Mechanical Drawing II

Code: MAE227

Surface Roughness

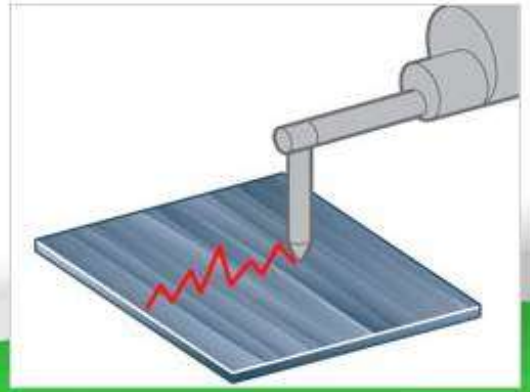
&

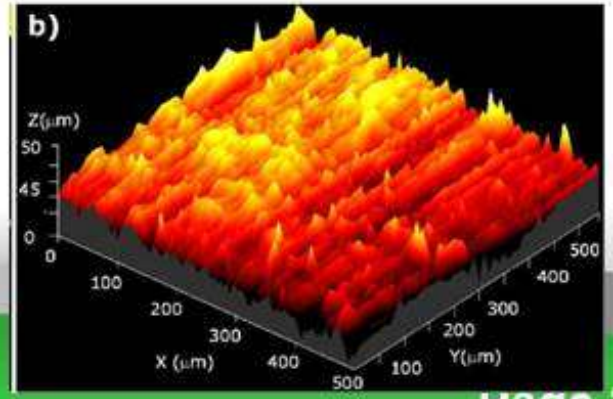
Operating Codes

Introduction:

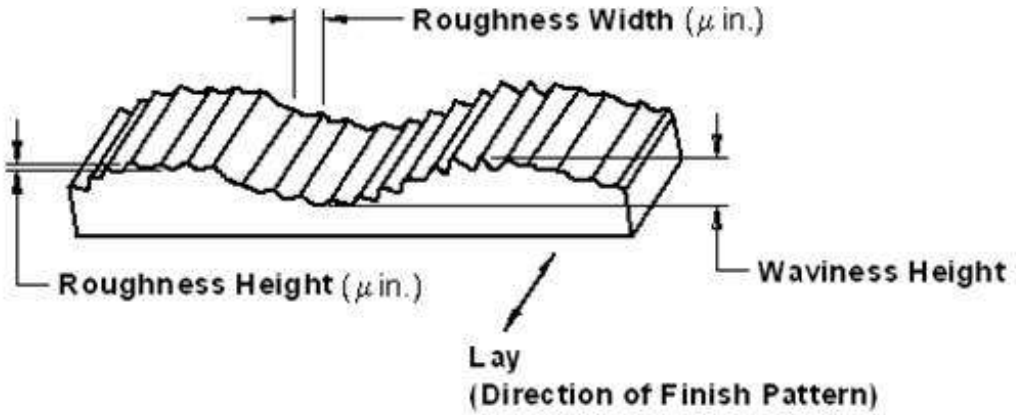
Surface roughness often shortened to **roughness**, is a component of **surface** texture.
It is quantified by the deviations in the direction of the normal vector of a real **surface** from its ideal form.
If these deviations are large, the **surface** is rough; if they are small, the **surface** is smooth.

The higher the smoothness of the surface, the better is the fatigue strength and corrosion resistance.
Friction between mating parts is also reduced due to better surface finish.





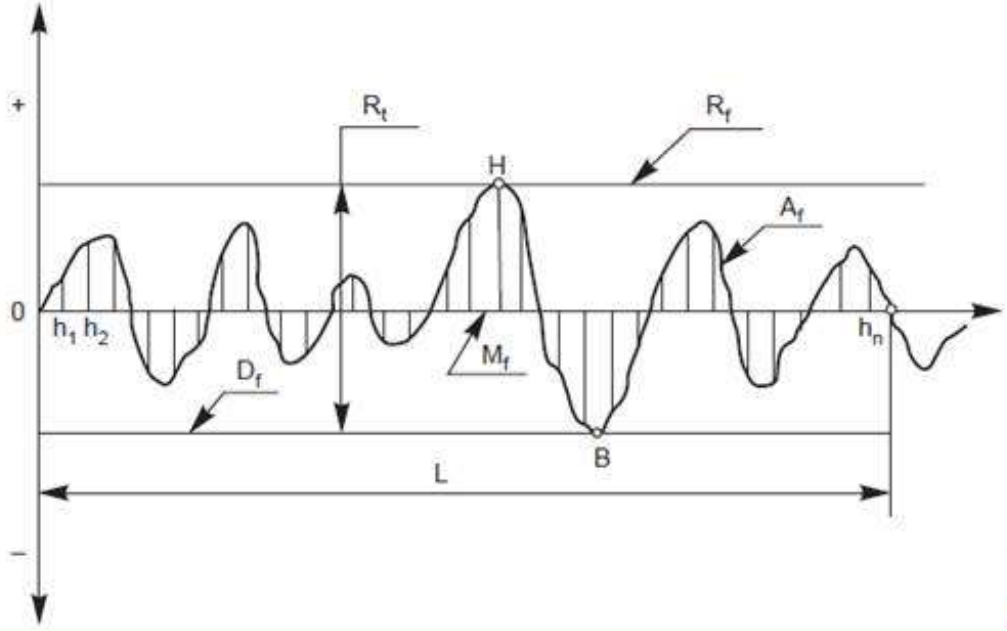
Introduction:



The surface roughness is evaluated by the height, R_t and mean roughness index R_a of the micro-irregularities.

Surface roughness values are usually expressed as the Ra value in microns.

$$R_a = \frac{h_1 + h_2 + h_3 + \ldots + h_n}{n}$$



Surface roughness expected from various manufacturing processes

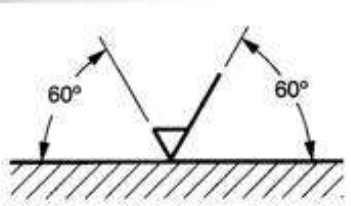
Sl. No.	Manufacturing Process	R_a in µm: 0.012	0.025	0.050	0.10	0.20	0.40	0.80	1.6	3.2	6.3	12.5	25	50	100	200
1	Sand casting									5				50		
2	Permanent mould casting							0.8			6.3					
3	Die casting							0.8		3.2						
4	High pressure casting					0.32			2							
5	Hot rolling								2.5					50		
6	Forging								1.6				28			
7	Extrusion				0.16					5						
8	Flame cutting, sawing & Chipping									6.3				100		
9	Radial cut-off sawing							1			6.3					
10	Hand grinding									6.3			25			
11	Disc grinding								1.6				25			
12	Filing				0.25								25			

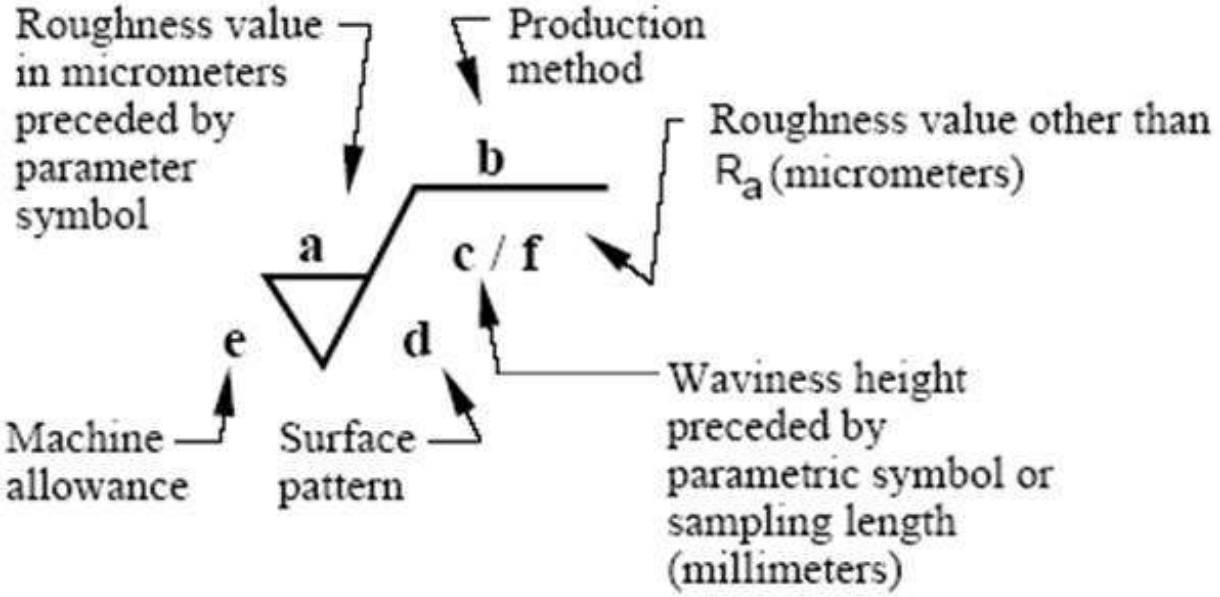
Surface roughness expected from various manufacturing processes

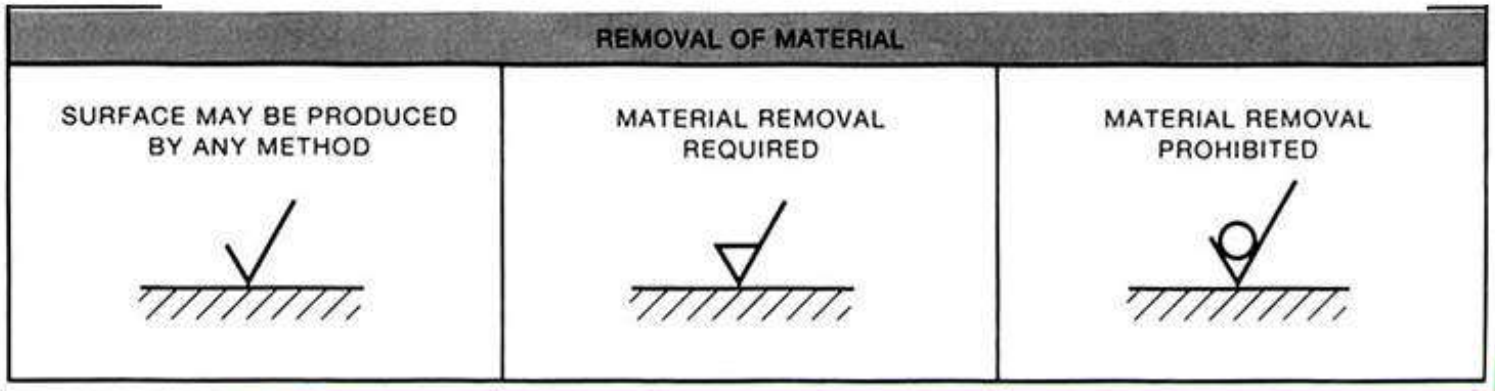
13	Planing	1.6 – 50
14	Shaping	1.6 – 25
15	Drilling	1.6 – 20
16	Turning & Milling	0.32 – 25
17	Boring	0.4 – 6.3
18	Reaming	0.4 – 3.2
19	Broaching	0.4 – 3.2
20	Hobbing	0.4 – 3.2
21	Surface grinding	0.063 – 5
22	Cylindrical grinding	0.063 – 5
23	Honing	0.025 – 0.4
24	Lapping	0.012 – 0.16
25	Polishing	0.04 – 0.16
26	Burnishing	0.04 – 0.8
27	Super finishing	0.016 – 0.32

Machining symbols

- The basic symbol consists of two legs of unequal length, inclined at approximately 60° to the line.

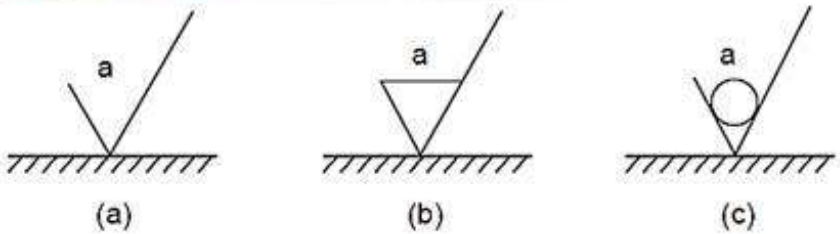




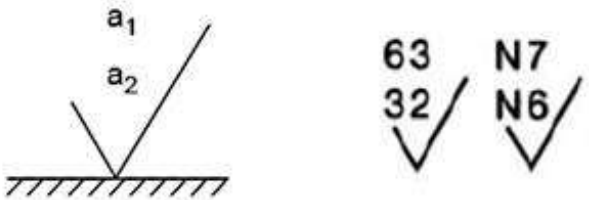


Machining symbols

The roughness value or values are added to the symbol as:
(Normally in micrometre)



If both the values should be shown, with the maximum limit, a_1, above the minimum limit, a_2.



The R_a may be indicated by the corresponding roughness grade number:

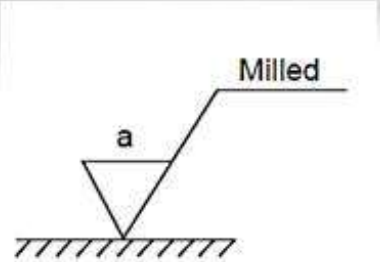
Roughness values R_a *µm*	*Roughness grade number*	*Roughness grade symbol*
50	N12	
25	N11	
12.5	N10	
6.3	N9	
3.2	N8	
1.6	N7	
0.8	N6	
0.4	N5	
0.2	N4	
0.1	N3	
0.05	N2	
0.025	N1	

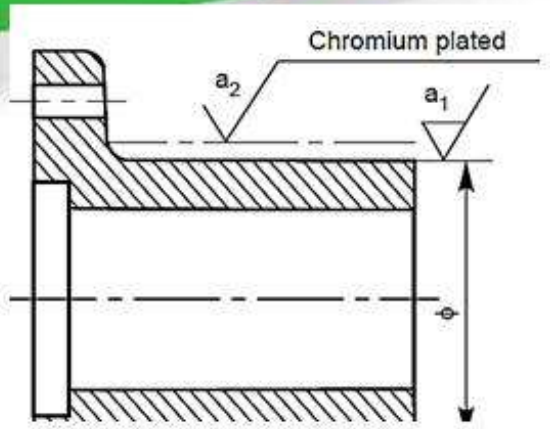
N1 & N2	0.025 & 0.05	Very smoothly finished surfaces produced by honing, lapping, buffing or super-finishing machines. A costly finish to produce and seldom required.
N3	0.1	Very. refined surfaces have this high degree of finish. It is produced by honing, lapping and buffing methods and is a costly finish to produce.
N4	0.2	A fine surfaces produced by honing, lapping and buffing methods. This texture could be specified on precision gauge and instrument work and on high speed shafts, and bearings. Once again cost of production is high.
N5	0.4	A fine quality surface which can be produced by fine cylindrical grinding, coarse honing, buffing and lapping methods. Used on high speed shafts and bearings and other applications where smoothness is desirable for the proper functioning of a part.
N6	0.8	A first class machine finish which can be easily produced on cylindrical, surface and centreless grinders but requires great care on lathes and mining machines. It is satisfactory for bearings and shafts carrying light loads and running at medium to slow speeds.

N7	1.6	A good machine finish which can be maintained on production lathes and milling machines using sharp tools, fine feeds and high cutting speeds. It is used when close fits are required, and is unsuitable for fast rotating members.
N8	3.2	A medium commercial finish easily produced on lathes, milling machines end shapers. A finish commonly used in general engineering machining operations, Which is economical to produce and of reasonable appearance.
N9	6.3	A coarse production finish obtained by taking coarse feeds on lathes, millers, shapers, boring and drilling machines. It is acceptable when tool marks have no bearing on performance and quality. This texture can also be found on the surfaces of metal moulded castings, forgings, extruded and rolled surfaces and can be produced by hand filing or disc grinding.
N10	12.5	A very rough coarse surface obtained by sand casting, saw cutting, chipping, rough forging and oxy cutting. This finish is rarely specified and is used only where it is not seen or its appearance is desirable or unimportant.
N11 & N12	25	A very rough surface produced by lathes, millers and other machine tools using heavy cuts and very coarse feeds. Other processes such as filing, snagging, disc grinding, sand casting and rough forging also produce a texture of this value.

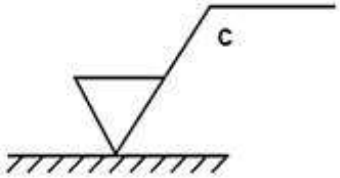
Machining symbols

The production method
Of the final surface texture.

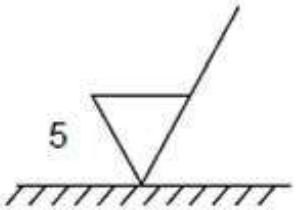




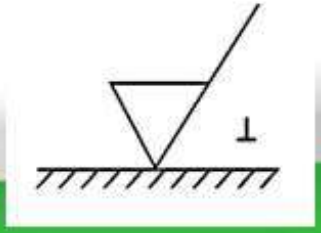
The sampling length
(normally in millimetres)



The machining allowance
(normally in millimetres)

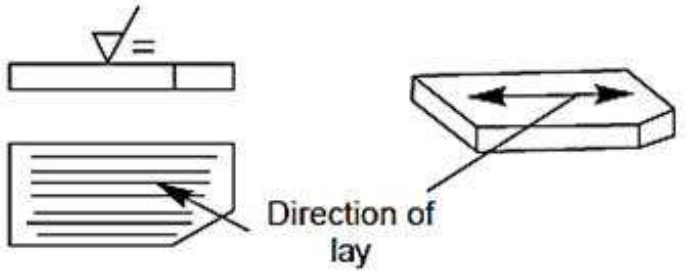
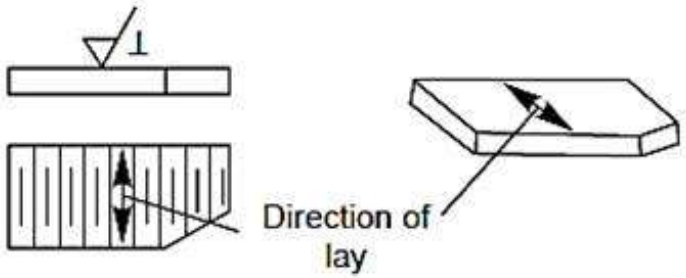
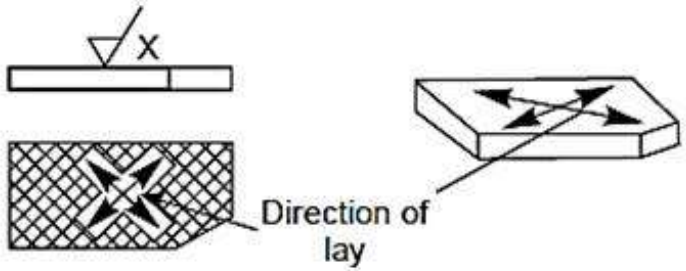


The direction of lay



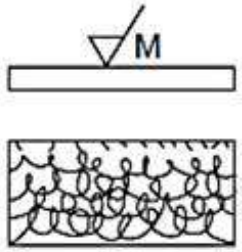
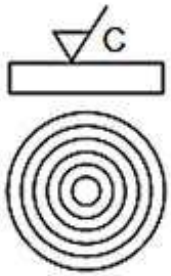
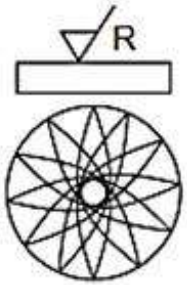
Machining symbols

The direction of lay

Symbol	*Interpretation*	
=	Parallel to the plane of projection of the view in which the symbol is used	
⊥	Perpendicular to the plane of projection of the view in which the symbol is used	
X	Crossed in two slant directions relative to the plane of projection of the view in which the symbol is used	

Machining symbols

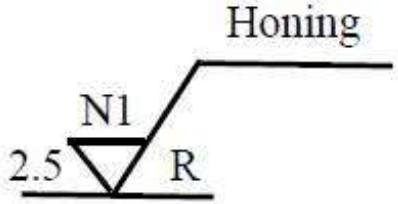
The direction of lay

M	Multi-directional	
C	Approximately circular, relative to the centre of the surface to which the symbol is applied	
R	Approximately radial, relative to the centre of the surface to which the symbol is applied	

Machining symbols

Example:

Give full explanation for each of the following symbols:



The symbol of surface roughness refers to:

- The removal of material by machining is required.
- The machining allowance is **2.5 mm**.
- The Roughness grade number is **N1 (0.025µm)** *:* Very smoothly finished surfaces produced by honing, lapping, buffing or super-finishing machines. A costly finish to produce and seldom required.
- The production method of the final surface texture is **Honing**.
- **R**: The direction of lay.

Approximately radial, relative to the centre of the surface to which the symbol is applied