

ME 1110 – Engineering Practice 1

Engineering Drawing and Design - Lecture 6

Representation of features Geometric tolerances

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Objectives for today

- How to represent standard engineering features
 - Gears; Bearings; Seals; Springs
 - Shafts, tubes; Fasteners
- What are tolerances and how are they specified
- Geometric tolerances
- Surface finish & machining

Exercise DrE-5 - Week 7

Parts to be measured and drawn



CITY UNIVERSITY LONDON Design

Representing standard features

ROTATING SHAFT SEAL WITHOUT DUST SEAL

ROTATING HOUSING SEAL WITHOUT DUST SEAL

ROTATING SHAFT SEAL WITH DUST SEAL

ROTATING SHAFT (HOUSING SEAL WITH DUST LIP (DOUBLE ACTING))

MALE THREADS

FEMALE THREADS SECTION AND HIDDEN

Retaining ring

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**NOTE: KEYWAY FOR GEAR 5/16 X 5/32
KEYWAY FOR PINION 1/4 X 1/8**

CUTTING DATA	GEAR	PINION
NO. OF TEETH	24	12
DIA. PITCH	4	4
TOOTH FORM	14 1/2' INV	14 1/2' INV
WHOLE DEPTH	.5393	.5393
CHORDAL ADD.	.3918	.3923
PITCH DIA.	6	3
CIRC. THICK.	.3925	.3925
WORK DEPTH	.25	.25

	GEAR	PINION
PART NUMBER	YSS624	YSS612
MATERIAL	STEEL	STEEL
FACE WIDTH	3.5	3.5

Gears

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HELICAL RIGHT AND LEFT

DOUBLE HELICAL

SPIRAL

Terminology and representation of standard components

General:

Housing: A component into which a 'male' mating part fits, sits or is 'housed'.

Bush/bearing: A removable sleeve or liner. Known also as a simple or plane bearing.

Boss: A cylindrical projection on surface of component.

Curved slot: Elongated hole, whose centerline lies on an arc. Used usually on components requiring adjustment.

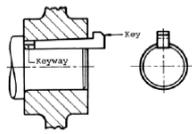
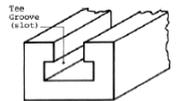
Rib: A reinforcement, positioned to stiffen surfaces.

Fillet: A radius or rounded portion suppressing a sharp internal corner.

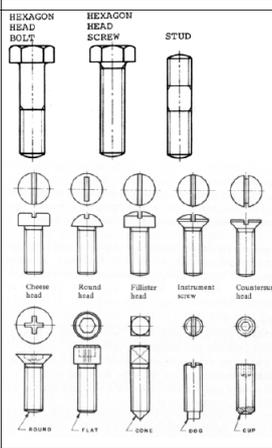
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Design

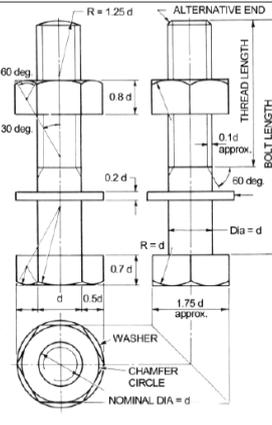
Terminology and representation of standard components

<p>Key: A small block or wedge inserted between a shaft and a mating part (a hub). Used to prevent relative rotation of the two parts.</p>	
<p>Key way: A parallel sided slot or groove cut into a bore or a shaft, to 'house' a mating key.</p>	
<p>Tea Groove (slot): Machined to 'house' mating fixing bolts and prevent them from turning.</p>	<p style="font-size: x-small;">Tea Groove (slot)</p> 
<p>Flat: A surface machined parallel to the shaft axis.</p>	<p style="font-size: x-small;">Flat</p> 

Terminology and representation of standard components

<p>Fasteners: Bolts, screws & studs: Threaded fasteners. Bolts have a shank partially threaded, whereas screws are threaded along the entire length.</p> <p>For guidance on dimensioning, see next page.</p> <p>The last three examples here are called set screws and are used to position or lock components.</p>	<div style="display: flex; justify-content: space-around; font-size: x-small;"> HEXAGON HEAD BOLT HEXAGON HEAD SCREW STUD </div> 
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Terminology and representation of standard components

<p>This diagram gives approximate dimensioning methods for drawing hexagon headed metric bolts, nuts and plane washers.</p> <p>(Manufacturers data sheets may give more accurate measurements.)</p>	
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Terminology and representation of standard components	Pins: Split Cotter Pin: Used to lock components, prevent fasteners from coming "un-fastened", e.g. lock-nuts on suspension systems.	
	Cotter Pin: Used to retain components, usually where loads are transmitted.	
	Dowel Pin & Taper Pin: Provides location, alignment.	
	Circlip: Internal & external.	

Terminology and representation of standard components	Features usually relating to components turned on a lathe: Straight Knurling, Shoulder, Undercut (or groove), Chamfer, Keyway, Taper, Domed or Spherical End.	
	This is a machining symbol. (It indicates that a surface is to be machined, without defining either the surface texture grade or process to be used).	
	Radius, Collar or Flange, Splines.	
	Knurling: Diamond, Straight.	

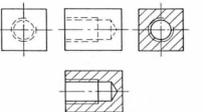
Terminology and representation of standard components	Long components: Rectangular bar, Round bar, Round tube.	
	Holes: Drilled: Loose tolerance, for pilot holes or clearance holes for fasteners.	
	Reamed: Accurate finishing process after drilling or boring.	
	Counterbore: Usually used to recess the head of a square shouldered fastener.	
	Countersunk: Usually used to recess the head of a countersink screw.	
	Spotface: Used to clean up and level the surrounding area, usually for a fastener or something such as a hydraulic fitting using a seal.	

Terminology and representation of standard components

Screw threads:
Female thread, through:
 Usually drilled and tapped.

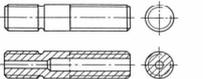


Female thread, blind:
 Usually drilled and tapped.



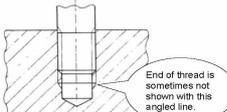
Male thread:
 Usually cut with a die, turned or rolled.

Note use of undercut or groove and appearance of thread in sectioned view.



Male & Female:
 e.g. a fastener in a tapped hole.

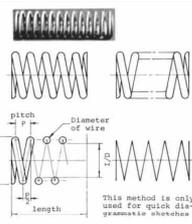
Note here that the tapped hole is sectioned, the fastener is not.



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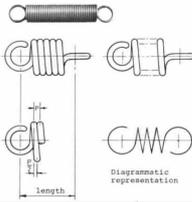
Terminology and representation of standard components

Springs:
Compression:



This method is only used for quick diagrammatic sketches

Tension:

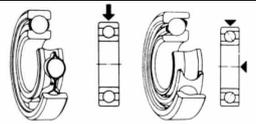


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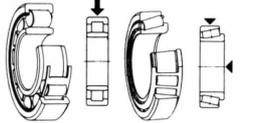
Terminology and representation of standard components

Bearings:
 Some examples of rolling element bearings. Arrows indicate directions of load bearing.

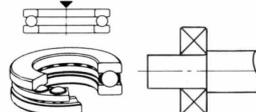
Deep groove (near).
 Angular contact (far).



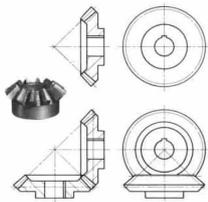
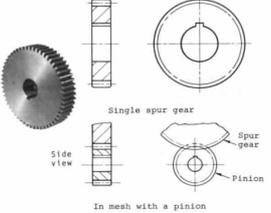
Roller (near).
 Taper roller (far).

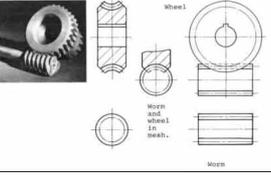
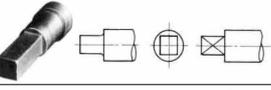
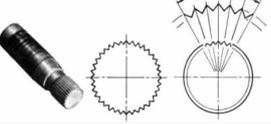


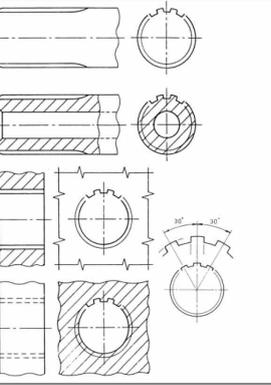
Thrust (near).
 Standard drawing representation of a bearing.



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<p>Terminology and representation of standard components</p>	<p>Gears: Bevel:</p> 
	<p>Spur:</p>  <p>Single spur gear Side view Spur gear Pinion In mesh with a pinion</p>

<p>Terminology and representation of standard components</p>	<p>Worm & wheel:</p> 
	<p>Shaft ends: Square: Frequently used for hand driven adjustments with removable handles, such as those found on machine tools, etc.</p> 
	<p>Serrations: Often used for push fit components such as plastic fans or pulleys, or levers such as motorcycle gear shifters.</p> 

<p>Terminology and representation of standard components</p>	<p>Splines: Usually used for transmitting rotational torque and allowing an axial 'sliding' movement. Examples can be found on automotive drive shafts. The figures opposite show splined shafts and housings in sectioned and non-sectioned views.</p>
	

Notation

50 M P

THEORETICALLY EXACT DIMENSION MAXIMUM MATERIAL PRINCIPLE PROJECTED TOLERANCE ZONE

Supplementary symbols: $\begin{array}{|c|} \hline - \\ \hline \end{array} 0,1$ $\begin{array}{|c|} \hline // \\ \hline \end{array} 0,1 A$ $\begin{array}{|c|c|c|c|} \hline \oplus & \varnothing 0,1 & A & C B \\ \hline \end{array}$

REFERENCE TO FACE SURFACE EDGE OR LINE Tolerance frame variations

LOCATION OF ARROWHEAD LOCATION OF DATUM TRIANGLE

REFERENCE TO AXES OR PLANE OF DIMENSIONED FEATURE ONLY

LOCATION OF ARROWHEAD REFERENCE COMMON AXIS OR MEDIAN PLANE OF ALL FEATURES

LOCATION OF ARROWHEAD LOCATION OF DATUM TRIANGLE

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Tolerance examples

0,1 Edge Tol. 0,1

Straightness

Tol. 0,2 at any position

Flatness

0,2

Tol. 0,5 Tol. 0,5 Tol. 0,2 Tol. 0,2

Median Plane Possible Surface

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Tolerance examples

0,05 Possible Form Tol. 0,05

Roundness

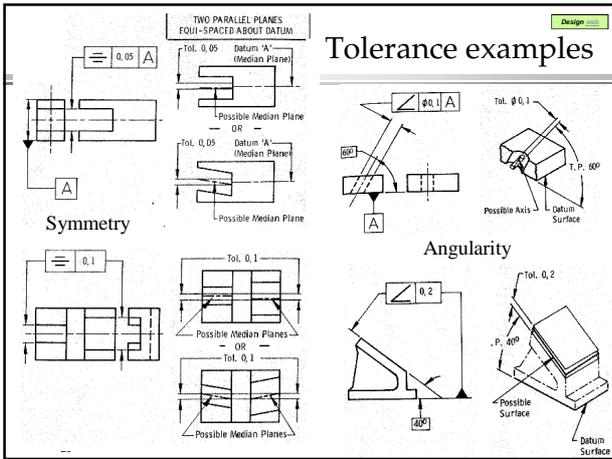
0,05 Surface at any cross section square to axis

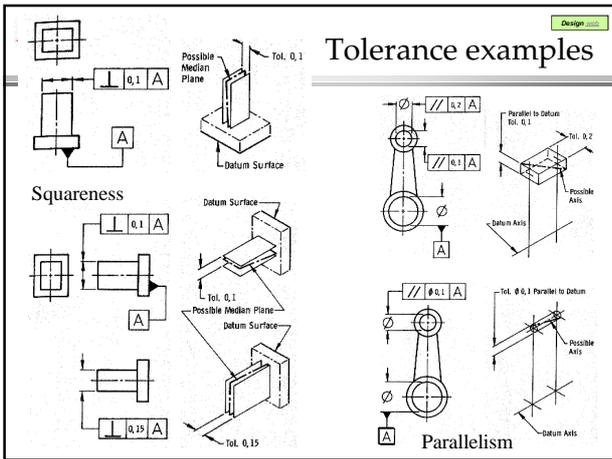
Form

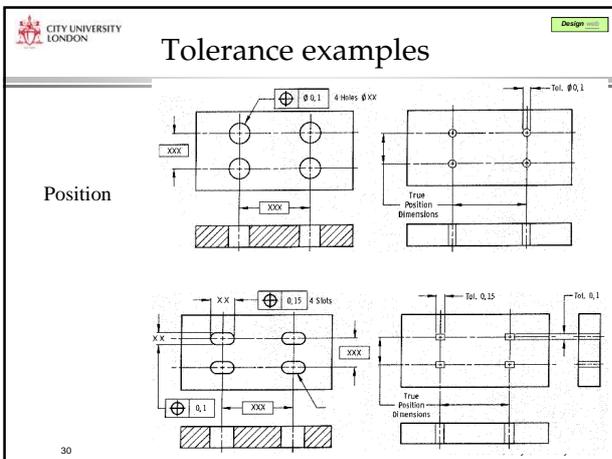
0,2 True Profile Possible Form Equi-distant Tol. 0,2

0,2 True Profile Internal Tol. 0,2 Possible Form

0,2 True Profile External Tol. 0,2 Possible Form

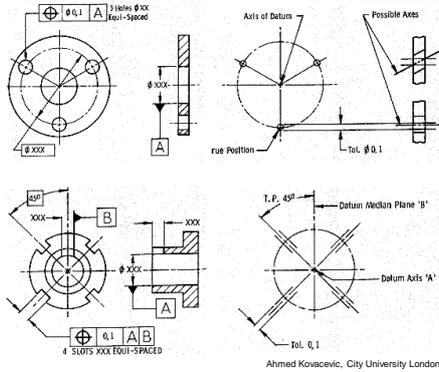






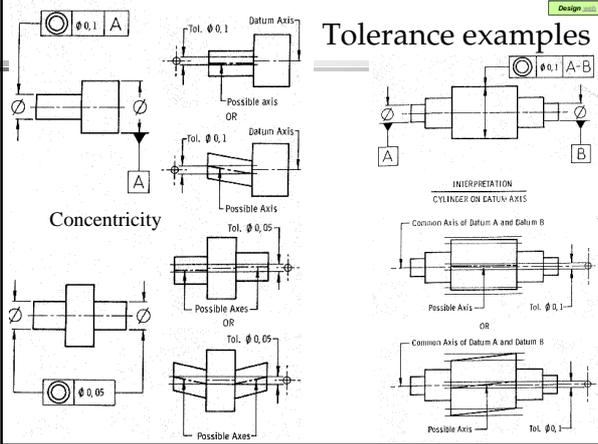
Tolerance examples

Position



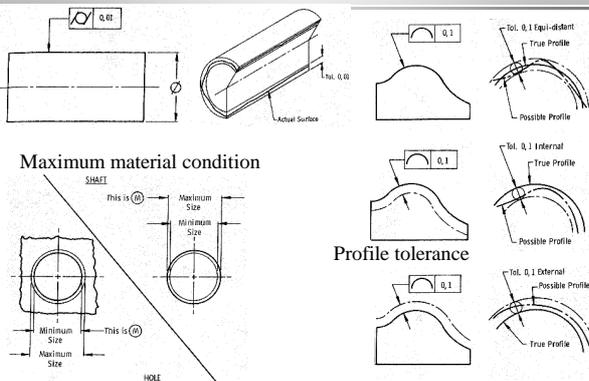
Tolerance examples

Concentricity



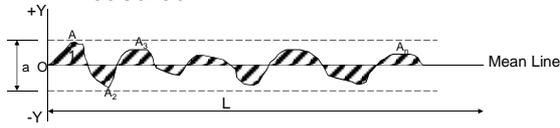
Tolerance examples

Cylindricity



Surface Roughness

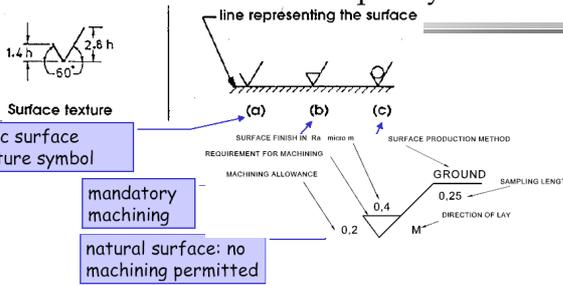
- Average deviation about the mean line measured



- Surface Roughness Measured by value

$$R_a = \frac{\sum A}{L}$$

Surface texture quality



basic surface texture symbol

mandatory machining

natural surface: no machining permitted

(µm)	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
(µinch)	1	2	4	8	16	32	63	125	250	500	1000	2000
N-Grade	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Finish	Ground Finishes			Smooth Turned			Medium Turned			Rough Machined		

Manufacture methods and roughness values

	12	11	10	9	8	7	6	5	4	3	2	1
Roughness number, N	12	11	10	9	8	7	6	5	4	3	2	1
Roughness value, Ra (µm)	5.0	2.5	12.5	6.3	3.2	1.6	0.8	0.4	0.2	0.1	0.05	0.025
Super polishing												
Lapping												
Polishing												
Honing												
Grinding												
Boring, turning												
Die casting												
Reaming												
Broaching												
Cold rolling												
Drawing												
Extruding												
Milling												
Planing, shaping												
Drilling												
Forging												
Sawing												
Hot rolling												
Sand casting												
Flame cutting												

Conclusions

Today we reviewed:

- Representation of features and parts
- Importance of tolerance
- Geometric tolerances
- Surface finish and machining

- To be continued ... (next week)
