Discussion :-

1. Derive the expression for surface roughness parameters w.r.t. tool geometry and feed.

if the feed is fixed at s mm and tool geometry is varied then, for a tool with a sharp angle between principal cutting edge and Auxiliary cutting edge, the microscopic helical grooves made by the tool on the cutting surface would look like in fig 1.

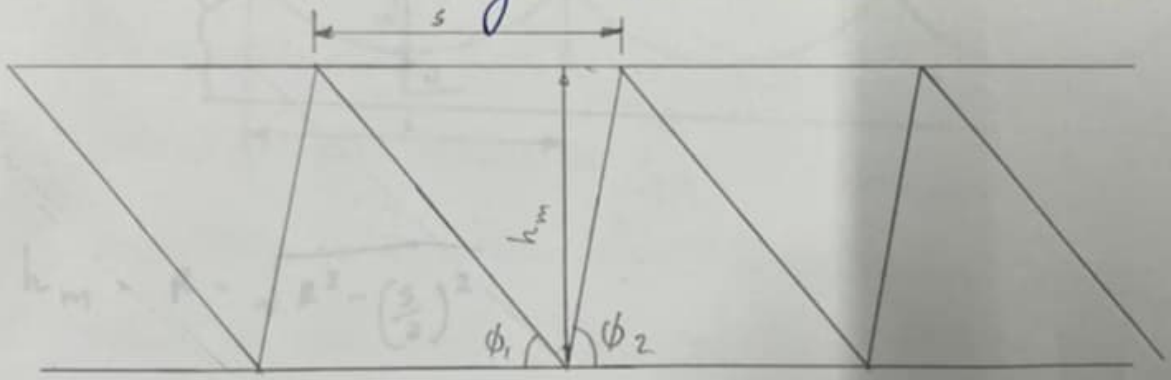
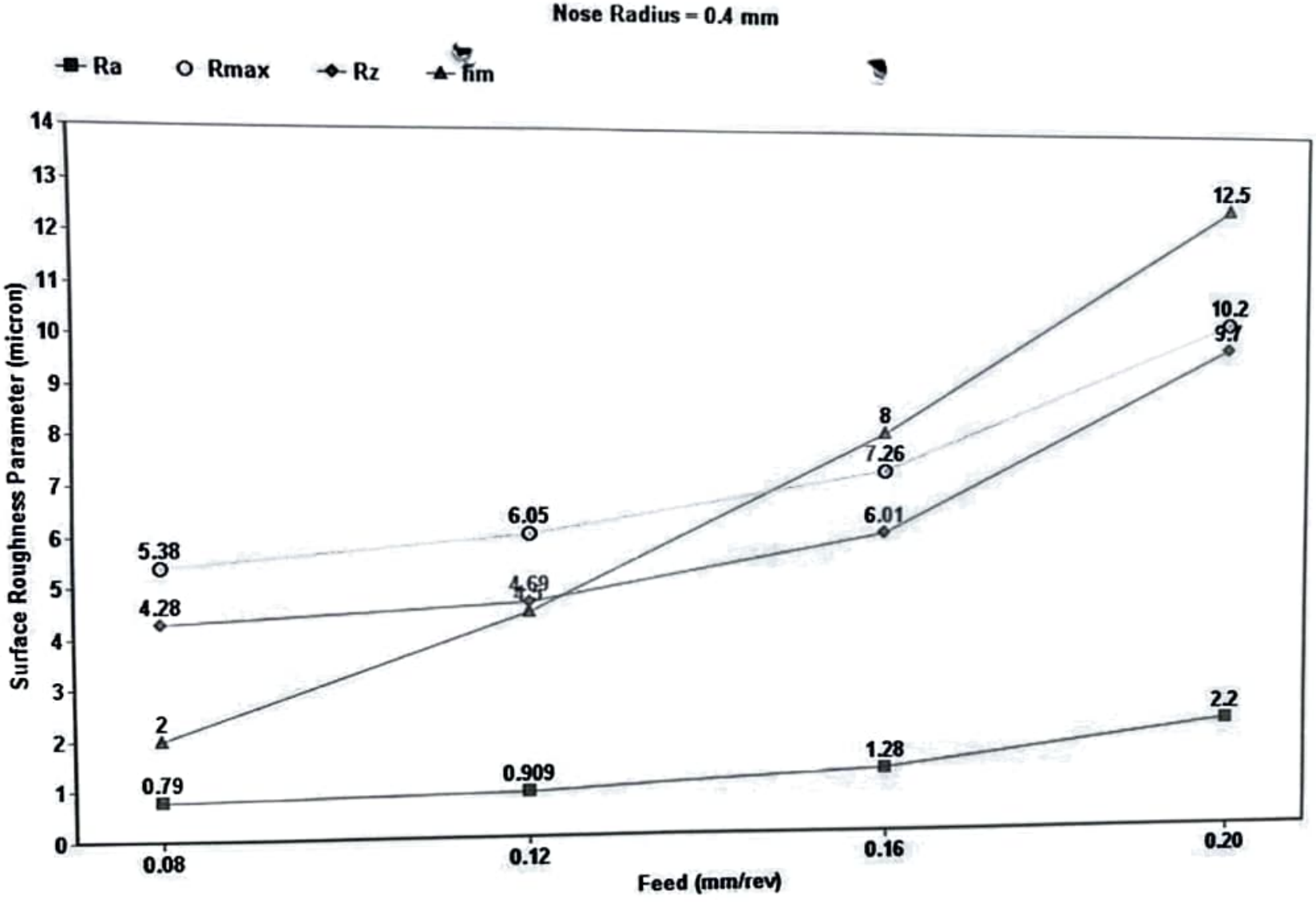


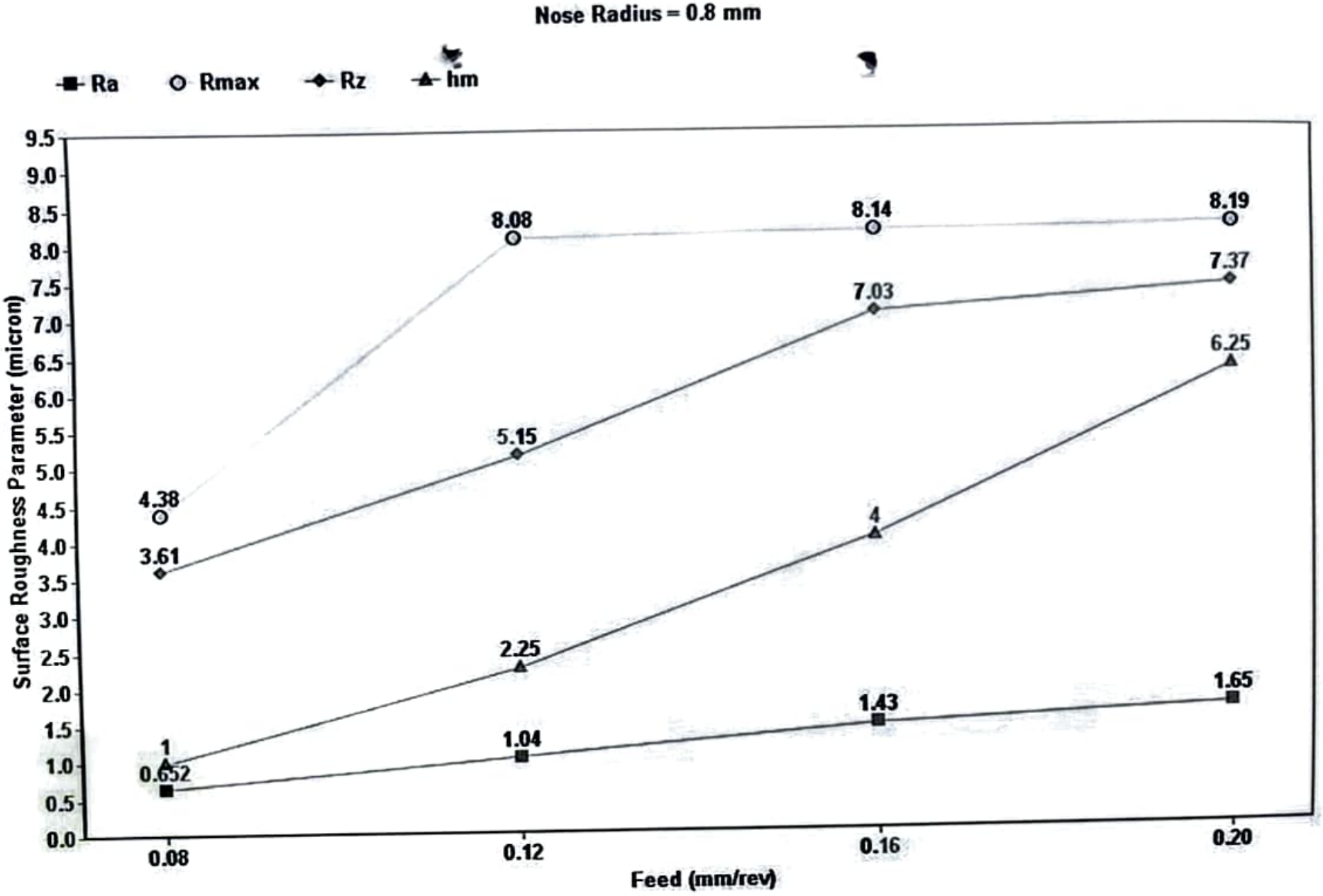
fig 1.

ϕ_1 = principal cutting edge angle

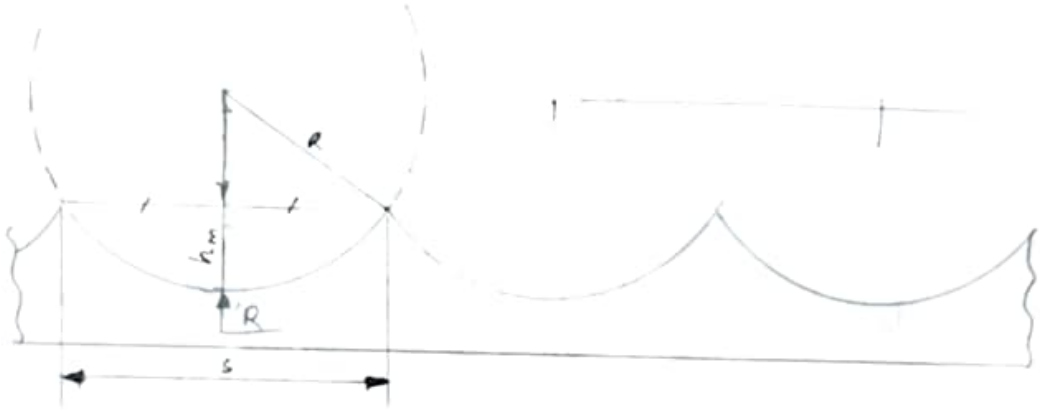
ϕ_2 = Auxiliary cutting edge angle

$$\Rightarrow s = h_m \cot\phi_1 + h_m \cot\phi_2 \quad \text{thus, } h_m = \frac{s}{\cot\phi_1 + \cot\phi_2}$$


Nose Radius = 0.4 mm
Ra
Rmax
Rz
fim
Surface Roughness Parameter (micron)
Feed (mm/rev)
0.08
0.12
0.16
0.20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
5.38
6.05
7.26
10.2
4.28
4.69
6.01
9.7
2
8
12.5
0.79
0.909
1.28
2.2


Nose Radius = 0.8 mm
Ra
Rmax
Rz
hm
Surface Roughness Parameter (micron)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.08
0.12
0.16
0.20
Feed (mm/rev)
4.38
8.08
8.14
8.19
3.61
5.15
7.03
7.37
1
2.25
4
6.25
0.652
1.04
1.43
1.65

if with the same feed, a tool with a nose radius between poincipal and cutting edge is used, then the cutting surface would look something like fig 2.



$$h_m = R - \sqrt{R^2 - \left(\frac{s}{2}\right)^2}$$

$$= R - \left[1 - \sqrt{1 - \left(\frac{s}{2R}\right)^2}\right]$$

$$= R\left[1 - \left(\frac{1}{2} - \frac{1}{2}\cdot\frac{s^2}{4R}\right)\right] \quad \text{(using binary expansion)}$$

$$= R\left[\frac{s^2}{8R^2}\right]$$

$$= \frac{s^2}{8R}$$

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Q > Explain the reason for the variations between the experimental and theoritical values.

Ans> As seen in the derivation of expression for surface roughness parameters with respect to nose radius

$$h_{theoritical} = R - \sqrt{R^2 - s^2/4}$$

$$= R - R\sqrt{1 - \left(\frac{s}{2R}\right)^2}$$

None only when $s \ll R$ i.e. feed $\ll$ nose radius above formula reduces to $\frac{s^2}{8R} = h_{experimental}$.

Hence there is variation between theoritical and experimental value as our assumption of $(s \ll R)$ is not always valid.

Moreover due to experimental ~~test~~ errors there may be difference between the theoritical and observed values.

Q3) Explain the nature of variation of surface roughness with feed and nose radius.

Ans) As evident from the formula, surface roughness increases with increased feed and decreases with increase in nose radius.

Formula → $h_{max} = \frac{f^2}{8R}$

The variation may be plotted as —

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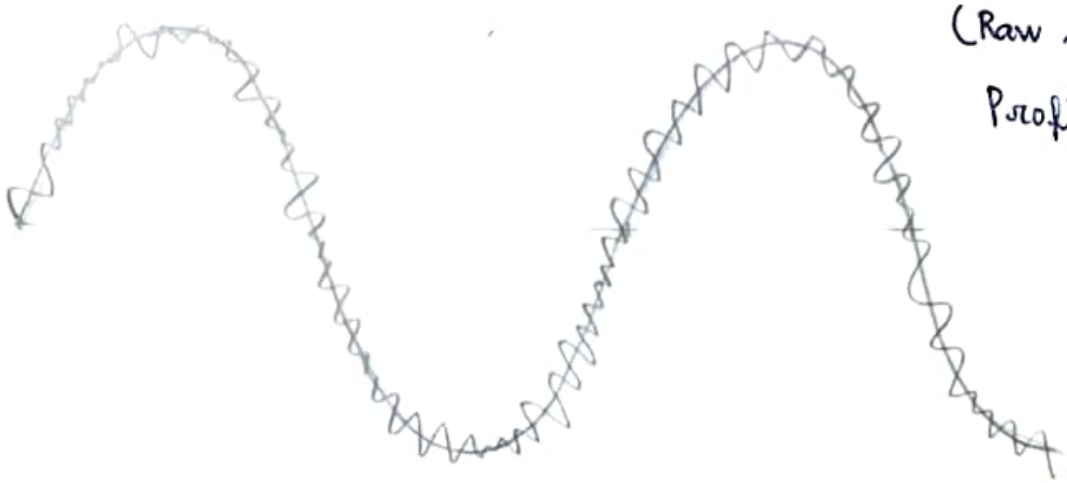


(Raw Surface Profile)

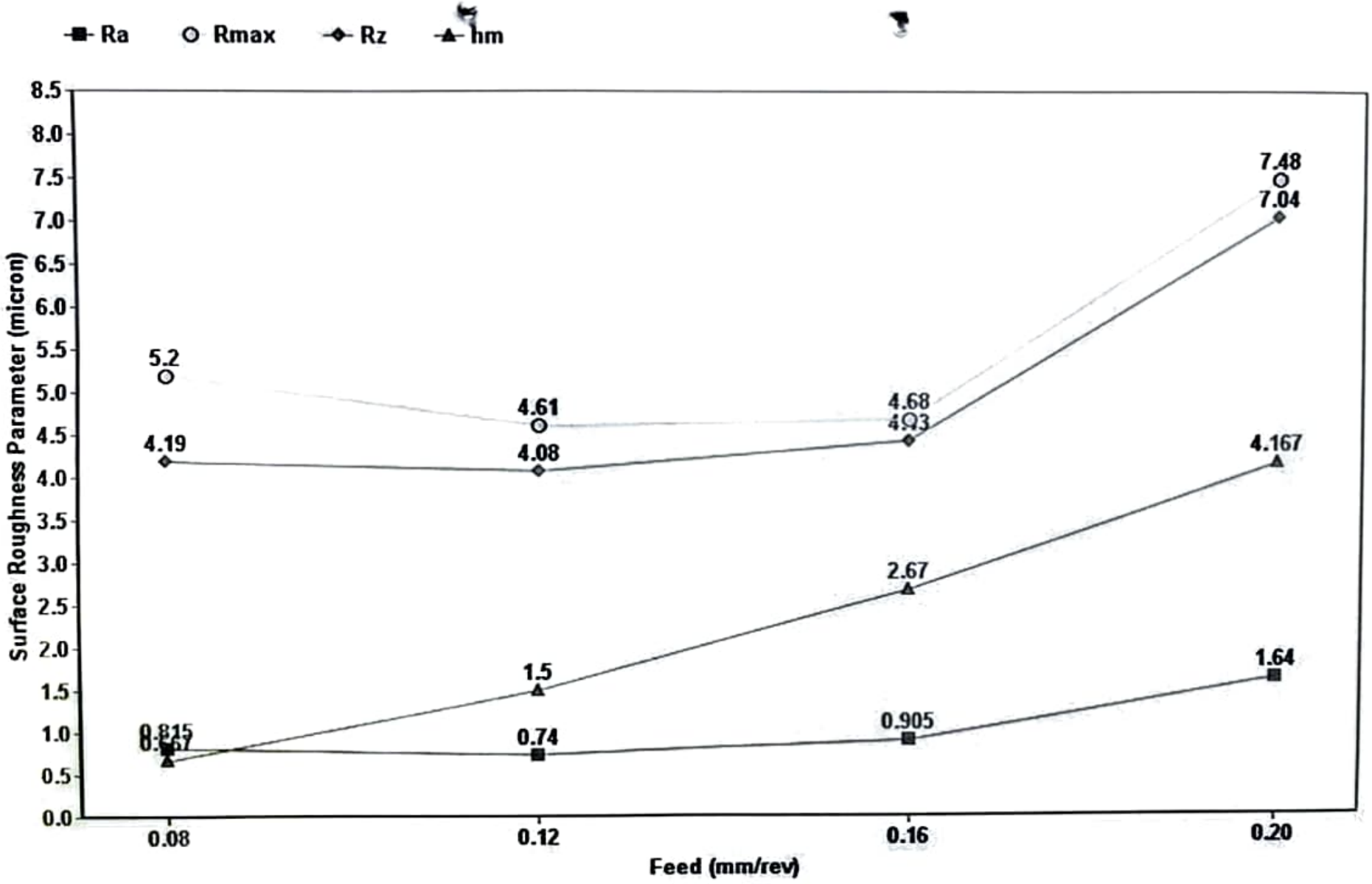
⬇ (Gaussian filter) { with λ_c = cutoff length ≈ 0.8 mm

(Waviness)

+

(Surface Roughness)

PRE


Nose Radius = 1.2 mm
Ra
Rmax
Rz
hm
Surface Roughness Parameter (micron)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.08
0.12
0.16
0.20
Feed (mm/rev)
5.2
4.61
4.68
7.48
7.04
4.19
4.08
4.167
2.67
1.5
1.64
0.905
0.74

MACHINE TOOL AND MACHINING (MTM) LABORATORY
DEPARTMENT OF MECHANICAL ENGINEERING

Title: Role of Process Parameters on Surface finish

Objective: To study the effect of feed and nose radius on surface roughness parameters in Turning with a single point tool.

Experimental Conditions and Observations:

Work Material: Ti-6Al-4V
Cutting Tool material:
Cutting Tool geometry:
Cutting Tool specification
Depth of cut: 2 mm
Cutting velocity: 100 m/min

Serial No.	Feed (mm/rev)	Nose radius (mm)	R_a (micron)	R_{max} (micron)	R_z (micron)	h_m (micron)
1.	0.08	0.4	0.39	5.38	4.28	2.00
2.	0.12		0.909	6.05	6.69	4.5
3.	0.16		1.28	7.26	6.01	8
4.	0.20		2.20	10.2	9.30	12.5
5.	0.08	0.8	0.652	4.38	3.61	1
6.	0.12		1.04	8.08	5.15	2.25
7.	0.16		1.43	8.14	7.03	4
8.	0.20		1.65	8.19	7.37	6.25
9.	0.08	1.2	0.815	5.20	4.19	0.667
10.	0.12		0.740	4.61	4.08	1.5
11.	0.16		0.905	4.68	4.43	2.67
12.	0.20		1.64	7.48	7.04	4.167

Report:

1. Derive the expression for surface roughness parameters with respect to tool geometry and feed.
2. Plot the variations in the surface roughness parameters with feed and nose radius.
3. Explain the nature of variation in surface roughness with feed and nose radius.
4. Determine the theoretical surface roughness parameters h_m for all combinations.
5. Explain the reasons for variations between the theoretical and experimental values.