Computer Numerical Control (CNC)

- CAD → Computer Aided Design
- CAM → Computer Aided Manufacturing
- Operations in CNC: a) CNC milling
  - b) CNC Plasma Cutter
  - c) CNC electric discharge machining

1) **Tailstock:** it enables to precisely & safely process shaft type workpieces.

2) **Headstock:** it has the main motor which drives the main spindle.

3) **Bed:** basic support for entire machine.

4) **Chuck:** a specialized clamp used to hold an object with radial symmetry, especially a cylinder.

5) **tailstock quill:** used to hold the end of workpiece opposite the drive plate

6) **foot switches (or) Pedals:** a switching device which is operated by user's foot.

7) **CNC control panel:** it allows for automated control when a part program runs in auto mode.

8) **Tool turret:** holds a group of tools & rotates to bring a new cutting tool into position

Types of CNC machine:

1) Motion type:
   i) Point to point: Eg: drilling
   ii) Continuous path control: Eg: milling and turning

2) Control loops:
   i) Open   ii) close

3) Power supply: i) Electric   ii) Hydraulic   iii) Pneumatic

4) Positioning system: i) incremental   ii) absolute.

- CNC instructions → part program commands.
- CNC is used for impellers, turbine blades, plastic mold tools.

G-code

- Each line of program → Block
- O → Program no. (for program identification)
- N → Sequence no. (for line identification)
- G → Preparatory function
- X → X axis designation.
- Y → Y " "
- Z → Z " "
- R → Radius "
- F → Feed rate "
- S → Spindle speed "
- H → Tool length offset "
- D → Tool radius " "
- T → Tool designation
- M → Miscellaneous function

G codes:

G00 → Rapid traverse	G21 → Metric unit
G01 → linear interpolation	G90 → Absolute system
G02 → Circular interpolation (CW)	G91 → incremental system
G03 → " " (ACW)	G94 → Feed per minute
G20 → Imperial unit	G95 → Feed per revolut

M codes:

M00 → Program stop	M08/M09 — Coolant on/off
M03 → Spindle on CW	M10/M11 — Vice open/close
M04 → " " ACW	M30 — Program stop & rewind
M05 → Spindle stop	M98 — Sub program call
M06 → ATC	M99 — Sub program end & return.

- feed rate → speed at which the cutter engages the part & measured in units/minute.
- spindle speed → rotational frequency of spindle of machine, measured in revolutions per minute (rpm).

- feed:

  Turning → mm/rev

  Milling → mm/tooth

- Cutting tools: is a device used to remove material from a solid block of material.
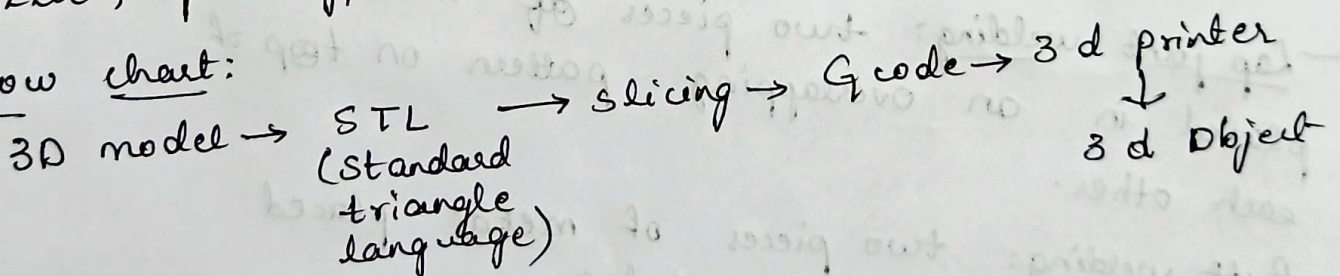
~~types of cutting tools:~~ i) Drill bit

3D Printing:

- The construction of a 3D object from a digital file by putting layer of materials until the object is created is called 3D printing.

- Parts: filament, filament extruder, temp. controlled heater, nozzle, prototype, base plate, moving bed.

- flow chart:

  3D model → STL → slicing → Gcode → 3d printer
  (Standard
  triangle
  language)
                                                      ↓
                                                  3d Object

- Application: 1) Jewellery
  2) dentistry
  3) replacing space parts
  4) rapid prototyping

- Additive process

- PLA (Poly lactic acid) is used ~~for~~ instead of plastic. It is obtained from sugarcane & cornstarch. It is biodegredable.

Welding:

- It is a process in which 2 materials usually metals & is permanently joined together by coalescence, resulting from temp., pressure & metallurgical conditions.

- Arc welding: process of joining 2 mixable solids by using an arc. This arc is generated by either cathode or anode. When AC/DC current flow is passed, the arc is obtained by electric discharge b/w electrodes.

- Straight polarity: electrode is cathode & workpiece is anode. It is used for large/strong metal welding.

- Reverse polarity: electrode is anode & workpiece is cathode. It is used for thinner metal welding.

- Lap joint welding: two pieces of metal are placed in an overlapping pattern on top of each other.

- Butt welding: two pieces of metal placed end to end without overlap

Laser Cutting

- It is a process that uses laser to cut materials.
- Laser type — CO_2 DC glass laser tube
- Laser power — 100 Watt
- Working area — 3' × 2'
- Wavelength — 10.3 µm
- Cutting speed — 0 – 300 mm/sec
- engraving speed — 0 – 300 mm/sec (for acrylic)
- Max. cutting thickness — 20 mm
- Graphics file supported — PLT, CDR AI, DxF DS, BHP, JPEG etc

-Applicable material: Acrylic wood, fabric, marble, rubber.
-Applicable industries: art & craft, toys, advertisement.

~~to~~

Software introduction:

~~main~~
- main interface operation: menu bar, ~~ms~~ edit, draw, setting, processing, view, ~~ss~~ help.
- System bar: most used buttons chosen from menu.
- Graphics bar: graphic location, size, scale
- Edit Bar — present on left of work area.
- Align bar — used to align
- layer bar — change layering
- control panel — used to complete laser processing

Task assignment: assign colour to that object.
Laser parameter: input panel for setting laser scanning parameters is brought up by double clicking on coloured layer.
Speed: Smooth cut ⇒ slower processing
Processing mode: controls how corresponding layer is processed
Scan, engrave & cut are 3 choices.

Minimum & maximum power: max → 100
                              min → 0

Maintenance?

1) Change water of chiller in every 15 days
2) Clean mirror lens every week
3) Clean slider every month
4) ~~clea~~ check allignment of mirror when surface finish is not appropriate.

– LASER → Light Amplification by Stimulated Emission of Radiation.

– Light amplification is the process of intensifying the amplitude of an electromagnetic light wave.

– Stimulated emission is the release of energy from an excited atom by artificial means.

Ruby is a crystal of aluminium oxides in which a part of the aluminium ion is substituted by chromium ion.

– The active material in Ruby is chromium ion. chromium ion takes part in lasing action.

– Colour of ruby crystal (pink or red) depends on amount of chromium in it.

– Ruby rod is arranged along the axis of a helical xenon flash tube. The flash of the tube lasts several milliseconds. During this period, the tube absorbs energy & most of this energy is spent on heating. ~~The heat produced is remov.~~ This energy ensures excitation of chromium ion from ground state to excited state. ~~for~~ a

- Then some of chromium jump to ground state through spontaneous emission of radiation. During this transition a photon of wavelength is emitted.
- This photon travels through the ruby rod in a direction ||^{el} to axis of rod & reflects back & forth by reflecting ends of optical resonar until it stimulates an excited chromium ion. This produces a photon.
- The transition of chromium to ground state is known as laser transition.
- This process repeats & gets multiplied giving a strong & coherent laser beam.
- Ruby laser is called pulse laser.
- Ruby laser has large power output. But frequent cooling is required as a lot of heat is produced.
- used in drilling, soldering, welding.
- Cutting & scanning speed, power :
  12mm/sec   3000mm/sec
  70-75 W   12-18 W