Al-Mustansiriyah University
College of Engineering
Mechanical Engineering Dept.
Class : 2\textsuperscript{nd}

**Mechanical Drawing**

Lect. Saad Najeeb Shehab
Auxiliary Views:

1. Inclined Surface:

Fig. (1)

Fig. (2)

Fig. (3)

Fig. (4)
II. Skew Surface:

Fig. (14)

Fig. (15)
Fig. (16) 

Fig. (17)
Tolerance and Fit:

I. Tolerance:

Hole tolerance zone

Ref. line

Shaft tolerance zone

Tol. = max. diam. - min. diam.
Max. diam. = nominal size + upper allowance
Min. diam. = nominal size + lower allowance
II. Fit:

Fit

- interference fit
- transition fit
- clearance fit

### Fit Types

<table>
<thead>
<tr>
<th>Fit Type</th>
<th>Maximum Clearance</th>
<th>Minimum Clearance</th>
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<tbody>
<tr>
<td>Interference fit</td>
<td>Max. interference</td>
<td>Min. interference</td>
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<tr>
<td>Transition fit</td>
<td>Max. clearance</td>
<td>Min. clearance</td>
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<tr>
<td>Clearance fit</td>
<td>Max. clearance</td>
<td>Min. clearance</td>
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</table>

- Clearance fit:
  Max. clearance = max. diam. of hole – min. diam. of shaft
  Min. clearance = min. diam. of hole – max. diam. of shaft

- Transition fit:
  Max. clearance = max. diam. of hole – min. diam. of shaft
  Max. interference = min. diam. of hole – max. diam. of shaft

- Interference fit:
  Max. interference = min. diam. of hole – max. diam. of shaft
  Min. interference = max. diam. of hole – min. diam. of shaft
### Selection of Fits - Hole Basis System

#### Clearance

<table>
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<tr>
<th>BASIC SIZE</th>
<th>H11</th>
<th>H10</th>
<th>H9</th>
<th>H8</th>
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The chart is to scale only for 20 mm basic size.
### Table (1) Tolerances of Holes

<table>
<thead>
<tr>
<th>ISO - TOLERANCE ZONE FOR HOLE</th>
<th>VALUES OF DEVIATIONS IN MICRONS (t = 0.001 mm)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>- 3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>&gt; 6</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>&gt; 18</td>
<td>30</td>
</tr>
<tr>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>120</td>
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<tr>
<td>&gt; 120</td>
<td>240</td>
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### Table (2) Tolerances of Shafts

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<th>VALUES OF DEVIATIONS IN MICRONS (t = 0.001 mm)</th>
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<td>6</td>
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<tr>
<td>&gt; 6</td>
<td>10</td>
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<tr>
<td>10</td>
<td>18</td>
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<tr>
<td>&gt; 18</td>
<td>30</td>
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<td>30</td>
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<td>&gt; 60</td>
<td>120</td>
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<tr>
<td>&gt; 120</td>
<td>240</td>
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12
Screw and Nuts:

Screw-Thread Nomenclature

Screw-Thread Forms
Standard Types of Bolt and Screw Heads:

a. Square Head

b. Hexagon Head

c. Fillister Head
d. Round Head
e. Flat Head
Machine Screws:

The preferred diameters and minimum lengths for machine screws are:

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<tr>
<th>DIAMETER</th>
<th>M1.6</th>
<th>M2</th>
<th>M2.5</th>
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<th>M4</th>
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<th>M8</th>
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Set Screws:

End of Set Screws:
- flat point
- cone point
- oval point
- full dog point
- half dog point
Bolts, Cap Screw, and Studs :-

a. Bolt  
b. Cap Screw  
c. Stud

Drilled and Tapped Holes :-
- Cap Screw :

(i)  
(ii)  
(iii)  
(iv)
Bolt:

\[ L_o = 2d \text{ to } 2.8d \]
\[ K = 3d \]
\[ d_o = 1.1d \]
\[ d_w = 2.2 \, d \]
\[ S = 0.15d \]
\[ C = 0.1d \]
Stud :-

$L_1 = 1.25d$
$L_2 = L_1 + 0.5d$
$K = 3d$
$d_0 = 1.1d$
$d_w = 2.2d$
$S = 0.15d$
**Keys :-**

Types of Keys :-

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<tr>
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<th>Square section</th>
<th>Rectangle section</th>
<th>Prismatic Key</th>
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<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
<td>a. Prismatic Key</td>
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<td>W = d/4</td>
<td>H = d/6</td>
<td>R = d/8</td>
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<td>d = Shaft diameter</td>
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<td>H = d/6</td>
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<td>---</td>
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<tr>
<td>W</td>
<td>A - B = d/4 T = d/6</td>
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Pins and Cotters :-
Types of Pins :-

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<td>b. Taper Pin</td>
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<td><img src="image" alt="Slot Pin" /></td>
<td>c. Slot Pin</td>
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<td><img src="image" alt="Joint Pin" /></td>
<td>d. Joint Pin</td>
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<td><img src="image" alt="Split Pin" /></td>
<td>e. Split Pin</td>
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Cotters :-

![Cotter Diagram](image)
Springs:

- Flat springs
  - Leaf spring
  - Power spring
  - Dish spring

- Helical springs
  - Compression spring
  - Tension spring
  - Torsion spring

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<td>Rectangular section</td>
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<table>
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<td><strong>Section</strong></td>
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<td><img src="image" alt="Torsion section" /></td>
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</table>
Compression Springs :-

\[ L_0 = n \times p + d \]
\[ n = n_1 - 2 \]
\[ L = \pi \times n, \ D_m \]
\[ D_m = D_o - d \]

**Where :-**
- \( L_0 \) = free length of spring.
- \( n \) = No. of active coils of spring.
- \( p \) = pitch.
- \( d \) = wire diam.
- \( n_1 \) = No. of total coils of spring.
- \( L \) = Length of wire spring.
- \( D_m \) = mean diam. of spring.
- \( D_o \) = outside diam. of spring.
Rivets and Rivet Joints:

Rivet Types:
Rivet Joints:

i. Lap Joint:

\[ d = 1.2 \sqrt{t} \rightarrow 1.4 \sqrt{t} \]

(a) Single Riveted  (b) Double Riveted

ii. Butt Joint:

(a) Single Riveted  (b) Double Riveted

(\[ Z \rightarrow Z_{\text{min}} \])
Welding and Welding Joints:

Types of Welding Joints:

Symbols of Arc and Gas Welding:

SUPPLEMENTARY SYMBOLS

Supplementary Symbols
Applications:

Vertical side always on left:

(a) (b) (c) (d) (e) Arrowside and Other Side.
Spot, Seam, and Flash Weld Symbols.

(a) Spot
(b) Seam
(c) Flash

Intermittent Welds.

Groove Welds.
# Gears

<table>
<thead>
<tr>
<th>Cylindrical Gear</th>
<th>Bevel Gear</th>
<th>Worm &amp; Worm Gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>- spur gear</td>
<td>- Straight bevel gear</td>
<td></td>
</tr>
<tr>
<td>- Helical gear</td>
<td>- Spiral bevel gear</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Rack &amp; Pinion Gear</td>
</tr>
</tbody>
</table>

An Assortment of Gears

(a) Cylindrical Gear  
(b) Bevel Gear  
(c) Worm & Worm Gear  
(d) Rack & Pinion Gear
1. Spur Gear:

- Tip diam.
- Pitch diam.
- Root diam.
- Face width
The Basic Relationships for Spur Gear:

<table>
<thead>
<tr>
<th>Formula</th>
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<tbody>
<tr>
<td>( M = \frac{P}{\pi} = \frac{d_p}{Z} )</td>
<td>Modul = Pitch Diameter / Number of Teeth</td>
</tr>
<tr>
<td>( A = \frac{d_T - d_p}{2} = 0.3138 \times P )</td>
<td>Addendum = Tip Diameter - Pitch Diameter / 2</td>
</tr>
<tr>
<td>( D = \frac{d_p - d_R}{2} = 0.3683 \times P )</td>
<td>Dedendum = Pitch Diameter - Root Diameter / 2</td>
</tr>
<tr>
<td>( X = \frac{d_{p1} + d_{p2}}{2} )</td>
<td>Thickness of Tooth</td>
</tr>
<tr>
<td>( P = \pi \times \frac{d_p}{Z} )</td>
<td>Pitch = Modul \times \frac{Pitch Diameter}{Number of Teeth}</td>
</tr>
<tr>
<td>( c = \frac{P}{20} )</td>
<td>Clearance = Pitch / 20</td>
</tr>
<tr>
<td>( h = A + D + c )</td>
<td>Whole Depth of Tooth</td>
</tr>
<tr>
<td>( t = \frac{P}{2} )</td>
<td>Mean Thickness of Tooth</td>
</tr>
<tr>
<td>( W = (L - 10) \times M )</td>
<td>Face Width</td>
</tr>
<tr>
<td>( r = \frac{1}{6} \times M )</td>
<td>Fillet Radius</td>
</tr>
</tbody>
</table>

Where:

- \( M \) = Modul
- \( d_p \) = Pitch Diameter
- \( Z \) = Number of Teeth
- \( A \) = Addendum
- \( D \) = Dedendum
- \( d_R \) = Root Diameter
- \( d_T \) = Tip Diameter
- \( d_{p1}, d_{p2} \) = Pitch Diameter for Pinion & Gear
- \( c \) = Clearance
- \( h \) = Whole Depth of Tooth
- \( t \) = Mean Thickness of Tooth
- \( W \) = Face Width
- \( r \) = Fillet Radius
- \( P \) = Circular Pitch
2. Straight Bevel Gear:

- **Angular addendum:** $\alpha_C$
- **Addendum:** $A$
- **Dedendum:** $D$
- **Pitch cone angle:** $\theta$
- **Addendum angle:** $\beta$

Diagram showing:
- Tooth diameter
- Pitch diameter
- Root diameter
- Common apex of gear
- Mounting distance
- Apex distance
- Rocking distance

Additional notes:
- $d$
- $d_p$
- $d_r$
- $d_s$
- $a$
- $b$
- $c$
- $e$
- $f$
- $g$
- $h$
- $i$
- $j$
- $k$
- $l$
- $m$
- $n$
- $o$
- $p$
- $q$
- $r$
- $s$
- $t$
- $u$
- $v$
- $w$
- $x$
- $y$
- $z$
Assembly of Straight Bevel Gear:
The Basic Relationships for Straight Bevel Gear:

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<tr>
<td>( d_p = M \times Z )</td>
<td>Pitch diameter</td>
</tr>
<tr>
<td>( P = \pi \times d_p / Z )</td>
<td>Pressure angle</td>
</tr>
<tr>
<td>( X_c = d_p / 2 \sin \alpha_p )</td>
<td>Cone distance</td>
</tr>
<tr>
<td>( \tan \alpha_A = A / X_c )</td>
<td>Addendum angle</td>
</tr>
<tr>
<td>( \tan \alpha_D = D / X_c )</td>
<td>Dedendum angle</td>
</tr>
<tr>
<td>( \alpha_R = \alpha_p - \alpha_D )</td>
<td>Root angle</td>
</tr>
<tr>
<td>( \alpha_F = \alpha_p + \alpha_A )</td>
<td>Face angle</td>
</tr>
<tr>
<td>( \alpha_{\beta} = \alpha_p )</td>
<td>Angle of bevel</td>
</tr>
<tr>
<td>( W = X_c / 3 )</td>
<td>Face width</td>
</tr>
</tbody>
</table>

**Where:**
- \( d_p \) = pitch diameter.
- \( M \) = Module.
- \( Z \) = Number of teeth.
- \( \alpha_p \) = Pitch angle.
- \( r_{p1}, r_{p2} \) = Pitch radii of big & small gear.
- \( X_c \) = Cone distance.
- \( \alpha_A \) = Addendum angle.
- \( \alpha_D \) = Dedendum angle.
- \( \alpha_R \) = Root angle.
- \( \alpha_F \) = Face angle.
- \( A \) = Addendum.
- \( D \) = Dedendum.
- \( \alpha_C \) = Angular Addendum.
- \( W \) = Face width.
Assembly Drawing:

(1) shaft / st. / 1 Qty

(2) dish ST. 2 Qty

(3) Washer ST. 2 qty

(4) grinding wheel 1 Qty

(5) Nut(M12) ST. 1 Qty

Grinding Tool Holder
Assembly (2)

Clamp Stop
(1) Frame (welded joint) / steel / 1 Qty
NOTE: The frame consists of 2 parts; stand & base are welded by:
Concave fillet welding around the stand with thickness 8 mm.

(2) Screw shaft / steel / 1 Qty

(3) Cup / Cast iron / 1 Qty

(4) Special bolt / steel / 1 Qty

(5) Handle / steel / 1 Qty

JACK
(1) base/C.I./1 req.  (2) cover/C.I./1 req.  (3) half bush I /bronze/1 req.  (4) half bush II /bronze/1 req.  (5) hexagon head bolt M10x35/St./2 req.  (6) washer 18x11x2/St./2 req.

Note: Unspecified Radii R2

Shaft Carrier
Knuckle Joint

(1) fork/st.
(2) rod/st.
(3) pin/st.
(4) washer/st.
(5) split pin/st.
(6) screw shaft/st.
(7) hex. Nut M 20/st.

M 20
(4) $\Delta 14$ (sphere)

(5) $\Delta 14$ (sphere)

(2) $\Delta 10.57$

(6) $\Delta 10.57$

(1) $\Delta 10.57$

(3) $\Delta 2.6$

(1) fork/St./1 req.
(2) jew/St./2 req.
(3) power screw/St./1 req.
(4) handle/St./1 req.
(5) sphere/St./1req.
(6) pin/St./2 req.

Note: All sharp edges chamfered with 1/45°.

Tension Tool
(with two jaws)
1 BRACKET (C.I.-1 REQD)

2 BASE (C.I.-1 REQD)

3 ROLLER (C.I.-1 REQD)

4 SPINDLE (S.E.N.S.-1 REQD)

5 BUSH (G.M.-2 REQD)

14" DRILL 2 HOLES

50 CRS

ALSO SUPPLY:
4 ONLY 12 DIA. x 38mm HEX. BOLTS AND NUTS

Pully Carrier
Gear Box

Z₁ = 20
Z₂ = 40
M = 2.5

Z₃ = 15
Z₄ = 60
M = 3

1. gear 1/st./1 req.
2. gear 2/st./1 req.
3. gear 3/st./1 req.
4. gear 4/st./1 req.
5. shaft 1/st./1 req.
6. shaft 1/st./1 req.
7. shaft 1/st./1 req.
8. key/st./4 req.
1- Vice base, C.I., 1 reqd.  
2- Sliding jaw, C.I., 1 reqd.  
3- Jaw plate, steel, 2 reqd.  
4- Vice screw, steel, 1 reqd.  
5- Vice nut, steel, 1 reqd.  
6- Handle rod, steel, 1 reqd.  
7- Handle ball, steel, 1 reqd.  
8- Hex. screw M8x20, steel, 1 reqd.  
9- Flat head cap screw, M8 X 15 steel, 4 reqd.  
10- Washer, steel, 1 reqd.  
11- Split pin, steel, 1 reqd.  

Vice