THREAD CUTTING

Presented to:

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Understanding Thread Cutting

What is Thread Cutting ?

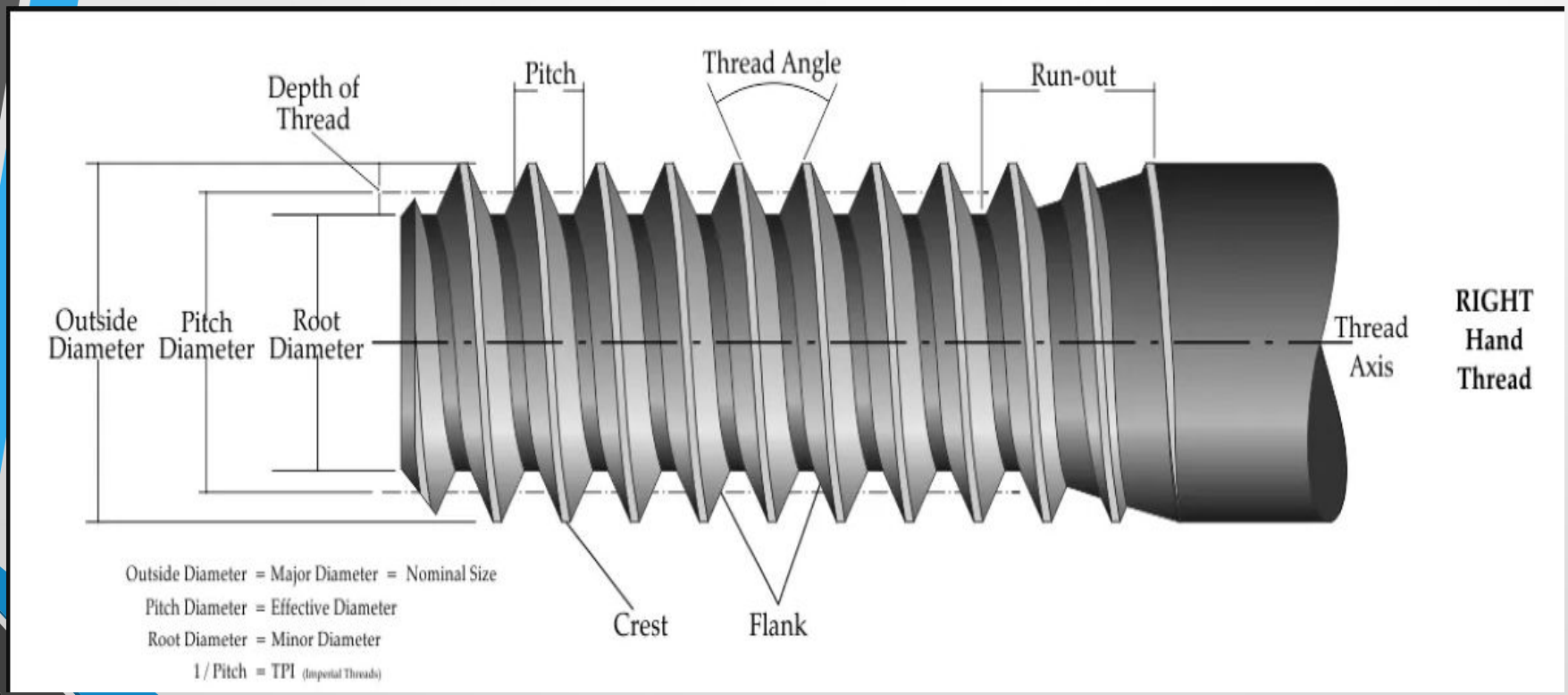
1) Defination of Thread Cutting And more details.

2) Process of Thread Cutting

3) Application of Thread Cutting

What is a Thread Cutting?

In engineering workshop technology, **Threads** refer to the helical ridges or grooves formed on cylindrical surfaces such as bolts, nuts, and screws. And, the way or process of making these thread is known as **Thread Cutting**.

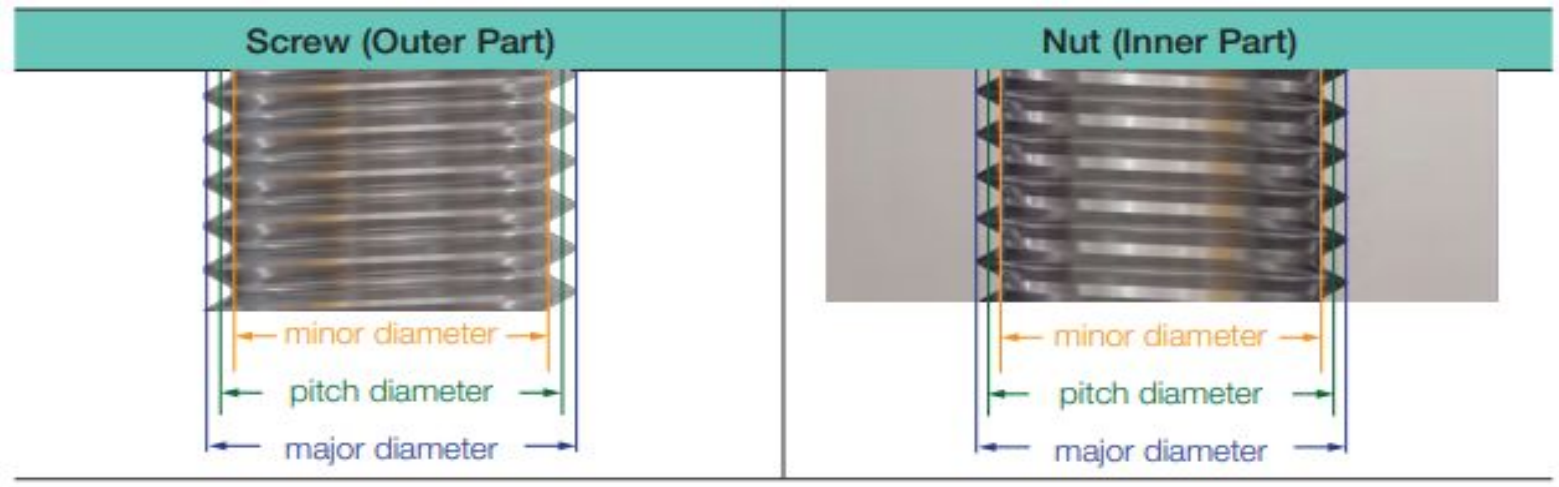

Depth of Thread
Pitch
Thread Angle
Run-out
Outside Diameter
Pitch Diameter
Root Diameter
Thread Axis
RIGHT Hand Thread
Crest
Flank
Outside Diameter = Major Diameter = Nominal Size
Pitch Diameter = Effective Diameter
Root Diameter = Minor Diameter
1 / Pitch = TPI (Imperial Threads)

Thread Parameters

The main parameters of thread geometry and thread functionality are**: Diameters, Pitch, Lead, Helix angle, Lead angle, and Truncation.**

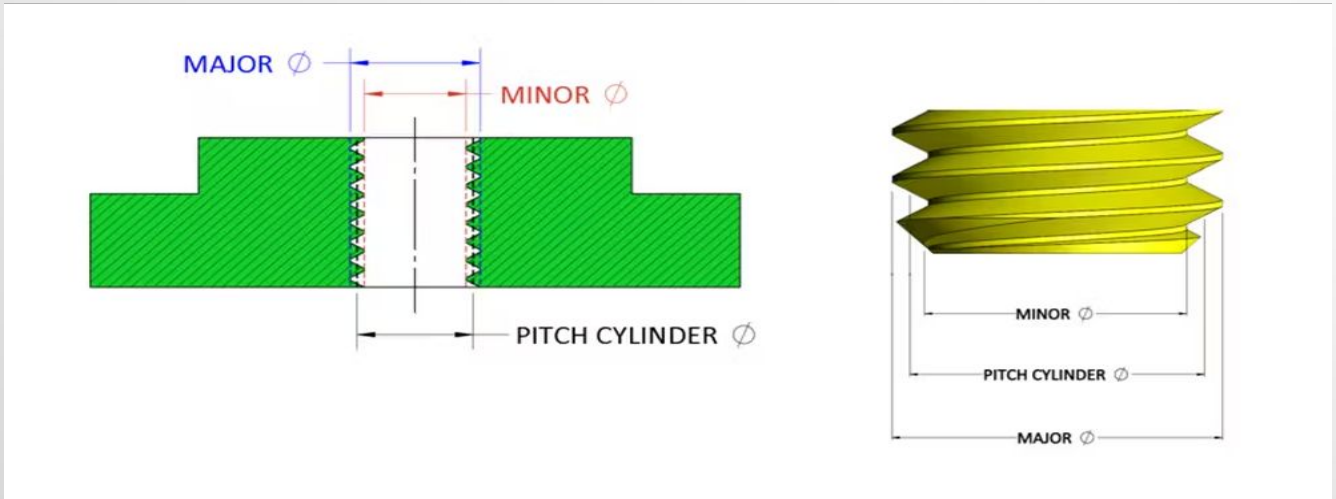
- **Diameter**

There are three main thread diameters: major diameter, pitch diameter and minor diameter.



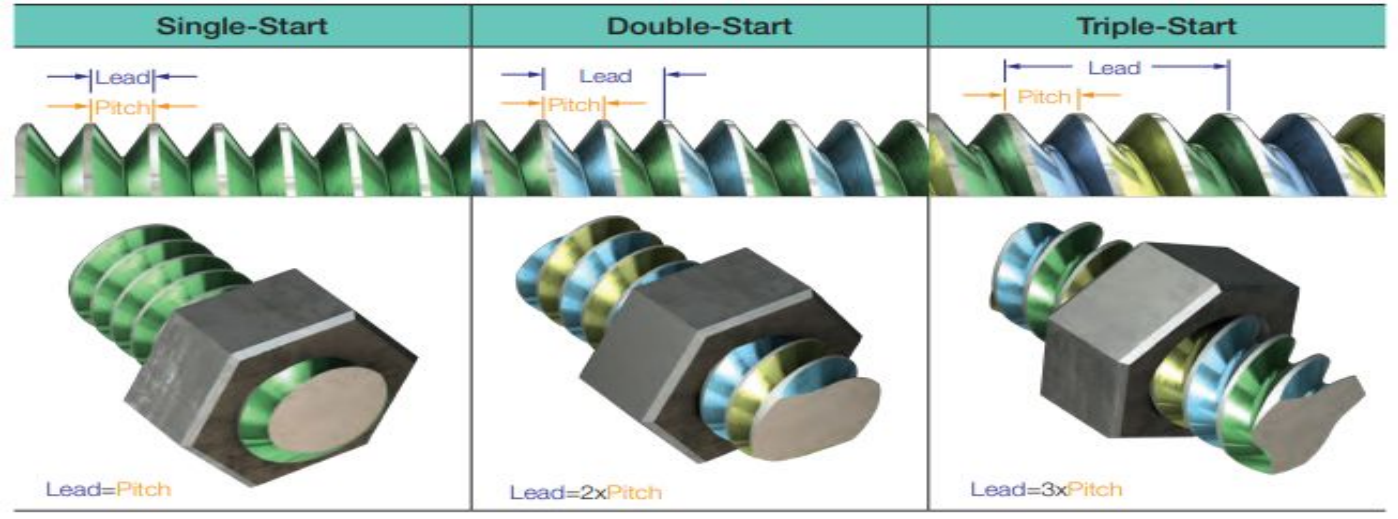
• **Major Diameter** :- The largest diameter of two extreme diameters. In external threads, the major diameter defines the end limit of a thread profile and in internal threads, the major diameter defines the start of a thread profile.

•**Minor Diameter** :- The smallest diameter of two extreme diameters. In external threads, the minor diameter defines the start of a thread profile and in internal threads, the minor diameter defines the end limit of a thread profile.



• **Pitch Diameter (Effective Diameter)** -: The pitch diameter is also known as an effective diameter that must be used to inspect the location of the threaded feature unless the minor or major diameter is specified. . Pitch diameter is a theoretical diameter representing the place where the width of the basic thread profile is equal to half a pitch.

Lead :-We can define lead-the distance a screw thread can advance axially in one turn. In a single-start thread, the lead is equal to the thread pitch. In a multi- start thread, the lead is equal to the thread pitch multiplied by the number of starts.



Helix Angle -: The helix angle is necessary for calculating torque in thread applications. The helix angle of the thread can be defined by unraveling the helix from the thread, representing the section as a right triangle and calculating the angle that is formed.

$\varphi = \arctan\left(P \pi \times D \text{ pitch}\right)$ When: φ = Helix angle

P = Thread pitch D pitch = Pitch diameter

$\pi \approx 3.142$

Lead Angle -: Lead angle is the angle between the helix of thread and a plane of rotation. The lead angle of the thread depends on the pitch diameter, thread pitch, and the number of thread starts. This parameter can be represented as a sweep of a right triangle.

The angle of the thread is calculated by the formula given below:

$$\varphi L = \arctan\left(\frac{\text{Lead}}{\pi \times D \text{ pitch}}\right)$$

$$\text{Lead} = n \times P$$

Where:

φL = Lead angle

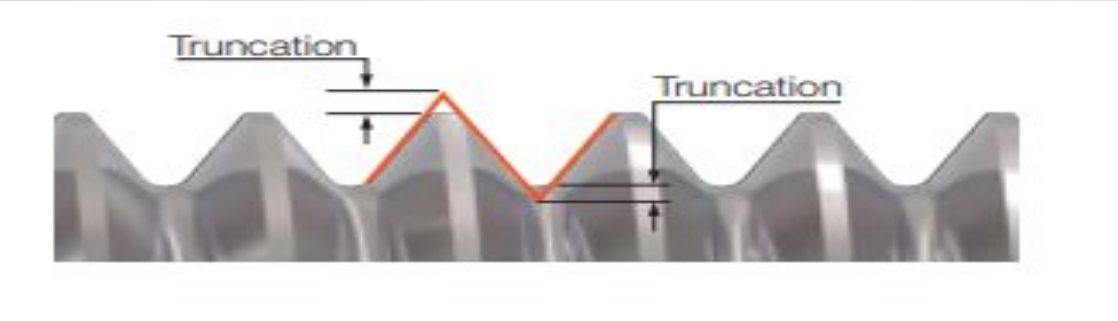
D pitch = Pitch diameter (effective diameter of thread)

P = Thread pitch

n = Number of thread starts $\pi \approx 3.142$

Where the thread is single-start, the lead angle is equal to the helix angle.

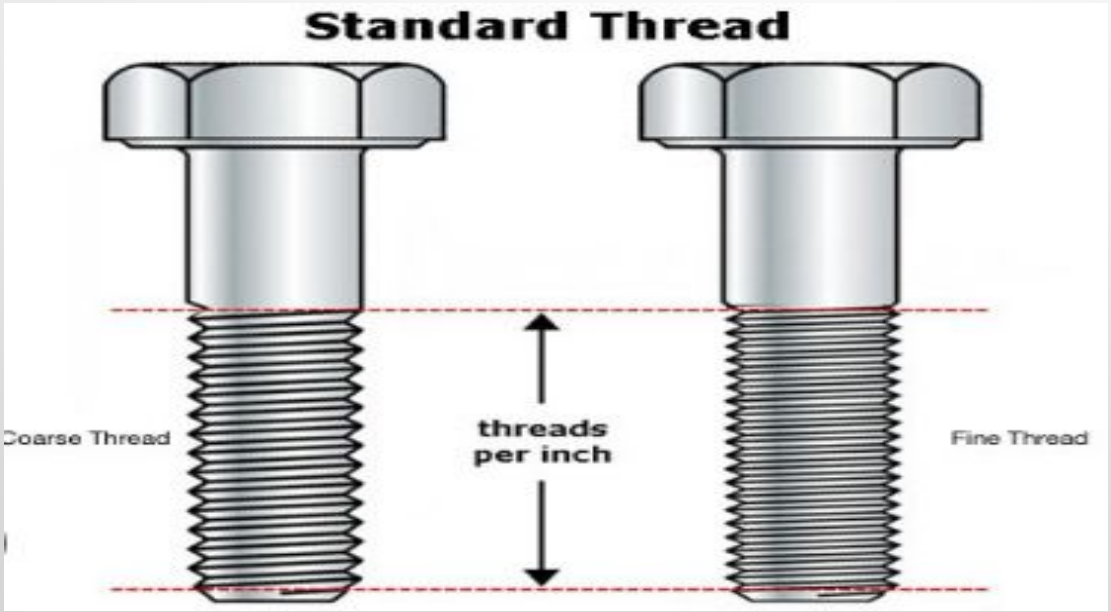
Truncation-: Truncation is the perpendicular distance to the axis of the thread from the imaginary point of intersection of two adjacent sides of the thread profile to the nearest point of its top or bottom.



Threads can be classified based on their pitch into several categories:

1) **Coarse Thread** :- Coarse threads have a larger pitch compared to fine threads. They are commonly used in applications where rapid assembly or disassembly is required, or where there may be debris or dirt present that could interfere with fine threads. Coarse threads provide better resistance to stripping.

2) Fine Thread :- Fine threads have a smaller pitch compared to coarse threads. They are used in applications where strong fastening with higher thread engagement is required. Fine threads offer finer adjustments and better resistance to loosening due to vibration.

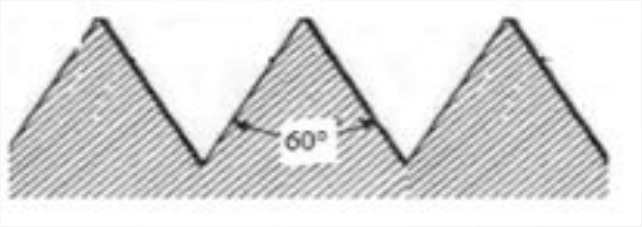


3) Extra Fine Thread :- Extra fine threads have an even smaller pitch compared to fine threads. They are used in applications where very precise adjustment or control is necessary, such as in instrumentation or delicate machinery.

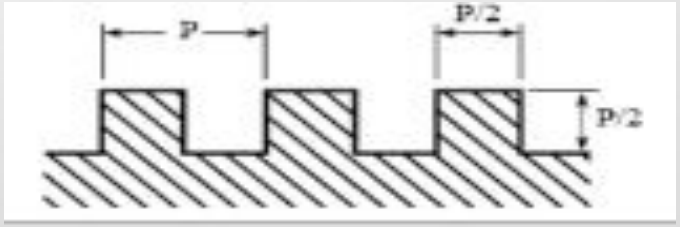
4) Specialized Threads :- Some threads may have unique pitches tailored for specific applications, such as those used in aerospace, automotive, or medical industries.

Threads can be classified based on their profile into several categories:

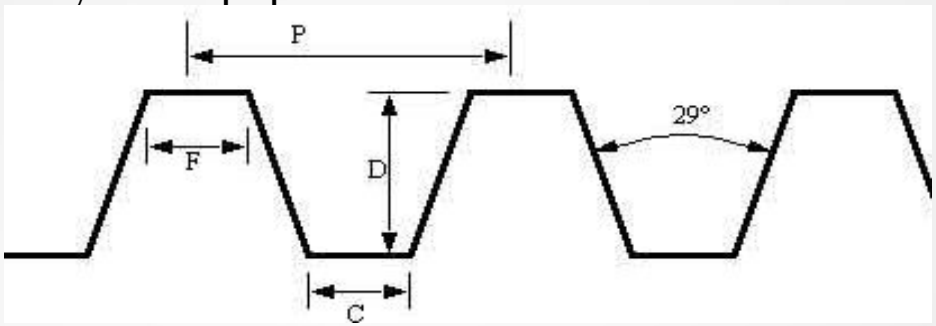
1) V-Thread :- V-thread profiles have an angle between the flanks of the thread. These are commonly used in fasteners like bolts and nuts. The most common V-thread profile is the 60-degree thread profile. Efficiency is low due to high friction.



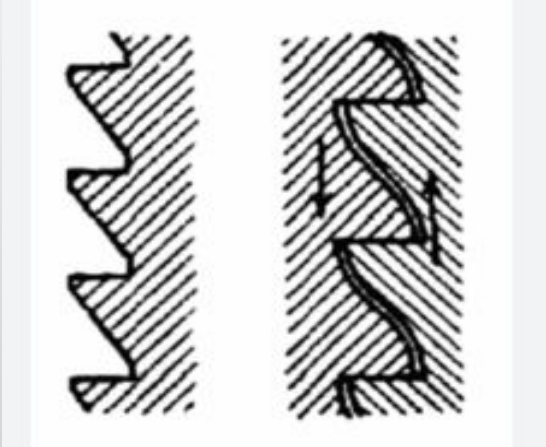
2) Square Thread : - Square thread profiles have a square shape. They offer high efficiency in transmitting power and motion, but they are more difficult to manufacture compared to V-threads. Square threads are often used in applications where heavy loads are involved, such as screw jacks and vises.



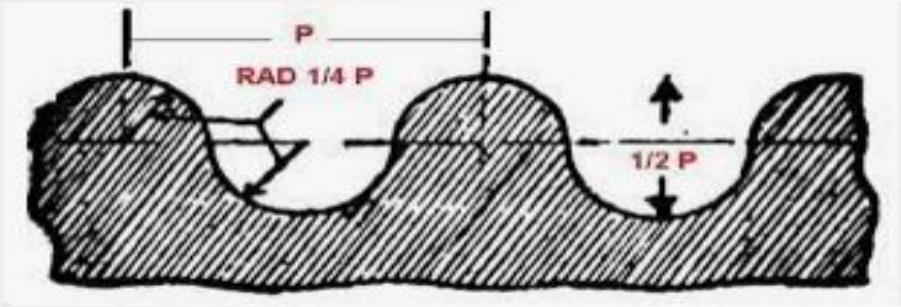
3) <u>Acme Thread</u> :- Acme thread profiles have a trapezoidal shape with flattened peaks and valleys. They are commonly used in applications requiring power transmission and linear motion, such as lead screws in machinery and equipment.



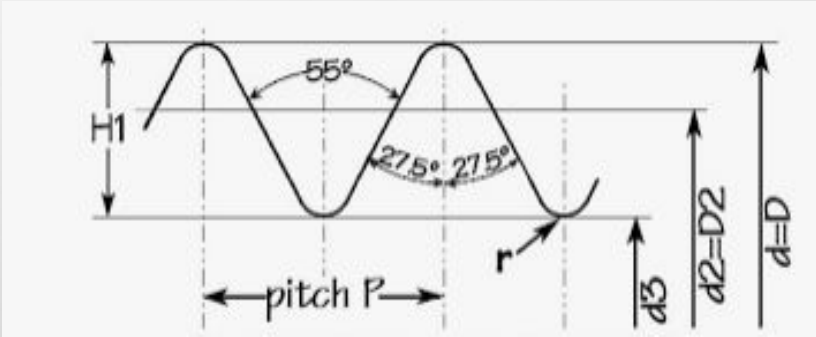
4) <u>Buttress Thread</u> :- Buttress thread profiles have one flank that is almost perpendicular to the axis of the screw and another flank that is inclined. They are designed to withstand heavy axial loads in one direction while allowing for easy assembly and disassembly in the opposite direction. Buttress threads are commonly used in applications like screw jacks and vise mechanisms.



5) <u>Rounded Thread(Knuckle Thread)</u> :- Rounded thread profiles have rounded crests and roots, providing smoother engagement compared to V-threads or square threads. They are used in some specialized applications where smooth operation and reduced wear are essential, such as in certain types of valves and pumps.



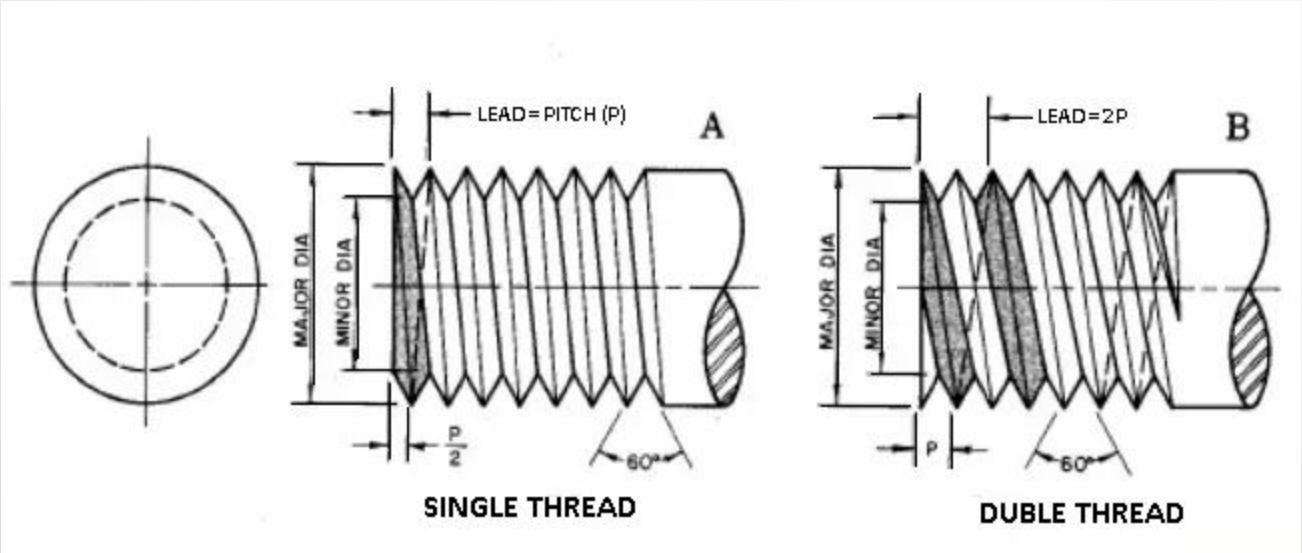
6) <u>Whitworth Thread</u> : - Whitworth thread profiles have a rounded profile with a 55-degree angle between the flanks. They were widely used in British manufacturing but have largely been replaced by metric threads. Whitworth threads are still found in some legacy equipment and applications.



7) Single and Multi-Threads:

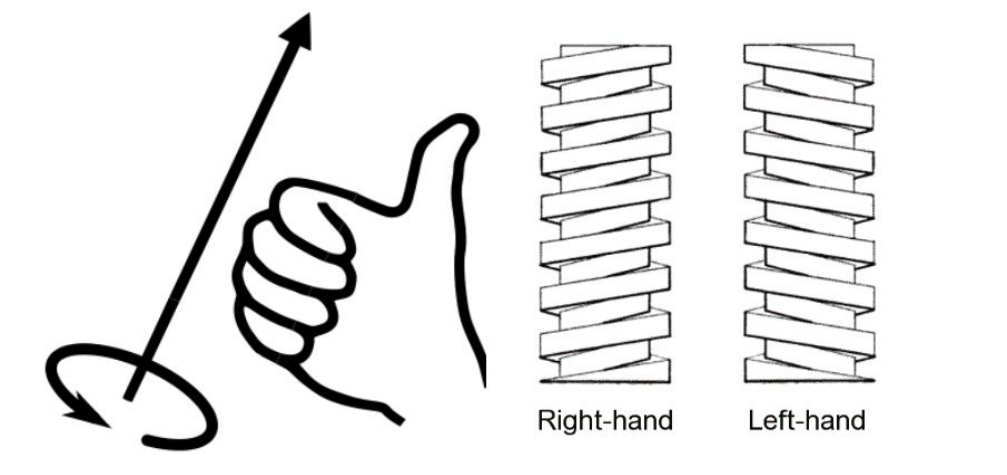
A single-threaded screw means a screw when one completely turns around the bolt or screw. And there is a movement of one thread. It is also known as starts, and we could have a single, two, or three starts.

When there is a moment of more than one thread, it is referred to as a multiple-threaded screw. Multi-start threads can be used when quick motion or movement is necessary.



8) Right-Hand Threads

These threads are leaning to the right-hand side and tightened in a clockwise direction. When viewed from a position on the axis through the center of the helix, it moves away from the observer when turned in a clockwise movement and towards the observer when turned in a counterclockwise movement. This is called a right-hand (RH) thread because it adheres to the right-hand grip rules.

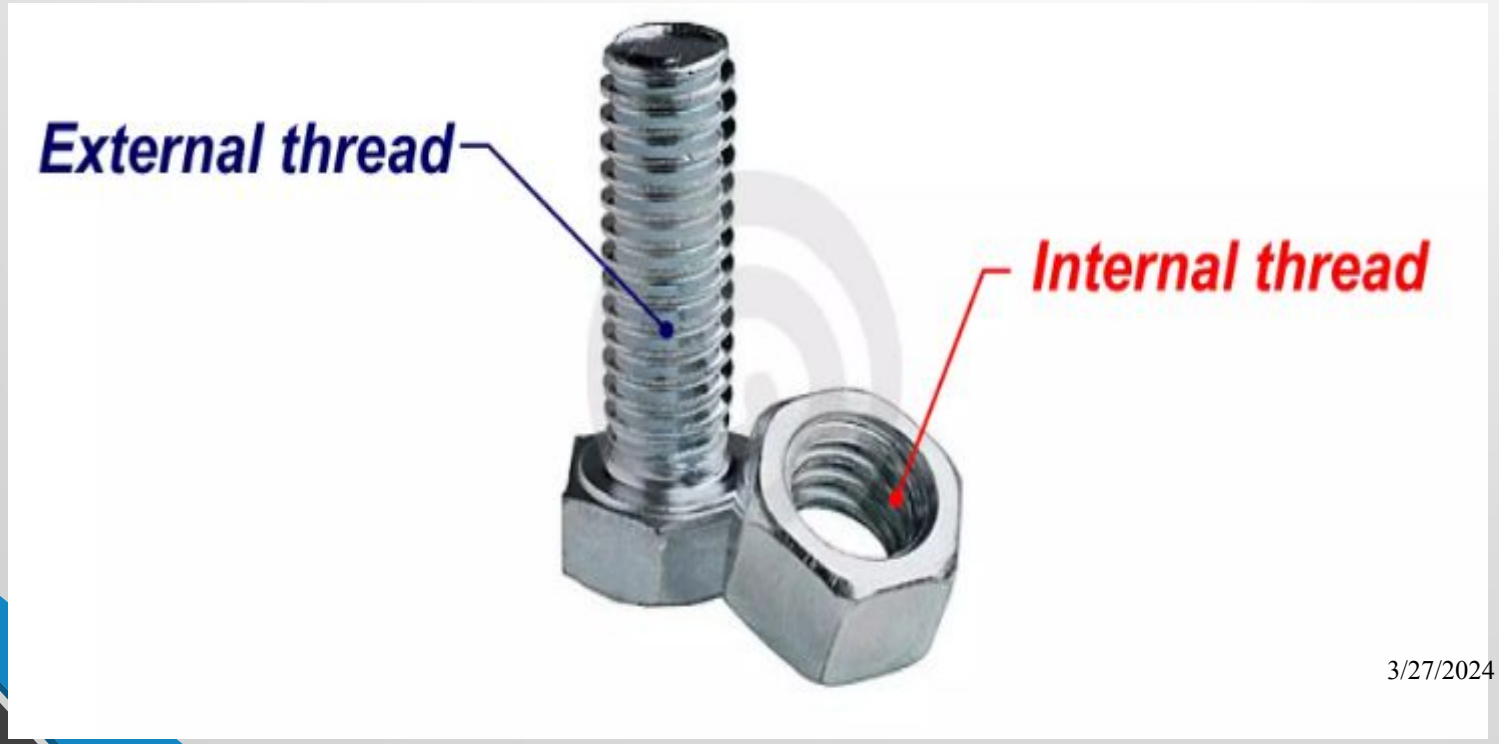


Classification Of Thread on position of threads:

There are many types of threads according to different classification standards. However, the two major types of threads are:-

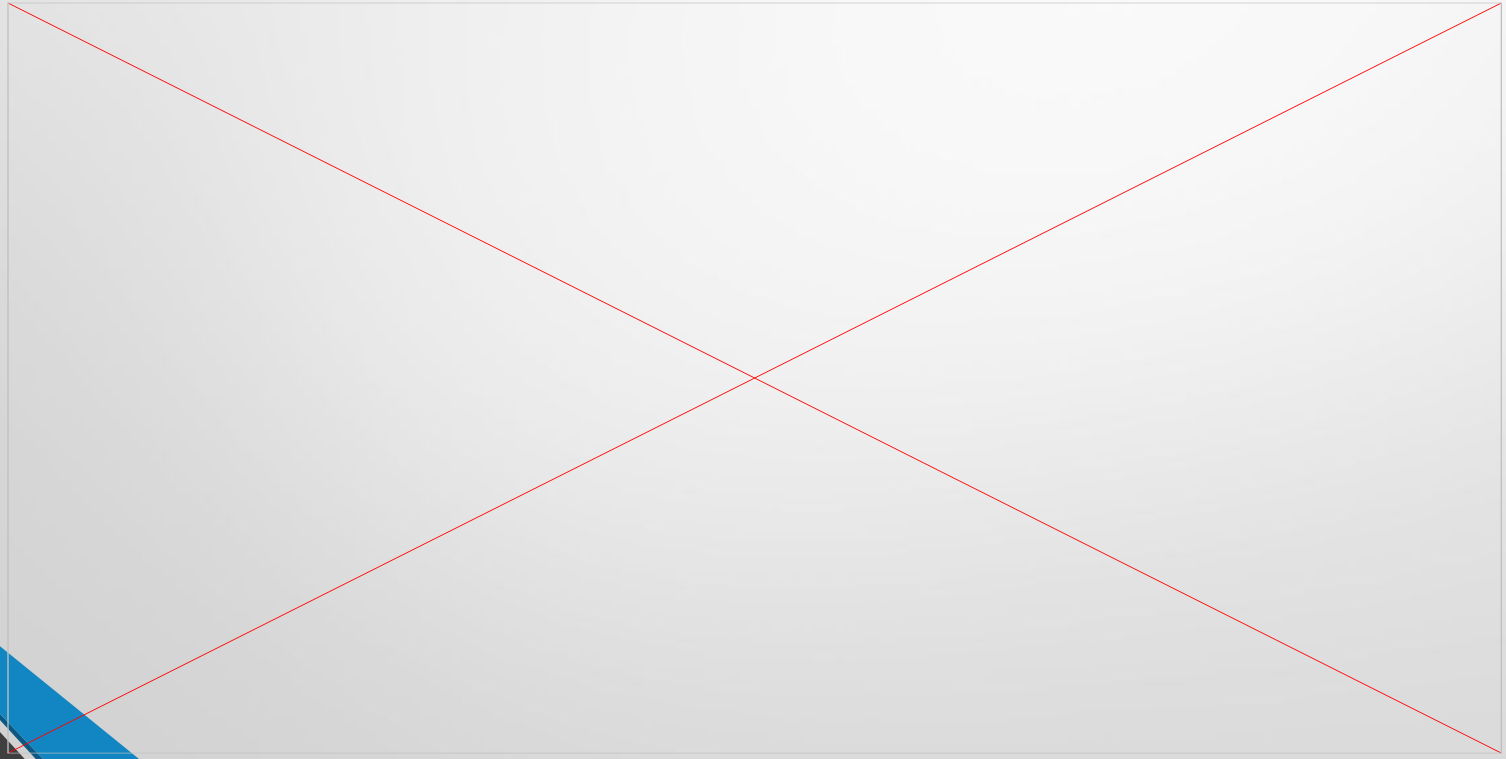
1. **Internal threads**
2. **External threads.**

External Thread	A thread cut on the ***outside*** of cylindrical body.
Internal Thread	A thread cut on the ***Inside*** of cylindrical body.

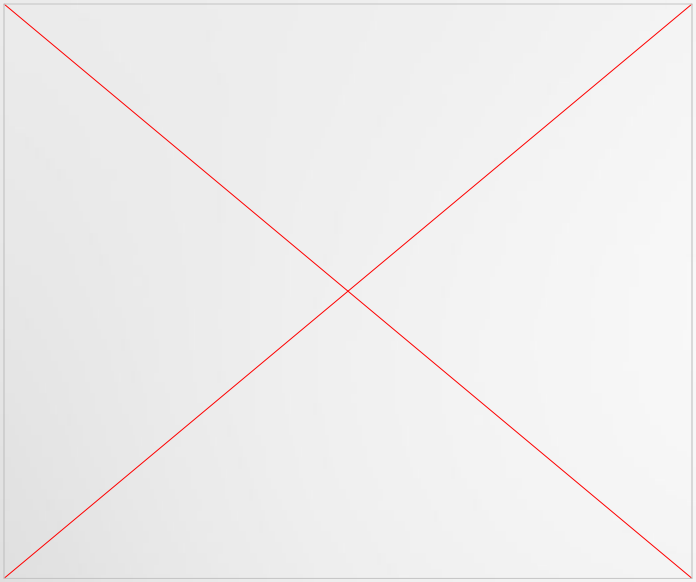


Internal Threads

An internal thread, also known as a female thread, undergoes machining using a single-lip threading tool. Aside from this single-lip tool, a traditional threading cap could also help cut CNC internal threading. It is important to note that cutting internal threads occur only on concave surfaces.



External Threads



Also known as a screw thread, this type of thread finds application in screws, bolts, studs, and plug gages. Using a lathe is one of the most effective ways of making external threads.
Another method is to use a round die to cut the external thread by hand.

Classification of threads based on their shape:

1: Straight Threads (Parallel Threads)

Description: Constant diameter along the length

Common examples:

- Metric threads (M) - Identified by diameter (e.g., M10) or diameter and pitch (e.g., M10 x 1.5)
- Unified National Coarse (UNC) threads - Coarse threads for general applications (e.g., UNC 1/4-20)
- Unified National Fine (UNF) threads - Fine threads for tighter connections (e.g., UNF 1/4-28)

Image: Examples of Metric, UNC, and UNF threads.

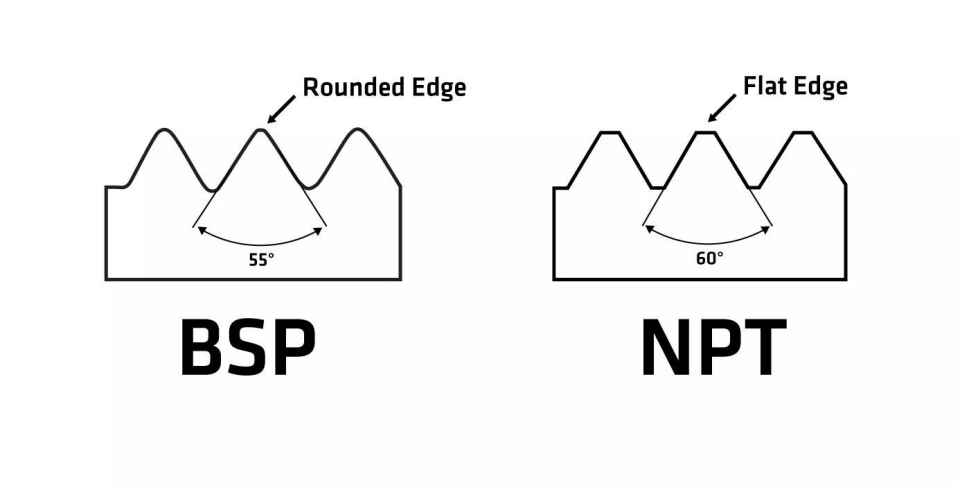
2: Tapered Threads

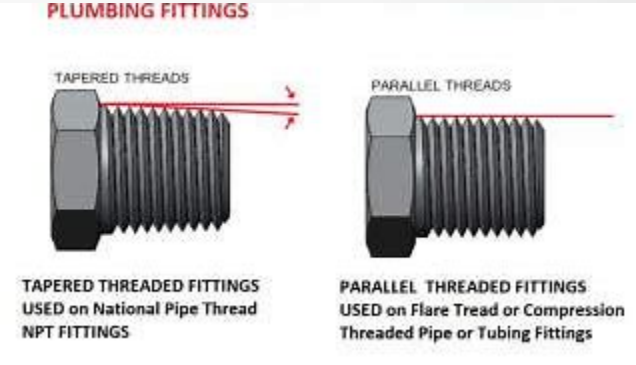
Description: Diameter decreases towards the end, creating a tighter seal

Common examples:

- National Pipe Thread (NPT) - Common in plumbing applications (e.g., NPT 1/2")
- British Standard Pipe Thread (BSPT) - Used in pipe systems (similar to NPT)

Image: Examples of NPT and BSPT threads .





Thread Cutting For hand threading

There are numerous ways in which threads may be cut. In a fabrication shop, threads may be cut using lathe machine, special tread cutting machines or through the use of taps dies.

In this module, we will deal with the process of cutting threads with taps and dies.

There are two main types of hand threading tools: taps and dies.

Taps:

Taps are used to create internal threads in a hole. They are tapered with flutes that remove material as the tap is rotated.

Dies:

Dies are used to create external threads on a rod or pipe. They have a matching thread profile on the inside that cuts the threads as the die is turned over the rod.

Here are some other tools that are commonly used for hand threading:

Tap wrench

A T-shaped wrench that is used to hold and turn taps.

Die stock

A tool that holds and aligns dies.

Thread lubricant

A lubricant that is applied to the tap or die to reduce friction and prevent galling.

Thread file

A small file that can be used to clean up threads or remove burrs.

Threading Taps: Types, Uses and Care:

- Tap is a tool used to cut thread in a hole. e.g., nut
- Internal thread is cut.

Types with uses:-

- **Taper tap:**
are normally used in through hole applications or as a starter tap for blind holes.

- **Intermediate tap, second tap, or plug tap**:
Used after taper tap to get closer to the bottom of hole.

- **Bottoming tap:** cut threads to the bottom of a blind hole.

Thing to be remember:-

Tap wrenches: holding the taps.

Threading Dies: Type, Uses and Care:

- Die is a tool to cut thread around a metal bar. e.g., bolt
- External thread is cut

Types with uses:

- **Solid Die :** It is not adjustable and is often used for repairing same diameter damaged threads by re-cutting them

- **Adjustable die:** They allow for cutting a slightly smaller or bigger size, suit for the non-standard sizes or the screws which used on special parts.

Also the adjustment happens when the dies were worn slightly.

Thread cutting by hand: Cutting External thread and Internal thread

External:

Tools Required for External Thread Include:

- Round Die(s)
- Die Stock
- Round Rod
- File/De Burring Blade
- Vice
- Screwdriver (recommended)

Procedure:

1)File a 45° chamfer to the round rod, which is slightly larger than the thread depth. This will allow a better entry when cutting the thread. It is recommended that the rod is clamped into place throughout this step-by-step process.

2) From then, it is time to cut the external thread. Start by placing the Round Die into the Die Stock and clamping it in place. Optionally, cutting spray could be used to improve the quality and service life of the thread cutting tool.

3) Next, attach the Round Die and Die Stock over the round rod.

4) Turn the thread cutting tool two full 360° From there, do one final third turn motion to break chip. Use cutting spray to help ease the process. The result should look as follows.

Internal:

Tools Required for Internal Thread Include:

- Hand Tap Pack (Set of 3 Hand Taps)
- Adjustable Tap Wrench
- Jobber Twist Drill Bit(s)
- Countersink(s)

Procedure:

1. Firstly, a hole in the applicational surface is required. Due to the size and diameter of the hole, a Jobber Twist Drill is required. As with the external thread, using cutting spray throughout this process will enhance the service life and surface quality of the hole drilling process.

2. Secondly, the hole will now require a countersinking process to allow better entry for cutting the thread.
3. Now begins the process of the internal thread cut. Clamp the Hand Tap into the wrench.

4. Turn the thread cutting tool two full 360° From there, do one final third turn motion to break chip. Use cutting spray to help ease the process. The result should look as follows.

5. Replace the tap with the second tap and repeat the turning process (step 4) again.

6. Now replace the second tap with the third and final tap and repeat the turning process (step 4) again.

7. The result should enable a smooth screw hole within the surface application to allow a screw to fit in place.

Visual demonstration for cutting of external and internal threads:

FAQ

Is thread milling faster than tapping?

- Tapping is generally quicker than thread milling. However, thread milling machines sometimes feature additional edges to compensate for the reduced speed.

What is the difference between a thread mill and a tap?

⇒ The major difference between thread milling and tapping is the smoothness of the cut. Thread milling creates smoother and more even cuts, while cuts made by tapping are rough and jagged.

What is the threading operation in the lathe?

- It is a process used to create a helical ridge with a uniform cross-section on the workpiece. It involves using a threading tool bit to make cuts on the workpiece successively. It is important to note that the tool bit used for this operation should be the same shape as the thread needed.

Application of Threads

- **Fastening**: Threads are extensively used for fastening components together. Nuts, bolts, screws, and studs with threaded profiles are utilized to securely join parts in machinery, equipment, structures, and consumer products.

- **Assembly and Disassembly**: Threaded fasteners facilitate the assembly and disassembly of components during manufacturing, installation, repair, and maintenance tasks. They allow for easy and efficient joining and separation of parts without the need for welding or adhesives.

- **Adjustment and Positioning**: Threads provide a means for precise adjustment and positioning of components. Threaded rods, screws, and nuts are employed in mechanisms like jacks, clamps, and screw-driven actuators to move parts to desired position or apply controlled pressure.

Threaded Tools and Fixtures: Workshop tools and fixtures, such as taps, dies, thread gauges, and thread-cutting machines, are employed to create, repair, and inspect threads with precision. These tools ensure the accurate sizing, shaping, and quality of threaded components.

- **Threaded Inserts**: Threaded inserts are embedded into materials like metal, plastic, or wood to provide durable and secure threads for fastening purposes. They reinforce weakened or stripped threads and enable the use of standard fasteners in diverse materials.

- **Power Transmission** : Threaded components are utilized in power transmission systems to convert rotary motion into linear motion or vice versa. Lead screws, ball screws, and worm gears with threaded profiles are employed in machinery and equipment for precise positioning and motion control.

References

1. Thread – From Wikipedia

2.13 DIFFERENT TYPES OF THREADS [COMPLETE GUIDE] WITH IMAGES – From The Engineers Post

3.Thread ID Made Easy. Learn All About Different Types of Threads – From The Hope Group

4.Thread Basics: The key geometric parameters Of The Thread – From Fidelity Tools

Thank you!!!