# SNS COLLEGE OF TECHNOLOGY

**COIMBATORE**

**DEPARTMENT OF AGRICULTURE ENGINEERING**

## SYLLABUS

| 16AG303 | MACHINE DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | (Agriculture Engineering) | 3 | 0 | 0 | 3 |

**UNIT 1 FUNDAMENTAL OF MACHINE DESIGN 10**

General consideration in machine design-properties of engineering materials. Limits and tolerances-types of fits-simple stresses in machine elements-tension-compression-shear and bearing stresses. Torsional and bending stresses in machine parts-torsional stresses in shafts, bending stresses in beams. Theories of failure-Rankine's theory, Guest theory, saint venants theory and Von Mises theory.

**UNIT 2 DESIGN OF FASTENERS 8**

Design of permanent joints-welded joints-types of welded joints-transverse and parallel strength of fillet welds-design of butt joints. Design of threaded fasteners-terminology of screw threads-design of bolts and nuts for under static loads.

**UNIT 3 DESIGN OF MACHINE ELEMENTS 9**

Keys and couplings-design of sunk keys-shaft couplings-design of sleeve coupling and flange coupling. Design of cotter and knuckle joints-design of shafts-shafts subjected to torsion, bending and combined stresses.

**UNIT 4 FUNDAMENTALS OF THEORY OF MACHINES 8**

Linkages-basic definitions-different types of mechanisms-instantaneous centre of rotation for four bar mechanisms-determination of velocities and acceleration in four bar and slider crank mechanisms-flywheel-fluctuation of speed and energy-energy stored in flywheel.

**UNIT 5 DESIGN OF TRANSMISSION SYSTEM COMPONENTS 10**

Gears-classification-gear terminology-law of gearing-design of spur and bevel gear based on Lewis and Buckingham equation. Springs-types of springs-terminology-design of helical springs for static loading. Belt drives-flat belts-Euler's formula-V-belt design-power calculation and selection-chain drive-components-design.

**L:45 T:0 P:0 TOTAL: 45 PERIODS**

**TEXT BOOKS**


1. Kannaiah,P 2003. Machine Design Scitech Publishers (India) Pvt. Ltd. Chennai.
2. Khurmi, R.S. and Gupta, J.S. 2001, A textbook of machine design. Eurasia Publication House, Delhi.


**REFERENCES**


1. Gill, P.S. 1992. A textbook of machine drawing. S.K. kataria and sons, New Delhi.
2. N. Siddeswar, P. Kannaiah and V.V.S. Sastry. 1993. Machine drawing. Tata McGraw-Hill Publication.
3. Narayana. K.L. and P. Kannaiah. 1992. Engineering graphics. Tata McGraw-Hill Publication.

**WEB RESOURCES**

1. Machinedesign.com/
2. Onesmartclick.com/engineering/machine-design.html
3. Utm.edu/departments/engine/lemaster/machine_design.html
4. Mech.uwa.edu.au/DANotes/intro/conents.html

**COURSE OUTCOMES**

At the end of the course students should be able to

CO1: Know about the basics of machine design

CO2: Know the design of fastenings

CO3: Know the design of machine elements

CO4: Know about the fundamentals of theory of machines

CO5: Know about the design of transmission system components

## 2 Marks Questions with Answer

## UNIT- I

## FUNDAMENTALS OF MACHINE DESIGN

**1) Define Design.**

Creating a plan or drawing for a product using intellectual ability and scientific knowledge is called design. A product so designed should permit economical manufacture, and it should meet the specification requirements.

**2) What are the classifications of machine design?**

a) Adaptive design
b) Development design
c) New Design

**3) What are the classifications of machine design based on methods?**

a) Rational design
b) Empirical design
c) Industrial Design
d) Optimum design
e) System Design
f) Element design
g) Computer aided design

**4) What are the general considerations to be considered in designing of a machine component?**

a) Type of load and stresses caused by the load
b) Motion of the parts or kinematics of machines
c) Selection of materials
d) Form and size of the parts
e) Frictional resistance and lubrication
f) Convenient and economical features
g) Use of standard parts
h) Safety of operation
i) Workshop facilities
j) Number of machines to be manufactures
k) Cost of construction
l) Assembling

**5) Write down the general procedure in Machine Design.**

a) Recognition of need
b) Synthesis (Mechanisms)
c) Analysis of forces
d) Material Selection

e) Design of elements (Size and Stresses)
f) Modification
g) Detailed drawing
h) Production

**6) What are the factors to be considered during design?**

a) Efficiency of machine
b) Absence of noise
c) Reliability
d) Life
e) Ease of control
f) Overload capacity
g) Maintenance
h) Space requirement
i) Weight
j) Size
k) Cost of manufacture
l) Ergonomics
m) Aesthetics
n) Safety

**7) What are the ergonomic considerations in Design?**

The ease with which the user of the designed equipment carries out various operations, like moving hand wheels and levers and seeing instrument dials fatigue of the operation, energy expenditure in hand and foot operations, environmental conditions (light, noise, and climate), human safety, etc. are the subject matter of ergonomics.

**8) How do you classify materials for engineering use?**

Engineering materials are classified as

- Metals and their alloys such as iron, steel, copper, aluminium etc.
- Non-metals, such as glass, rubber, plastic etc.
- The metals may be further classified as Ferrous Metals and Nonferrous metals.

**9) What are the factors to be considered for the selection of materials for the design of machine elements?**

a) Properties of materials
b) Manufacturing ease and cost
c) Quantity required
d) Availability of material
e) Space available
f) Cost

**10) What are the different properties of materials and discuss?**

**Strength:** It is the ability of a material to resist the externally applied forces without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.

**Stiffness:** It is the ability of a material to resist deformation under stress. The modulus of elasticity is the measure of stiffness

**Elasticity:** It is the property of a material to regain its original shape after deformation when the external forces are removed. This property is desirable for materials used in tools and machines. It may be noted that steel is more elastic than rubber.

**Plasticity:** It is property of a material which retains the deformation produced under load permanently. This property of the material is necessary for forgings, in stamping images on coins and in ornamental work.

**Ductility**: It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. Mild steel, copper, aluminium, nickel, zinc, tin and lead are the ductile materials

**Brittleness:** It is the property of a material opposite to ductility. It is the property of breaking of a material with little permanent distortion. Cast Iron is a brittle material.

**Malleability:** It is a special case of ductility which permits materials to be rolled or hammered into thin sheets. A malleable material should be plastic but it is not essential to be so strong. Lead, soft steel, wrought iron, copper and aluminium.

**Toughness:** It is the property of a material to resist fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. This property is desirable in parts subjected to shock and impact loads.

**Machinability:** It is the property of a material which refers to a relative case with which a material can be cut.

**Resilience:** It is the property of a material to absorb energy and to resist shock and impact loads. It is measured by the amount of energy absorbed per unit volume within elastic limit. This property is essential for spring materials.

**Creep:** When a part is subject to a constant stress at high temperature for a long period of time, it will undergo a slow and permanent deformation called creep. This property is considered in designing internal combustion engines, boilers and turbines.

**Fatigue:** When a material is subjected to repeated stresses, it fails at stresses below the yield point stresses. Such type of failure of a material is known as fatigue. The failure is caused by means of progressive crack formations which are usually fine and microscopic size. This property is considered in designing shafts, connecting rods, springs, gears etc.

**Hardness:** It is a very important property of the metals and has a wide variety of meanings. It embraces many different properties such as resistance to wear, scratching, deformation and machinability etc. It also means the ability of a metal to cut another metal. The hardness is usually expressed in numbers which are dependent on the method of making the test.

**11) What alloying element improves the Hardenability of steels?**

Hardenability can be improved by using alloying elements like boron, vanadium, manganese, chromium and molybdenum.

**12) Why do we use alloy steels in some machine components?**

In general, adding alloying elements to steel will improve the hardenability and steel may be heat treated to the desired hardness with less drastic quenching and therefore with less problem of distortion and cracking.

**13) What is duralumin?**

Duralumin is an Al-Cu-Mg-Mn alloy and it has good corrosion resistance and strength. This alloy is available in the form of sheets, plates, tubes, rods, extruded section, bolts and rivets and is widely used in aircraft industry.

**14) What are proof resilience and proof stress?**

Greatest strain energy that can be stored in a member without permanent deformation is called the **proof resilience** and the corresponding stress is called the **proof stress**. The proof resilience per unit volume of a material is known as **modulus of resilience**.

**15) What do you mean by factor of safety? / What is factor of safety?**

Factor of safety is defined, as the ratio of the maximum stress to the working stress or ultimate stress to the working/design stress or yield stress to the working/design stress.

**16) List the important factors that influence the magnitude of factor of safety?**

a) Loading uncertainty
b) Type of loading
c) Material strength uncertainty
d) Size effect
e) Working extreme environments
f) Effect of manufacturing process
g) Effect of stress concentration
h) Uncertainty due to the method of analysis.
i) Reliability requirements
j) Risk to life and property

**17) What is design stress?**

Permissible stress or design stress of a material is defined as the ratio between maximum stress (yield stress in case of brittle material / ultimate stress in case of ductile material) to the factor of safety.

**18) Give the different failure theories and the type of materials for which these theories are applicable?**

Failure theories relate a complex stress state to a single strength (yield point stress in tension) and from this relation design criteria for safety can be derived.
**Maximum principle stress theory (Rankine theory):** According to this theory, failure occurs whenever the maximum principle stress induced in the machine

component becomes equal to the strength. Mathematically, for safety for ductile materials and for brittle materials and n = factor of safety. This theory is applicable to ductile materials.

**Maximum shear stress theory (Guest's or Coulomb's theory):** According to this theory, failure occurs whenever the maximum shear stress induced in the component becomes equal to the maximum shear stress in a tension test specimen when the specimen begins to yield. Mathematically for safety. This theory is best suited for ductile materials.

**Maximum strain theory (St. Venant's theory):** According to this theory, failure occurs whenever the maximum strain in the component becomes equal to the strain in the tension test specimen when yielding begins. Mathematically for safety where ν= Poisson's ratio. This theory is not confirmed by experimental data.

**Maximum strain energy theory (Haigh Theory):** According to this theory failure will occur when the strain energy stored per unit volume of the stress element becomes equal to the strain energy stored per unit volume in the tension test specimen at the yield point. Mathematically, for safety. This theory is useful for ductile materials. According to this theory for the case of pure shear $\tau_y$=0.62σy.

**Distortion Energy theory / Shear energy theory / Von Mises / Hencky Theory / Octahedral Theory**: According to this theory, failure will occur when the strain energy of distortion per unit volume of the component becomes equal to the strain energy of distortion per unit volume of the tension test specimen. Mathematically, for safety. This theory is applicable to ductile materials. According to this theory, for the case of pure shear $\tau_y$=0.577σy.

**19) Distinguish between endurance limit and endurance strength.**

**Endurance limit** is the limiting value of alternating stress for which failure does not occur on the material for an infinite number of cycles.

**Endurance (Fatigue) Strength** is the alternating stress at which failure occurs for a particular finite value of life. Fatigue strength is always accompanied by a finite number of cycles.

**20) Explain the Stress concentration**

**Stress Concentration**: Stress concentration may occur due to abrupt changes of cross section of the member due to the presence of discontinuities like holes, notches, grooves or shoulders. It may also be due to the presence of internal cracks or air holes in the materials.

**21) What is meant by fatigue failure?**

Many machine and structural members are subjected to loads that vary in magnitude. This induces cyclic or fatigue stresses in members and the members fail at a stress much less than the yield point stress. This is known as fatigue failure.

**22) What are the different failure modes of machine components?**

a) Failure by yielding
b) Failure by fracture
c) Due to deflection
d) Due to wear
e) Due to buckling
f) Due to corrosion
g) Due to caustic embrittlement

**23) What is bearing stress?**

Local compression occurs between two members held in contact, i.e., between the pin and the eye. The pressure distribution will not be uniform and it is difficult to determine accurately. Hence the average bearing pressure or bearing stress is obtained by dividing the load by the projected bearing area. Bearing stress or Bearing pressure,

where l = Length of the pin in contact and d = diameter of the pin.

**24) What are the different types of varying loads? Give one example for each.**

a) Completely Reversed Loading – Shafts carrying pulleys
b) Repeated Loading – Gears, Chain
c) Fluctuating Loading – Vehicle springs, Engine valve springs
d) Alternating Loading – IC engine connecting rods

**25) What is meant by eccentric loading and eccentricity?**

- An external load, whose line of action is parallel but does not coincide with the centroidal axis of the machine component, is known as an eccentric load.
- The distance between the centroidal axis of the machine component and the eccentric load is called eccentricity.

**26) Define stress concentration factor.**

Theoretical or form stress concentration factor is defined as the ratio of Maximum stress and Nominal stress.

**27) Define- Allowance.**

It is the difference between the basic dimensions of the mating parts.

**28) Define- Tolerance**

It is the difference between the upper limit and lower limit of a dimension. In other words, it is the maximum permissible variation in a dimension.

**29) What are the types of tolerance?**

Uni lateral and Bi-lateral tolerances.

**30) Define- Fits**

The degree of tightness or looseness between the two mating parts is known as a fit of the parts.

**31) List out the types of fits.**

i) Clearance fit ii) Interference fit iii) Transition fit.

**32) Define Poisson's ratio**

It has been found experimentally that when a body is stressed within elastic limit, the lateral strain bears a constant ratio to the linear strain.

Lateral strain / Linear strain = Constant

This constant is known as Poisson's ratio and is denoted by 1/m or μ.

**33) Define Bulk Modulus**

When a body is subjected to three mutually perpendicular stresses, of equal intensity, then the ratio of the direct stress to the corresponding volumetric strain is known as bulk modulus. It is usually denoted by K.

K = Direct stress / Volumetric strain