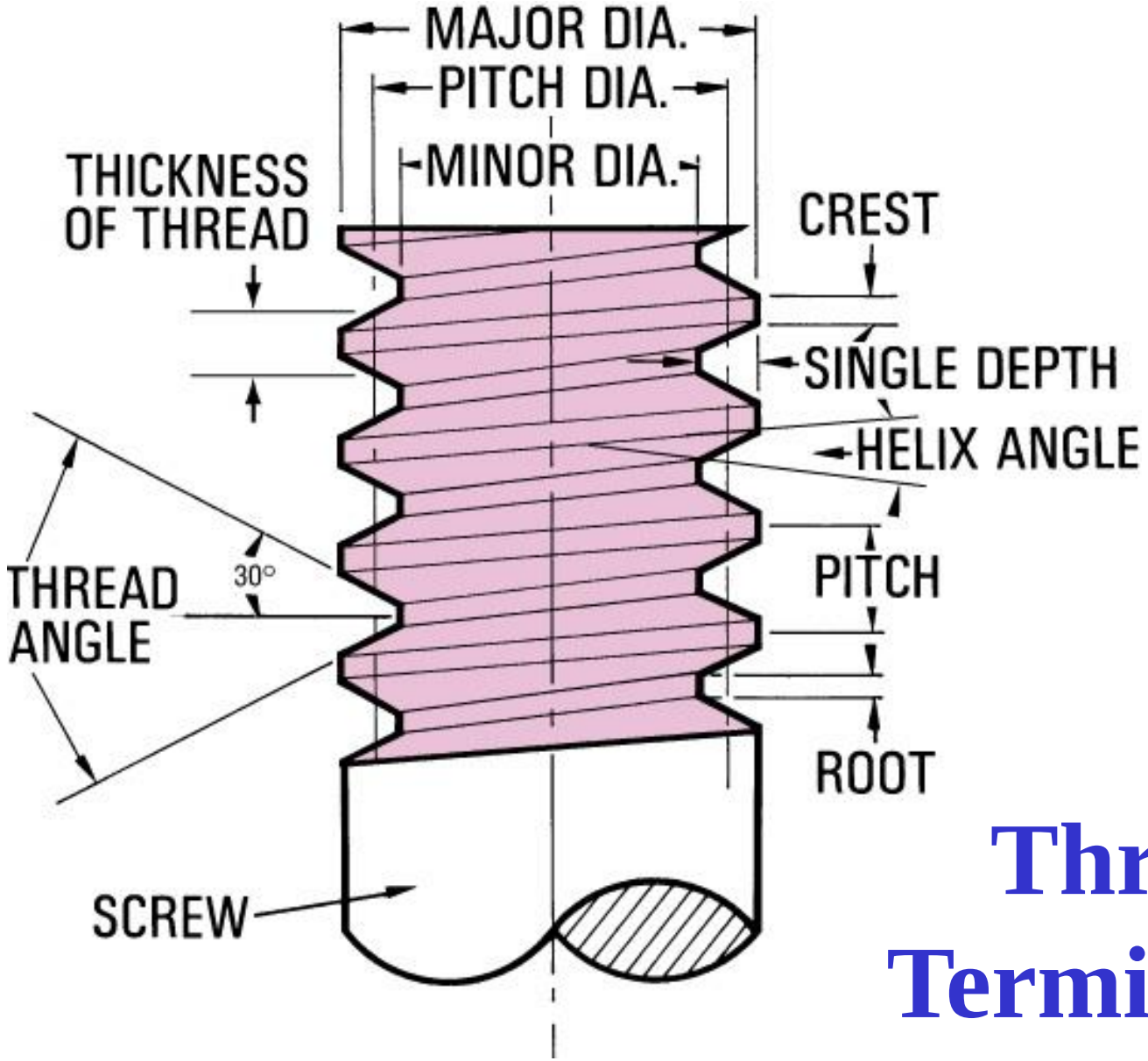
Threads

- Used for hundreds of years for holding parts together, making adjustments, and transmitting power and motion
- Art of producing threads continually improved
- Massed-produced by taps, dies, thread rolling, thread milling, and grinding

Threads

- Thread
  - Helical ridge of uniform section formed on inside or outside of cylinder or cone
- Used for several purposes:
  - Fasten devices such as screws, bolts, studs, and nuts
  - Provide accurate measurement, as in micrometer
  - Transmit motion
  - Increase force



Thread Terminology

Thread Terminology

- Screw thread
  - Helical ridge of uniform section formed on inside or outside of cylinder or cone
- External thread
  - Cut on external surface or cone
- Internal thread
  - Produced on inside of cylinder or cone

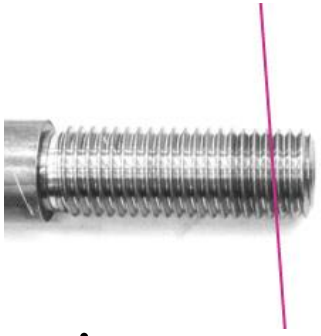
- Major diameter
  - Largest diameter of external or internal thread
- Minor diameter
  - Smallest diameter of external or internal thread
- Pitch diameter
  - Diameter of imaginary cylinder that passes through thread at point where groove and thread widths are equal
  - Equal to major diameter minus single depth of thread
  - Tolerance and allowances given at pitch diameter line

- Number of threads per inch
  - Number of crests or roots per inch of threaded section (Does not apply to metric threads)
- Pitch
  - Distance from point on one thread to corresponding point on next thread, measured parallel to axis
  - Expressed in millimeters for metric threads
- Lead
  - Distance screw thread advances axially in one revolution (single-start thread, lead = pitch)

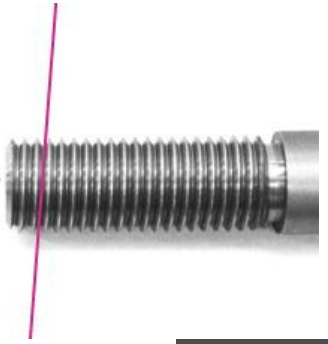
- Root
  - Bottom surface joining sides of two adjacent threads
  - External thread on minor diameter
  - Internal thread on major diameter
- Crest
  - Top surface joining two sides of thread
  - External thread on major diameter
  - Internal thread on minor diameter
- Flank
  - Thread surface that connects crest with root

- Depth of thread
  - Distance between crest and root measured perpendicular to axis
- Angle of thread
  - Included angle between sides of thread measured in axial plane
- Helix angle
  - Angle that thread makes with plane perpendicular to thread axis

- Right-hand thread
  - Helical ridge of uniform cross section onto which nut is threaded in clockwise direction
  - When cut on lathe, toolbit advanced from right to left



- Left-hand thread
  - Helical ridge of uniform cross section onto which nut is threaded in counterclockwise direction
  - When cut on lathe, toolbit advanced from left to right



Thread Forms

- April, 1975 ISO came to an agreement covering standard metric thread profile
  - Specifies sizes and pitches for various threads in new ISO Metric Thread Standard
  - Has 25 thread sizes, range in diameter from 1.6 to 100 mm
  - Identified by letter M, nominal diameter, and pitch **M 5 X 0.8**

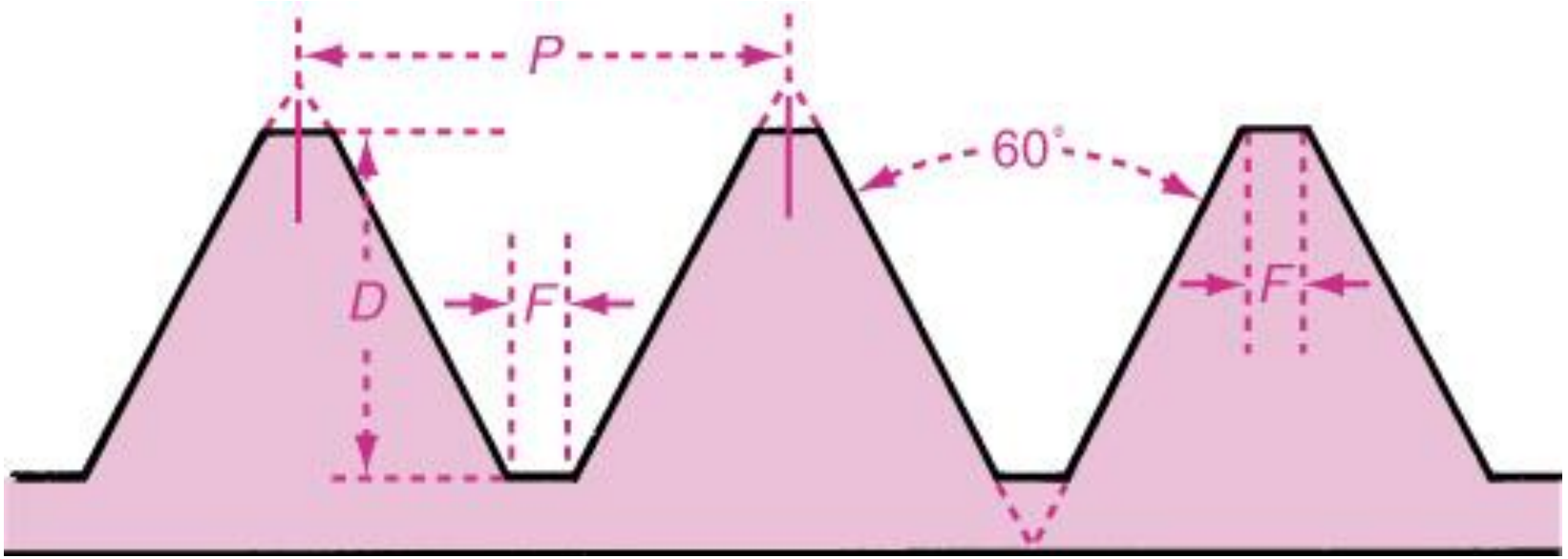
American National Standard Thread

- Divided into four main series, all having same shape and proportions
  - National Coarse (NC)
  - National Fine (NF)
  - National Special (NS)
  - National Pipe (NPT)
- Has 60º angle with root and crest truncated to 1/8th the pitch
- Used in fabrication, machine construction

American National Standard Thread

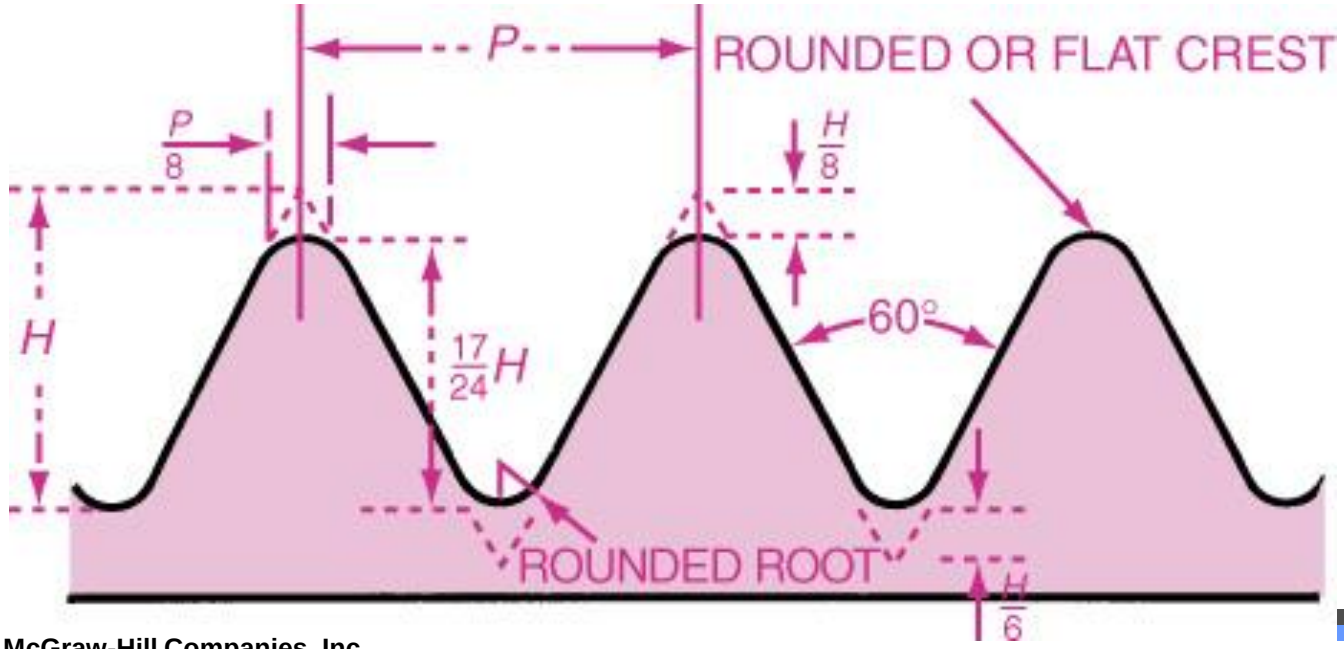
$$D = .6134 \text{ x } P \text{ or } \frac{.6134}{N}$$

$$F = .125 \text{ x } P \text{ or } \frac{.125}{N}$$



Unified Thread

- Developed by U.S., Britain, and Canada for standardized thread system
- Combination of British Standard Whitworth and American National Standard Thread

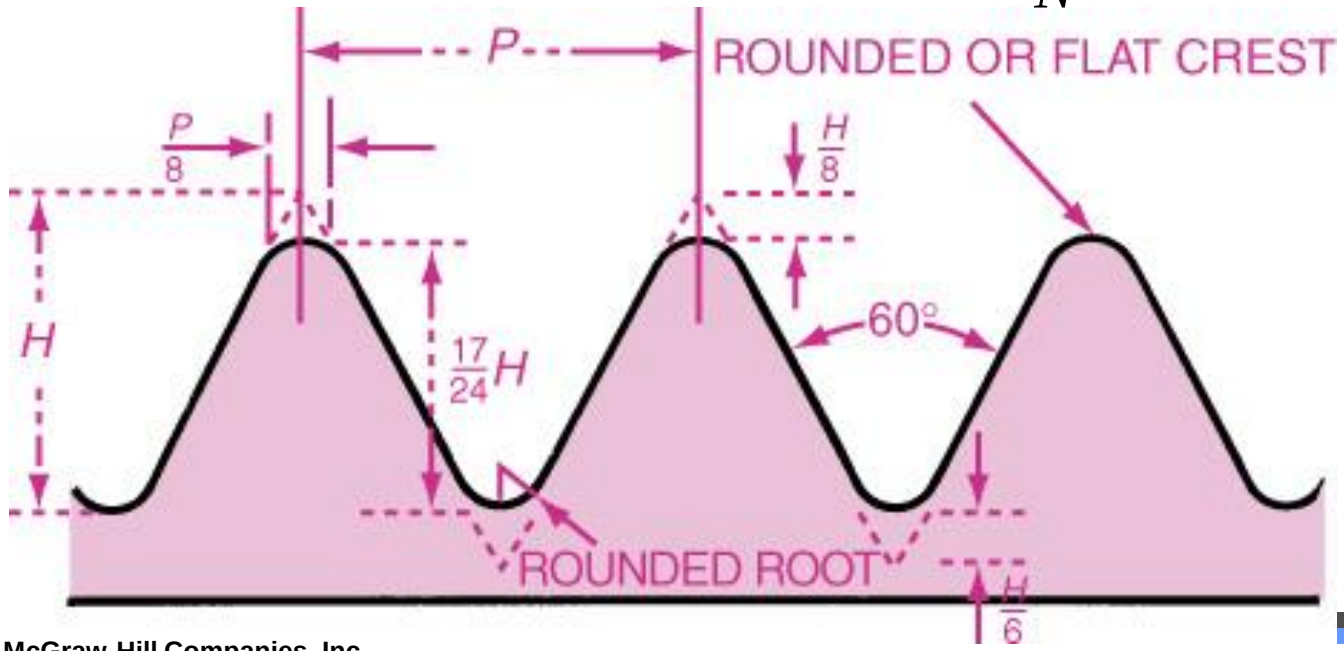


$$D\,(\text{external thread}) = .6134 \text{ x } P \text{ or } \frac{.6134}{N}$$

$$D\,(\text{internal thread}) = .5413 \text{ x } P \text{ or } \frac{.5413}{N}$$

$$F\,(\text{external thread}) = .125 \text{ x } P \text{ or } \frac{.125}{N}$$

$$F\,(\text{internal thread}) = .250 \text{ x } P \text{ or } \frac{.250}{N}$$



American National Acme Thread

- Replacing square thread in many cases
- Used for feed screws, jacks, and vises

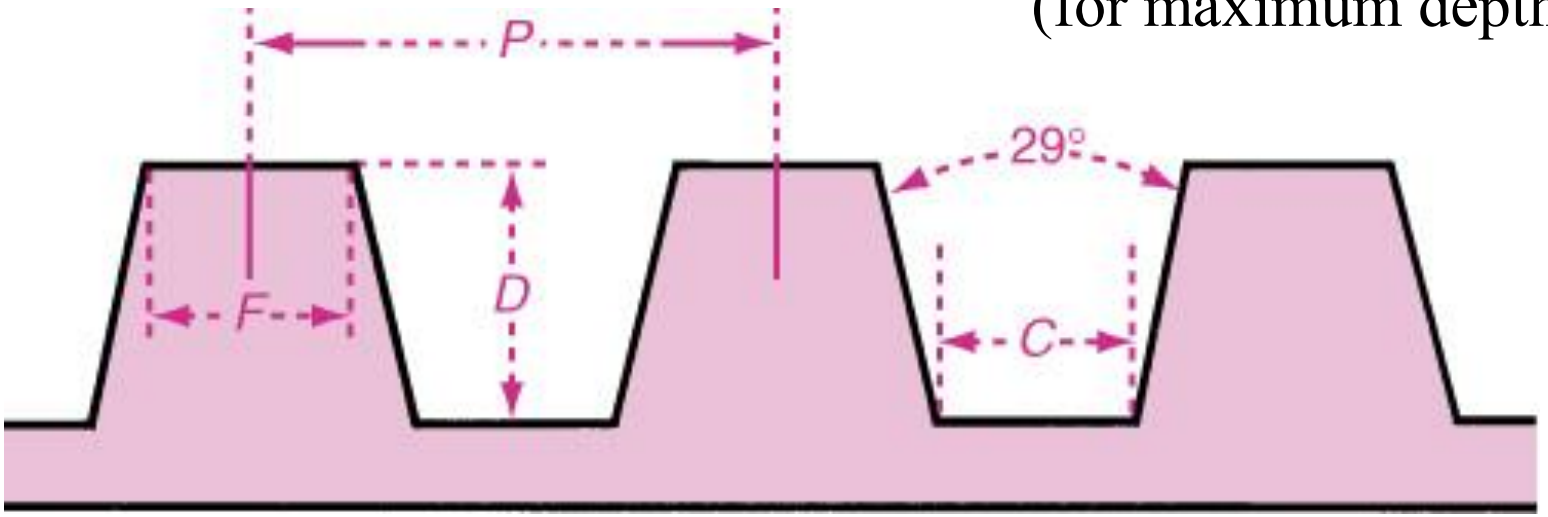
D = minimum $.500P$

= maximum $.500P + 0.010$

$F = .3707P$

$C = .3707P - .0052$

(for maximum depth)



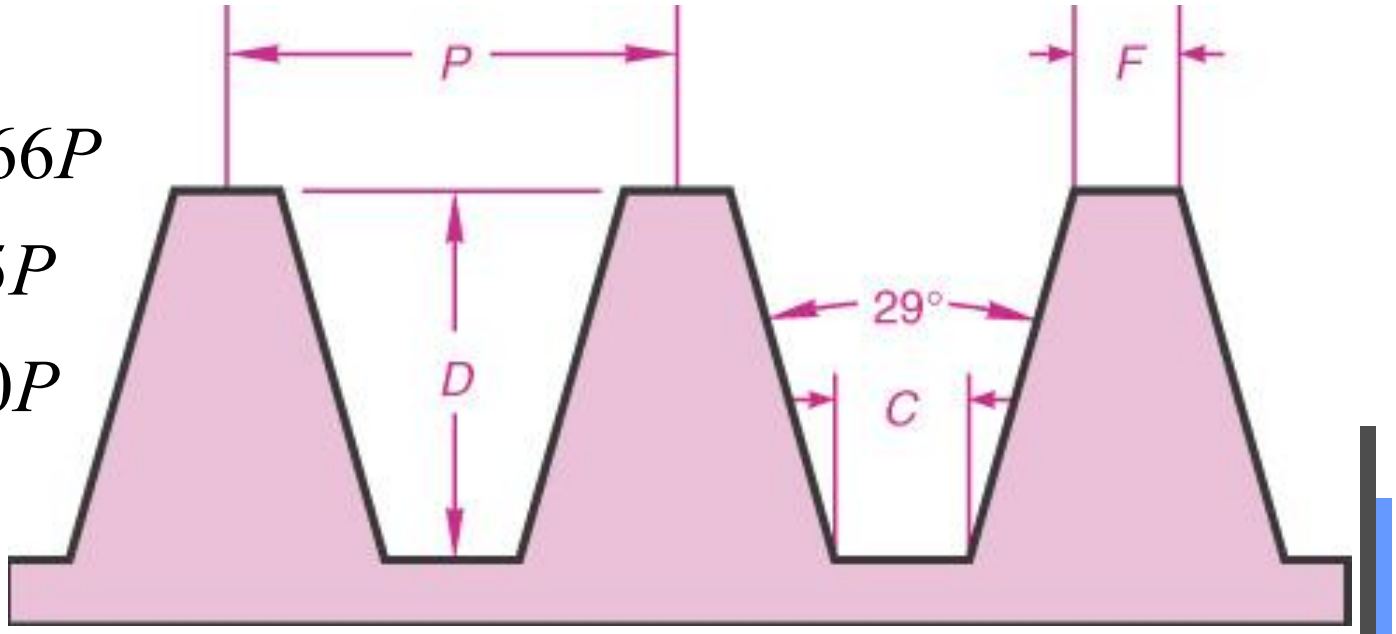
Brown & Sharpe Worm Thread

- Used to mesh worm gears and transmit motion between two shafts at right angles to each other but not in same plane

$D = .6866P$

$F = .335P$

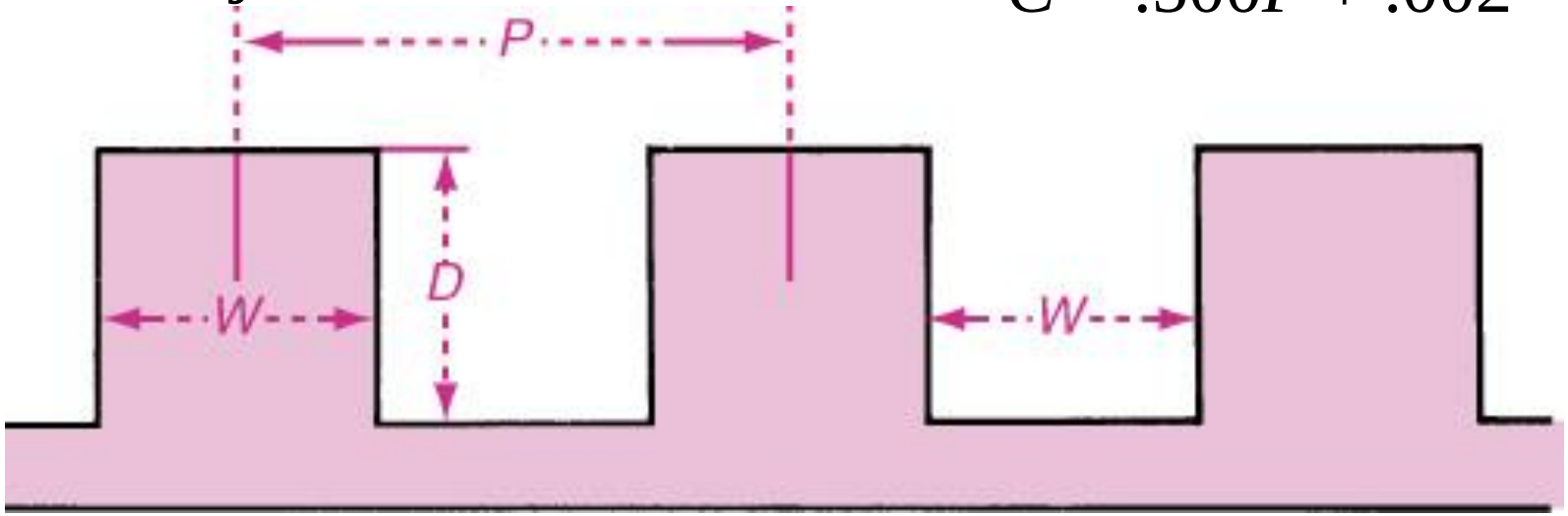
$C = .310P$



Square Thread

- Being replaced by Acme thread because of difficulty in cutting it
- Often found on vises and jack screws

$$D = .500P$$
$$F = .500P$$
$$C = .500P + .002$$



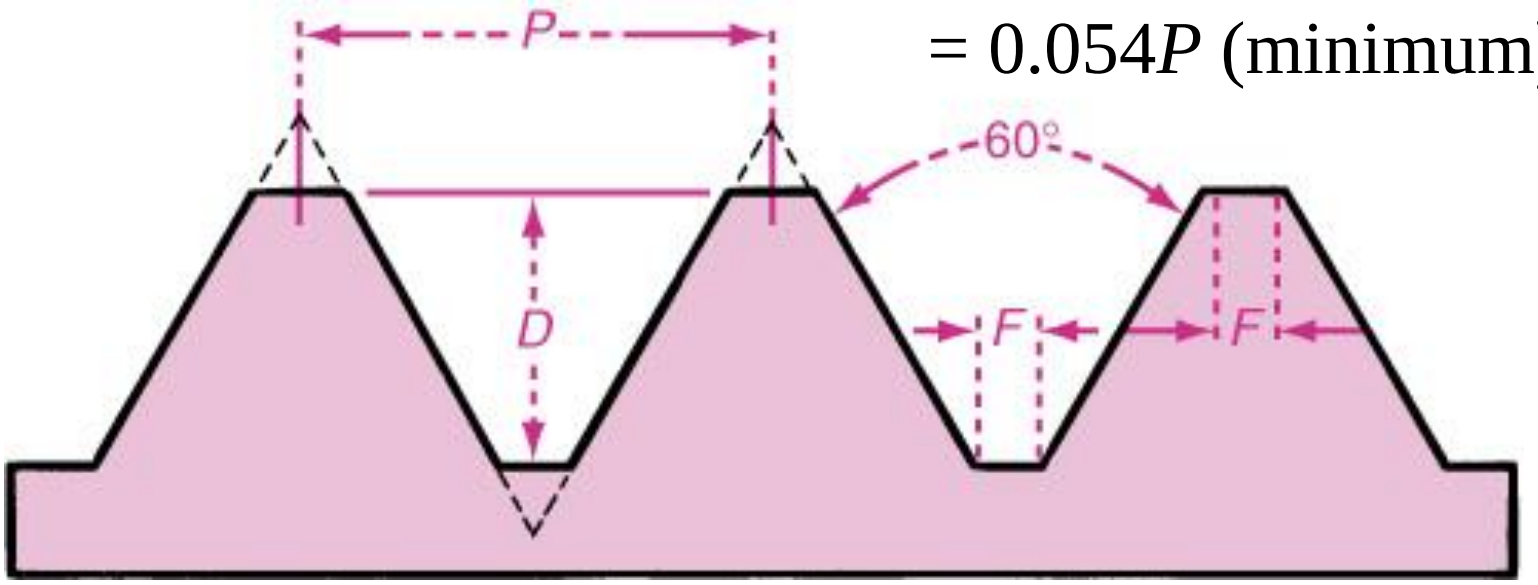
International Metric thread

- Standardized thread used in Europe

$D = 0.7035P$ (maximum) $= 0.6855P$ (minimum)

$F = 0.125P$

$R = 0.0633P$ (maximum) $= 0.054P$ (minimum)



Thread Fits and Classifications

- Fit
  - Relationship between two mating parts
  - Determined by amount of clearance or interference when they are assembled
- Nominal size
  - Designation used to identify size of part
- Actual size
  - Measured size of thread or part
  - Basic size: size from which tolerances are set

Allowance

- Permissible difference between largest external thread and smallest internal thread
- Difference produces tightest fit acceptable for any given classification

The allowance for a 1 in.—8 UNC Class 2A and 2B fit is:

Minimum pitch diameter of the internal thread (2B)	= .9188 in.
Maximum pitch diameter of the external thread (2A)	= .9168 in.
Allowance	= .002 in.

Tolerance

- Variation permitted in part size
- May be expressed as plus, minus, or both
- Total tolerance is sum of plus and minus tolerances
- In Unified and National systems, tolerance is plus on external threads and minus on internal threads

The tolerance for a 1 in.—8 UNC Class 2A thread is:

Maximum pitch diameter of the external thread (2A)	= .9168 in.
Minimum pitch diameter of the external thread (2A)	= .9100 in.
Tolerance	= .0068 in.

Limits

- Maximum and minimum dimensions of part

The limits for a 1 in.—8 UNC Class 2A thread are:

Maximum pitch diameter of the external thread (2A) = .9168 in..
Minimum pitch diameter of the external thread (2A) = .9100 in.

Three Categories of Unified Thread Fits

- External threads classified as 1A, 2A, and 3A and internal threads as 1B, 2B, 3B
- Classes 1A and 1B
  - Threads for work that must be assembled
  - Loosest fit
- Classes 2A and 2B
  - Used for most commercial fasteners
  - Medium or free fit
- Classes 3A and 3B
  - Used where more accurate fit and lead required
  - No allowance provided

Thread Calculations: Example 1

To cut a correct thread on a lathe, it is necessary first to make calculations so thread will have the proper dimensions.

Calculate pitch, depth, minor diameter, and width of flat for a ¾—10 UNC thread.

D = single depth of thread

P = pitch

$$P = \frac{1}{tpi} = \frac{1}{10} = .100 \text{ in.}$$

$$D = .61343 \text{ x } P$$

$$= .61343 \text{ x } .100 = .061 \text{ in.}$$

$$\text{Minor dia} = \text{Major dia} - (D + D)$$

$$= .75 - (.061 + .061)$$

$$= .628 \text{ in.}$$

$$\text{Width of flat} = \frac{P}{8} = \frac{1}{8} \text{ x } \frac{1}{10}$$

$$= .0125 \text{ in.}$$

Thread Calculations: Example 2

What are the pitch, depth, minor diameter, width of crest and width of root for an M 6.3 X 1 thread?

P = pitch = 1 mm

D = 0.54127 x 1

= 0.54 mm

$$\text{Minor dia} = \text{Major dia} - (D + D)$$

$$= 6.3 - (.54 + .54)$$

$$= 5.22 \text{ mm}$$

$$\text{Width of root} = 0.25 \text{ x } P$$

$$= 0.25 \text{ x } 1$$

$$= 0.25 \text{ mm}$$

$$\text{Width of crest} = 0.125 \text{ x } P$$

$$= 0.125 \text{ x } 1$$

$$= 0.125 \text{ mm}$$

When tool is fed in at 29º, most of the cutting is done by the leading edge of toolbit.

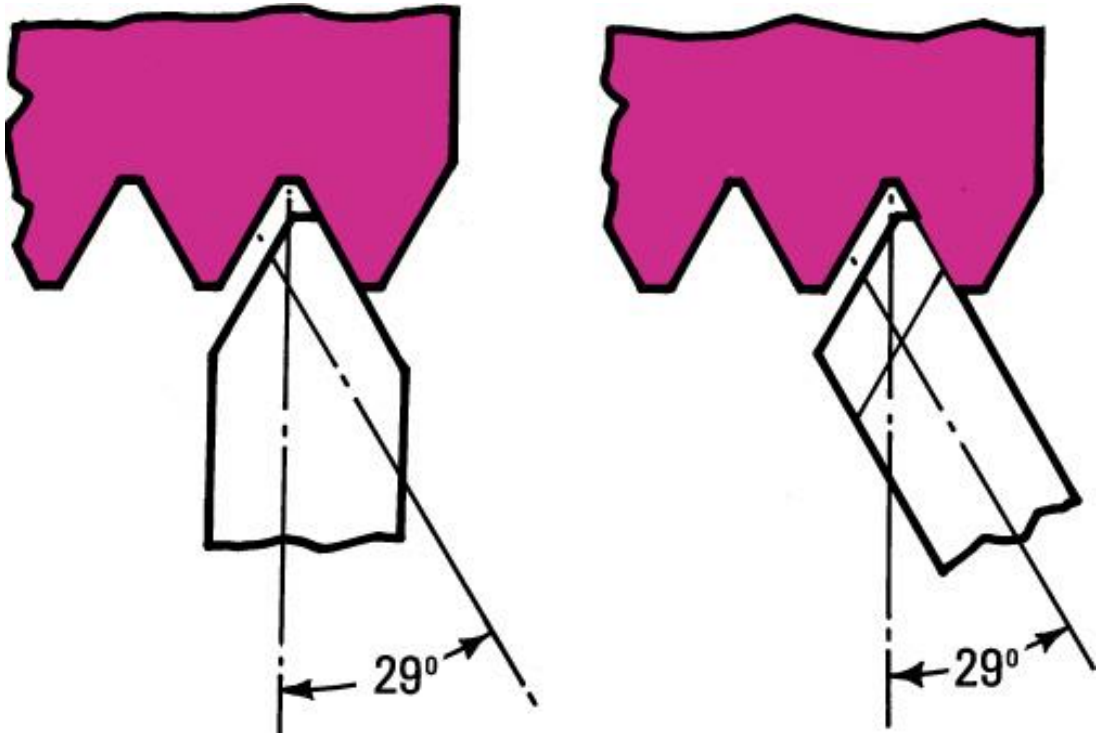


Table 55.2 Depth settings for cutting 60° national form threads*

	Compound Rest Setting		
tpi	**0°**	**30°**	**29°**
24	.027	.031	.0308
20	.0325	.0375	.037
18	.036	.0417	.041
16	.0405	.0468	.046
14	.0465	.0537	.0525
13			
11			

Portion of table taken from textbook

Six Ways to Check Threads

- Depends on accuracy required:
  1. Master nut or screw
  2. Thread micrometer
  3. Three wires
  4. Thread roll or snap gage
  5. Thread ring or plug gage
  6. Optical comparator