# Design of Machines and Mechanical Systems (PC-BTM711)

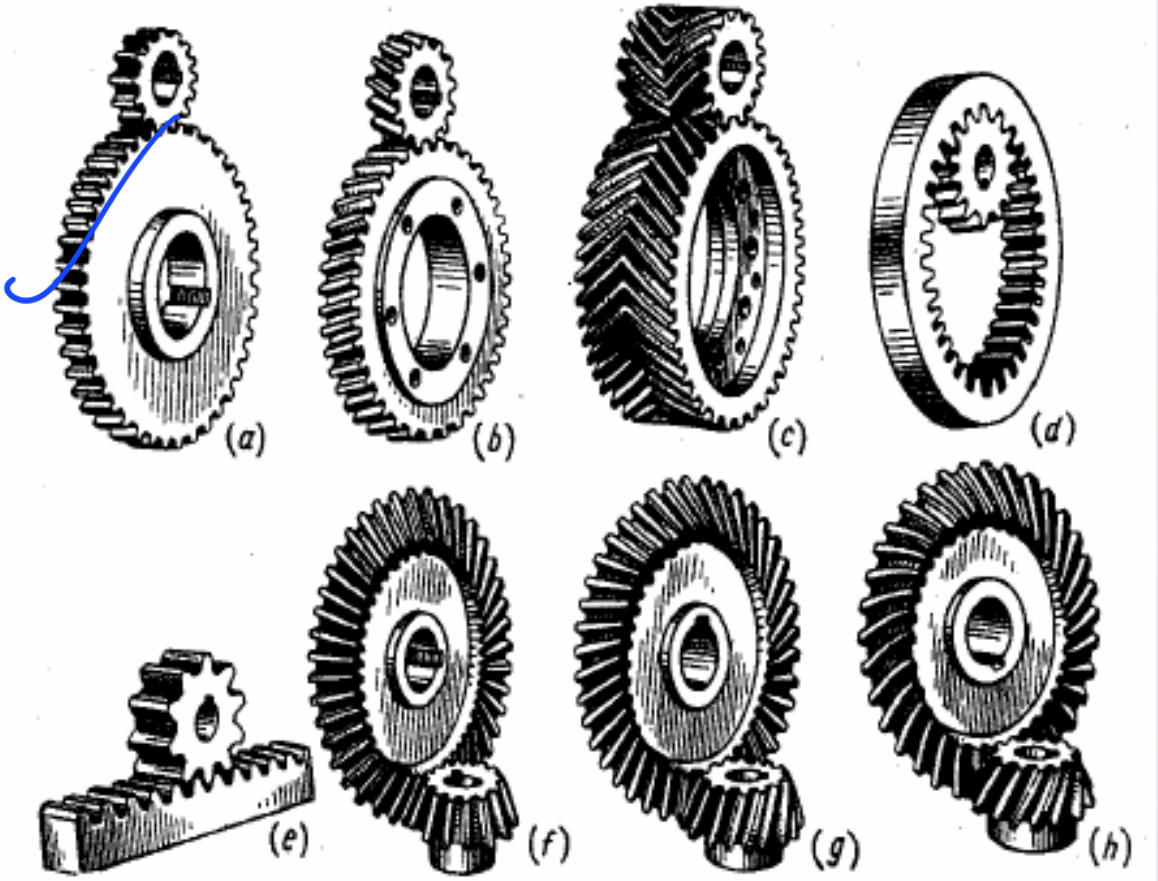
Session 02

Module 1: Spur Gear Design

# Session Outcomes

- Discuss overview of spur gear design parameters
- Perform force analysis for spur gears

# Types of gears



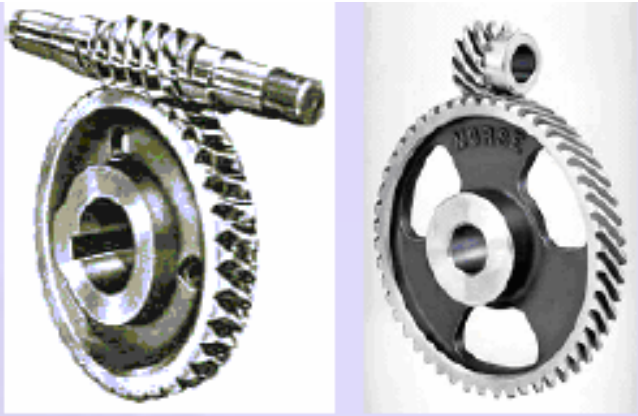
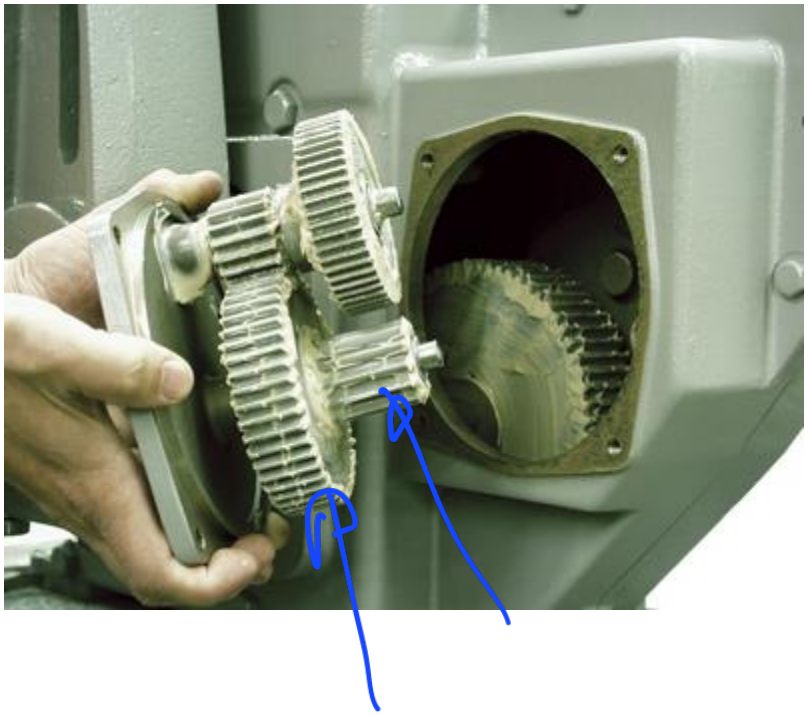




**Fig. 1.6 (a) Spur gear, (b) helical gear, (c) Double helical gear or herringbone gear, (d) Internal gear , (e) Rack and pinion, (f) Straight bevel gear, (g) Spiral bevel gear, (h) Hypoid bevel gear , (i) worm gear and (j) Spiral gear**

Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

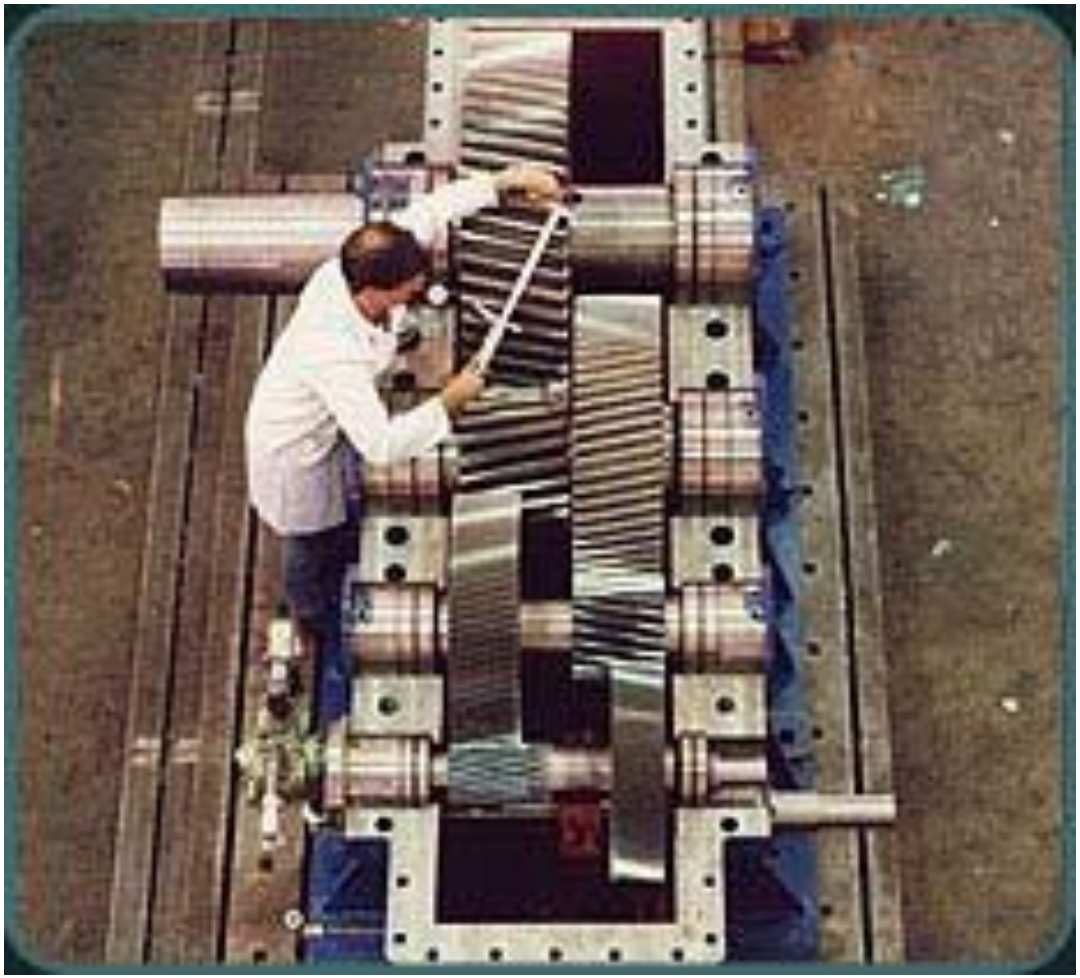
# Spur gears in actuator assembly





Ref: http://www.haroldbeck.com/images/drive-train.png

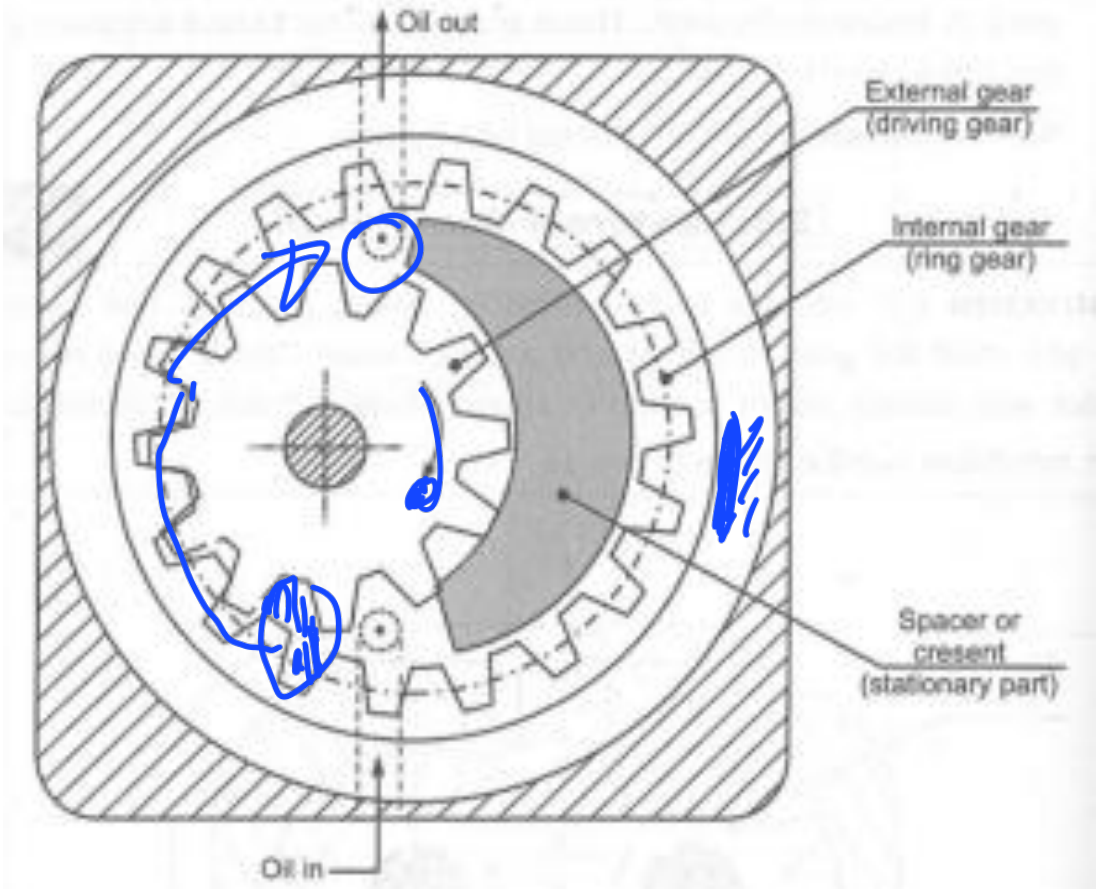
# Helical gears in hoists and cranes

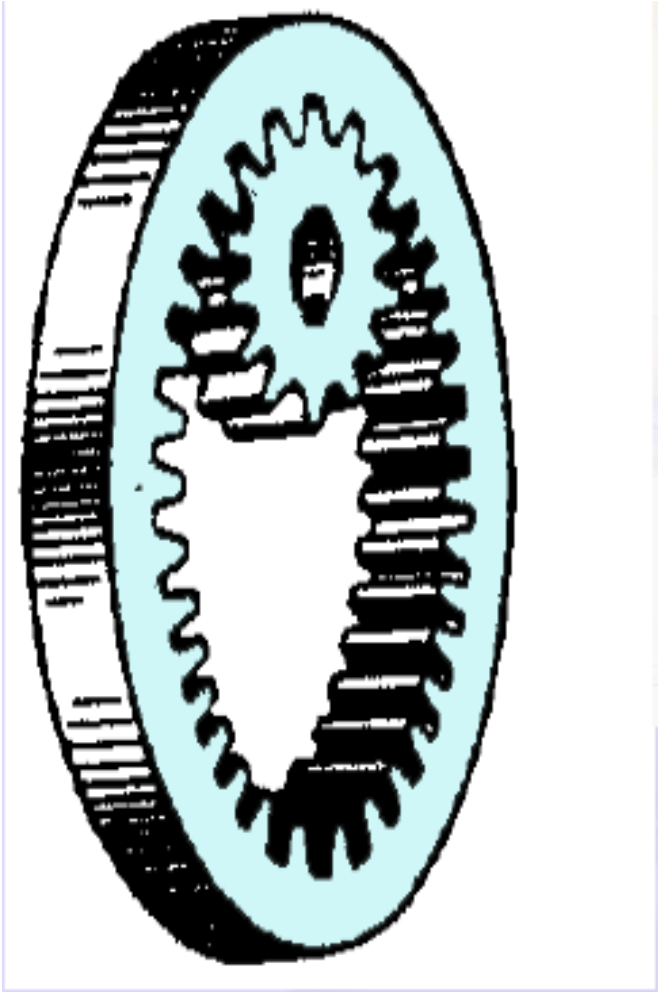




Ref: http://www.ashokamachord.com/gear-reducers.html

# Internal gear

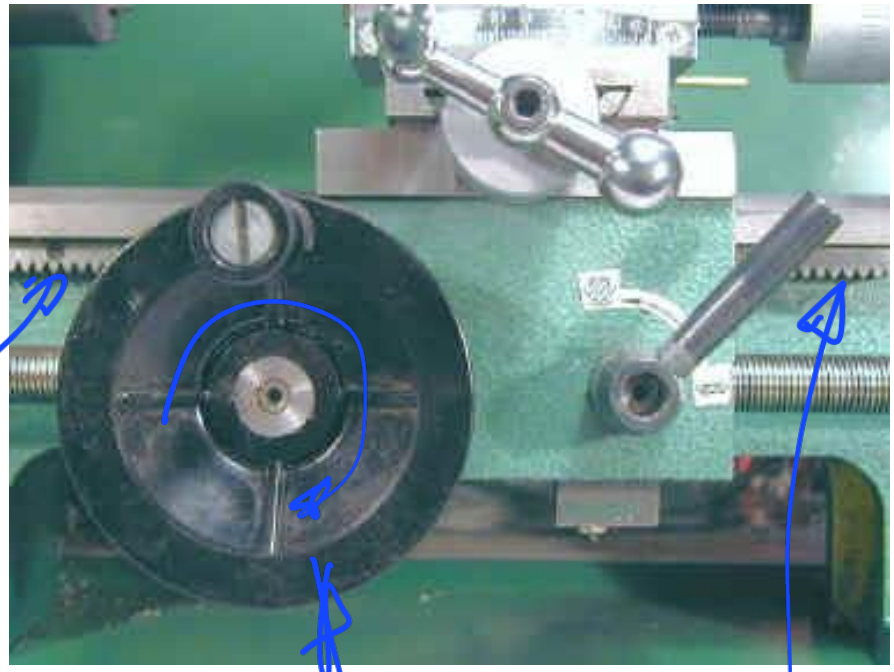


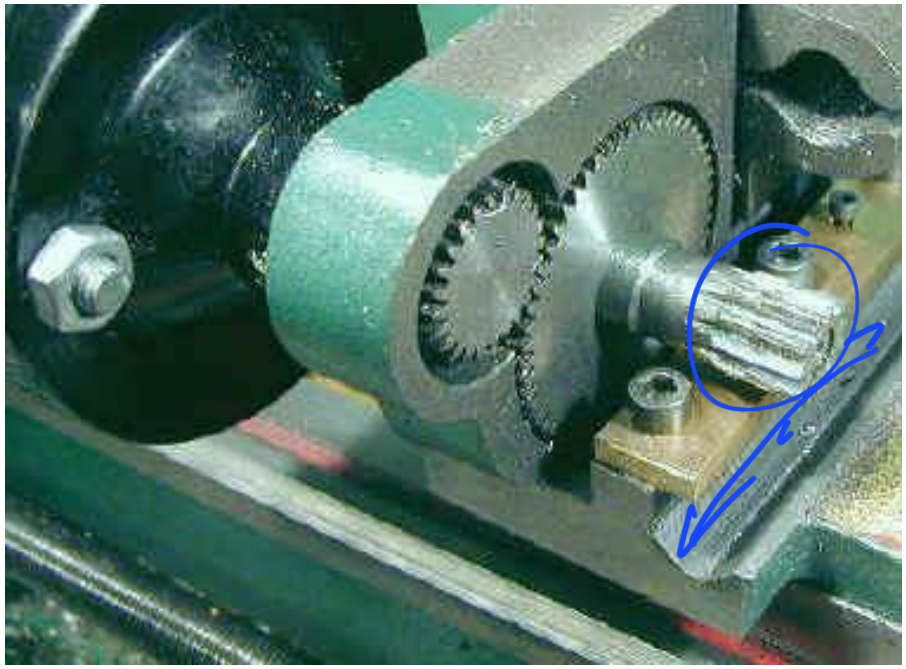





Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Rack and pinion in lathe

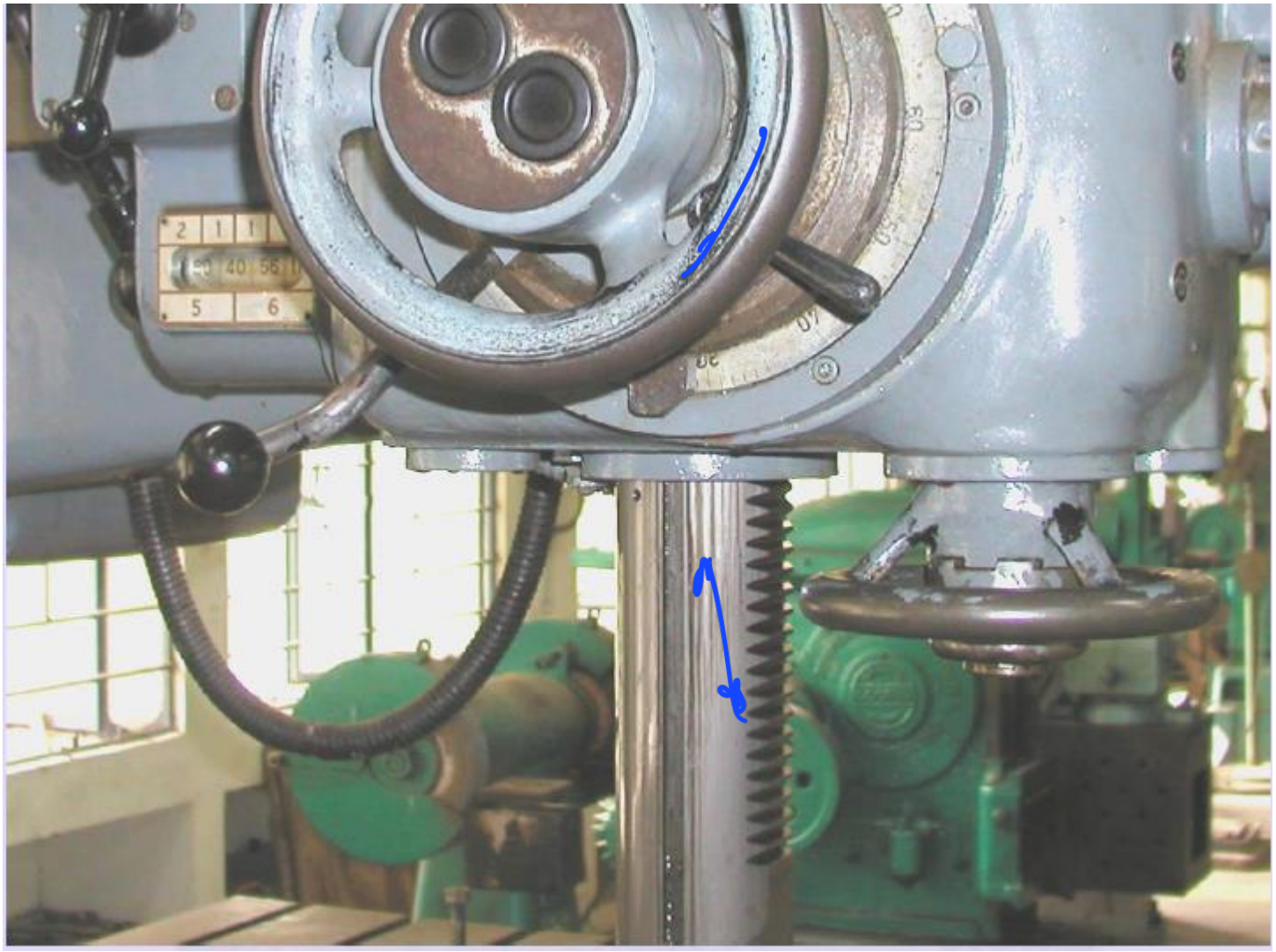






Ref: http://www.mini-lathe.com/Mini_lathe/Features/features_2.htm

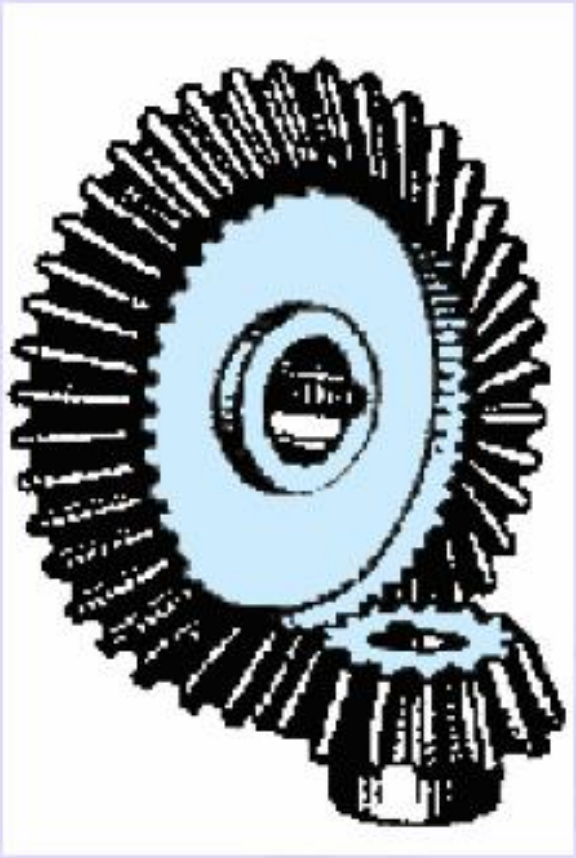
# Rack and pinion in radial drilling machine

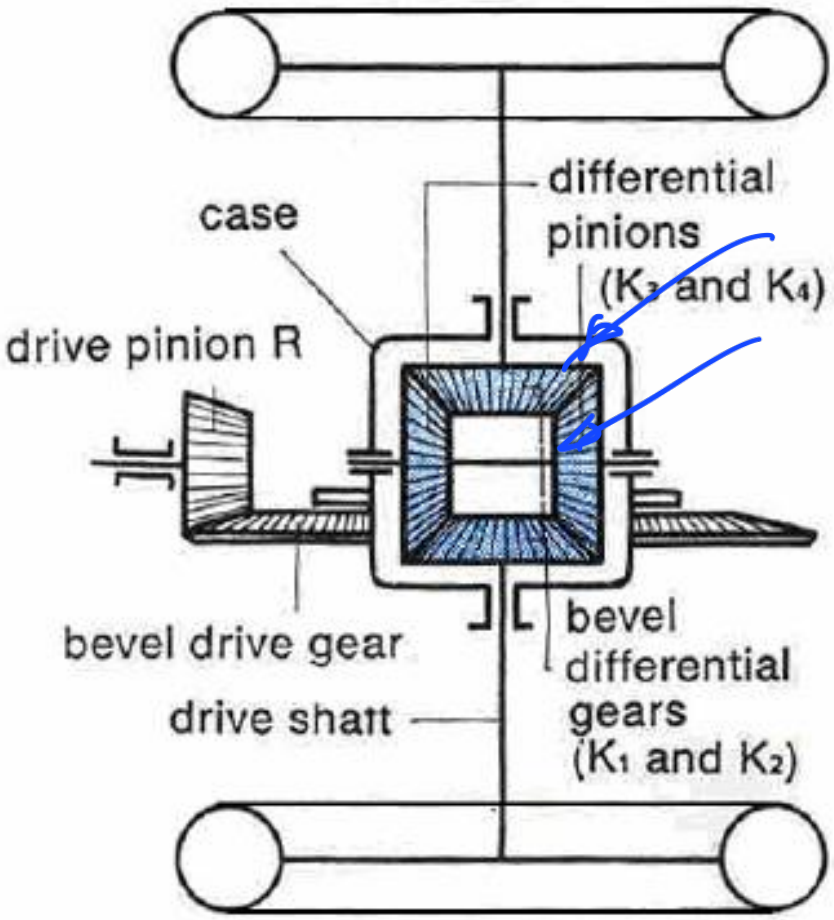




Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Bevel gears in automobile differential

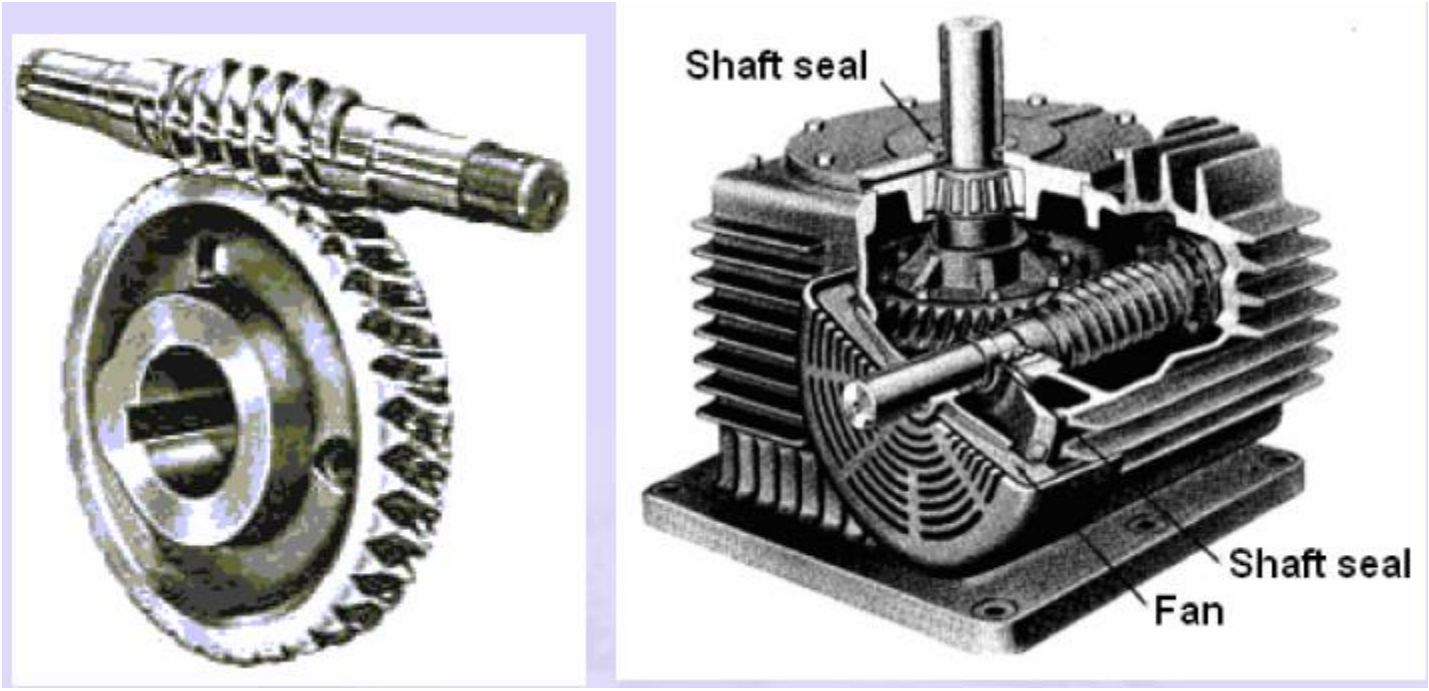







Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Worm gear in crane drive



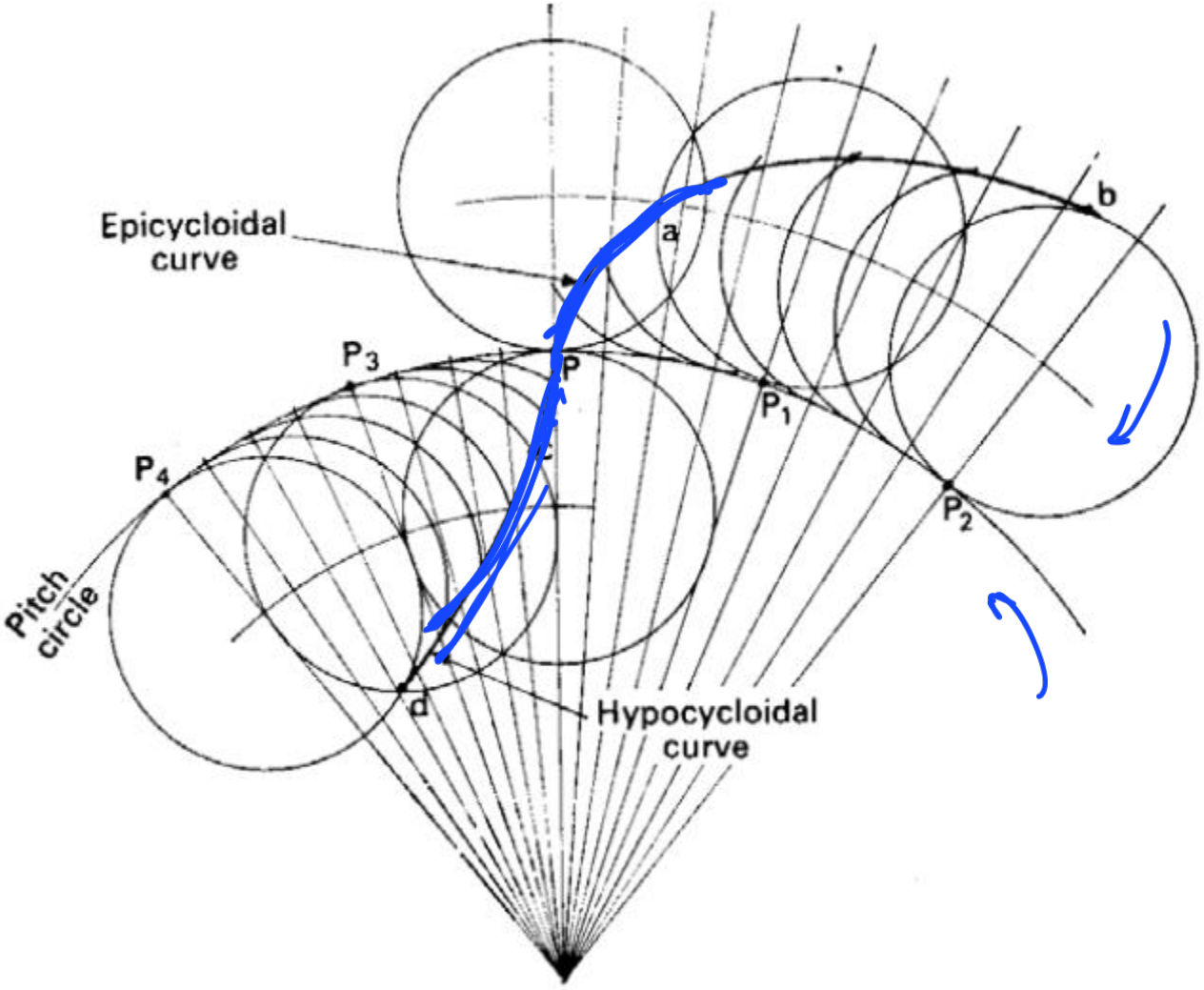


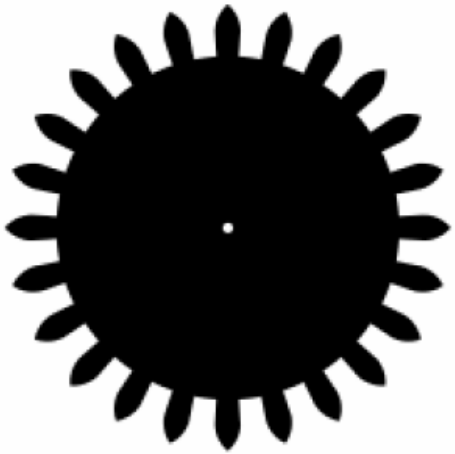

Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Gear Terminology

Reference to Design Data Book

# Cycloid profile

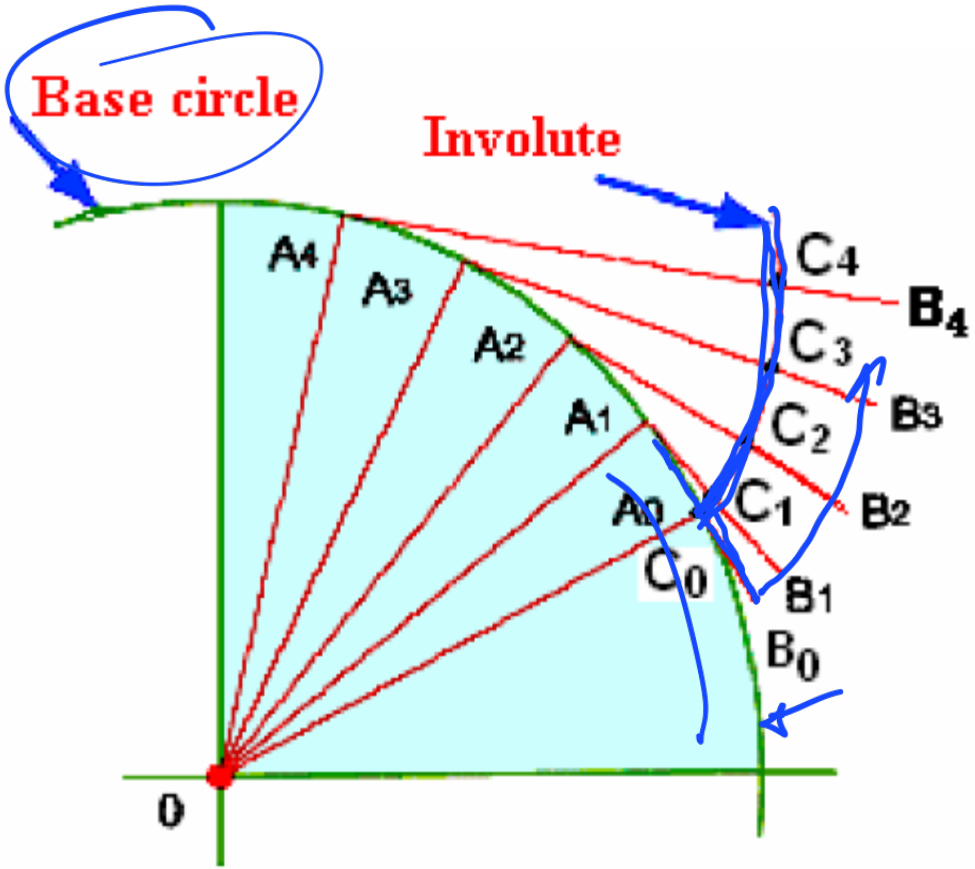


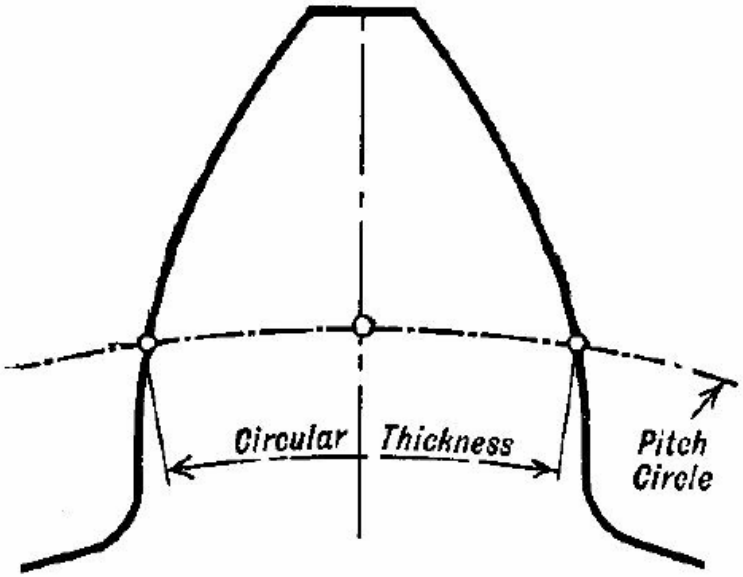





Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Involute profile

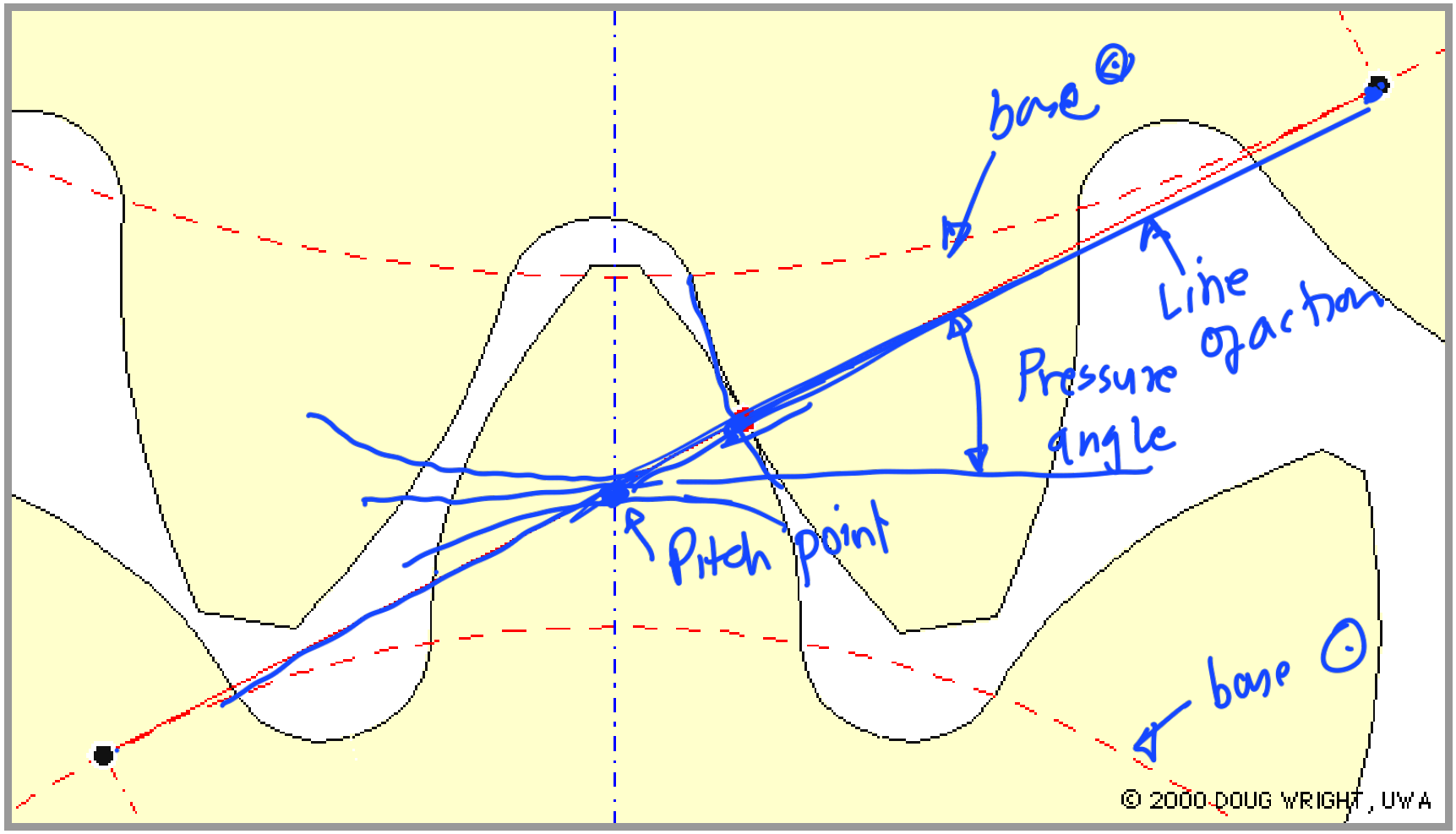





Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

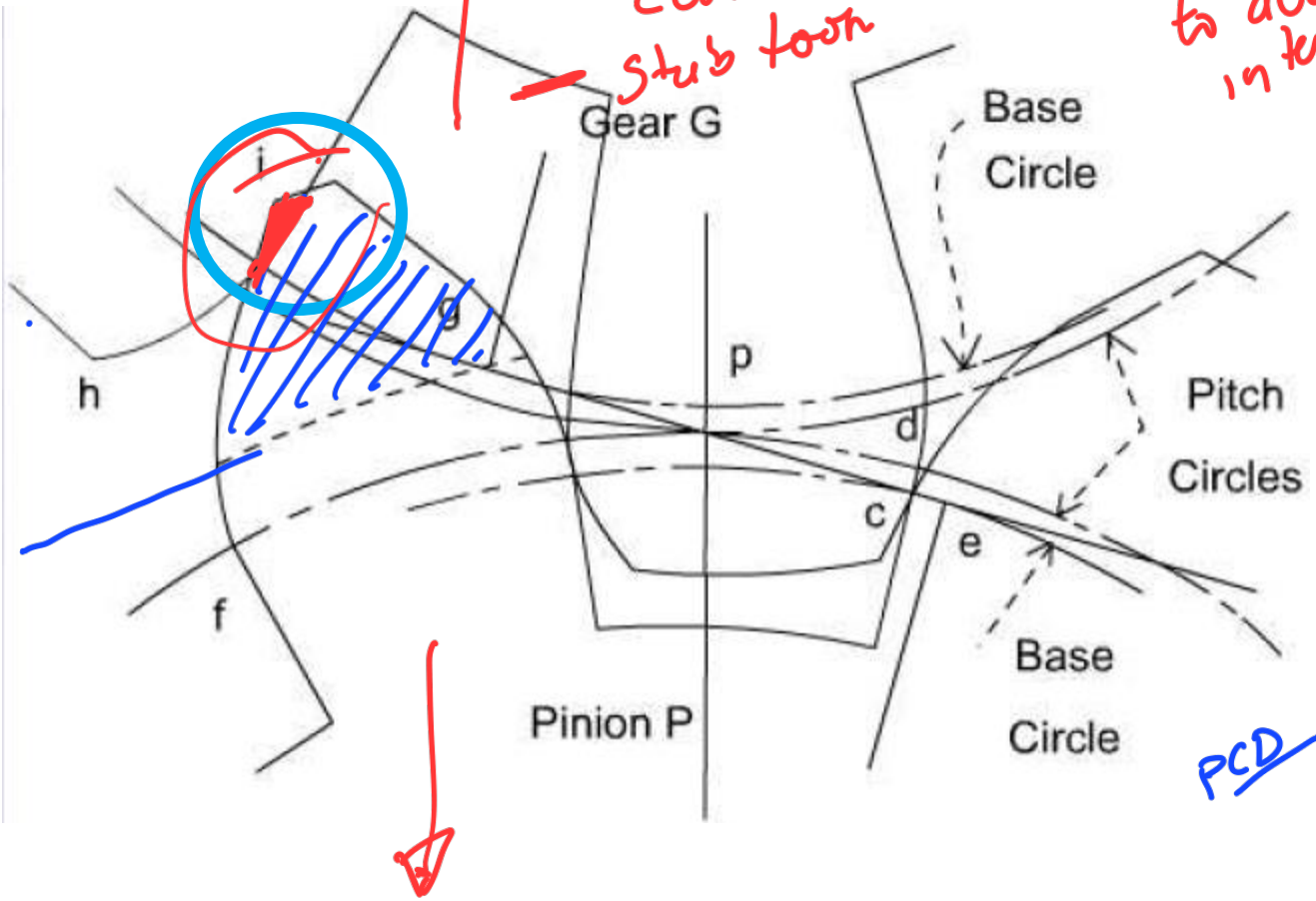
# Involute gear tooth meshing






Ref: http://www-mdp.eng.cam.ac.uk/web/library/enginfo/textbooks_dvd_only/DAN/gears/meshing/meshing.html

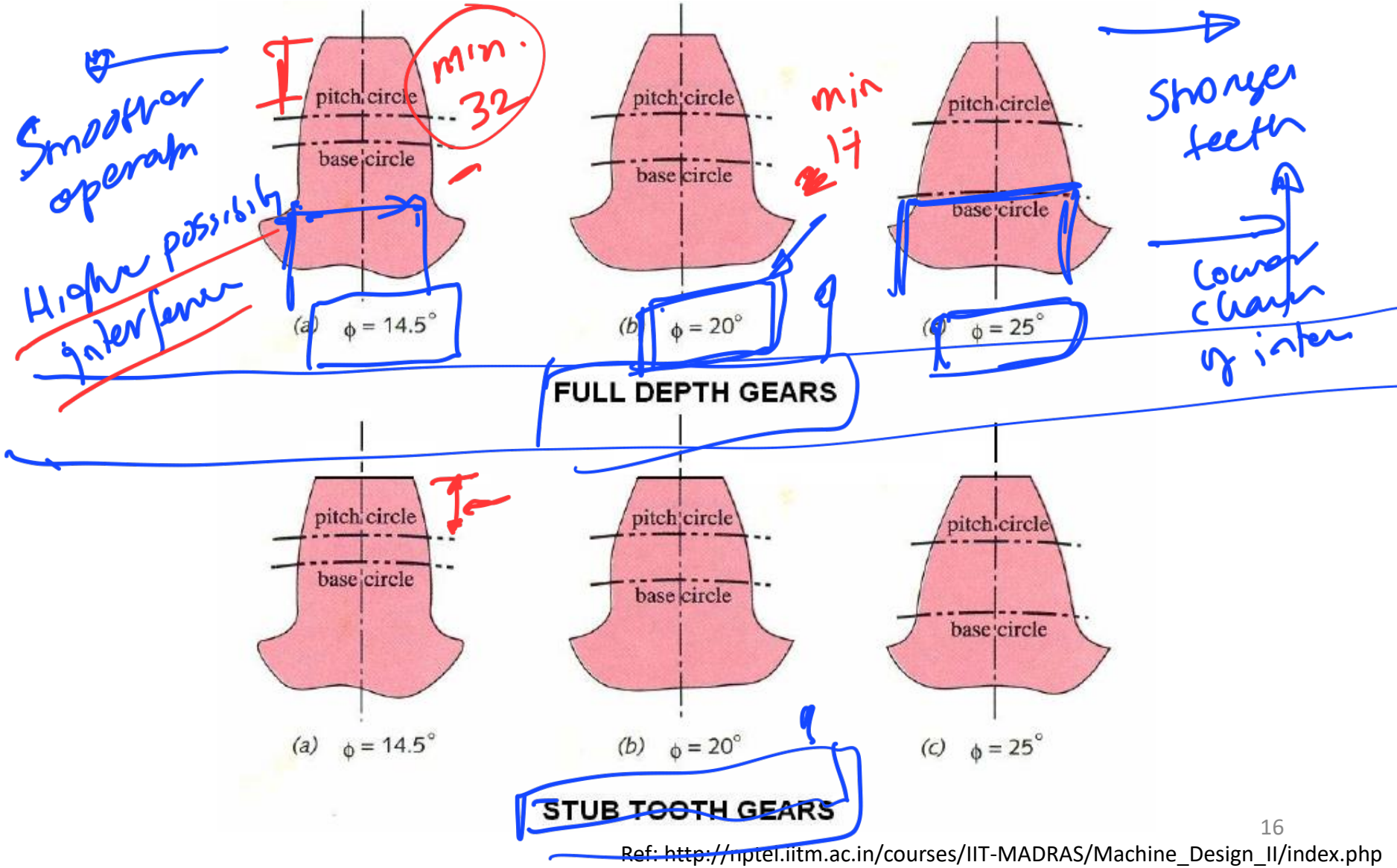
# Interference






Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Standard system of gears





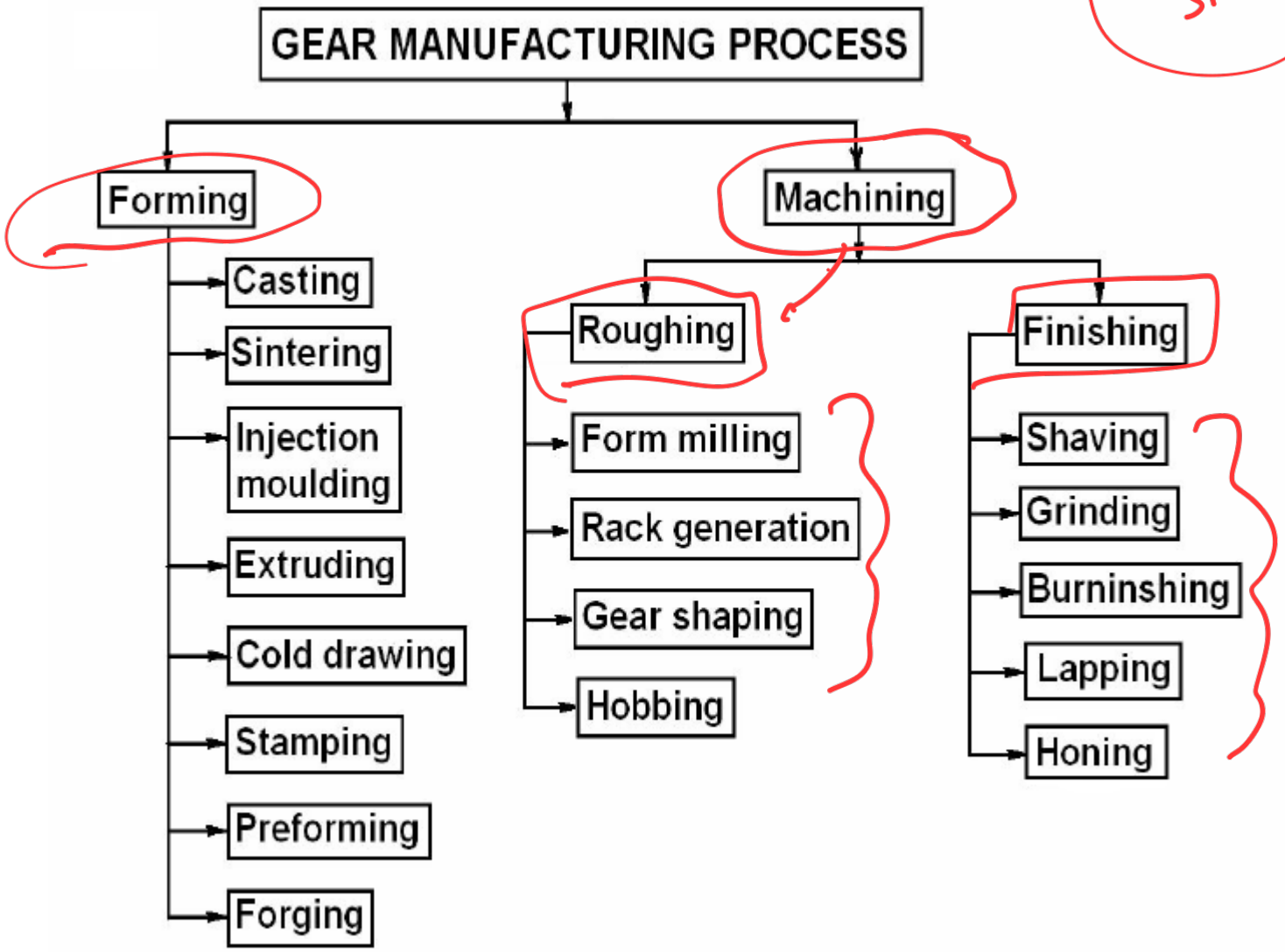

Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Crowning of gear tooth

Ref: http://www.bandhgears.co.uk/gear_crowning.php and
http://www.ameridrives.com/Products-Amerigear-Mill-Spindles-Advanced-Gear-Design.asp

# Gear manufacturing

Self study



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# Gear manufacturing

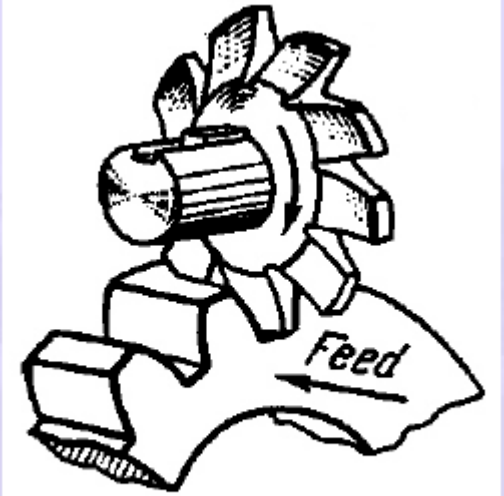



Fig 5.23 Form milling by disc cutter

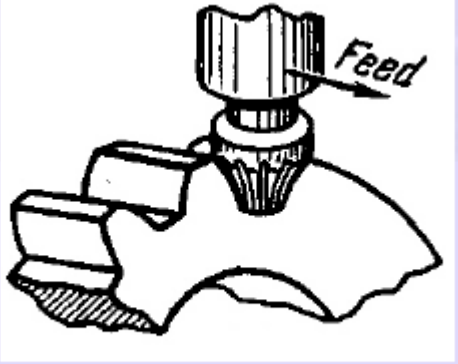



Fig 5.24 Form milling by end mill cutter

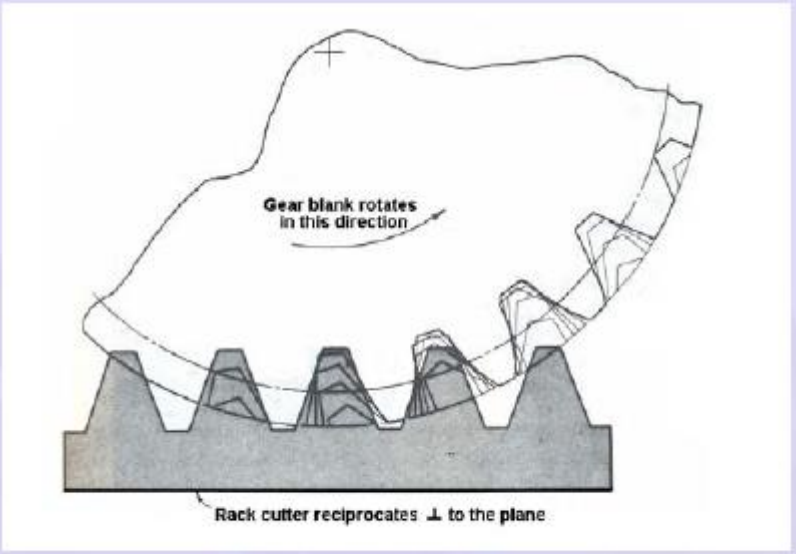
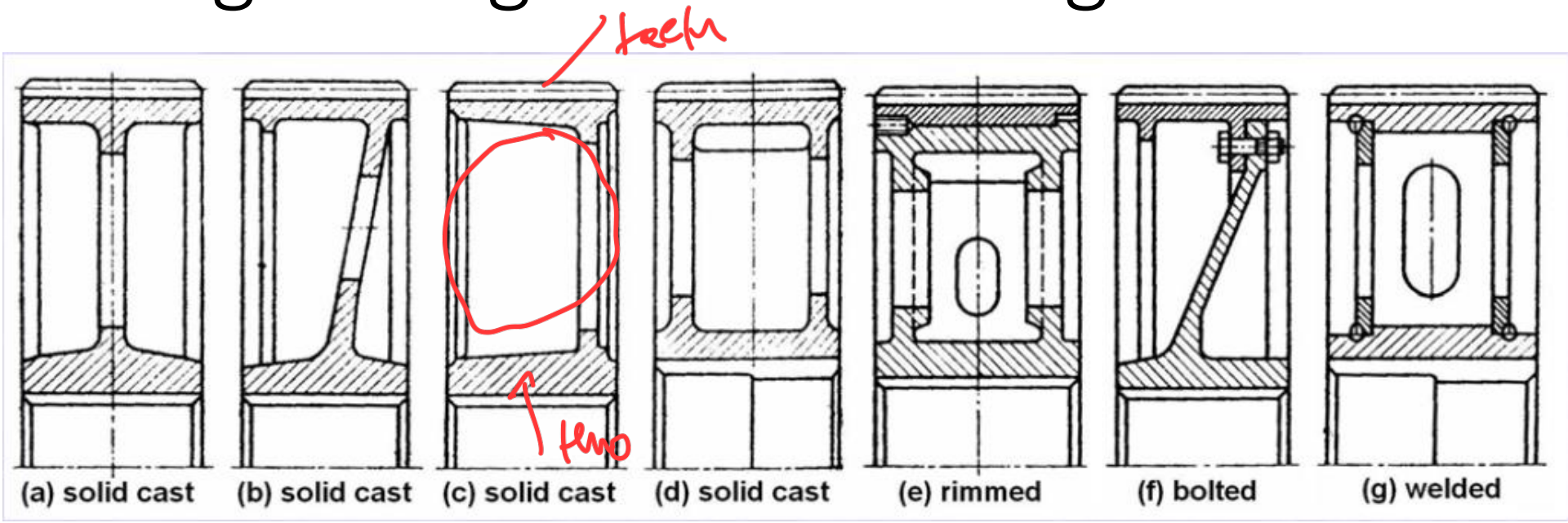


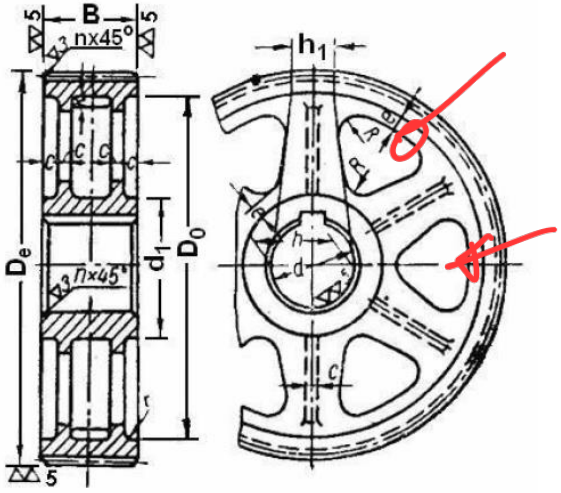

Fig 5.25 Generation of involute tooth on gear blank

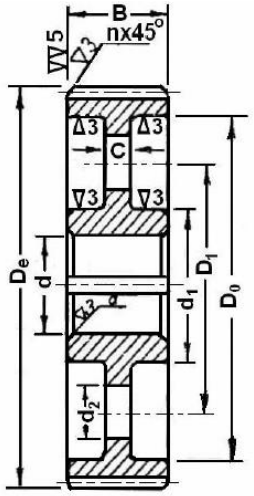


Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

# Large size gear blank design




$d_1 = 1.6d$

$D_0 \approx D_e - 10m$

$c \approx 0.3B$

$n = 0.5m$

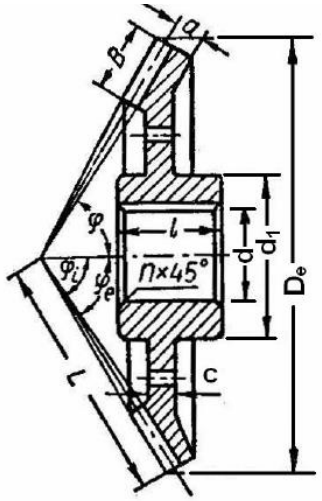
$D_1 = \frac{D_0 + d_1}{2}$

$d_2 \approx \frac{D_0 - d_1}{5}$

$d \approx 0.3A$

m is module in mm

A is centre distance




$d \approx 0.5L$

$d_1 \approx 1.6d$

$l \approx 1.1d$

$c \approx 0.3d$

$a \approx 0.2L$



Ref: http://nptel.iitm.ac.in/courses/IIT-MADRAS/Machine_Design_II/index.php

QUIZ

# Line of action

Line of action is tangent to _____

1. Base circle
2. Pitch circle
3. Dedendum circle

QUIZ

# Pressure angle

Increasing pressure angle results in _____

1. Increase in strength of gear tooth
2. Increase in the minimum number of teeth to avoid interference
3. Both 1 and 2

14.5° 20°

32 → 17

QUIZ

# Interference in gear teeth

Which of the following are ways to reduce interference?

1. Increase centre distance
2. Increase number of teeth
3. Both 1 and 2

# Example 1: Gear geometry

A pair of spur gears consists of a 14 teeth pinion meshing with 70 teeth gear. m = 3 mm. Calculate-

i. Center distance
ii. Pitch circle diameters
iii. Addendum and Dedendum
iv. Bottom clearance
v. Gear ratio
vi. Given pressure angle = $20^{o}$. If center distance is increased by 1.5%, what is new pressure angle?

(i) Center distance : $a = \frac{m(z_p + z_g)}{2} = 126$

DDB
17.8
17.9

(ii) $d_p = m \cdot z_p = 42$ mm

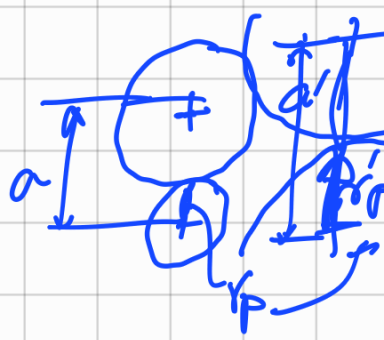
$d_g = m \cdot z_g = 210$ mm

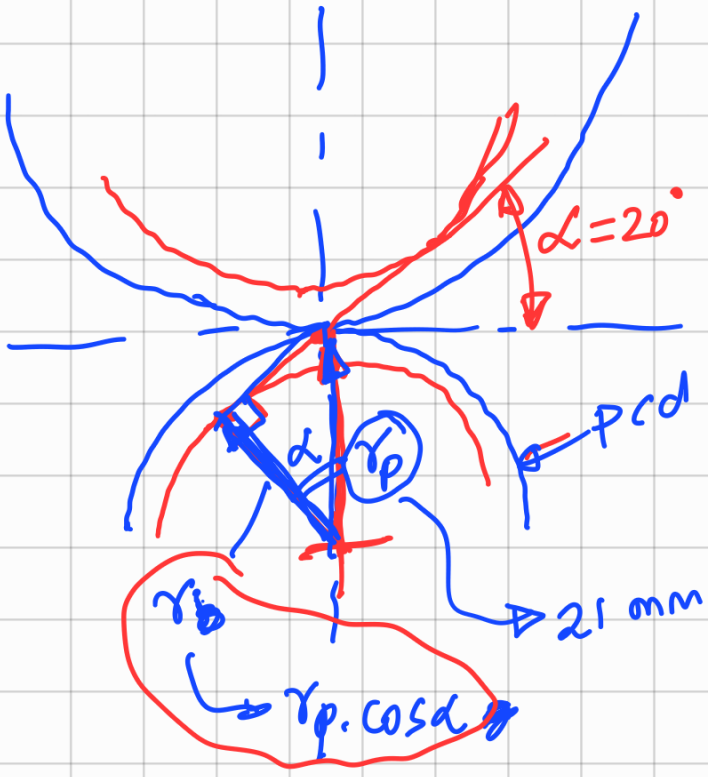
(iii) Addendum $= h_a = m = 3$ mm

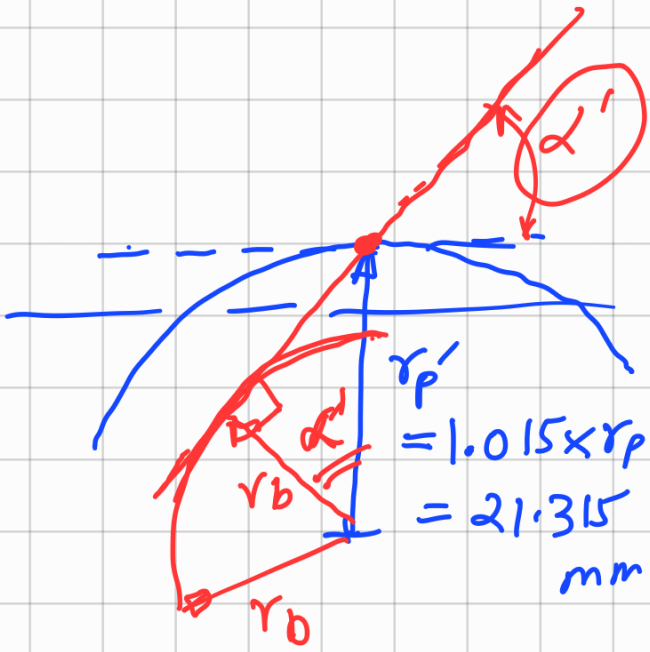
dedendum $= h_f = 1.25m = 3.75$ mm

(iv) Clearance $= 0.25m = 0.75$ mm

(v) Gear ratio $= \frac{70}{14} = 5$




$r_b = r_p' \cdot \cos\alpha'$

$r_p \cdot \cos\alpha = 21.315 \cos\alpha'$

$21 \times \cos 20 = 21.315 \cos\alpha'$

$\boxed{\alpha' = 22.2°}$

# Spur gear force analysis