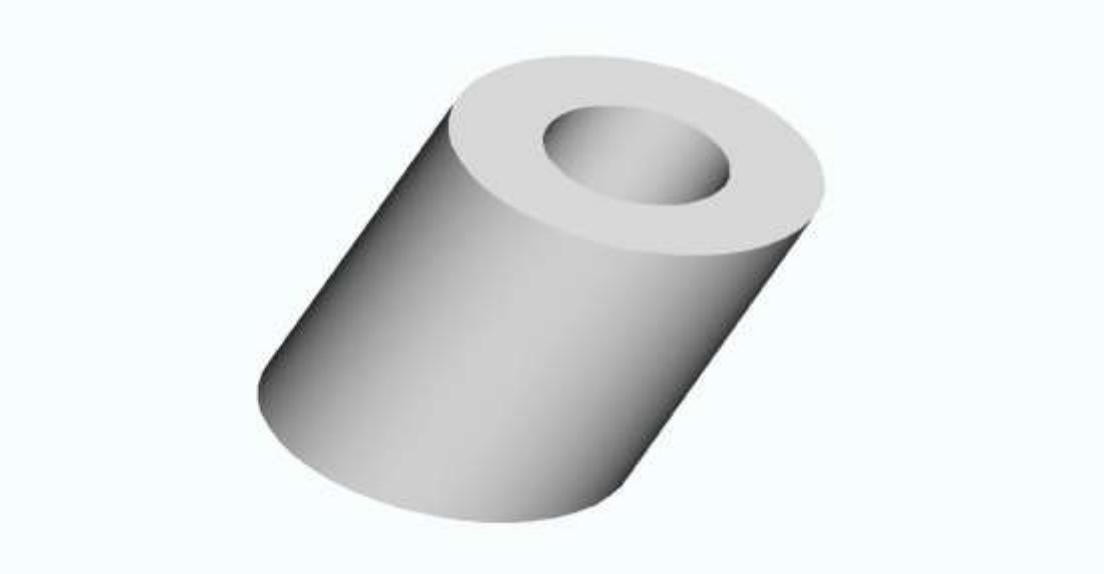


Figure 1

Thick Wall Pressure vessel: For the thick-walled assumption to be valid the vessel must have a wall thickness of no more than about one-tenth (often cited as Diameter / t < 20) of its radius.



Hoop Stress

- The hoop stress is the force exerted circumferentially (perpendicular both to the axis and to the radius of the object) in both directions on every particle in the cylinder wall. It can be described as:

$$\sigma_\theta = \frac{F}{tl}$$

Continue…

- Identify longitudinal and circumferential stresses.

Thin walled cylindrical pressure vessels

- Pressure vessels are largely used in industrial applications to store and transport the huge quantities of fluids. These vessels are used as the machine elements in marine and aeronautics transportation. When the pressure vessel is loaded by the internal pressure, then the stresses such as circumferential stress, longitudinal stress and radial stress would result in the cross-section of the cylindrical vessel.
- Show the thin-walled cylindrical pressure vessel of radius r and thickness t with the internal pressure p as in Figure (1).
- Consider a small element on the cylindrical pressure vessel to evaluate the longitudinal stress acting on the vessel. The stresses surrounding the vessel should have a resultant to stablize the internal pressure acting on the cross-section of cylindrical pressure vessel.

Longitudinal stress

- Express the total force acting on the vessel end.
- Here, total force is F, internal pressure is p, diameter of thin-walled cylinder is d.
- Express the cross-sectional area to retard the force on the vessel.
- Here, thickness of thin-walled cylinder is t.
- Calculate the longitudinal stress in thin-walled cylinder.
- Hence, the longitudinal stress acting in thin-walled cylinder is .

Longitudinal Stress In Thin-walled Cylinders:

Thin walled cylindrical pressure vessels

Pressure vessels are largely used in industrial applications to store and transport the huge quantities of fluids. These vessels are used as the machine elements in marine and aeronautics transportation. When the pressure vessel is loaded by the internal pressure, then the stresses such as circumferential stress, longitudinal stress and radial stress would result in the cross-section of the cylindrical vessel.

Show the thin-walled cylindrical pressure vessel of radius *r* and thickness *t* with the internal pressure *p* as in Figure.