**COURSE TITLE : APPLIED MECHANICS & STRENGTH OF MATERIALS**
**COURSE CODE : 4021**
**COURSE CATEGORY : A**
**PERIODS/ WEEK : 5**
**PERIODS/ SEMESTER : 75**
**CREDIT : 5**

**TIME SCHEDULE**

| MODULE | TOPIC | PERIODS |
|---|---|---|
| 1 | Simple stresses and strains. Shear stress and strain. Thermal stress and strain | 19 |
| 2 | Friction, centre of gravity and moment of inertia. | 18 |
| 3 | Riveted joint, welded joint, thin cylinders, theory of torsion on shaft | 19 |
| 4 | Torsion on spring, Shear force and bending moment diagram. Deflection of beams. Column and struts | 19 |
| TOTAL | | 75 |

**Course Distribution:**

**COURSE OUTCOME :**

| sl.no. | sub | student will be able to |
|---|---|---|
| 1 | 1 | Understand the simple stress, strain on machine and structures. |
| | 2 | Comprehend the theory of shear stress & shear strain. |
| | 3 | Comprehend the laws of friction, centroid and centre of gravity. |
| 2 | 4 | Understand the moment of inertia of a section. |
| | 5 | Appreciate the strength and efficiency of riveted joints & welded joints |
| | 6 | Appreciate the effect of forces on spring. |
| 3 | 7 | Comprehend the stresses on thin cylinders and theory of torsion on shaft. |
| | 8 | Appreciate the shear force and bending moment diagrams. |
| | 9 | Understand the deflection of beams, theory of columns and struts. |

**SPECIFIC OUTCOME**

**MODULE I**

**1.1.0 Understand the simple stress, strain on machine and structures**.

1.1.1 Explain the terms stresses and strains, tensile and compressive, longitudinal strain, lateral strain and Poisson's ratio.

1.1.2 Draw stress strain diagram for mild steel under tension and identify the significant points.

1.1.3 Draw stress strain diagram for a brittle material and compare it with stress strain diagram of mild steel.

1.1.4 Explain elastic limit, ultimate stress, working stress and factor of safety.
1.1.5 State Hook's law.
1.1.6 Define Young's modulus.
1.1.7 Understand the principles of super position
1.1.8 Solve simple problems involving direct stress and strain, longitudinal strain, lateral strain, Poisson's ratio and Young's modulus for bars of solid, composite and varying sections.
1.1.9 Solve simple problems to compute ultimate stress, working stress, factor of safety and elastic limit of members under direct tensile load.

**1.2.0 Comprehend the theory of shear stress**

1.2.1 Explain the shear stress and shear strain.
1.2.2 Define modulus of rigidity.
1.2.3 Define volumetric strain and bulk modulus.
1.2.4 State the relation between Young's modulus, modulus of rigidity and bulk modulus.
1.2.5 Solve simple problems involving shear stress, shear strain, volumetric strain, modulus of rigidity, bulk modulus and the relation between three moduli. .

**1.3.0 Comprehend the theory of shear strain**

1.3.1 Define thermal stress and strain.
1.3.2 Define the coefficient of linear expansion.
1.3.3 Find the magnitude and nature of temperature stresses in a bar of uniform cross section when it is prevented from expansion or contraction partially or totally by end grips.
1.3.4 Calculate the load on the end grips.
1.3.5 Calculate the magnitude and nature of temperature stress induced in a composite bar made of two materials.

## MODULE II

**2.1.0 Comprehend the laws of friction**

2.1.1 Define friction.
2.1.2 List the types of friction.
2.1.3 Explain static and dynamic friction.
2.1.4 Explain sliding friction, rolling friction, and pivot friction.
2.1.5 Explain the limiting friction.
2.1.6 State the laws of friction.
2.1.7 Explain coefficient of friction, angle of friction and cone of friction.
2.1.8 Analyse the force on a sliding body resting on horizontal plane.
2.1.9 Analyse the force on a sliding body resting on an inclined plane
2.1.10 Solve simple problems based on the laws of friction and force analysis.

**2.2.0 Comprehend the centre of gravity of sections.**

2.2.1 Define centroid and centre of gravity.
2.2.2 List the methods of finding centre of gravity of simple geometrical shapes.
2.2.3 Find the centre of gravity by geometrical consideration and by moments.
2.2.4 Explain axis of reference and axis of symmetry.
2.2.5 Find the centre of gravity of symmetrical and unsymmetrical geometrical sections.
2.2.6 Find the centre of gravity of plane sections with cut out holes.

**2.3.0 Understand the moment of inertia of a section.**

2.3.1 Define moment of inertia and radius of gyration.
2.3.2 Derive the expression for the moment of inertia of a rectangular section.
2.3.3 Derive the moment of inertia of a circular section.

2.3.4 State and prove parallel axis theorem and perpendicular axis theorem.
2.3.5 Calculate the moment of inertia of standard geometrical sections.

## MODULE III

**3.1.0 Appreciate the strength and efficiency of riveted joints, welded joint**
3.1.1 List the different types of riveted joints.
3.1.2 Explain the failure of riveted joints.
3.1.3 Define plate value, rivet value, strength and efficiency of riveted joints.
3.1.4 Calculate strength and efficiency of single and double riveted lap joint and but joint.
3.1.5 Illustrate the purpose and procedure of caulking and fullering.
3.1.6 List different types of welded joints on plates
3.1.7 Define different welding terms.
3.1.8 Calculate the strength of welded joints.
**3.2.0 Compute the thickness of thin cylinders for various stress conditions**
3.2.1 State the failure of thin cylindrical shell due to an internal pressure.
3.2.2 Define stresses in a thin cylinder subjected to an internal pressure.
3.2.3 Calculate the thickness of cylinder.
**3.3.0 Comprehend the stresses on thin cylinders and theory of torsion on shaft**
3.3.1 Derive the torsion equation and state the assumptions.
3.3.2 Understand the expression for strength of solid and hollow shaft.
3.3.3 Understand the equation for power transmitted by the shaft.
3.3.4 Define polar moment of inertia.
3.3.5 Calculate strength and power of solid shaft and hollow shaft.

## MODULE IV

**4.1.0 Appreciate the effect of forces on spring**
4.1.1 List the types of springs.
4.1.2 Distinguish between closely coiled and open coiled helical spring.
4.1.3 Define the terms spring index and stiffness.
4.1.4 Understand the expressions for deflection, stiffness, torque and energy stored in the spring.
4.1.5 Calculate the stress induced diameter, deflection and stiffness of closely coiled helical spring subjected to axial loads.
**4.2.0 Appreciate the shear force and bending moment diagrams**
4.2.1 Explain types of beams and loading.
4.2.2 Define shear force and bending moment.
4.2.3 Draw bending moment and shear force diagram for cantilever with point load.
4.2.4 Draw bending moment and shear force diagram for cantilever with uniformly distributed load.
4.2.5 Draw bending moment and shear force diagram for cantilever with point load and Uniformly distributed load.
4.2.6 Draw bending moment and shear force diagram for simply supported beam with point load.
4.2.7 Draw bending moment and shear force diagram for simply supported beam with uniformly distributed load.
4.2.8 Draw bending moment and shear force diagram for simply supported beam with point load and uniformly distributed load.
4.2.9 Calculate the maximum bending moment on the section.

4.2.10 Understand overhanging beam and point of contra flexure.

**4.3.0 Compute deflection and slope of beams**

4.3.1 Derive the equation for simple bending

4.3.2 Define the slope and deflection.

4.3.3 Calculate the maximum deflection and slope of simply supported beam with central point load.

4.3.4 Calculate the maximum deflection and slope of simply supported beam with uniformly distributed load over entire span.

4.3.5 Calculate the maximum deflection and slope of cantilever beam with a point load at free end.

4.3.6 Calculate the maximum deflection and slope of cantilever beam with uniformly distributed load over entire span.

**4.4.0 Apply the theory of axial loads**

4.4.1 Define column and struts.

4.4.2 Distinguish between long and short columns.

4.4.3 Define the terms buckling load or crippling load, effective length and slenderness ratio .

4.4.4 State Euler's formulae and Rankine's formula.

4.4.5 Calculate the slenderness ratio, equivalent length and buckling load on columns using the two formulae under different end conditions.

## CONTENT DETAILS

### MODULE I

**l. Direct Stresses and strains**

Types of stresses and strains - tensile and compressive - longitudinal and lateral strain -Poisson's ratio – (Review of stress strain diagram - behavior of mild steel & brittle material under tension and identify the significant points-limit of proportionality - elastic limit - yield point) - ultimate stress - working stress - factor of safety - Hooks law and Young's modulus –principle of super position- stresses in varying section -stresses in composite section - simple problems.

**2. Shear stress and shear strain**

Shear stress and shear strain - modulus of rigidity - volumetric strain- Young's Modulus (E)- Bulk Modulus ( K) and Modulus of Rigidity (C) relations-simple problems

**3. Thermal Stress and strain**

Nature and magnitude of stresses due to change in temperature - total or partial prevention of expansion and contraction in a bar of uniform cross section - temperature stress on composite bar- simple problems.

### MODULE II

**1. Friction**

Introduction - type of friction - static friction- dynamic friction- sliding friction- rolling friction- pivot friction- limiting friction- angle of friction- coefficient of friction- cone of friction - state laws of friction. - Static friction and dynamic friction - force analysis of a sliding body resting on a horizontal plane - inclined plane - force acting parallel to the base - along the plane and at an angle.

**2. Centre of gravity of sections**

Centroids - centre of gravity - axis of symmetry and axis of reference – CG of simple geometric sections such as rectangle- triangle- circle and semicircle sections by geometric consideration - combinations of

symmetrical sections such as T- I and channel sections combinations of unsymmetrical sections such as L section. - Plane sections with cut out holes.

**3. Moment of inertia of sections**

Moment of inertia - radius of gyration - methods to find moment of inertia plane area - moment of inertia of rectangular and circular sections by integration method - parallel axis theorem-perpendicular axis theorem - moment of inertia of standard geometrical sections such as T -I- L and channel sections.

## MODULE III

**1. Rivet**

Types - lap joint - single riveted- double riveted ( chain and zigzag ) - butt joint - single cover single riveted- double cover single riveted) - failure of riveted joints - failure of rivets - shearing and crushing - failure of plates - tearing across a row of rivets - tearing off plate at an edge - strength of rivet- strength of plate and strength of riveted joint - efficiency of a riveted joint - simple problems on single and double riveted lap joint- single cover and double cover single riveted butt joint - caulking and Fullering operations**.**

**2. Welded joints**

Types of fillet and butt welds - welding terms - leg of the weld- size of the fillet weld- throat thickness- effective length of the weld- side fillet weld and end fillet weld - strength of welded joints - fillet and butt - parallel welds -combination of transverse and parallel welds - butt welds (flat plates only).

**3. Thin Cylinders**

Introduction - failures of thin cylinder - stresses in thin cylindrical shell - hoop stress -longitudinal stress - simple problems to calculate thickness and pressure of thin cylinders with joint efficiency.

**4. Torsion of circular shafts**

Introduction-assumptions for shear stress in a circular shaft subjected to torsion - torsion equation derivation- strength equation for solid and hollow shaft - power equation -polar moment of inertia - simple problems to calculate strength and power.

## MODULE IV

**1. Springs**

Introduction - types of spring - leaf spring - helical springs - closely coiled and open coiled helical spring with round wire – spring index - formulae for deflection- stiffness- torque and energy stored ( no proof ) -simple problems on closely coiled helical springs subjected to an axial load to find out stress induced- deflection -stiffness and diameter**.**

**2. Shear force and bending moment**

Types of beams - cantilever beam- simply supported beam- over hanging beam- built in beam or fixed beam and continuous beam - types of loading - concentrated or point load- uniformly distributed load and uniformly varying load - shear force and bending moment diagrams - cantilever beams - point load- uniformly distributed load and combination of point load and uniformly distributed load - simply supported beam - point load- uniformly distributed load and combination of point load and uniformly distributed load - maximum bending moment on the section. Introduction to overhanging beam – Point of contra flexure.

**3. Deflection of beams**

Introduction –derivation of bending equation – $M/I = \sigma_b /Y = E/R$ - simply supported beam with central point load (no proof) - simply supported beam with uniformly distributed load on entire span (no proof) - cantilever with a point load at the free end (no proof) — cantilever with a uniformly distributed load over entire span (no proof) - simple problems on cantilever and simply supported beams.

**4. Columns and struts**

Introduction - column- strut- buckling load- equivalent length- slenderness ratio - types of columns - short column- medium size column- long column - Euler's equations and its assumption for crippling load for different end conditions (no proof) - both end hinged -one end is fixed and other is free- one end is fixed and other is hinged- both ends fixed-equivalent length - Rankine's formulae for columns - simple problems on columns to calculate buckling load- slenderness ratio- equivalent length on different end conditions.

## TEXT BOOKS


1. **Strength of Materials - R.S. Khurmi, S.Chand & Company Ltd**
2. **Engineering Mechanics - Dr. R.K.Bansal, Lakshmi Publishers**
3. **Strength of materials – SS Bhavikatti Vikas Publishing House**


## REFERENCE


1. **Strength of Materials - Dr. R.K.Bansal, Lakshmi Publishers**
2. **Strength of Materials - Ramamrutham, Dhanpat rai & sons**
3. **Engineering Mechanics - Dr. R.K.Bansal, Lakshmi Publishers**
4. **Applied Mechanics and Strength of Materials - R.S. Khurmi, S.Chand & Company Ltd**
5. **Theory of Machines - Sadhu Singh, Pearson**