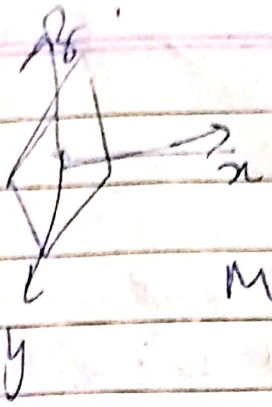
CNC



Fabrication → to make by art or skill & labor.

Manufacturing → processing raw materials into finished goods through tools, labor, machinery

manufacturing processes

Subtractive	Additive	Shape change	Net/Near Net productn
Milling	Welding		3D Printg
Turning (rotatory)			

CNC ⇒ Computer Numeric Control.

Need ⇒ manufacture complex curved geometries in 2D or 3D by mechanical means

- extremely expensive
- Complex jigs to drive cutter motions
- Change of operation is tedious

⇒ Maching components with repeatable accuracy

⇒ Unmanned

Advantage ⇒ versatile, less errors, cheap

Motion type ⇒ Point to point / Continuous

Feedback ⇒ Closed loop / Open loop

Power source ⇒ Electric / Hydraulic / Pneumatic

Positioning ⇒ Absolute / Incremental

CNC

Conversational Program / CAM Software / G code Prog

G01 Move while cutting (Linear Interpolation).
G00 Move rapidly thro' air (Rapid traverse)
F Control feed rate in a cut
G02 Circular Interpolation Clockwise
G03 " " Counter "
G90 Absolute Syste
G91 Incremental
G94 FPM G95 FPR
M00 Program stop. M05 Spindle Stop.
M03 Spindle on CW M04 Spindle on CCW
M08/M09 Coolant On/Off M30 Program stop & rewind

Origin x=0, y=0, z=0 postion of the machine is called Machine Zero
Work zero ⇒ Center front of Workpiece.
G54. Z zero offset _ X zero offset. [Gaps b/w machine zero & work zero.]

Solidworks — 3D
Inkscape - 2D.

CAD → file in which we draw
- Computer aided design.
CAM → Computer aided manufacture
changes into G - codes

FDM
Fused deposition modelling

LASER CUTTING

⇒ Laser type ⇒ CO_2 DC glass laser tube
Laser power ⇒ 100 W
Wavelength = 10.3 μm
Cutting Speed ⇒ 0 - 300 mm/s.
Engraving speed ⇒ 0 - 300 mm/s.
Max cutting thickness ⇒ acrylic (20 mm).
Files supported ⇒ JPEG, dxf,

Materials ⇒ acrylic wood, marble etc.

Use colours for assigning tasks ⇒ cut, engrave.

Power ⇒ Max 100 Min 0

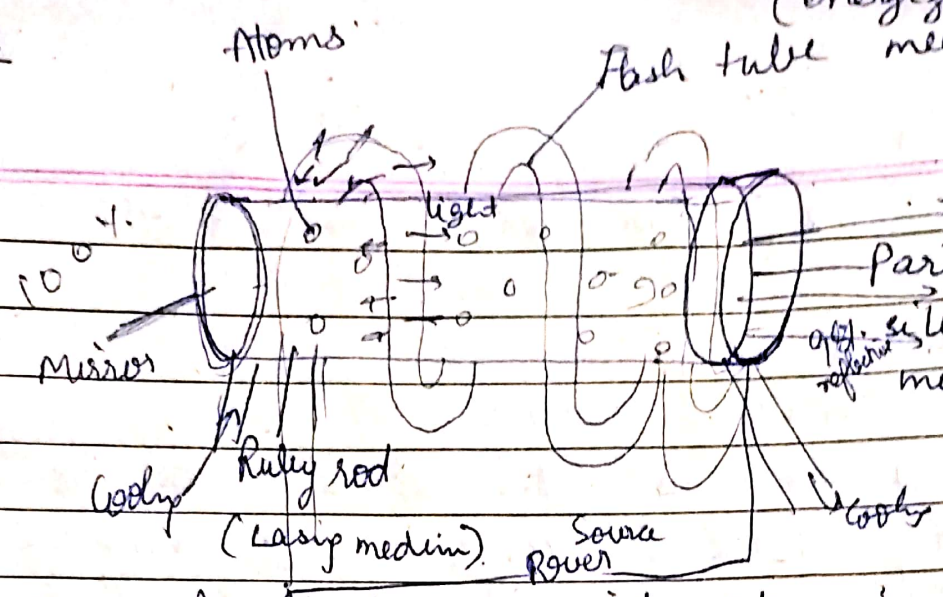
LASER ⇒ Light Amplification by Stimulated Emission of Radiation
intensifies amplitude of EM wave.
Release of energy from an excited atom by artificial means

Ruby ⇒ Cr, Al_2O crystal (Cr in Al oxide)
Cr → active → take part in lasing action
(colour depends on amount of Cr).

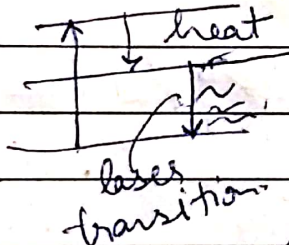
Cutting speed 12mm/sec Saving ⇒ 300 mm/sec
Power 70 - 75 W 1248 W

INKSCAPE → .dxf → RD Works V8

LASER CUTTING

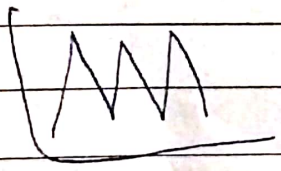


Light by flash tube exites atoms in the Ruby, atoms emit photons These bounce back and forth and come out throug. partially silvered mirror as monochromatic single phase laser.



⇒ G ions go to metastable state and come back to ground state & release energy

⇒ Operates in Pulse Mode, Efficiency is very less



Glass CO_2 Laser tubes

⇒ rely on DC to excite the CO_2 gas.
⇒ beam diameter (laser spot size) tends to be larger with glass tubes.
⇒ Pulsing action is not that fast, so engraving speeds are lower

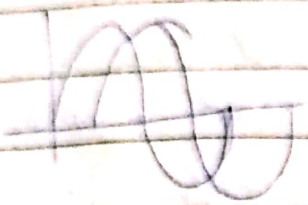
Metal laser tubes ⇒ AC ⇒ better at pulsing
⇒ engraving with fine detailing.

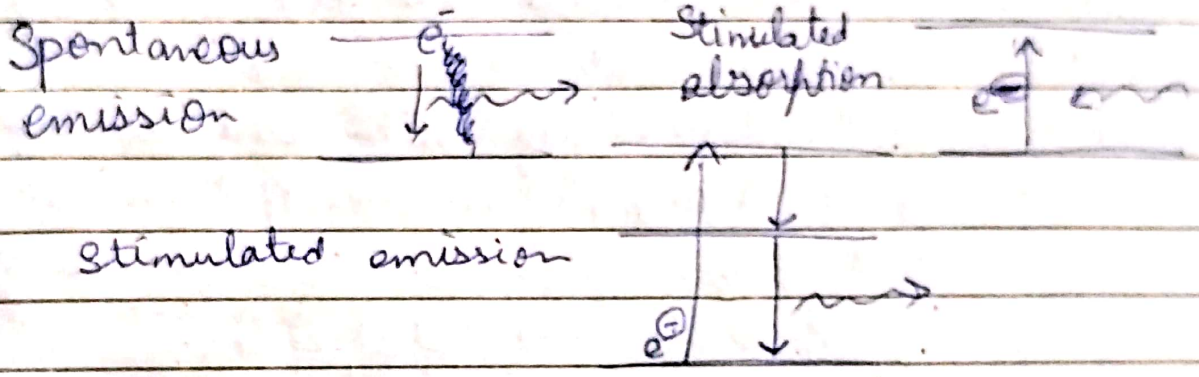
LASER CUTTING

Source ends

Monochromatic source → single wavelength, single colour light

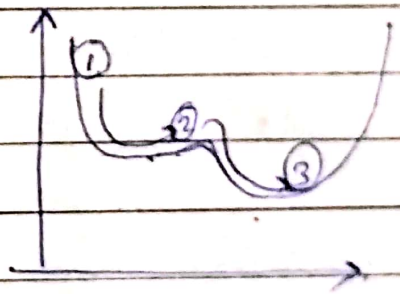
Coherent source → emits light wave with same frequency, λ and phase or having constant phase diff.





Metastable State

denotes an intermediate energetic state other than system's state of least energy



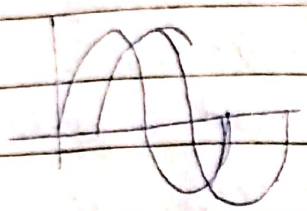
→ such a state of an atom through excited atom cannot emit radiation without a further supply of energy.

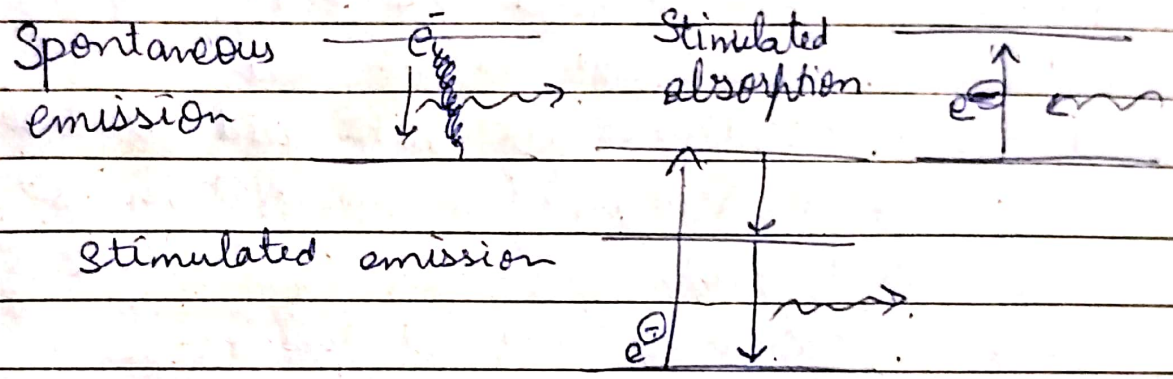
LASER CUTTING

Source emits

Monochromatic source ⇒ single wavelength, single colour light.

Coherent source ⇒ emits light wave with same frequency, λ and phase or having constant phase diff.





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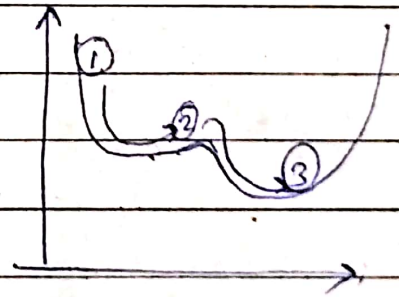


⇒ such a state of an atom through excited atom cannot emit radiation without a further supply of energy.

CNC

Turning Machine

Tailstock → enables to precisely & safely process shaft type workpieces.

Headstock → has the main motor which drives the main spindle.

Bed → Basic support for entire machine

Chuck → a specialized clamp used to hold an objects with radial symmetry, (cylinder)

Tailstock Quill → used to hold the end of workpiece opposite the drive plate

~~Foot~~

CNC panel → allows for automated control when a part program runs in auto mode.

Tool turret → holds a group of tools & rotates to bring a new cutting tool into position.

~~Milling machine~~

CNC $1 + e^{i\pi} = 0$

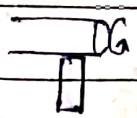
Feed Rate ⇒ Speed at which cutter engages the part (units/min)

Spindle Speed ⇒ rotational f of spindle of machine (rpm)

Feed ⇒ Turning → mm/rev

Milling → mm/tooth.

Turning



Lathe Machine

Milling

⇒ Single point Turning tool
⇒ Cutting tool continuously in contact with workpiece
⇒ Workpiece rotated

⇒ Multi point Cutting tool
⇒ tooth continuously engages & disengages (intermittent cutting)
⇒ Cutter rotated at fixed RPM

Diff b/w Machine & CNC Machine.

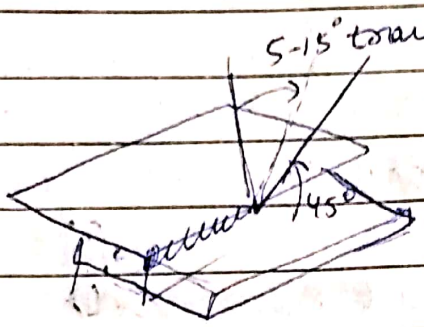
⇒ operator directly controls movements of machine tool
⇒ cost is low
⇒ diff duplication
⇒ More & skilled labor required
⇒ Less accuracy
⇒ Less safety of workers
⇒ less types.
⇒ Lower range of cutting parameters
⇒ Prototype required

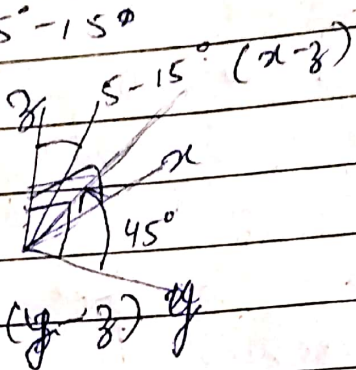
⇒ by numeric control.
⇒ cost higher.
⇒ Replication easy
⇒ Just code hi karna hai
⇒ More accuracy.
⇒ more - - -
⇒ can use almost all types of materials.
⇒ Higher speeds can be done.
⇒ No prototype required.

(Copper was the first welded instrument).

WELDING

LAP Joint ⇒ Steel plates in overlapping pattern.





function of electrode coating ⇒

improves the arc stability by providing certain chemicals which have this ability by ionizing the path of the arc provide a protective gaseous atmosphere to prevent oxygen, hydrogen & N_2 picks up by the molten metal.

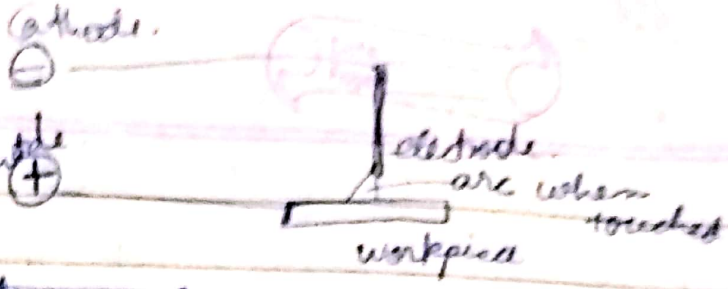
Electrode coating is made of flux. ⇒ marble, quartz, fluorite ⇓ reducing at high temperatures. prevents oxidation of base & filler materials.

Disadvantages of welding

Manual job
Advanced testing methods req.
Materials distortion
Residue Generation ⇒ reduces load carrying Capacity
Change in metal properties ⇒ due to heating & cooling

WELDING

Principle of Arc Welding ⇒



An arc is sustained (electric discharge) through ionized gas column called plasma b/w the cathode & anode. Electrons liberated from the cathode move towards the anode at a high speed & large amount of heat is generated.

⊕ — Workpiece	⊖ — Workpiece
⊖ — electrode	⊕ — electrode
Straight polarity	Reverse polarity.
for thick metals (as more heat required)	thin metals (as less heat required)

face shields important as high intensity light

Weld spatter ⇒ droplets of molten metal scattered during the welding process.

gas metal arc welding produces most spatter.

Distance b/w electrode & workpiece ⇒ 1.25 cm ($\frac{1}{2}$ inch)

WELDING

Why electrode stick with metal?

① Low current / Unstable current ⇒ tip of electrode melt but are not striken properly.
⇒ rod not dissolve properly.

②

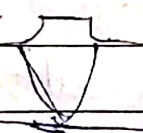
③ Short are length ⇒ distance b/w electrode & base metal.

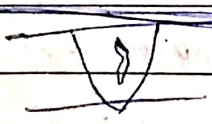
Short ⇒ stick
long ⇒ are disappear.

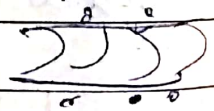
④ Dirty Surface ⇒ it increases resistance & thus lowers voltage.
& so the electrode sticks.

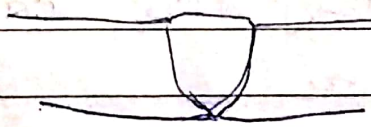
⑤ Using wrong electrode

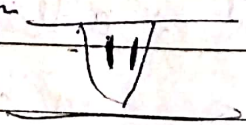
Welding defects ① Porosity ⇒ bubbles or pores by trapped gases

② Undercut ⇒ 

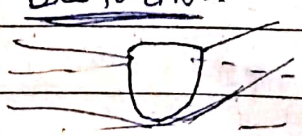
③ Weld Crack. 

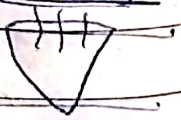
⑥ Spatter 

④ Incomplete Fusion 

⑤ Slag Inclusion 

⑥ Incomplete Penetration 

⑦ Distortion 

⑧ Hot Tear 

⑨ Burn through 

⑩ ~~Thickness~~ Overlap 

⑪ 

Resistance Welding → Thermoelectric process.
electrical resistance employed to create heat

~~3D Printing~~

Gas metal arc welding
→ All same but there's a shielding gas
fed through welding gun which shields the process from atmospheric contamination.
(instead of electrode coating).

Gas Tungsten arc welding
Uses tungsten electrode (protection by inert shielding gas - Ar or He).

Shielded metal arc welding (stick welding)
Abe Hamare Wale

Flux cored arc welding
→ filler wire works as electrode fed continuously from the gun. It has its core as flux and creates gas shielding around weld.

Electron Beam Welding
Atomic Hydrogen Welding
Plasma Arc Welding

Submerged arc welding ⇒ cover metal pieces, arc, welding wire, joint with blanket of flux.

Oxyacetylene welding ⇒ 3500°C generates heat when a mixture of fuel gases & O_2 passes in a torch.

Thermite Welding → $(Al + Fe_2O_3) \xrightarrow[1300°C]{} Fe + Al_2O_3$.
Exothermic. molten.

Forge welding ⇒ Metal heated to malleable state and hammered into desired form and cooled to set in shape.

3D - Printing

Setup ⇒
Selecting origin
Base Temp ⇒ 60 - 70°C
Nozzle Temp ⇒ depends on material being filled
~~Setup ⇒~~
Laser Temp - 220°C.

Why to warm bed initially? ⇒
Heating the bed reduces the tendency for prints to warp by evening out the temp. diff as well as holding the print down with better adhesion.

(Selective Laser Sintering).
Powder bed fusion

↓

Sinter (coalesce into a solid by means of heat without liquefaction).
Or melt powder particles with a laser into the desired object layer by layer while a recoat blade adds more powder for each new layer

Binder jetting

⇒ Uses a print head that deposits a liq bonding agent to the powder print bed.
Liq binds particles to form each layer of desired object & fresh coat of powder added & repeat

~~HLPS~~

3D - Printing

Fused Deposition Modelling
heat to liquify polymer that is fed into system as filament

Stereo Lithography (photopolymerisation / optical fabrication)
create in layers by layer sense
monomers light → polymers

Standard Triangle Language.
(STL format).

DICOM ⇒ for bioprinted files

Print Wizard, Cura.
CMB file.

Build → PLA (Poly Lactic Acid)
Support → ABS (Acronitrile Butadiene Styrene)
HIPS ⇒ Soluable in limonene
Support material
PVA (Polyvinylalcohol dissolves in water)
Build materials → Nylon, PP/Poly Propylen
PC (Polycarbonate)

Observations
Time..
Material Consumption
No. of layers..
Model material, support material.

⇒ digital file (STL format). ⇒ then divide into layers ⇒ G-code
⇒ 3D printing machine ⇒ Tech B, Mojo
⇒ Solid edge for making 3D model.
⇒ Cura for setting quality, size, scale etc.
and transferring file into printer.

FDM ⇒ The filament is pushed into chamber by a tractor wheel arrangement and it is this pushing that generates extrusion pressure.
⇒ wide range & effective mechanical properties of materials produced.
⇒ Parts made strong.

3D Printing

Digital Light Process
⇒ digital projector screen instead of laser in SLS

Multi Jet Fusion
⇒ uses inkjet as fusing agents to the bed of nylon powder. Then heating element passed overbed to fuse each layer

Polyjet (plastic)
→ Fabricate parts with multiple colours & materials

Direct metal laser sintering (metal).
metal multi parts assemble into single conponent or lightweight parts with internal channels or hollowed out features.

EBM (Electron Beam melting).
Uses EB controlled by EM coils to melt metal powder. The bed is heated up and in vacuum condition during the build.