Machine Design :

CHAPTER-1 (Introduction)

Machine Design is defined as the branch of mechanical engg which deals with the Creation of new and better machines and improving the existing ones.

Classification of Machine Design

1. Adaptive Design 2. Developement Design 3. New Design

General considerations in Machine Design

(a). The type of load and stresses caused by the load.

(b). Motion of parts:-

* Rectilinear Motion, which includes Unidirectional and Reciprocating motion.
* Curvilinear motion, which includes Rotary, Oscillatory, Simple Harmonic.
* Constant velocity
* Constant or Variable Acceleration.

(C) Selection of Material :—

Every Machine Design engineer should have a thorough knowledge of the properties of Material and their behavior under working conditions.

(D) Form & Size of the parts :-

Inorder to design any machine part for form & size, it is necessary to know the forces which the part must sustain. Any suddenly applied or impact load must be taken into consideration, which may cause failure. The smallest practicable Cross-section may be used but it may be checked that the stresses induced in the Designed Cross-section are reasonably safe.

(E) Frictional resistance and Lubrication :-

There is always a loss of power due to frictional resistance. Careful attention must be given to the matter of Lubrication of all Surfaces which moves in contact with others.

(F) Safety of operator:-

A Machine Designer should always provide Safety device for the Safety of the Operator. The Safety appliances should in no way interfere with the operation of the machine

(G) Use of standard parts :-

The use of standard parts are closely related to the cost of Machine, because the cost of standard parts is only a fraction of the cost of similare parts made to order

(H) Convenient & Economical features:-

The operating feature of the machine should be carefully studied. The starting, controlling and stopping levers should be located on the basis of convenient handling

(I) Workshop facilities:-

A Design engineer should be familar with limitation of his Employer's Workshop, in order to avoid the necessity of having workdone in some other workshop.

(J) Assembling:-

Every machine must be assembled as a unit before it can function. The final location of any machine is important and the Design engineer must anticipate the exact location and the local facilities for erection

Design Consideration

The following are the general characteristics, which influence the design of elements or the entire machine

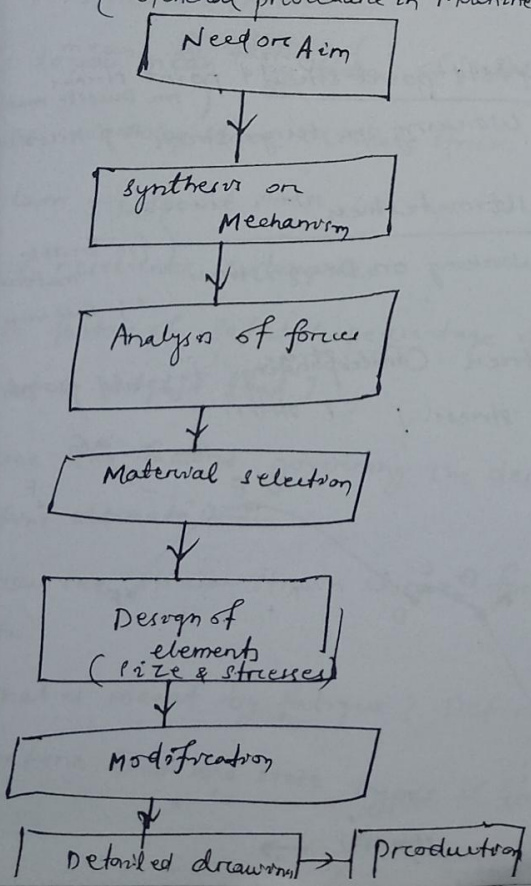
1. Strength
2. Reliability
3. Thermal consideration
4. Corrosion
5. Wear
6. Friction
7. Processing
8. Utility
9. Cost
10. Safety
11. Weight
12. Noise
13. Styling
14. Shape
15. Size
16. Flexibility
17. Control
18. Stiffness
20. Lubrication
21. Maintenance
22. Volume

Procedure in Design

A general procedure to solve a problem in Design is as follows.

1. First make a complete statement of the problem, clearly indicating the purpose of the machine to be designed.
2. Select the possible groups of mechanisms, which will give the desired motion.
3. Find the forces acting on each member of the machine and the energy transmitted by each member
4. Select the best material
5. Fined the size of each member of the machine, considering the forces acting and the stresses with in permissible limits.
6. Modify the size of the member of the machine to agree with the part experience and judgement to facilitate manufacture
7. Draw the detail drawing of each component and the assembly of the machine with complete specification for the material and manufacturing processes suggested

Flow chart of
[General procedure in Machine Design]



Load:- It is defined as any external force acting upon a machine parts.

Types of load

(a) Dead or steady load – When the load doesn't change in magnitude & direction.

(b) Live or variable load :- When the load changes continu

(c) Suddenly applied or shock loads :- When the load applied su & removed.

(d) Impact loads :- When a load applied with certain initial velocity

Working stress :-

When designing machine parts, it is desirable to keep the stress lower than the maximum or ultimate stress at which failure of material takes place. This stress is known as working stress or Design stress or safe or allowable stress

Factor of Safety :- It is defined as the ratio of maximum stress to the working stress, Mathematically

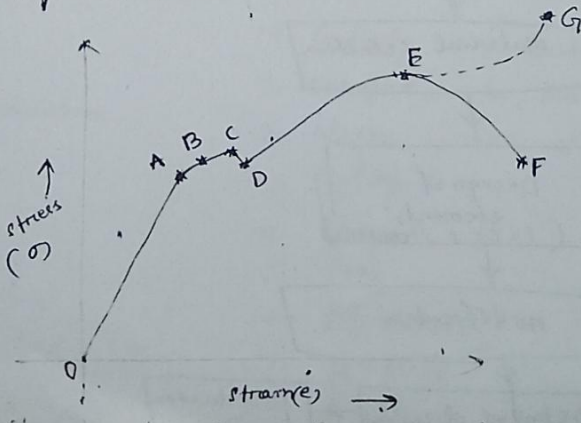
$$\text{Factor of Safety} = \frac{\text{Maximum stress}}{\text{Working or Design stress}}$$

$$\text{Factor of Safety} = \frac{\text{Yield point stress}}{\text{Working or design stress}}$$ (for Ductile mate e.g. Mild ste

$$\text{Factor of Safety} = \frac{\text{Ultimate stress}}{\text{Working or Design stress}}$$ (for brittle mater e.g. Cast iron)

Yield point stress :- The stress corresponding to yield point is known as yield point stress.

A → proportional limit
B → Elastic limit
C → Upper yield point
D → Lower yield point
E → Ultimate stress
F → Breaking stress



Mechanical properties of material

Mechanical properties are those properties which are associated with the ability of a material to resist mechanical forces & load.

The mechanical properties of the material includes

(i) strength (ii) stiffness (iii) Elasticity (iv) plasticity (v) Ductility (v) Brittleness (vii) Malleability (ix) Toughness (x) Machinibility (xi) Resilience (xii) Creep (xiii) Fatigue (xiv) Hardness

possible Questions from Chptr 1

Q1. What are the factors to be considered for the selection of materials for the design of machine elements?

Q2. Define mechanical properties of an engineering material state any six mechanical properties.

Q3. Define the following properties of a material
(i) Creep (ii) Toughness (iii) Hardness (iv) Ductility

Q4. Define the terms load, stress, strain. Discuss the various types of stresses & strains.

Q5. What do you mean by factor of safety?

Q6. Define working stress, Ultimate stress.

Q7. Explain yield point stress.

Q8. Define resilience & toughness.

Q9. State factor of safety & percentage of elongations.

Q10. What is impact load?

Q11. Name the factors governing the design of machine elements.

Q12. Define Ultimate Stress.

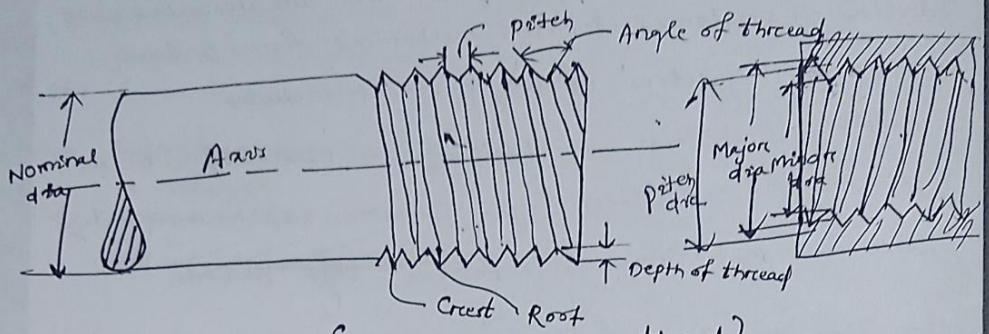
Q13. Draw the stress-strain curve for mild steel, explain various points.

Q14. What is meant by fatigue? Define endurance limit

Q15. Define load and state types of load.

Screwed Joints

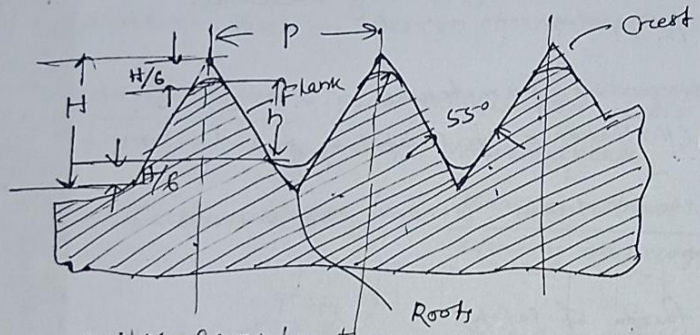
A screwed joint composed of two elements i.e. a bolt & nut



(Term used in Screw thread)

Forms of Screw thread

1. British standard Whitworth (B.S.W) thread



$H = 0.96p$

$h = 0.64p$

$r = 0.1373p$

2. British Association thread (B.A) thread

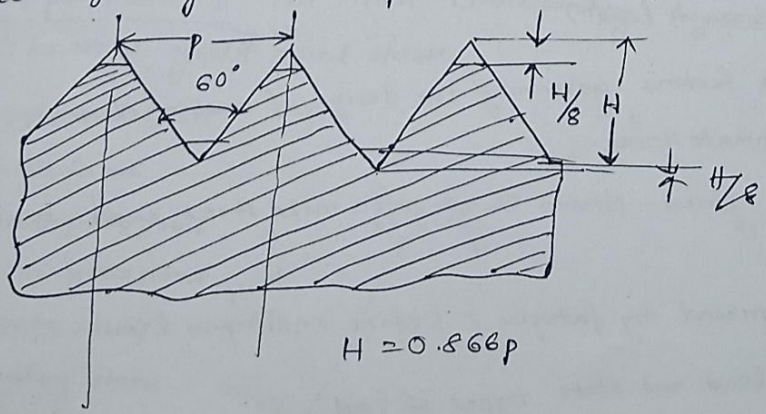
This is a B.S.W. thread with fine pitches. The proportion of the B.A. threads

$H = 1.13639p$ $h = 0.6p$, $r = 0.18083p$

It is used for instruments or other precision works.

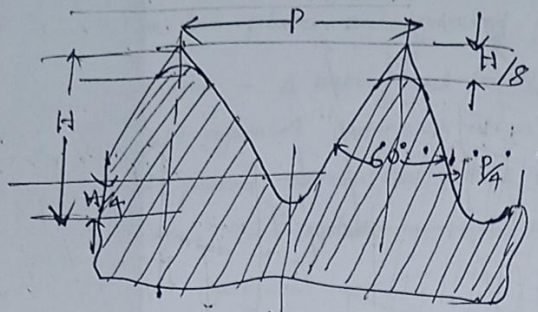
3. American national standard thread or U.S. or Sellers's thread

It has flat crests and roots. The flat crest can withstand more rough usage than sharp V-threads. It is used for



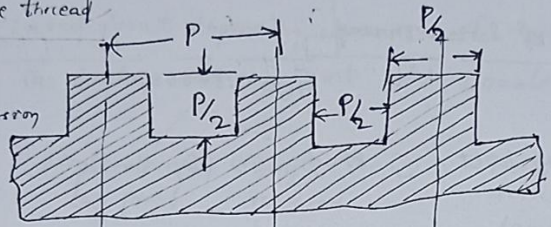
$H = 0.866p$

4. Unified standard thread



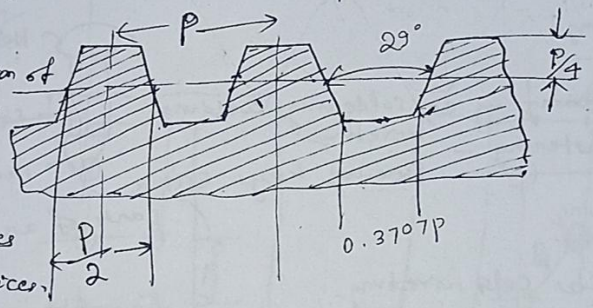
$H = 0.866p$

5. Square thread



It is used for transmission of power. Such types of threads are found on the feed mechanism of machine tools, valves, spindles, screw jack.

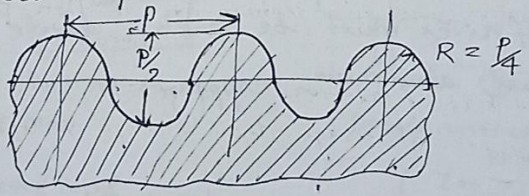
6. Acme thread



It is a modification of square thread. It is frequently used on screw cutting lathes, brass valves cocks and bench vices.

7. Knuckle thread

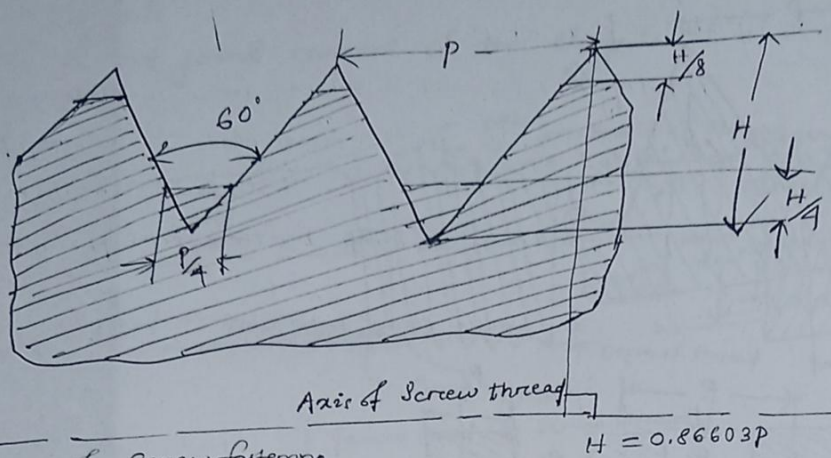
It is also a modification of square thread. It is rounded on top & bottom



8. Buttress thread

9. Metric thread

It is an ISO standard thread and is similar to B.S.W thread. It has an included angle of 60° instead of 55°.



Types of Screw fastening

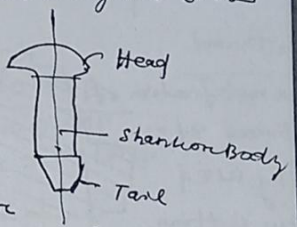
(i) Through bolt (ii) Tap bolt (iii) Stud (iv) Cap Screw

Riveted joint

A rivet is a short cylindrical bar with a head integral to it

Types of fastening

(a) Permanent fastening - eg soldering, welding, riveting
(b) Temporary fastening - Screwed, keys cotter



(parts of a rivet)

Methods of riveting

(a) Hot riveting (b) Cold riveting

Materials of rivet

The materials of rivet must be tough & ductile.
Carbon steel, brass, aluminium, copper

Types of riveted head

(a) Snap head (b) pan head (c) mushroom head (d) Countersunk head 120°. (e) Flat countersunk head 90° (f) Flat countersunk head 60° (h) Flat head.

Types of riveted joint

There are two types of riveted joint depending upon which the plates are connected together
(a) Lap joint (b) Butt joint