

Spur Gear Design



Idealized Spur Gears





• The speed ratio is given by:



Tooth pitch

 However, in order for the gears to mesh, they must have the same tooth pitch





Tooth pitch

- "Circular pitch" is arc-length per tooth:
 - *p* =
 - In metric use "module":
 - *m* =
 - With inch units use "diametral pitch":
 - P =



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Standard (AGMA) Gears

Gears come with standard pitches and pressure angles

 TABLE 7 1
 Standard Tooth Sizes

	Standard Diametral Pitches U.S. Customary, teeth/in		
Coarse	$1, 1\frac{1}{4}, 1\frac{1}{2}, 1\frac{3}{4}, 2, 2\frac{1}{4}, 2\frac{1}{2}, 3, 4, 6, 8, 10, 12, 16$		
Fine	20, 24, 32, 40, 48, 64, 80, 96, 120, 150, 200		
	Standard Modules SI, mm/tooth		
Preferred Next choice	1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 32, 40, 50 1.125, 1.375, 1.75, 2.25, 2.75, 3.5, 4.5, 5.5, 7, 9, 11, 14, 18, 22, 28, 36, 45		

TABLE 7.2 Standard Tooth Systems for Spur Gears

System	Pressure Angle, ϕ (deg)	Addendum, a	Dedendum, d
Full depth	20°	1/ <i>P</i> or 1 <i>m</i>	1.25/P or 1.25m
Full depth	22.5°	1/P or $1m$	1.25/P or $1.25m$
Full depth	25°	1/P or $1m$	1.25/P or $1.25m$
Stub teeth	20°	0.8/P or 0.8m	1/P or $1m$



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Pressure Angle

As meshed gears rotate, the teeth slide against each other and the contact point changes continuously, but the contact point always lies on the pressure line.
The direction of the force is always in the direction of the pressure line (i.e., normal to surface at contact point).





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The Involute Gear Tooth Profile

 In order to maintain contact on the line of action with the force always at the same pressure angle, an involute profile must be used. It is generated as shown.





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Addendum and Dedendum

 Addendum (a) is the distance from the pitch circle to the top of the teeth Dedendum (*d*) is the distance to the bottom.





Finished Spur Gears



Clearance: c = d - aTooth thickness at pitch circle: t = p/2



Racks and Internal Gears



Internal Gear





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Interference and Undercutting

- If the teeth are too large for the pitch diameter, there will be interference on the flank of the driving teeth during approach.
 There should only be contact between points A and B (where the base circle meets the pressure line). Points C and D (where the addendum circles meet the pressure line) should be between A and B.
- If teeth are too large, the gear designer must:
 - provide undercutting leave space at base of teeth \rightarrow very weak teeth
 - increase number of teeth \rightarrow smaller teeth are weaker
 - increase pitch circle radius \rightarrow bigger, faster, noisier gears
 - increase pressure angle \rightarrow more friction
 - make gear teeth stubbier \rightarrow non-standard gears



Interference and Undercutting





Contact Ratio

Average number of teeth in contact at once.



CD

 p_b

 m_c =

CD = CP + PD $p_b = p \cos \Phi$

Length & Angle of Approach & Recess



Angle of recess:

 $\alpha_2 = CP/r_2$ $\beta_2 = PD/r_2$ $\alpha_3 = CP/r_3$ $\beta_3 = PD/r_3$

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Increasing the center distance

