Introduction to Manufacturing Processes.

Turning centre

a) machining:
Man. pro. of getting desired shape by removing extra amt. of materials.

b) forming: not in course
Man. pro. of getting desired shape through plastic deformation by application of forces.

forming
- → Rolling
- → forging
- → extrusion.
- → wire drawing
- → sheet metal forming process

c) welding and joining: rivets, nuts & bolts, screws. soldering, brazing, etc.
→ Man. pro. of joining two metal pieces by application of heat, pressure or both

T_W — Temp. developed in workplace

If $T_W > M.P$ (Fusion welding) → oxy acetylene, → shielded metal arc

$T_W < MP$ (solid state welding)

d) Casting:
Man. pro. of getting desired shape by pouring liq. metal into a mould cavity and allowing it to solidify.

Diff b/w strength & hardness

Machining:

Yield strength:

Hardness : bulk property
strength : surface property.

Requirements for maching

~~Hardness~~

→ cutting tool : hardness & sharpness req^d.

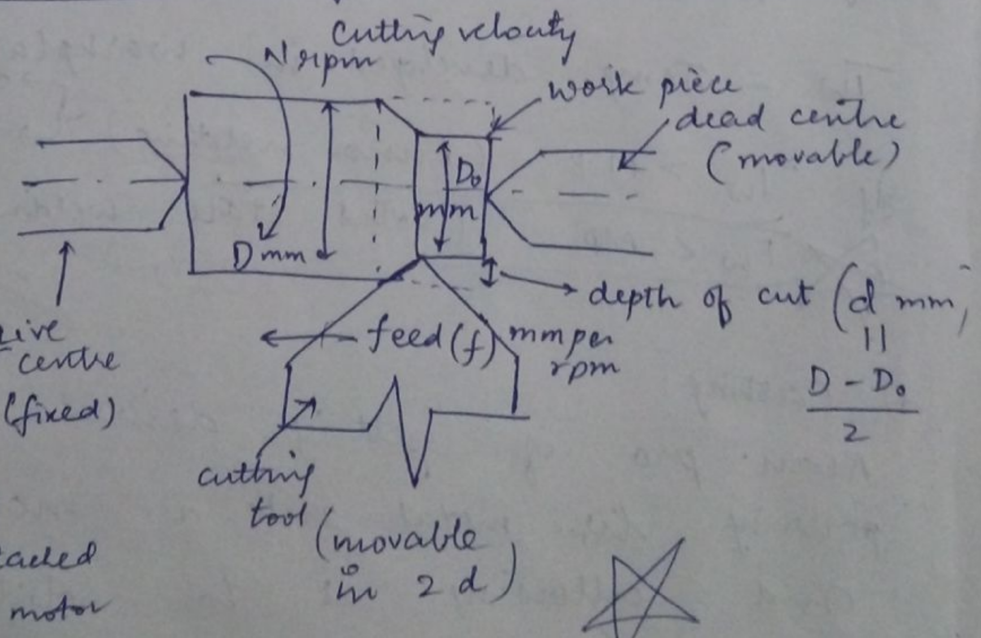
→ machine tool: holds work piece and cutting tool and it provides rel. motion b/w them.

egs of machine tools: Lathe, milling, drilling, shaper, slotter, grinding mach., broaching mach., gear hobbing

Lathe:

Turning process (Top view)

Red^n in diameter takes place



Depth of cut depends on strength of workpiece and cutting tool. ②

Less depth of cut ⇒ smoother cut

→ Process parameters are used to control time & quality of product

Process parameter:
a) depth of cut (d in mm)
b) feed (speed of cutting tool)(f) mm per rpm
c) cutting velocity (V_c) N = rpm

$$V_c = \frac{\pi D N}{60 \times 1000} \text{ m/s}$$

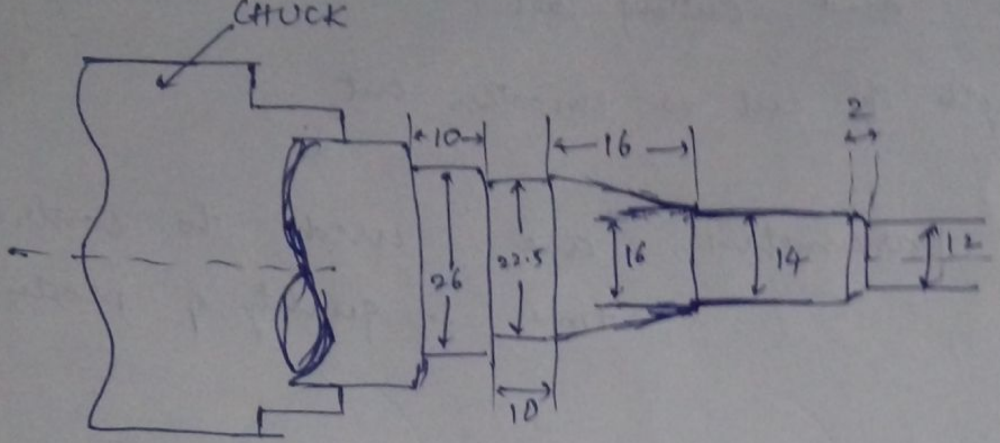
tangential vel. of removed material

CNC (computer numerical control) Technology

↳ used for complex operations.

$N d f \quad \frac{\pi D}{60}$

Turning centre All dimensions in mm



PROGRAM CODES

```
N1 (TURNING)
G50 S2800;
G0 T0606 M42;
G96 S120 M04
G0 X31 .0Z1.
G71 U0.75
G71 P1000 Q1100 U.2 W.1 F.08
N1000 G0 X12.0
G1 Z0
G1 X14.0Z-2
Z-24.0
X16.0
G1 X22.5. Z-40.0
Z-50.0
X-26.0
Z-60.0
N1100 G1 X 32.0
G0 X200.0 Z 50.0
G0 G42 X200.0 Z1
G70 P1000 Q1100 F.05
G40 G0 X200.Z 100.0
```

M05

M01

N2 (PARTING)

G28 U0

G28 W0

G50 S2000

G0 T0707 M42

G96 S80 M04

G0 X32.0

G0 Z-63.0

G1 X-1.0 F0.2

G1 X32.0 F.05

G0 X100.0 Z200.0

M05

M30

X → diameter

Z – length

$\boxed{\text{Max}^{m} \text{ rpm of chuck} - 3500 \text{ rpm}}$

<1000 rpm low rpm

> high rpm

Turret : cutting tool holding device
can hold 8 tools

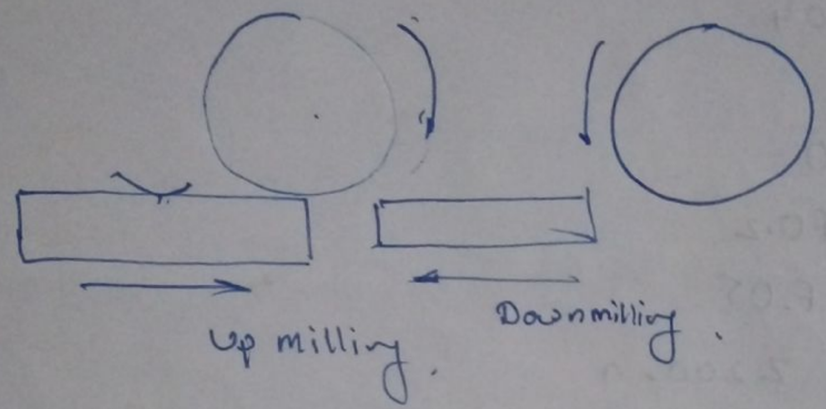
Cutting tool material : Tungsten carbide

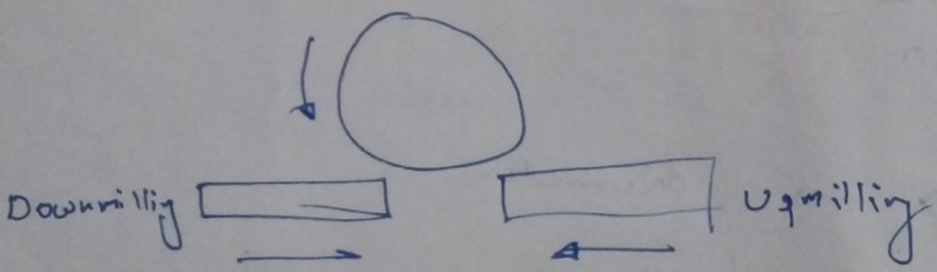
workpiece : mild steel (low C steel)

Milling

end mill cutter - used for slots
& groove

High depth of cut → low rpm preferred





upmilling - demerits

→ Large force reqd

→ the workpiece may get lifted up

→

3.22 mm = sq. depth

diameter: 22 mm

hexagonal depth = 1.473

Cutting speed (CS) = $\frac{\pi DN}{1000}$

of mild steel is 25 - 30 m/min

D = dia. of cutter = 100 mm

N = rpm

$$N = \frac{1000\,(CS)}{\pi D} = \frac{1000 \times 25 \text{ m/min}}{\pi \times 100 \times 10^{-6} \text{ mm}}$$

= 80 rpm

For 30 m/min rpm = 100

Lathe

MFTW ☆

M - Machine tool

F - Fixture ?

T - Cutting tool → (high speed steel) ☆

W - workpiece

Parts :

1) Head stock (Live center)
2) Tail stock (Dead centre)
3) Carriage
4) lathe bed
5) Lead tool
6) Feed rod
7) Spindle
8) Chuck → 3 jaw self centering chuck
   → 4 jaw chuck
9) tool post - tool holding device

Feed - Longitudinal feed
transverse feed
cross feed

Apron mechanism

Lathe bed - made of cast iron.

Operations done by Lathe :

a) turning - reducing of dia
b) facing
c) tapered turning
d) grooving
e) thread cutting
f) parting off
g) ~~t~~ champfering

10 units = 1mm reduction in diameter
(0.5mm in Z dirⁿ)

1) primary cutting motion :
Motion imparted to chuck (RPM)

2) Feed motion

3) Depth of cut

HSS - high speed steel
(cutting tool)

18% tungsten

4% chromium

1% Vanadium

0.5 - 0.6% carbon

Rest - iron

Cutting velocity or Surface speed:

unit: m/min

$$C.V = \frac{\pi D N}{1000} \text{ m/min}$$

C.V = 21 - 30 m/min for mild steel
15 - 19 m/min for cast iron
70 - 90 m/min for brass / Cu
120 m/min for Aluminium

Feed:

Advancement of the tool per rotation of the job.

units: mm/revolution.

Depth of cut:

Perpendicular dist. b/w finished & unfinished surface. (mm) $\left(\frac{\Delta d}{2}\right)$

450 rpm

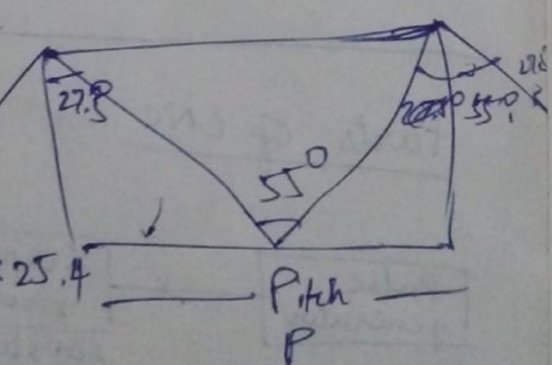
Thread Cutting.

	∠le
1) Metric	60°
2) BSP	60°
3) ACME	29°
4) Worm	29°.
5) Bch	$47\frac{1}{2}$°.
6) Square	90°.
7) $\boxed{\text{BSW — 55°}}$	

→ British standard Width(worth)

BSW Thread depth. Thread per Inch.

Dia	TPI (→ Thread)	~~depth~~ 6403×pitch
1°	8	6403 × 1/TPI
1½°	12	6403 × 1/12
1/4°	20	(6403 × 1/12) × 25.4 = 1.35mm.



VMC – Vertical Machining Centre.

$$T_{\text{manual machining (m/c)}} = T_{\text{orig m/c}} + T_{\text{changing tool}} + T_{\text{changing workpiece}} + T_{\text{manual ops.}}$$

$\Downarrow$

30–40%

Disadvantage of manual cutting:

a) No flexibility b) low productivity

CNC

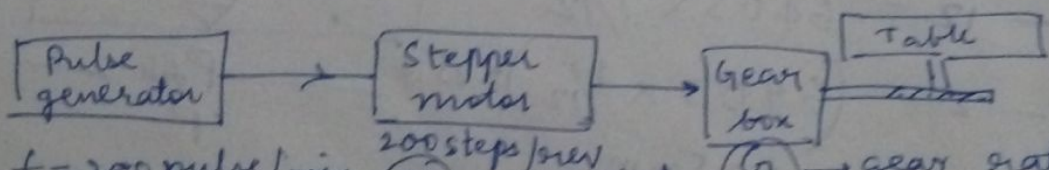
- open loop control
  - path unimportant
  - No feedback req^d
  - eg: drilling
- closed loop control
  - path dependent
  - feedback req^d
  - eg: turning, milling

CNC

- Point to point ~~Path~~ control
- Contouring control

Parts of CNC

1 pulse = 1 step



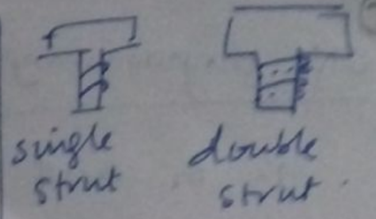
f = 200 pulse/min (eg) can be varied

200 steps/rev (eg) can be varied

G → gear ratio

L = lead p = pitch n = no. of start

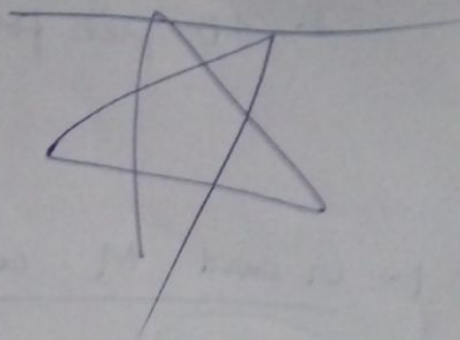
L = np.



1 min - 200 pulse - 200 steps

$\to$ 1 rev

Gnp unit — G rev —



feed

V → velocity

BLU - Basic Length Unit.

↳ length moved for 1 pulse.

i.e $\left(\frac{Gnp}{200}\right)$ unit

a) $f = 200$ pulse/min $G = \frac{1}{2}$, $n = 2$, $p = 2$ mm

$V = ?$, $BLU = ?$

1 min - 200 pulse - 1 rev - $\frac{1}{2} \times 2 \times 2$ mm $= 2$mm

$V = 2$mm/min

1 pulse - $\frac{2}{200} = 10\,\mu m$

a) $f = 10$ pulse/sec $G = \frac{1}{4}$ $n = 1$ $p = 4$mm

~~1 min~~ — as 200 steps/rev

1 sec - 10 pulse

1 min - 600 pulse - 3 rev - $\frac{1}{4} \times 1 \times 4 \times 3 = 3$mm

$v = 3$mm/min

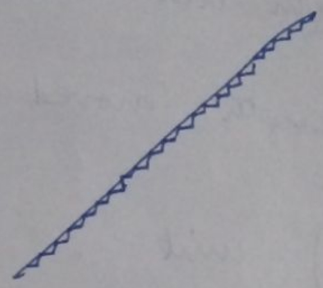
1 pulse - $\frac{3\text{mm}}{600} = 5\,\mu m$

CNC programming :

1. G and M code
2. computer aided offline prog
3. 3D free form surface m/c ing.

1- G and M code:

Interpolation :



G → machine code   M – miscellaneous.

CRC – Cutter Radius Compensation.

T → command used to change tool

H → height compensation

D → Diameter of cutter

R → radius to be cut

F → Feed ~~force~~ velocity ~~[illegible]~~

S → spindle rpm

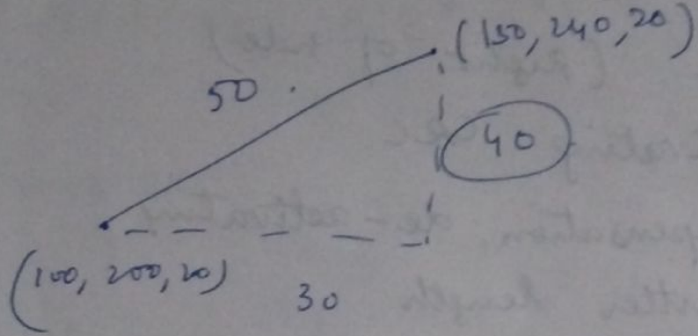
N → line number

Q) N01 G90 G00 X100 Y200 Z20

N02 G01 X130 Y240 F50

Feed vel. in Y dir^n?

Sol^n:



$\therefore F_y = 40$ units (mm/sec)

M code

M01 - optional stop
M03 - cutter rotation CCW
M04 - cutter rotation CW
M05 - Spindle stop
M06 - tool change
M08 - coolant on
M09 - coolant off
M30 - program stop

G Code

G00 - positioning (rapid)
G01 - Linear interpolation
G02 - circular interpolation (CW)
G03 - Circular interpolation (CCW)
G04 - exact stop
G17 - X_p Y_p plan selection
G18 - Z_p Y_p plan selection

G19 - Z_p Y_p plan selection

G40 - cancellation of CRC

G41 - CRC (Left of side)

G42 - CRC (Right of side)

G43 - Activating CRC

G49 - compensation de-activating
cutter length

G53 - M/c coordinate system

G56 - work coordinate system

G80 - cancellation of canned cycle

G81 - drilling cycle

G90 - absolute command

Program for machining centre job.

```
G90 G0 G40 G49 G80 G53 X0 Y0 Z0;
T18 M06;
G0 G90 G56 G17 X20 Y20;
G43 H18 Z50;
M03 S1500;
G90 G0 Z10;
G42 D18 G01 X20 Y20 F500;
G01 Z-2.5;
G01 X110
G03 X120 Y30 R10;
G01 Y100;
G02 X100 Y120 R20;
G01 X40
G01 X20 Y100
```

G01 Z5;

G40 G0 X70 Y50;

G01 Z-2.0 F100;

G03 X70 Y90 R20 F500;

G03 X70 Y50 R20;

G01 Z5;

G00 G53 Z0;

M05;

T06 M06;

G0 G56 G90 X100 Y35;

G43 H06 Z50;

M03 S1000;

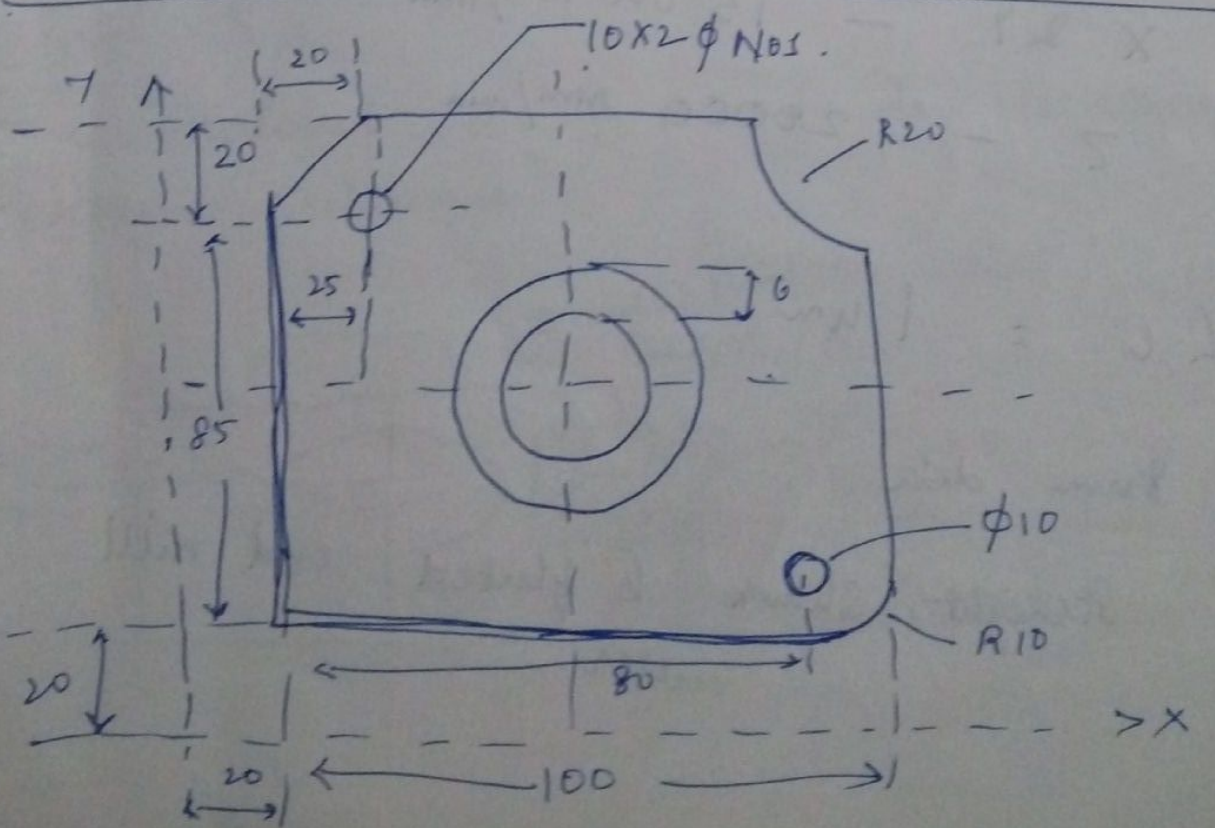
G81 G99 X100 Y32 Z-25 R15 F100;

X45 Y105;

G80 G90 G53 G0 Z0;

M05;

M30;



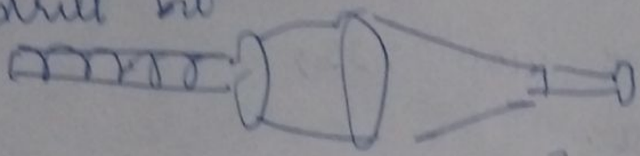
Max rpm = 6000

Max possible tools - 20 20

10mm thickness — polymer (Perspex)

best coolant — kerosene
or dielectric
fluid

drill bit



collet chuck

MDI - manual data input

Feed rate
vel

X & Y — 15 000 mm/min

Z - 20000 mm/min

L.C = 1 μm

8mm dia

Straight Shank 6 fluted end mill
cutter

no. of flutes = no. of grooves on cutter

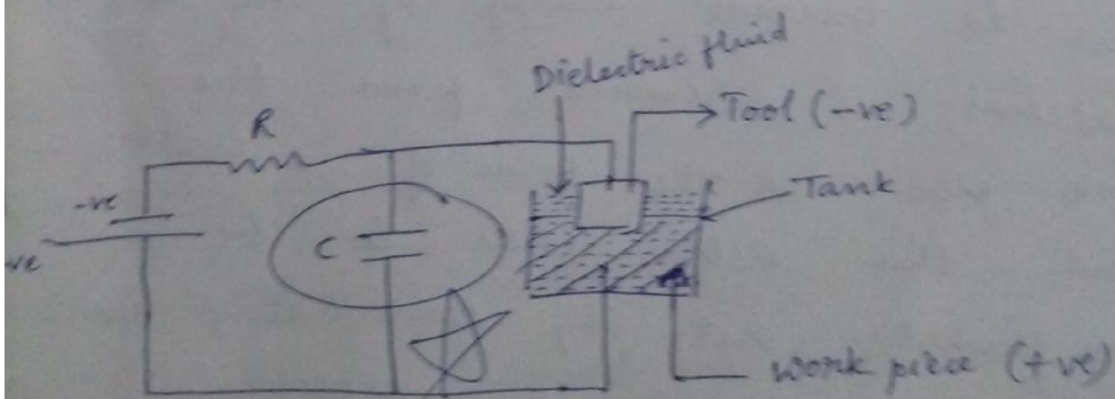
Non-conventional machining processes

In this machining process, the material is removed due to thermal action, chemical action, erosion or combinations of above mechanisms.

i) Electro chemical machining (ECM)
ii) Laser beam machining (LBM)
iii) Electron beam machining (EBM)
iv) Electrical discharge machining (EDM)
(v) Abrasive jet machining (AJM)
(vi) water jet machining (WJM)
(vii) Ultra sonic Machining (USM)

EDM :

The material is removed due to spark-erosion technique.



Requirements:

1) Pulse generator
2) Tank with recirculating + flushing arrangement
3) Dielectric fluid
4) bed having x, y movement (CNC)
5) tool with z movement (CNC).

→ If tool is charged -ve and work piece charged +ve, it is called positive polarity

→ Depending upon the work function and p.d. e's are emitted from work piece

→ According to p.d, these e's collide with dielectric molecules which further ionise by emitting further e's.

→ After complete ionisation, a plasma state is created. This plasma state is reflected like a spark.

→ There are number of sparks between tool and workpiece interface.

⇒ Due to thermal energy of the spark, material is removed from the work piece in the form of a crater and this debris has to be ~~was~~ flushed out by recirculating the dielectric fluid through nozzle.

Tool:

(i) high electrical conductivity
(ii) high thermal conductivity
(iii) high M.P
(iv) high density (to retain shape of tool).
(v) high machinability, permeability, ductility.

Cu, graphite, brass, etc. are used as tool materials.

Dielectric fluid:

Dielectric fluid is req^{d} to induct spark during machining process.

(i) Its dielectric const should not be very high
should not be very low

(ii) less viscous
(iii) non-corrosive (as metal oxides are non conductors)
(iv) should not liberate toxic gases.

kerosene, deionised water

Tool-work piece wear ratio:

$$= \frac{\text{material removed from tool (g)}}{\text{material removed from W.P. (g)}}$$

Advantages:

i) any brittle or hard materials can be machined using softer tool.

ii) any complex shape can be machined.

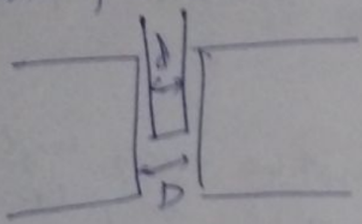
iii) micro-machining can be done.

Limitations:

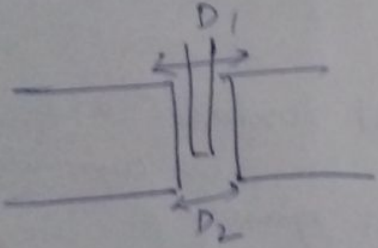
i) Only conducting materials can be machined

ii) Slow process

iii)



Overcut $= D - d$



$D_1 > D_2$

due to sideway sparks

This can be overcome by sideways insulation.

M. Lal

O.P. Khanna

P. N. Jain

(12)

FOUNDRY REPORT: (green sand composition)

Contents: $\boxed{\text{P.T sheets}}$

- → Diff sections of foundry
- → Diff types of pattern with sketches
- → Mould making process.
- → Diff components of moulding
- → Diff tools used with sketches. (one or two lines description)
- → Sketch of complete mould cross section
- → Q & A. in Questionnaire var.

Riser: acts as (major) ventilator for air in cavity

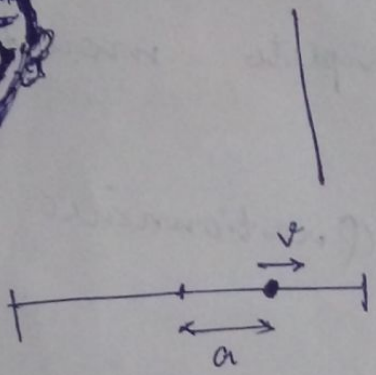
minor – vent holes

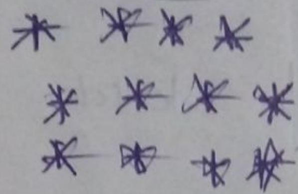
↳ indicates filling of cavity.

→ Directional solidification

MP of Al – 650°C

→ 3 Stages of solidification (cooling)





$$\frac{d^2x}{dt^2} + \omega^2 x = 0$$

$$x = A\sin\omega t$$

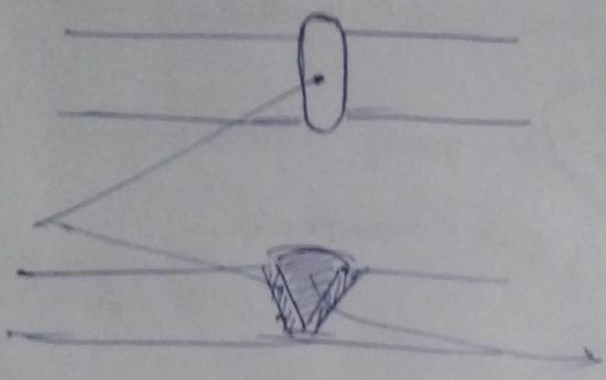
$$v = \dot{x} = A\omega\cos\omega t$$

$$A = \frac{v}{\omega}$$

WELDING

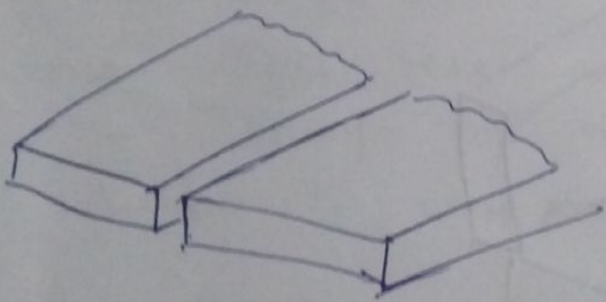
[illegible]

Solid phase and fusion welds

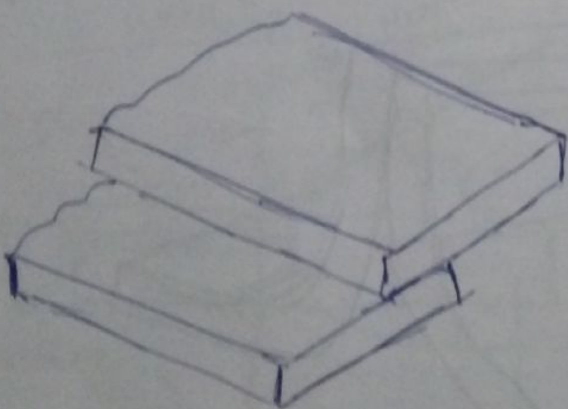


Types of welded joints

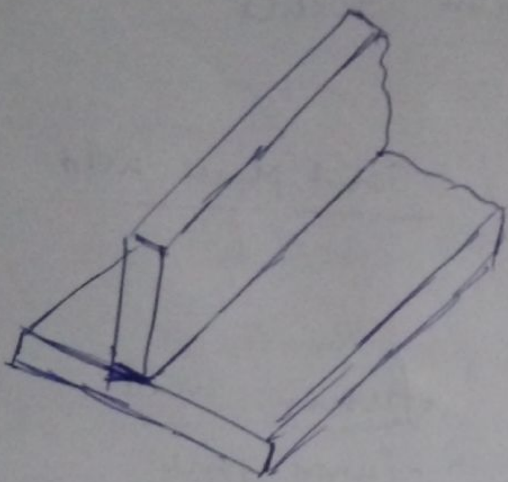
(A) Butt



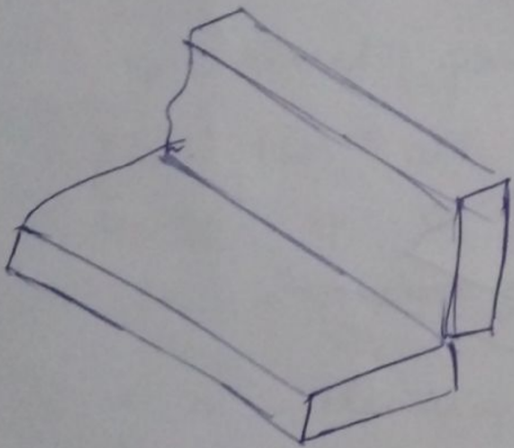
(B) lap



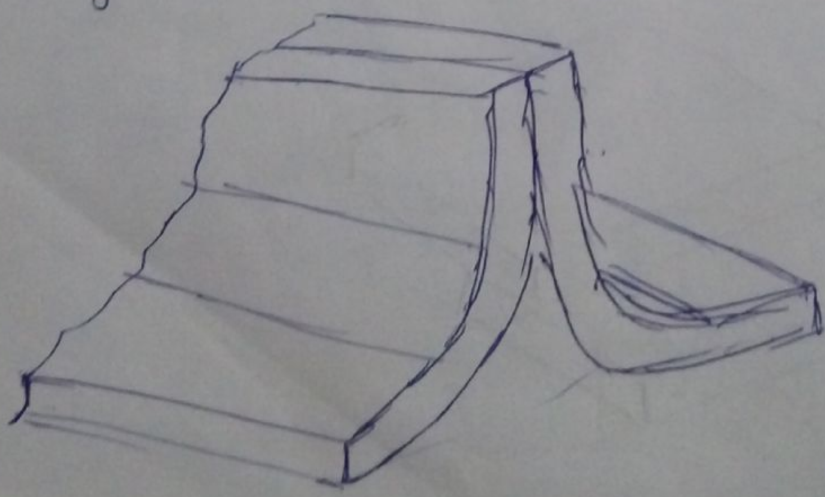
(C) Tee



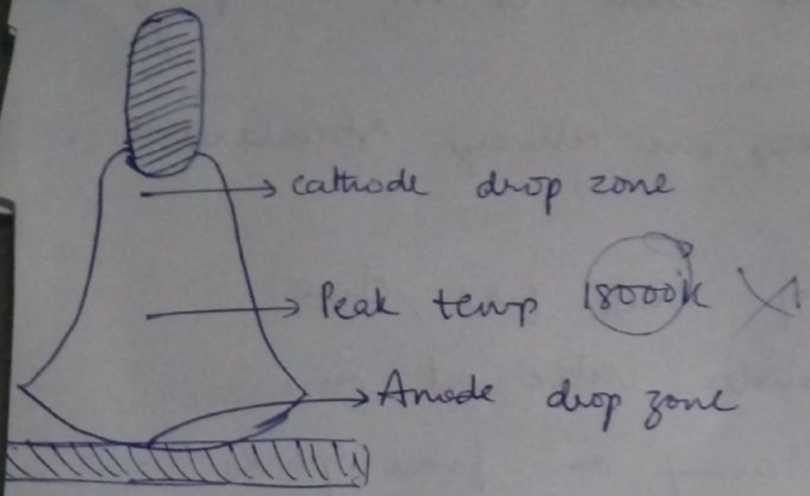
(D) Outside corner



(E) Edge

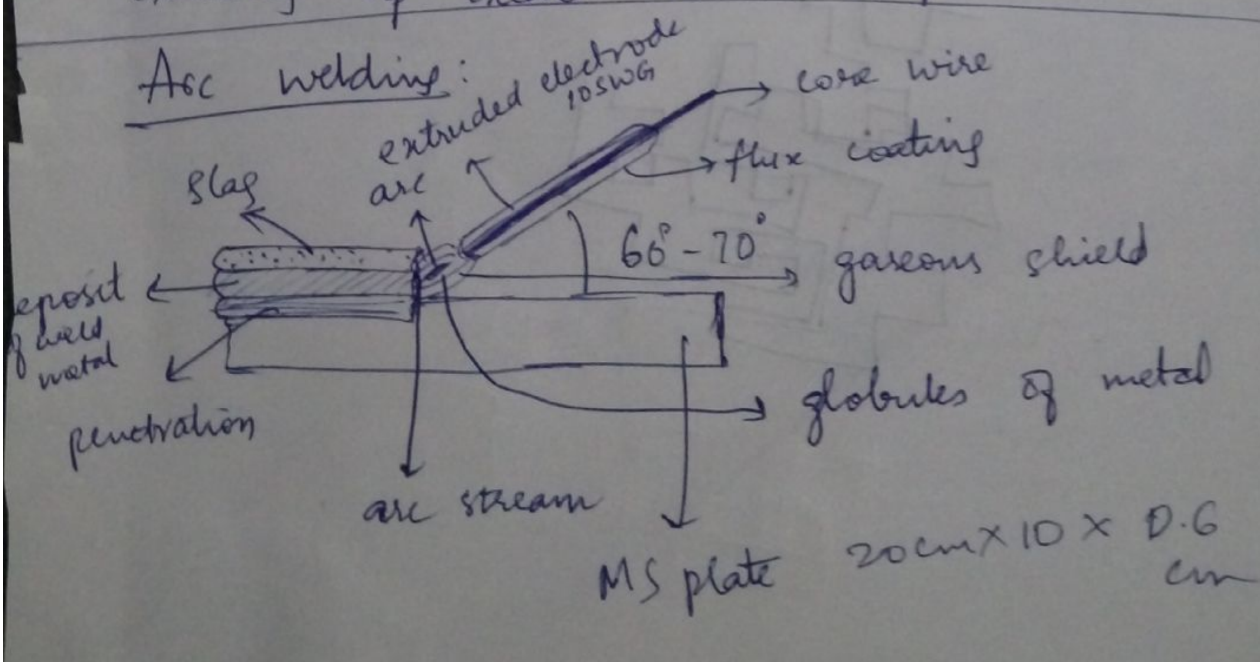


The electric arc:



- Electric discharge between two electrodes through a gas at 10 to 2000 amps and 10 to 500V.
- → Column of ionised gas at high temp.
- → Forces stiffen the arc column.
  - Transfer of molten metal from electrode to work ~~place~~ piece
- → Can have a cleaning action, breaking up oxide on work piece.

Arc welding:



Gas welding precaution

1. Be sure that there is no leakage of gas

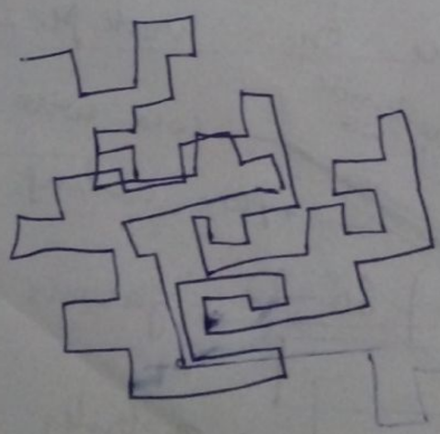
2- While working use always standard welding glasses

3. In case of back fire, close acetylene cylinder valve at once.

4. Keep hoses away from sparks & hot metals.

5 Do not turn the flame towards the cylinders & also don't play with the flame

6. While putting off the flame, always put off acetylene first, then O_2.



$-183°C$

(15)

Welding : → non-fusion/pressure

non-fusion/pressure → with heat
- resistance
- soldering
- brazing
- braze welding

non-fusion/pressure → without heat
- cold pressure
- cryogenic

Welding → fusion

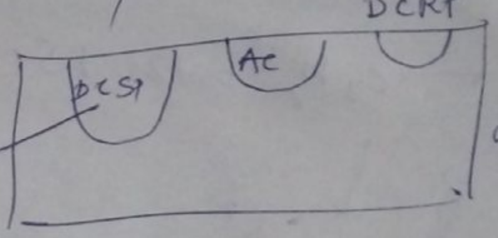
fusion → Chemical

fusion → arc
- manual arc
  - AC
  - DC
    - DCSP
    - DCRP
- Submerged arc
- TIG - Tungsten inert gas
- MIG

fusion → gas
- $O_2 - C_2H_2$
- Air $- H_2$
- omic H_2
- y H_2

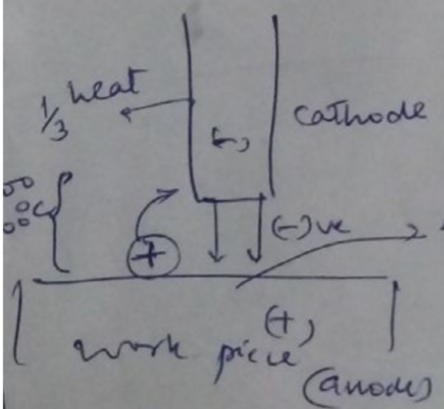
used for thin plates → DCRP

used for thick plates → DCSP



→ st. polarity

DCSP - manual ar



200 - 300 amp i

70 - 90 volts.

$O_2 - C_2H_2$:

$$C_2H_2 + O_2 \longrightarrow 2CO + H_2 + heat$$

$$2CO + O_2 \longrightarrow 2CO_2 + heat$$

$$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O + heat$$

Flame types:

$\frac{O_2}{C_2H_2}$ ratio

Fe ↑		T_{max}	T_{avg}
$= 1$ – neutralising	3260	2000-210
> 1 – oxidising	3330	2100-2200
< 1 – reducing or carborizing	3040	1800-19c

Pressure value:

~~150~~ ← O_2 – 17 KSC → kg/cm^2

~~0~~ ← C_2H_2 – 120 KSC

↓

~~If stored as CaC_2 then 120 KSC.~~