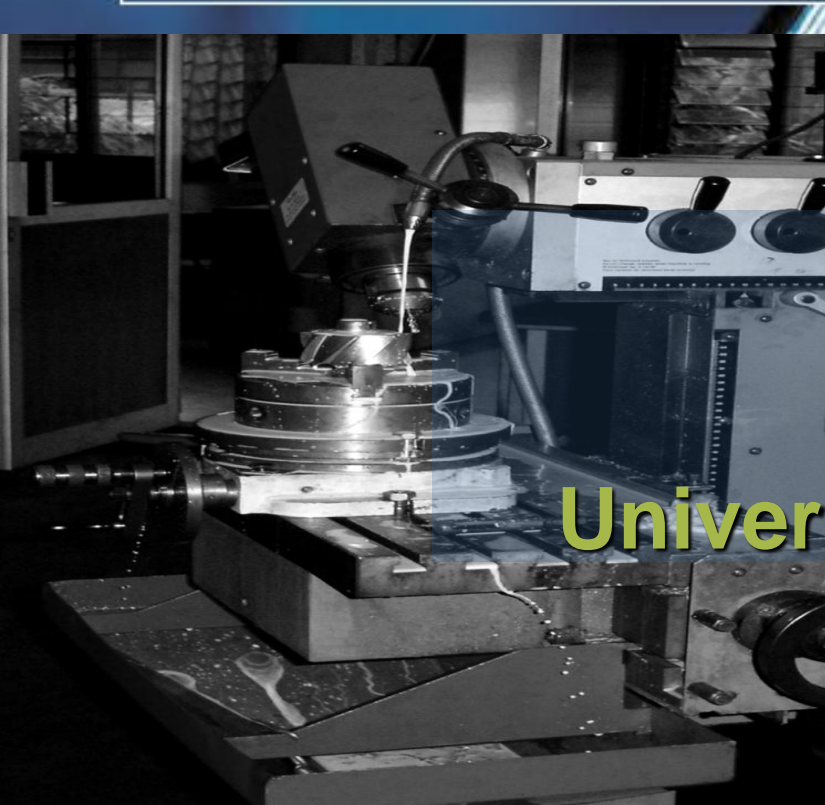




Proses Frais

Metal Cutting Process



Sutopo
Fakultas Teknik
Universitas Negeri Yogyakarta



Cutting tools review questions:

- *Penentuan parameter pemotongan manakah yang paling mempengaruhi keausan alat potong? (a) cutting speed, (b) depth of cut, atau (c) feed.*

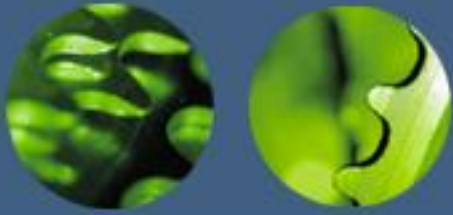
Answer: (a)

- *Sebagai unsur paduan high-speed steel, tungsten memiliki sifat-sifat istimewa. Sifat manakah yang dimiliki oleh tungsten (jwb lebih dari satu)? (a) forms hard carbides to resist abrasion, (b) improves strength and hardness, (c) increases corrosion resistance, and (d) increases hot hardness.*

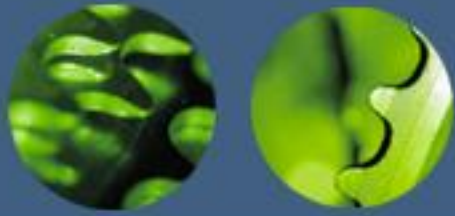
Answer: (a), (b), (d)

- *Unsur-unsur utama pembentuk Cast cobalt alloys adalah (jwb lebih dari satu)? (a) aluminum, (b) cobalt, (c) chromium, (d) nickel, and (e) tungsten.*

Answer: (b), (c), (e)

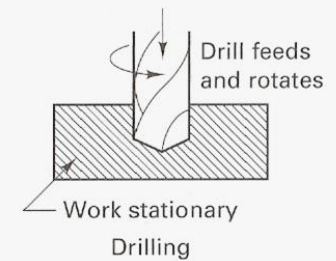
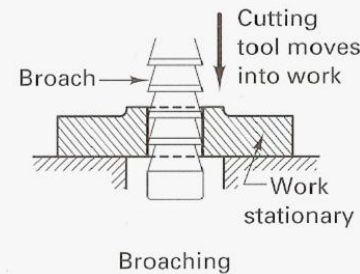
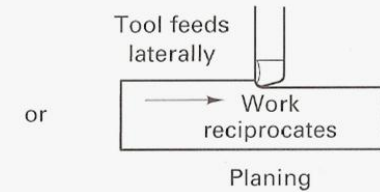
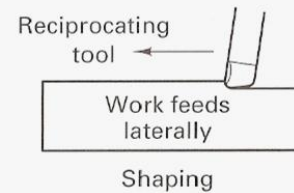
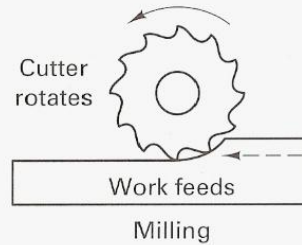
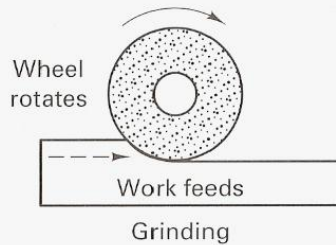
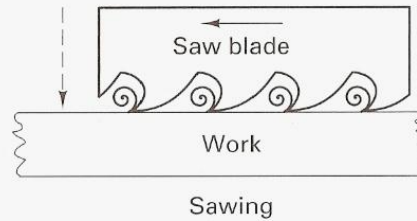
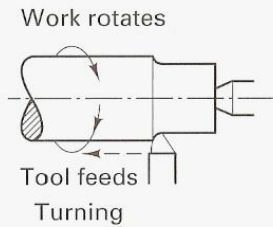


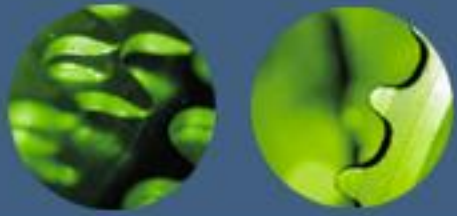
- *Berikut ini yang bukan unsur pembentuk cemented carbide cutting tools (more than one answer)?*
(a) Al_2O_3 , (b) Co, (c) CrC, (d) TiC, and (e) WC. **Answer: (a), (c)**
- *Meningkatkan kandungan cobalt pada WC-Co cemented carbides akan memberikan pengaruh (one best answer)?*
(a) decreases transverse rupture strength, (b) increases hardness, (c) increases toughness. **Answer: (c)**
- *Berikut adalah unsur yang tidak terdapat dalam cemented carbide untuk pemotongan baja (more than one answer)?* *(a) Co, (b) Ni, (c) TiC, (d) TaC, and (e) WC.* **Answer: (b)**



Dasar-dasar proses pemesian

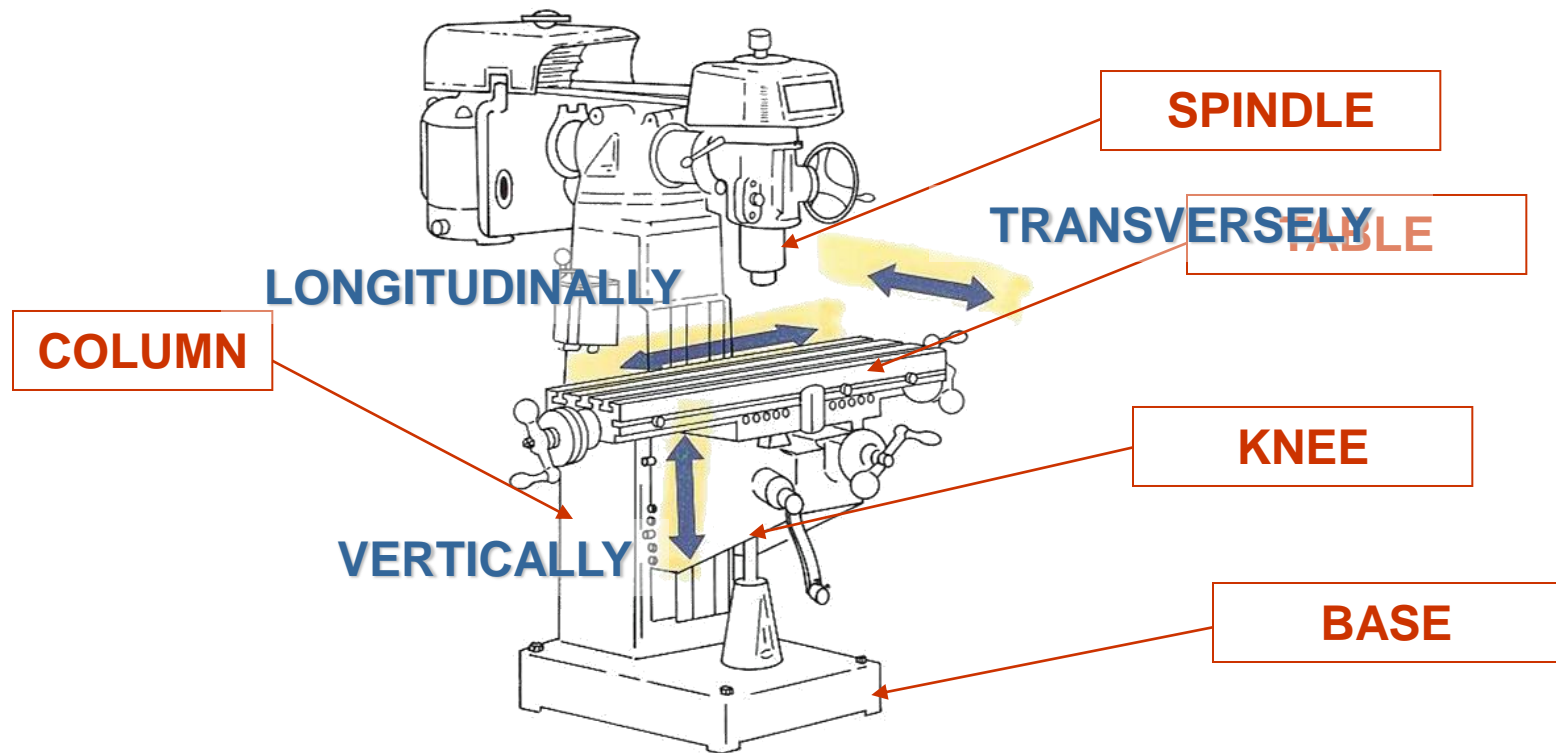
Beberapa dasar proses pemesian

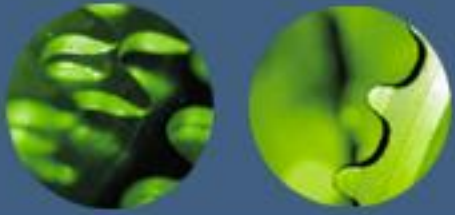




Machining Fundamentals

- Mesin Frais (Milling Machine)



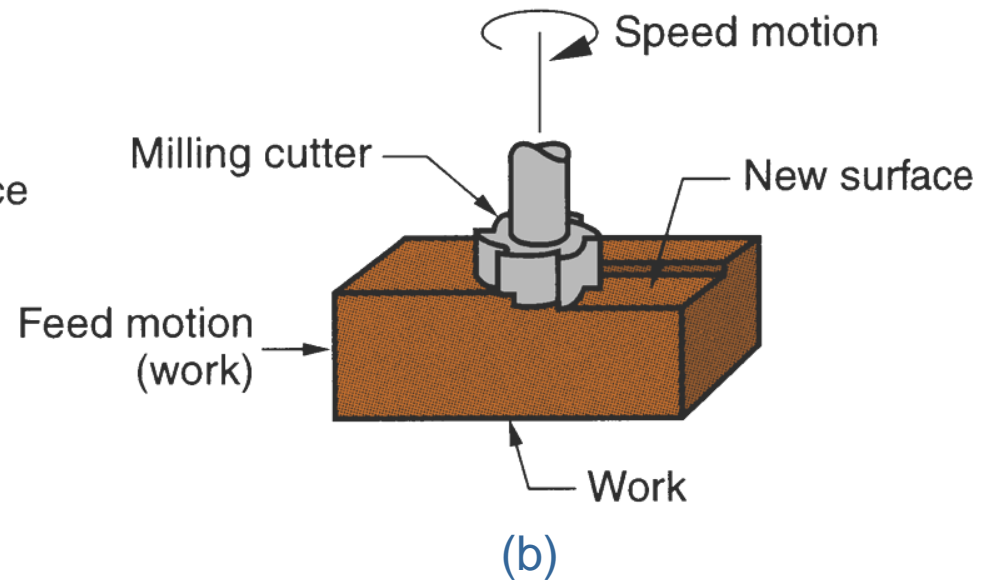
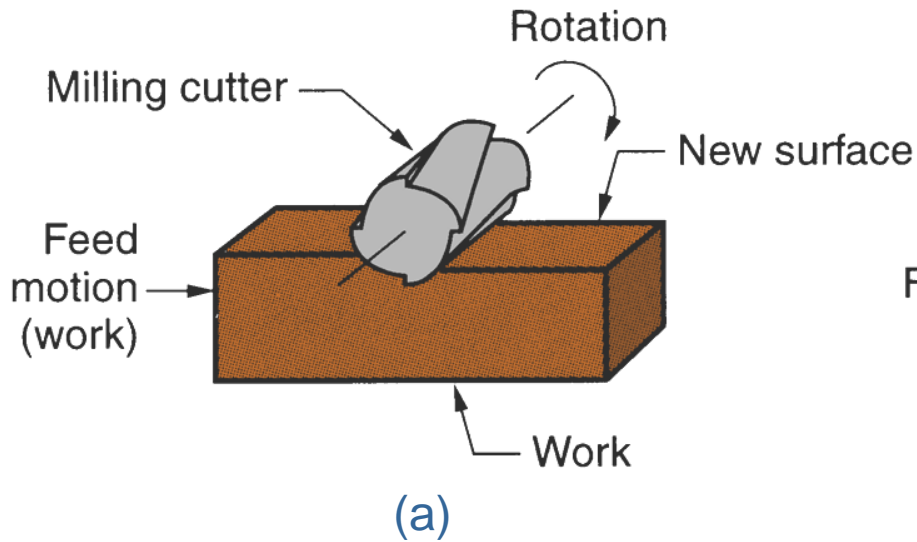


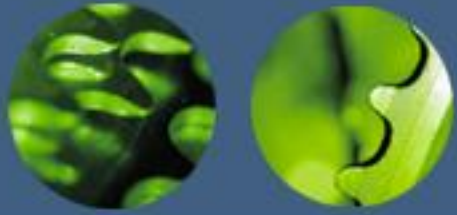
Proses Frais

•Ada 2 bentuk:

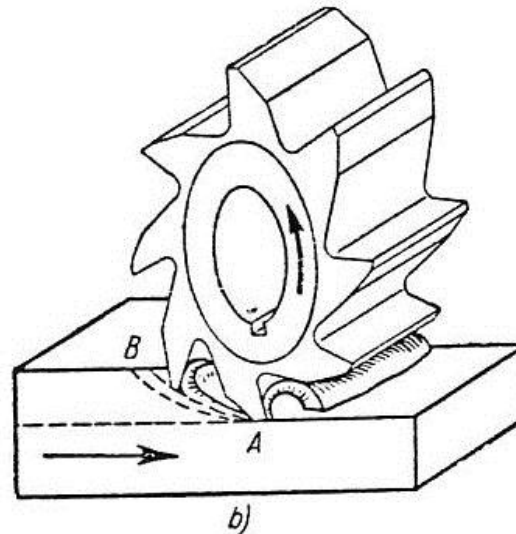
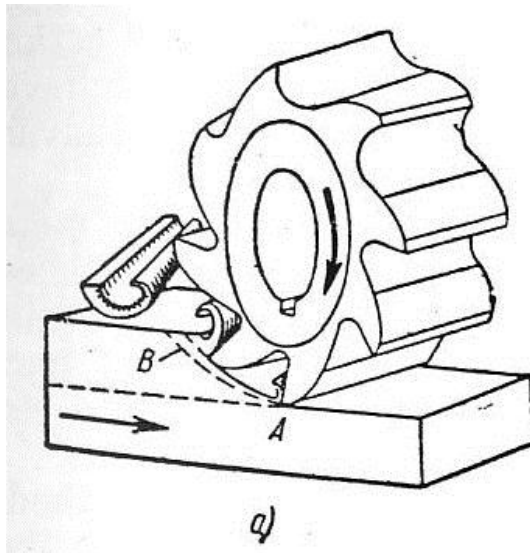
(a) *peripheral milling (Frais horizontal)*

(b) *face (or end) milling (Frais Vertikal)*





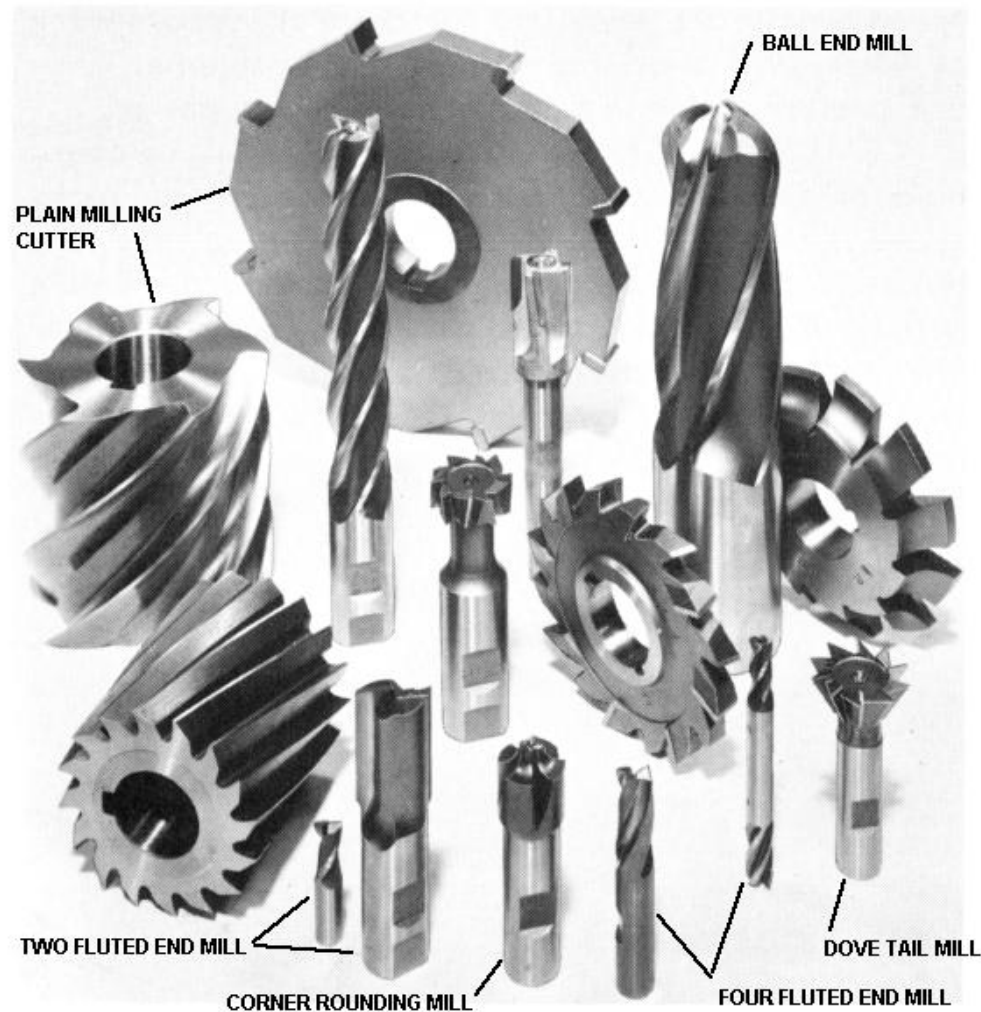
Metode pengefraisan

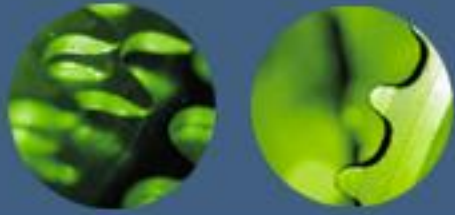


(a) frais naik (*up milling*) dan (b) frais turun (*down milling*)



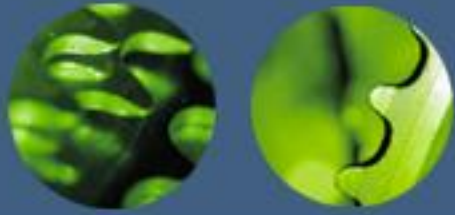
Berbagai jenis bentuk pahat frais





Parameter dasar proses pemesian

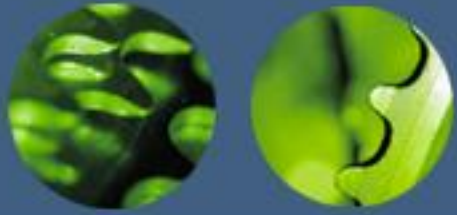
- Cutting Speed
 - Feed Rate
 - Depth of cut
 - Machining time
-
- Metal Removal Rate



Basic Machining Parameters

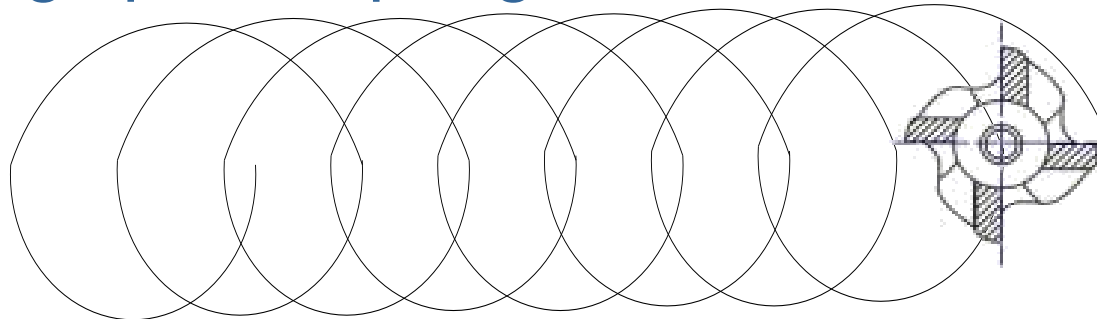
Penentuan variabel pemesinan seperti: cutting speed, feed speed, metal removal rates, dan depth of cut tergantung:

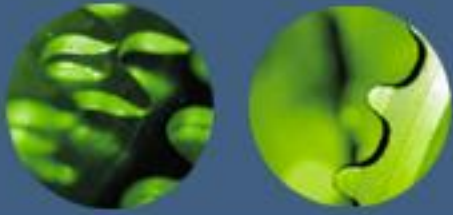
- Work material
- Tool material
- Specific process/equipment



Cutting Speed

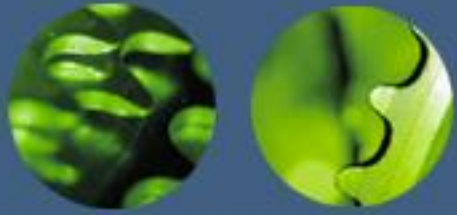
- Cutting speed adalah jarak yang ditempuh oleh sisi potong pisau frais dalam gerak melingkar selama satu menit
- Biasanya diukur dalam satuan m/min atau **Surface Feet per Minute (SFPM)**
- Cutting speed dipengaruhi oleh?





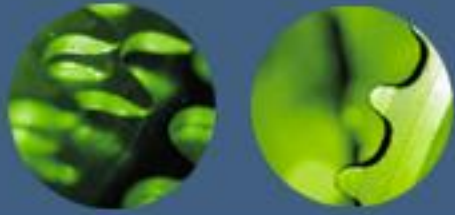
Cutting Speed

- Penggunaan cutting speed:
 - cutting speed terlalu tinggi, cutter akan overheat dan cepat tumpul
 - cutting speed terlalu rendah, banyak waktu yang terbuang dan ongkos produksi akan meningkat



Cutting Speed

- Faktor-faktor yg mempengaruhi penentuan cutting speed dlm proses frais:
 - Material properties,
 - cutting tool (HSS, carbide, cast alloy),
 - Feed
 - Depth of cut
 - cutting fluids
 - Machine rigidity



Cutting Speed Formula

$$V = (\pi * D * n)/1000$$

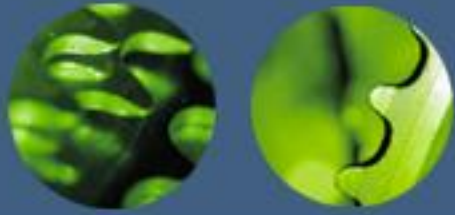
Dimana

V = Cutting speed (m/min)

π = Circumference constant per mm of Diameter

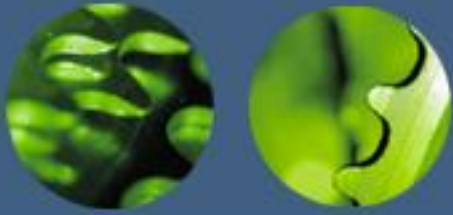
D = Diameter of the cutter, measured in mm

n = revolutions per minute of the spindle (rpm)

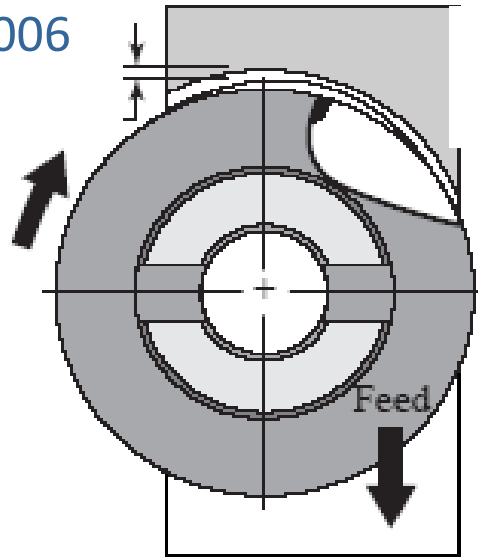


Feed Rate

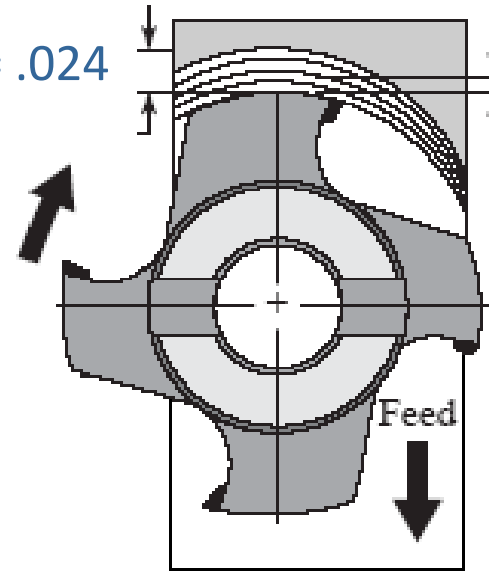
- Jarak yang ditempuh oleh pisau frais dalam arah linier yang diukur dalam mm/min.
- Feed rate dlm proses frais ditentukan oleh:
 - Jumlah gigi pisau frais
 - Gerak makan yang bekerja tiap gigi (chip load)
 - Putaran pisau frais



$$f_r = f_z = 0.006$$

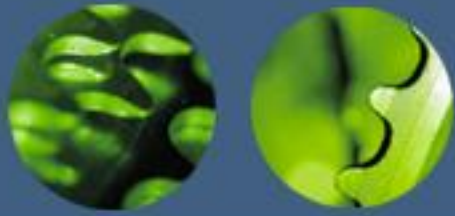


$$f_r = .024$$



$$f_z = .006$$

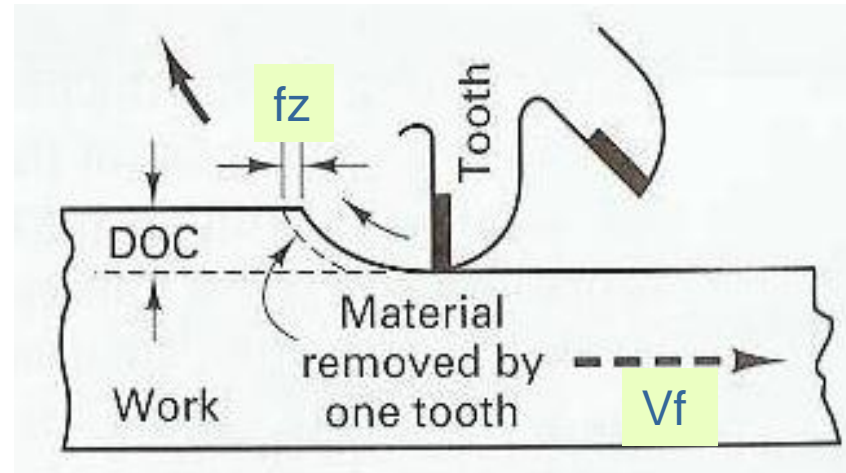
Perbedaan antara gerak makan per gigi (f_z) dan gerak makan per putaran (f_r).



Chip Load

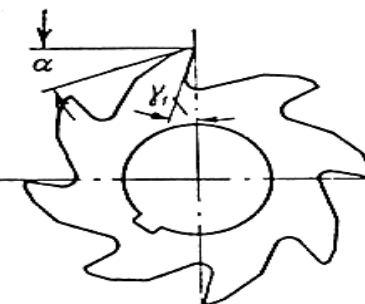
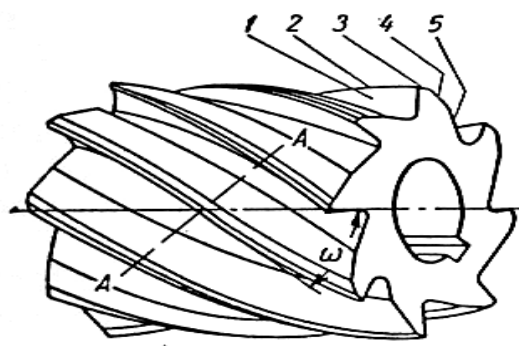
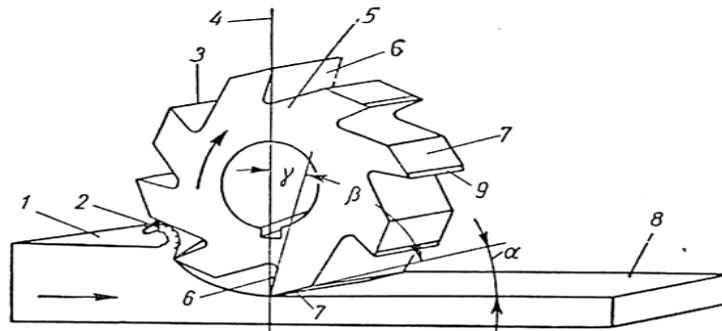
Gerak makan per-gigi

- Chip Load adalah sejumlah material yang harus dipotong oleh setiap gigi dalam satu putaran pisau frais

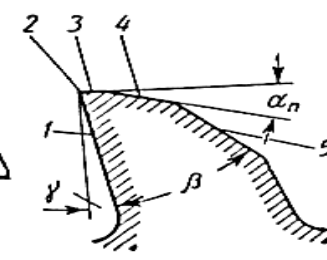


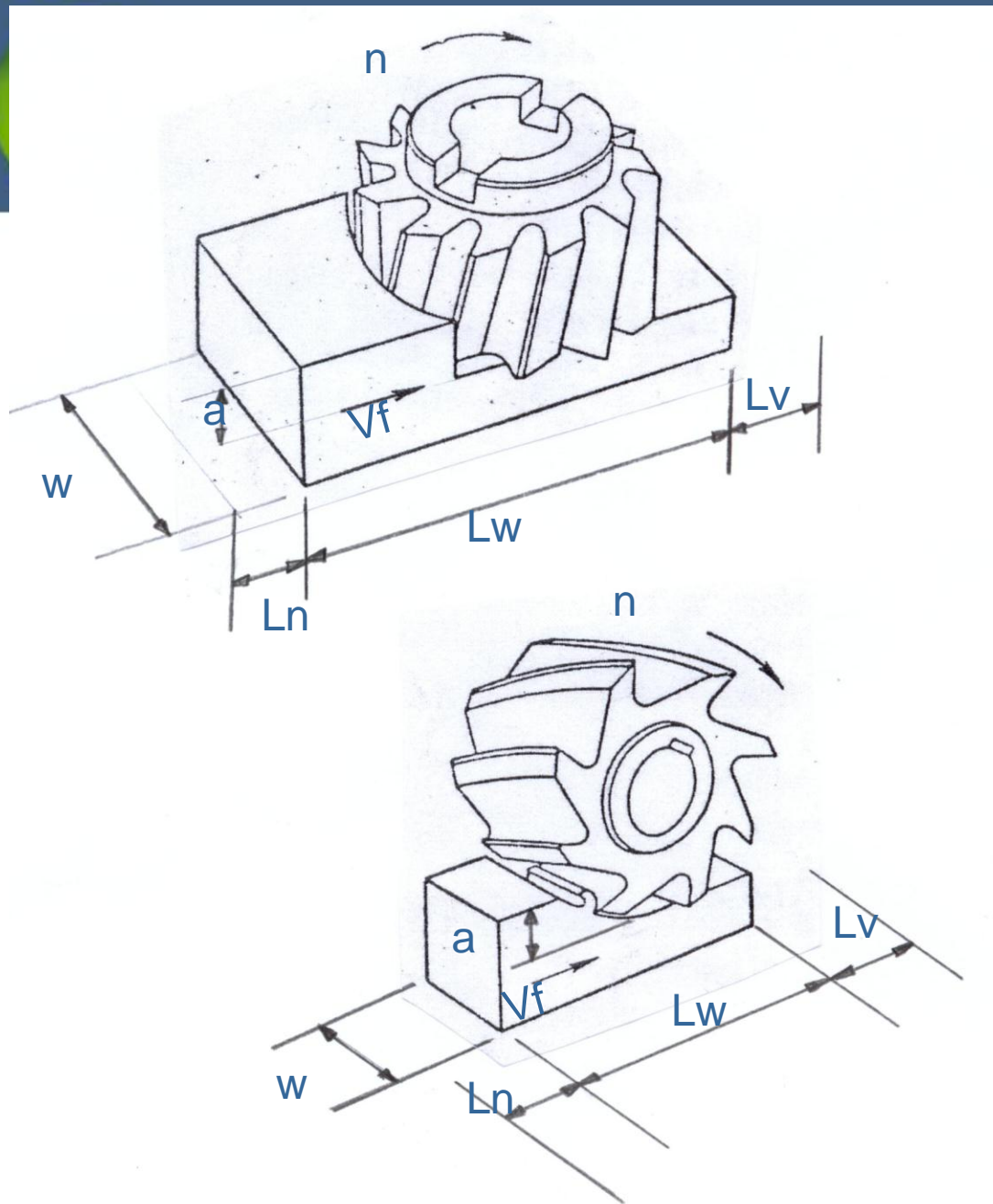
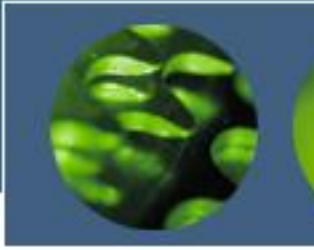


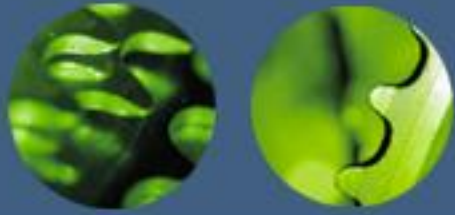
Geometri pahat frais selubung HSS



Potongan A-A







Milling Feed Rate Formula

$$v_f = n * f_z * Z$$

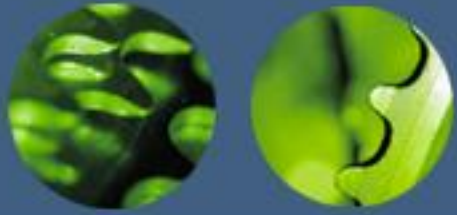
where

v_f = kecepatan pemakanan (mm/min)

n = putaran spindle mesin (rpm)

f_z = gerak makan per gigi (mm/gigi)

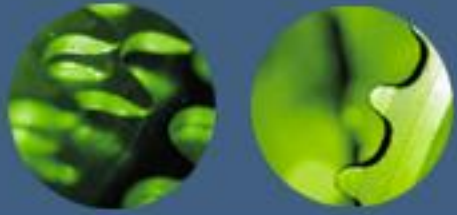
Z = Jumlah gigi pada pisau frais



Calculating Feed Rate

Sebuah cutter frais dengan diameter 60 mm dan memiliki 8 gigi, sedangkan putarannya 500 rpm. Berapakah kecepatan pemakanan yang diijinkan apabila feed pergigi 0,01 mm

$$\begin{aligned}v_f &= n \times f_z \times z \\ &= 500 \text{ rpm} * 0.01 \text{ mm/tooth} * 8 \text{ teeth} \\ &= 40 \text{ mm/min}\end{aligned}$$

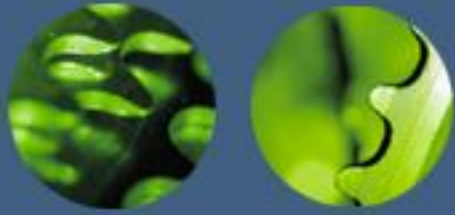


Waktu Pemotongan

T_c = Panjang pemesinan : kecepatan pemakanan

$T_c = L_t/v_f$ (min).....satu langkah

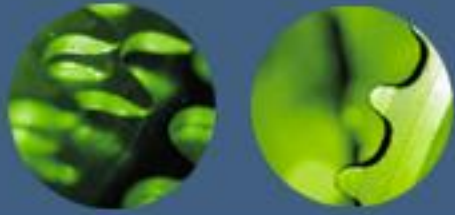
- Panjang pemesinan = L_t
- Dimana: $L_t = L_v + L_w + L_n$
 - L_v = jarak pengawalan (mm)
 - L_w = panjang pemotongan (mm)
 - L_n = jarak pengakhiran (mm)



Metal Removal Rate

Metal Removal Rate (MRR) adalah volume penghasilan tatal dalam satu menit.

- Limited to available machine power
- How much material is removed in 1 minute



MRR Formula

$$\text{MRR} = w * a * v_f : 1000$$

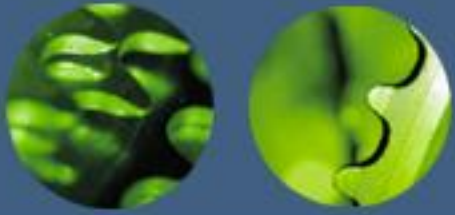
Di mana

MRR = cm³ /min

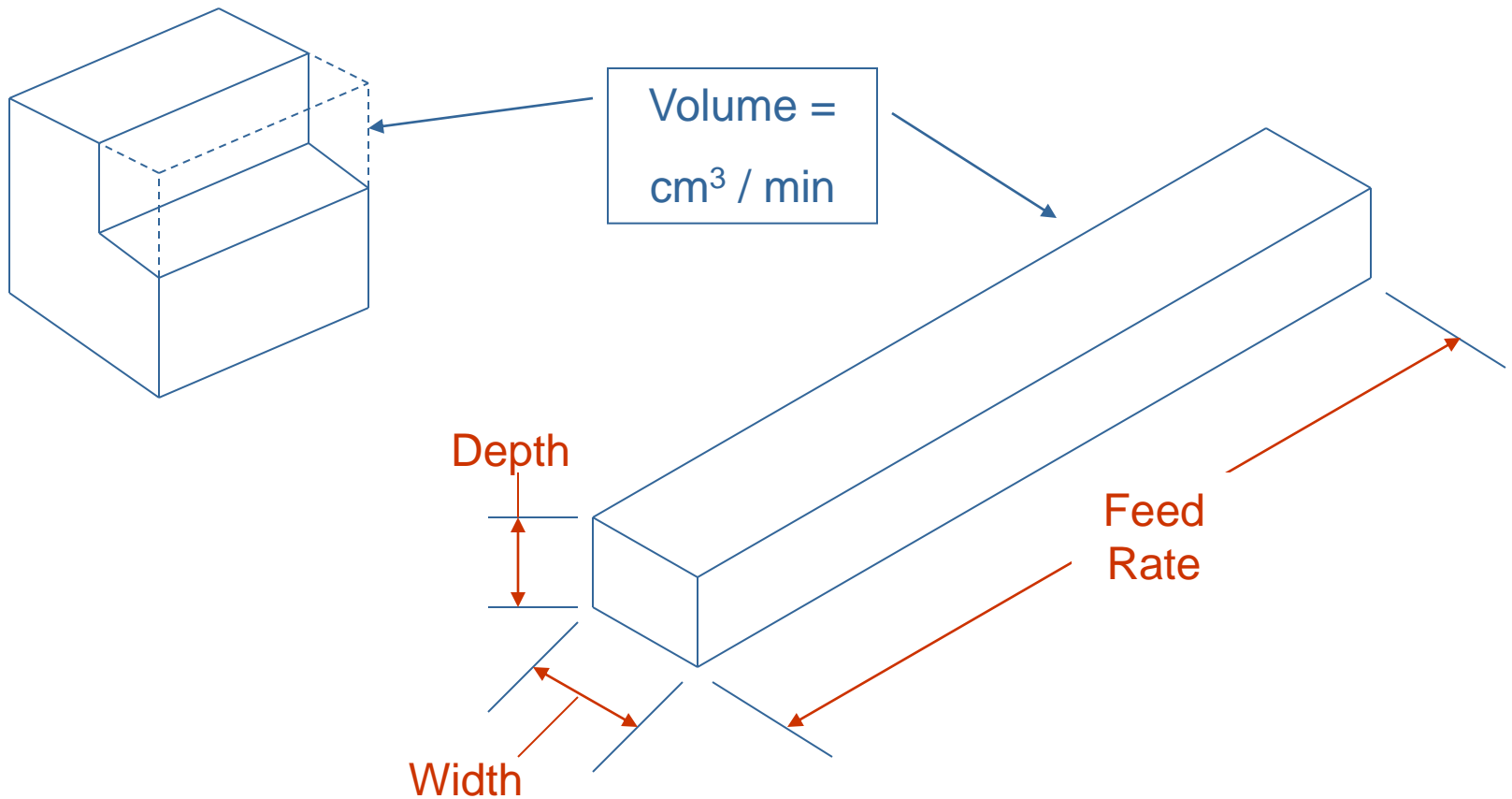
w = lebar pemotongan (mm)

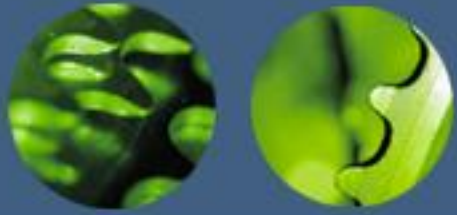
a = kedalaman potong (mm)

v_f = Kecepatan makan (mm/min)



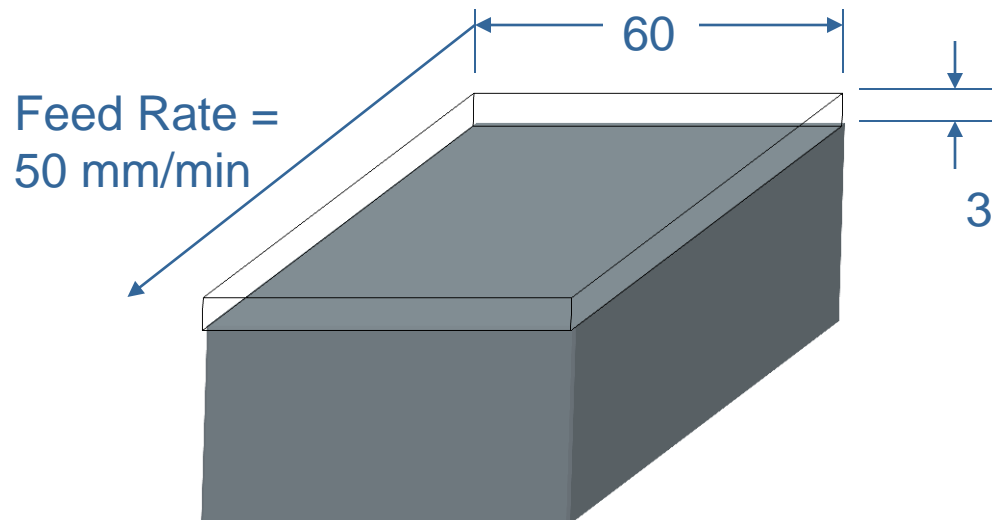
MRR Graphic

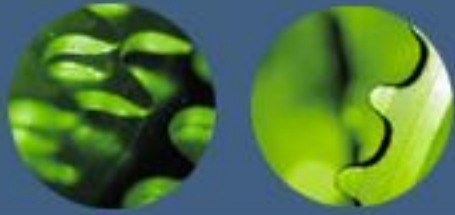




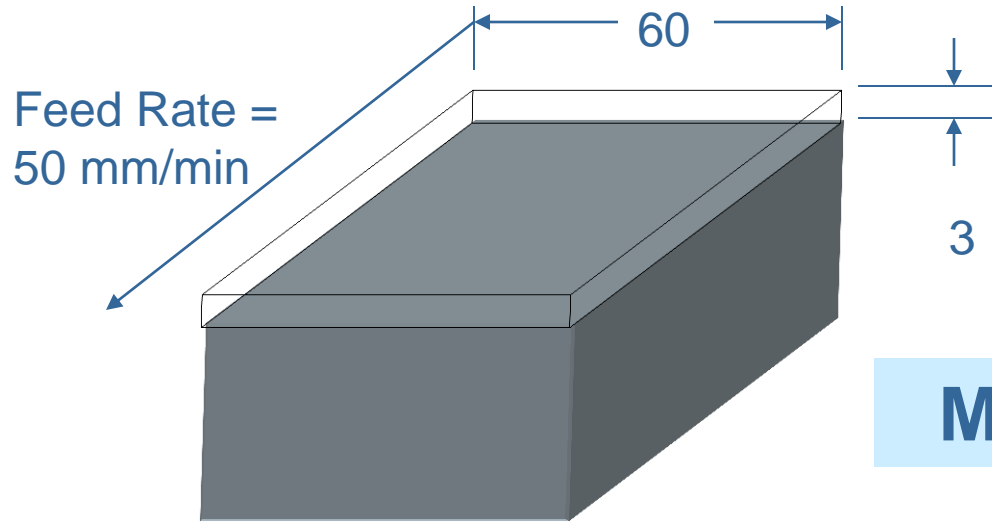
MRR Example

Sebuah bahan dengan lebar permukaan 60 mm akan difrais menggunakan cutter yang memiliki 6 gigi. Tentukan MRR-nya, jika depth of cut diambil 3 mm dan feed rate meja adalah 50 mm per menit





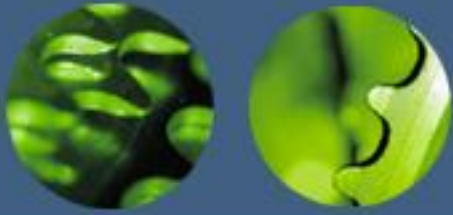
MRR Example



$$\text{MRR} = w * a * vf$$

$$\text{MRR} = (60) * (3) * (50) : 1000$$

$$\text{MRR} = 9 \text{ cm}^3/\text{min}$$

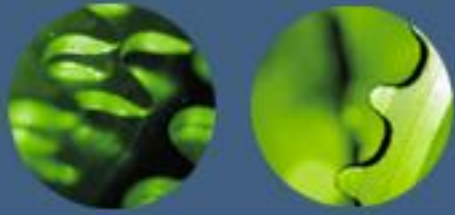


Review

Machining variables such as cutting speed, RPM, table feed rates, metal removal rates, and depth of cut all depend on:

- Work material
- Tool material
- Specific process/equipment

WHY?



Mengefrais helix

- Kisar meja (6mm)
- Dividing head (40:1)
- Benda kerja dengan diameter 50 mm akan difrais helix dengan sudut 10,5 derajat, hitunglah kisar benda kerja dan roda-roda tukar yang diperlukan