Part-B.

12.1.17.

* Materials:

1. UTS OR TS
UCS OR CS
USS OR SS

E/N/K

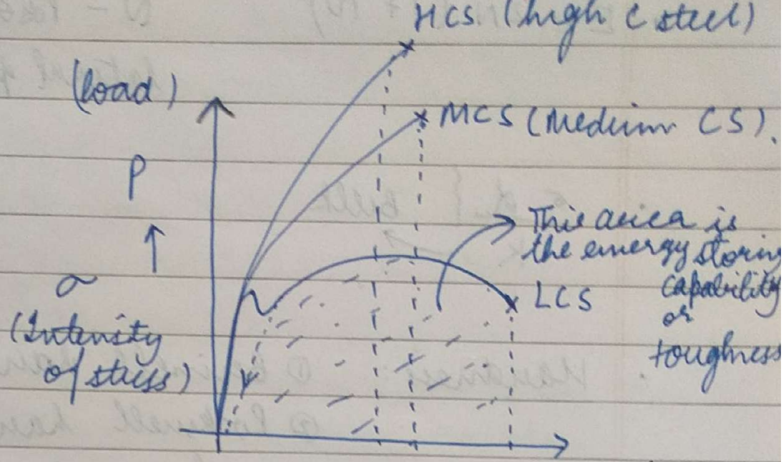
Toughness

Hardness

Ductility

YP Stress

Proof stress



ε (strain) $= \frac{\delta l}{l_0}$.

% elongation $= \frac{l_f - l_0}{l_0} \times 100\%$.

% reduction in area.

** UTS: ultimate tensile stress.
UCS: " compressive stress.
USS – ultimate ~~proof~~ shear stress.

- Stress

- Shear

- Intensity of stress → load per unit area (P/A).

- Engineering stress

- Hooke's law : $\frac{\sigma}{\varepsilon}$ = constant = E = $\frac{\text{stress}}{\text{strain}}$.

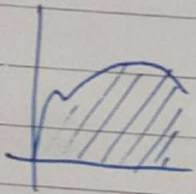
- Y (young's Modulus) ∝ $\frac{1}{\text{elongation}}$.

- $E = 2N(1+\nu)$ ν – Poisson ratio.
  lateral strain strain and

- $\frac{\sigma\ d}{K}\Big\{$ Bulk

- Hardness: ① Brinell hardness no.
  ② Rockwell hardness no.
  ③ Vickers hardness no.

- Ductility < 5% : Brittle.

- 
  P vs δ → Area = Toughness.
  σ vs ε → Area = Modulus of toughness.

19.1.17.

* Pig iron

* Cast iron (types)

* Steel (Based on C content).

* Alloys steels.

* Gray Cast iron:

• Characteristics:

→ Basically, it's a mix of carbon & silicon with Fe.
→ It is readily cast into a desired shape in a sand mould.
→ It contains 2.5% — 3.8% : carbon
1.1% — 2.8% : Si
0.4% — 1.0% : Mn
0.15% : P
0.1% : S

→ It is marked by the presence of flakes of graphite in a matrix ferrite which is also called α-iron, is a bcc structure. The matrix can be of pearlite also, or even austenite which is called γ iron (fcc).

→ Graphite flakes occupy about 10% of the metal volume.

→ Length of flakes may vary from 0.05 – 0.1 mm.

→ when fractured, a bar of grey cast iron gives greyish appearance.

→ Grey C.I. possesses the lowest m.p. of the ferrous alloys - 1150°C, 1200°C.

→ G.C.I. possesses high fluidity, hence can be cast into complex shapes and thin sections.

→ It possesses machineability better than steel, ∵ in steel C is in a combined form but in G.C.I., C is in free form & works as a lubricant.

→ It has high resistance to wear.

→ Possesses high vibration damping capacity.

→ G.C.I. has low ductility & low impact strength as compared to steel.

→ G.C.I. has shrinkage of 1 mm per 100 mm.

→ " possesses high compressive strength.

→ Hardness no. is 150 - 240 Brinelle Hardness no.

→ In compression, its strength is 600 — 750 $N/(mm)^2$.

→ A good property of G.C.I. is that free graphite in its structure acts as a lubricant & when machining is done, a very free working operation results.

* Applications:

1) Machine tool beds due to good vibration absorbing capacity.

2) Manhole covers

3) Cylinder blocks & heads for IC engines

4) frames for electric motors.

5) Sanitary wares (pipes).

6) Piston rings in engines.

7) Rolling mills and general machinery parts.

* FG 200 => implies ferrous grey (Grey Cast Iron)

$UTS = 200 N/mm^2 = 2000 kgf/cm^2$

$= 200 MPa$

* White Cast Iron:

• Characteristics:

→ WCI derives its name from the fact that it's freshly broken surface shows a bright white fracture.

→ Unlike GCI, WCI has almost all its carbon chemically bonded with Iron as Fe_3C (Iron Carbide).

→ Fe_3C also called cementite.

→ Cementite is a very hard & brittle constituent & its formatⁿ is helped by the presence of relatively larger quantities of Mn.

→ A very small amt. of Si, high rapid cooling also encourage formatⁿ of carbides.

→ Ordinary rate of cooling → free graphite.

→ Its very hard with a BHN value of 400-600 & is very brittle.

→ fractured surface has silvery metal appearance.

→ White colour of Fe_3C in the midst of black coloured pearlite.

→ WCI under normal circumstances is not machineable.

→ By using a fairly low Si content, Cast I. may be made to solidify as WCI.

→ White iron castings can be made in sand molds.

→ WCI contains

1.8 – 3.6 %	:	Carbon
0.5 – 2 %	:	Si
0.2 – 0.8 %	:	Mn
0.18 →	:	P
0.10 %	:	S

→ The solidification range of W CI is 2550 upto 2065 °F

→ Shrinkage is 1mm for every 100 mm.

• Uses:

→ Doesn't have many uses.

→ Starting pt. for producing malleable iron castings.

→ for manufacturing those components which require hard and high abrasion resistant materials.

→

* Malleable C I:

• Characteristics:

→ It can be hammered & rolled to obtain diff. shapes.

→ Obtained from hard & brittle WCI through a controlled heating & cooling process.

→ A ferritic malleable cast I. has ferrite matrix.
A pearlitic " " " " pearlite ".

→ An alloy " " " contains Cr & Ni also & possesses high strength & corrosion resistance.

→ Possesss high yield strength.

→ low co-eff. of thermal expansion.

→ Possesses good wear resistance & vibration damping capacity.

→ can be used from $-60°$ F to $1200°$ F.

→ solidification range of 2550 to 2065 ° F.

→ Shrinkage of 1.5 mm / 100 mm.

→ low to moderate cost.

→ contains 2-3% Carbon, 0.2-0.6% Mn
0.6 - 1.3% Si, 0.15 P
0.1% Sulphur.

* Uses:

→ for automotive industry
→ " railroad industry
→ agricultural implements
→ electrical line hardware
→ links of a conveyor chain
→ gear box casings
→ rear axle housing
→ truck axle assemblies
→ automobile crankshafts.

2.2.17.

* Characteristics of Nodular Cast Iron:

→ Unlike long flakes as in G.C.I, graphite here appears as ppt. as rounded particles, also called nodules or spheroids.

→ These spheroidising elements when added to the melt eliminate S & O from the melt.

B, Ti, Mg, Ce, Ca, Bi, Zn, Cd, help in nodulising, called innoculants.

It changes solidification characteristics & accounts for noduli

→ Ductile Cast Iron possesses very good machinability

→ Soft Annealed grades of Nodular cast Iron can be turned at very high feeds & speeds.

→ Properties of NCI depends on the metal composition & the cooling rate.

* Composition of NCI or Ductile CI:

3.2 – 4.2 % C
3.5 % Si
0.3 – 0.8 % Mn
0.8 % P
0.2 % S

→ Possesses damping capacity, intermediate b/w GCI & steel. (steels have poorer damping capacity).

→ ~~A~~ Possesses excellent castability & wear resistance.

→ High fluidity in molten state (very fluid).

✱ Uses:

→ Paper industry Machinery
→ Internal Combustionⁿ engine
→ Power transmission equipment.
→ farm implements & tractors
→ earth moving machinery
→ valves & fittings
→ pipes
→ steel mills, rolls, mill equipment
→ pumps & compressors.
→ constructionⁿ machinery.

✱ SG $\frac{800}{2}$ 800 = UTS (Ultimate Tensile Stress) N/mm^2

2 = % elongationⁿ upto fracture.

Steels.

* Intro:

Alloy of Fe & C : C → upto 1.6 %.

→ C is distributed throughout, in a combined state.

→ if C > 1.5 % it appears as free C

→ Besides C, other elements are:
Si, S, P, Mn, etc.
C is the most imp. property modifying element.

→ Fe forms the mass of steel (major), ∴ its called quantity partner. While C performs the duty of determining quality of steel and is called quality partner.

→ Imp. of C in steel doesn't lie in its relative volume but in its influence on internal structural changes & its " " mechanical properties which occurs when steel is subjected to variety of heat treatment processes.

Classification:

1) Unalloyed steel (Plain Carbon Steels):

→ Principal factor affecting properties of PCS are C content & microstructure · as a result of heat treatment or manufacture processes.

→ ↑ in C %. strengthens & hardens steel, UTS value increases, hardness no. goes up; It lowers Ductility, It reduces machineability & weldability.

→ ↑ in C content reduces thermal & electrical conductivity as well as corrossion resistance. It can become more rusty.

→ Microstructure is determined by composin of steel, i.e. % of C, Mn, Si, P, S, etc. which are always present and because of the presence of residual elements like O, H, N.
(Killing process is used for removing these residual elements).

→ PCS are predominantly Pearlitic in the cast-rolled & fold conditions.

→ Pearlite consists of alternate plates of Ferrite & Cementite. Contains about 87% of " , rest is ".

→ Types of PCS acc. to C content :

0.05% — 0.3 % : Low Carbon Steel / Mild Steels (Ductile, soft)

0.3 — 0.6 % : Medium C S

0.6 — 1.5 % : High C S

(0.9 — 1.5 %) → Tool steels (used for tools).

→ Types acc. to deoxidation Practice or Killing:

(1) ~~Thin~~ Killed: strongly deoxidised & are characterised by High Composiⁿ & Property Uniformity. All forging steels (& in general all steel with > 0.5% C) are killed.

essential quality: soundness, freedom from blowholes, segregation.

When it is deoxidised sufficiently, there is no evolution of gases & the top surface of the ingot solidifies almost immediately.

Symbol: 'K' for killed steels.

(2) Semi - killed steels: also called balanced steels; intermediate b/w killed & rimmed steels. & have variable degree of uniformity.

Structural steels with 0.15 – 0.25% C are generally semi-killed. The aim is to produce metal free from surface blowholes. The surface should have a sound skin of considerable thickness. Structural products are broadly made from this steel.

No symbol is used.

This category comprises 90% of total steel productⁿ.

C 40 : 0.4% C steels. } Designation for steels.
St 40 : UTs = 40 Kgf/mm^2

(3) Rimmed steels: least deoxidised / partially deoxidis

Symbol: 'R'.

Steels with less than 0.15% C are used in the rimmed condition. In mild steel, the aim is to produce a clean surface low in C content.
~~A wide variety of steels for~~
A wide variety of steels for deep drawing are made from rimmed steels.

* Solid solubility.

Date __/__/__
Page ____

* Alloyed steels:

→ These are the steels to which elements other than C are added in sufficient amt. to produce desirable improvement in properties.
Most common are Cr, Ni, Mn, Si, Va, Mb, W, P, Cu, Ti, Zr, Co, Al, etc.

Each element confers certain qualities to steel to which they are added; may be used individually or in combinaⁿ to produce desirable changes.

→ like C, a no. of alloying elements are soluble to produce alloys with improved strength, ductility, toughness, etc.

→ ~~like C~~,

→ some alloying elements prevent / restrict grain growth.

→ Al is considered the most effective ~~to~~ in preventing grain growth. (Zr, Va, Cr, Ti also).

→ Structurally, addiⁿ of alloying elements, almost always affect the austenite, ferrite transformaⁿ mechanism by changing the temp. at which the transformaⁿ from γ (austenite) (FCC) to α (ferrite) (BCC) takes place.
Some of the alloying elements lower the temp., some raise the temp.

→ The composition & structural changes produced by alloying elements change & improve the physical, mechanical & processing properties of steel.

Scanned by CamScanner

→ Because alloy steels give better ductility, strength, toughness properties ∴ design & production engineers should consider this steel in designs subjected to high stresses & impact loading.

→ Almost all alloy steels are produced with fine grained structures.
Fine grained steels have less tendency to crack during heat treatment. They have better toughness, shock resistance properties, whereas coarse grain steels exhibit better machining properties & may be hardened to greater depths than fine grain steels.

→ Effects of alloying elements:

Ni: enhances toughness, corrosion resistance, deep hardening tendency (entire bulk is hardened)

Cr: improves corrosion resistance, toughness, hardenability.

Mn: helps in deoxidising steels, improves strength, hardness.

Si: helps in deoxidising, helps in resisting oxidation at high temp, it enhances the tendency to graphitise from cementite to Fe + graphite (Fe_3C to Fe + C)

Molybdenum: promotes hardenability, ↑ tensile strength

Va : deoxidises steel & promotes fine grain structure.

Cu : ↑ resis to corrosion, acts as a strengthening agent.

Al : same as Cu, it aids in nitriding (Heat treatment process), surface of steel becomes (iron nitride) case hardening process.

B : increases hardenability.

* Classificaⁿ of Alloy steels :

9.2.17.

① Chemical composⁿ :

3 component steel ; 4 components steel

② Structural class : → low alloy steels (alloying elements < 5%)
→ medium " " (" " < 10%)
→ high " " (- - — — > 10%)

③ Usage :
↳ Structural
↳ Tool steels
↳ Special property steels.

* Structural steels :

Widely used in eng. industry for parts subjected to static and dynamic loads.

more set of favourable qualities than PCS :

Principle alloying elements : Cr, Ni, Mn, W, Mo, V, Ti, ...
are usually not applied as individual elements but accompanied by Cr, Mn, Ni, etc .

* Tool Steels :

→ employed in tool manufacture when the tool life provided by PCS is insufficient .

Low alloy steels which retain high hardness at temp. upto 250°C , whereas medium & high alloy steels retain hardness upto 650°C .

→ Designation : (given in the sheet)

Multipliers employed for only low & medium alloy steels .

No multipliers are employed for HAS (High Alloy steels).
If a cross (X) is given , it implies HAS .

C → 100 (we should divide the given no. by 100).
Cr → No multiplier .

If given like XT → High Alloy steel & specially meant for tools. (T).

* Special Property steels :

* Non ferrous metals & alloys:

→ These do not contain iron as base.

→ m.p. are generally lower than those of Fe.

→ These metals suffer generally from hot shortness, possess low strength at high temp., show greater shrinkage than ferrous metals.

→ Are used for the following reasons:

1) resistant to corrosion
2) special electrical & magnetic properties.
3) soft & facilitate cold working.
4) fusibility & ease of casting.
5) good formability.
6) low density.
7) Attractive colours.

→ Principal non-ferrous metals used for eng. applicaⁿ: Cu, Al, Pb, Sn, Zn, Ni, etc. & their alloys.

* Cu: → easily distinguished because of its red colour.
→ extracted from Cu ores, chief being copper pyrites
→ extracⁿ may be done either by dry or wet process
→ the former is carried in blast furnace preceded by various stages of ore refinement & followed by various metal refining processes.

* Characteristics of Cu:

→ Relatively soft
→ Very Malleable
→ Ductile.
→ flexible (can be given diff shapes)
→ yet it is quite tough. (Area of stress-strain curve is high)
→ strong (high UTS)
→

* Very efficient conductor of heat & elec., being 2nd only to silver (Ag).
→ largely used in wire, sheets, form electrical purposes.
→ It may be cast, rolled, drawn into wires.
→ Non-corrosive & resists weather changes very effectively.
→ Cu in the form of tubes is used widely in mech. eng. & for making ammunitions for defence purposes.
→ Castings may have tensile strength of 15-17 kgf/mm^2 enhanceable to 21-23 by strain hardening.
→ Tensile strength of hard drawn Cu wire can go upto 38-46 kgf/mm^2.
→ m.p. of Cu is 1083 °C.

* Cu alloys:

→ May be alloyed with numerous elements to produce diff. grps of industrial elements.

Ex: CuAl : Aluminium bronzes.
CuSnSb : Babbit Metals.
Antimony.

CuSn : Bronzes

CuSnP : Phosphor bronzes.

CuZn : Brasses.

CuNi : Cupronickels.

→ CuAl : 6 – 10% Al
gives the alloy lightness, colour changes to fine gold colour, used for imitation jewellery.

→ CuSnSb : Babbit metal is one of the most imp. alloy of industrial use.
Tin based white metal & contains 88% Sn, 8% Sb, 4% Cu.
soft metal, low value of co-eff of friction.
Used for making bearings (for shafts).
Makes a fine bearing & doesn't abbrade shafts easily even if lubrication fails.
Used for cast iron boxes when bearings are subjected to high pressure.

→ CuSn : Bronzes; Gun metal is a member of this family
Bell Metal also.
Bronzes : alloy mainly of Cu & Sn, Cu can be 75 – 95% & Sn can be 5 – 25%.
Relatively hard, resists surface wear, can be cast into diff. shapes, rolled into wires, etc.
In corrosion resistance, bronzes are superior to Brasses (CuZn).
Used in Hydraulic fittings, pump linings, utensils,

bearings, bushes, sheets, rods, wires & many other stamped, drawn items

* Some of the most common bronzes & their uses:

(i) Phosphor bronze: Cu 93.7%, Sn 6%, P 0.3%.

→ Can be forged or cast
→ P increases the strength, ductility & soundness of castings.
→ resistant to salt water
→ used for all bearings where wearing qualities are ~~mediate~~ needed.
→ pump parts
→ propellers
→ making coiled springs
→ used for bearings subjected to heavy loads.
→ worm wheels, gears, nuts for machines, lead screws

* Gun Metal: Cu 88%; Sn: 10%; Zn 2%.
Zn added to cleanse the metal & increase fluidity.
It is forged in hot state only at 600 °C
Metal very strong & resistant to corrosion by water & atmosphere.
Originally used for casting guns, But now used for casting boiler fittings, bushes, bearings, glands, etc.

* Bell Metal: Cu 80%; Sn 20%.
Hard & Resis. to surface wear
Used for making bells, gongs, utensils etc,

Scanned by CamScanner

* Cu Zn : Brasses :

Most widely used Cu-Zn alloy
Alloys of Cu with as much as 40-50% of Zn.
Various classes of brass depending on proportion of Cu & Zn are available for diff uses.
Suitable types lend themselves to the following processes like
casting, forging (hot & cold), cold rolling into sheets, wires drawing, extrusion through ~~dyes~~ dies
m.p. of brass : 800 - 1000°C.

The metal is non-corrosive in air and water & some acids also don't appreciably affect it.
It is soft ductile & has high tensile strength.

It becomes possible to give it a good surface finish.
It's non-magnetic & poor conductor of electricity.
By adding small quantities of other elements, its properties can be changed:
1-2% of Pb improves machining proper
small quantity of Sn enhances the hardness.
→ Used for hydraulic fittings, pump linings, utensils, bearings, bushes.

Date ___/___/___
Page ___
my companion

* Aluminium:

→ White metal produced by electrical processes from Alumina which is prepared from a mineral called bauxite.
→ Silvery white in colour & used where a light & non-corrosive metal is required as in aircrafts, automobile components.
→ in pure state Al would be weak & soft but when when mixed with small amt. of other metals, its becomes hard & rigid so it may be stamped, formed, drawn, cast, turned, forged.

Charac. & Uses:

→ Has good electri. conduc. ∴ used for overhead cables
→ " " resis. to corrosion & is non-toxic ∴ used for cooking utensils.
→ Has property of being beaten into foil.
→ Al metal of high purity has got high reflecting power in the form of sheets ∴ widely used for reflectors for solar applicaⁿ in mirrors & telescopes.
→ m.p. is 658°C.
→

* Al alloys:

even when mixed with small amt. of other elements, Al retains its light wt. character.

Classificaⁿ:

① Cast alloys ② Wrought alloys.

① For general use castings, Al is alloyed with Cu from 12.5 to 14.5% & Zn 2.5 to 3%.

② An imp. series of casting/forging alloys having high strength have recently been developed for use in aeroplane construcⁿ:

~~Duralumin~~

Cu 2.2%.
Zn 5%.
Ni 1%.
Mg 0.5%.
Al rest

** An interesting wrought alloy Duralumin:

Cu 3.5 ~~%~~ – 4.5%.
Mn 0.4 – 0.7%.
Mg 0.4 – 0.7%.
Al 95%.

forging, stamping, bars, sheets, tubes, rivets.
It has age hardening properties also.

** Age Hardening:
After going through various processes,
It is allowed to age for 3-4 day, it will be hardened through this process. In heat treated Age hardened condition 40 kgf/mm² (tensile strength).

Duralumin → used in aircraft industry as Alclad.
→ making auto compo.
→ used in locomotives
→ surgical instruments
→ cables, etc.

Scanned by CamScanner

* Cu, Ni, Mg may be cast or wrought Y-alloy

Cu 2.5 – 4.5 %

Ni 1.8 – 2.3 %

Mg 1.2 – 1.7 %

Has charac. of retaining a good strength at high temp. Used for pistons & other compo. in aeroengines. also used in form of sheets & strips & after proper heat treatment this maybe brought to a min tensile strength level of $350 N/mm^2$.

Martensitic
Ferritic

23.2.17. Assignment.

1. State the ranges of percentages of constituents like carbon, Si, Mn, S, P in plain carbon steels & the way these affect their properties.

2. Discuss characteristics & applications of special alloy steels (~~sople~~ alloys).
→ Magnet steels → Heat resis. steels → Shock resis. steels → Stainless steels
→ High speed steels (cutting tools material).

3. (i) State the desirable properties of materials used for making cutting tools.

(ii) Detail the composiⁿ & characteristics of the following cutting tool materials
→ High Carbon Steels
→ " Speed "
→ Cast Non-ferrous alloys
→ Carbides
→ Diamonds
→ Ceramic

4. (i) Discuss thermoplastic & thermosetting plastics. Name any 2 from each category.

(ii) What are composite materials? Stating different matrices & re-inforcements, also give their applications.

* Ma... [illegible] → Composite Material
Ex: RCC.

Date ___/___/___
Page ___

* Welding : (joining 2 materials).

1. What are the welding processes & weldability?
2. What are the features a materials should have to be easily welded? (Weldability)
3. State various welding processes.
4. Explain the diff. b/w fusion welding & pressure welding mentioning 2 processes of each type.
5. Explain gas welding process. (various gases used) giving details related to oxy-acetylene welding.
6. Sketch & Explain the 3 oxy-acetylene flames detailing their applications.
7. Give diff welding techniques/positions (horizontal, vertical, overhead, inclined).
8. Explain diff types of welding joints with sketches & also detail various edge preparations made for But joints.
9. Discuss oxy-acetylene welding equipment.
10. Explain electric arc welding, detailing the equipment needed for this process. Also give a schematic diagram of an electric arc welding machine.
11. Compare electric arc welding with AC & DC arc welding machines.

→ M.I.G → Metal Inert gas welding.

→ Plasma arc welding.

12. What is understood by arc crater & arc blow?

13. Discuss diff. types of electrodes used in arc welding.
(carbon, non-consumable, tungsten

14. Explain tig (T.I.G) tungsten inert gas welding, MIG, plasma arc welding

15. Discuss submerged arc welding / hidden arc welding.
(tip of electrode not visible).

16. What is electrical resistance welding - give circuit of such a welder.

17. With relevant sketches explain spot welding, seam welding, projection welding.

18. Explain thermite welding with help of sketches.
(fusion welding).

* Pattern Making & Foundry Process:

• Pattern Materials:

To be a good Patt. Mater. it should have the following properties:

→ easily worked & shaped
→ light in weight
→ strong, hard & durable so that it may be resis. to wear & abberation.
→ should be dimentionally stable in all situations.
→ " not be corroded easily.
→ chemically inert / resistant.
→ easily & economically available.
→ repairable, reusable.
→ good surface finish

Wide variety of Pat. Mat. which meet these characteristics are wood & wood products (laminated boards, etc), metals & alloys, plasters (POP, gypsum cement), Plastics, rubber, waxes (paraffin).

• Pattern types:

* Pattern Making Allowances:

→ Shrinkage allowance :
→ Draft allowance : } +ve allowance.
→ Wrapping allowance : -ve allowance

3.17.

* Core:

* Tools:

① Hand tools
② Flasks (Cope, Drag, etc).
③ Mechanical Tools.

* Natural Moulding Sand:

→ All sands are formed by breaking up of rocks. Ingredients are ① silica, sand, grains
② clay (provides bonding, adhesion).
③ Moisture
④ Miscellaneous

* Silica sand contains 80–90% of SiO_2. Its a product of breaking up of quartz rocks or decomposiⁿ of granite into quartz and feldspar. The latter of the two becomes clay on decomposiⁿ. Clay (Hydrous Aluminium silicate).

Classificaⁿ:

→ Grade A : 5–10% clay

Sintering temp = 1350 – 1450 °C. (fusing temp. for sand).

→ Grade B : 10–15% clay

Sintering T = 1200 – 1350 °C

Grade C : 15 – 20% clay.

S.T. = 1100 – 1200°c

* Properties of Moulding sand :

① Porosity / Permeability

② Flowability .

③ Collapsability . (for Reusage)

④. Adhesiveness

⑤ Cohesiveness (Strength).

⑥ Refractoriness (withstand high temp.).

** ① Porosity : Molten metal always contains a certain amt. of dissolved gases that are evolved when the metal solidifies. Also the molten metal coming in contact with the sand (moist) generates steam. If these gases & water vapours do not find some means to escape completely through the mould they will form gas holes & pores in the casting ∴ sand must be sufficiently porous to allow the gases or moisture to be removed. This property is called porosity/permeability.

② Flowability : It refers to the ability to behave like a fluid so that when rammed, it flows to all portions of a mould and pour all round the pattern & take up the required shape.

High flowability is required for sand to get compacted to a uniform density & to obtain good impression of the pattern in the mould.

③ **Collapsability**: After the molten metal in the mould gets solidified, the mould must be collapsable.

④ **Adhesiveness**: The sand particles must be capable of adhering to another body like the moulding boxes & the pattern, etc.

⑤ **Cohesiveness**: Ability of sand particles to stick together. Insufficient strength may lead to collapse in the mould or its partial destruction during conveying turning over. The mould may also be damaged during pouring of molten metal by washing off the walls. and the core by the molten metal.
The strength should be sufficient to retain the desired shape even after the molten metal is poured into the mould. (~~[illegible]~~
Green strength: This property of cohesiveness of green sand / moist sand.

⑥ **Refractoriness**: The sand must be able to withstand high temp. of the molten metal without fusing (burning). Moulding sands with poor refractoriness may burn onto the casting. Refractoriness is measured by the sinter pt. / sintering temp. of the sand.

Sheet Metal.

* Introduction :

generally regarded as working of metal sheets of gauges 16–30. (16: thickest). They are worked with hand tools and simple machines into various forms by cutting/shearing, punching, blanking, forming, bending, joining, etc.

*Applications :

1. Hoppers
2. Canisters
3. guards
4. Covers
5. Pipes
6. hoods
7. Funnels
8. Bends
9. boxes
10.

Such articles are found less expensive, light in weight & can often substitute the use of castings in forging.

* Sheets :

Black iron
Galvanised "
Stainless steel
Cu
Brass
Aluminium
Tin Plate
Lead.

→ sheets are specified by gauge nos.
→ each gauge ⇒ a thickness.

1. Black iron : cheapest, can be rolled to any desired thickness, annealed by placing in a furnace until red hot & then cooled gradually. It is a bluish-black appearance

and is referred to as uncoated sheet, corrodes fast, limited usage, articles likes, tanks, pans, which are to be painted.

② G. I. sheets: Zn coated Fe sheets; coating resists rust, superior appearance, permits easy soldering; welding not easy as Zn gives toxic fumes & reduces in the process. Because of Zn coating, can resist contact with water. Pans, buckets, furnaces, heating ducts, ~~cab~~ cabinets.

③ Stainless steel: alloy of steel with Cr, Ni & other metals. corrosion resis., welded easily, expensive, can be worked as G. I. sheets but prove to be tougher. Used in dairies, food processing machines, chemical plants, kitchen utensils.

④ Copper: Available as cold rolled / hot rolled sheets. Can be worked easily. Resis. to corrosion. Has better appearance than other metals. Costly metal than G. I. sheets. Cutlers, expension joints, hoods, etc.

⑤ Aluminium: can be used in pure form but used with small amt of Si, Mn, Fe, Cu. Corrosion to resistance. light in wt. Refrigerator trays, lighting fixtures, windows, aeroplanes, fittings & fixtures for doors. Electrical and transport industry.

⑥ Tin Plate: sheet Fe coated with Tin, protect against rust, used for all soldered work. Tin is the easiest metal to join by soldering

* Tools :

1. Measuring tools :

* Operations :

1. Squeezing

Scanned by CamScanner

23.3.17.

* Drilling & Boring:

One of the simplest machine tools in producⁿ & tool-room work is the ordinary drill press, consists of a spindle imparting rotary motion to the drilling tool, A mechanism for feeding the drilling tool.
+
The table on which work has to rest & a frame.

* Operaⁿ of Drilling:

→ consists of producing a hole in an object by forcing a rotating drill against it. The same results are accomplished in some machines by holding the drill stationary & rotating the workpiece such as drilling on a lathe with the workpiece held & rotated by a chuck.

Other methods of producing a hole are:

→ Punching like (Paper punches, sheet metal punches are there).
→ In welding (Oxidising flame is used) flame cutting.
→ Coring

Cores, flames might not produce accurate holes while drilling & punching produce accurate holes.

* Flame Cutting:

→ By oxy-acetylene flame, holes can be made through any thickness of a commercial material, Although holes are neither accurate in shape nor in size.

* Coring primarily used for large holes in castings to save metal & reduce final mach...

* Boring: It is the enlarging of a hole that has already been drilled or cored.
Basically, it is an operaⁿ of truing a hole made previously.
To perform this operaⁿ on a drill press, a special holder or a boring tool is needed.

* Counter Boring: It is the enlarging of one end of a drilled hole. The enlarged hole, which is concentric with the original hole, is flat at bottom.
The tool is similar
It is used mainly to set bolt heads and nuts below the surface.

* Counter sinking: if the top of a drilled hole is bevelled to accomodate the conical seat of a flat head screw, operaⁿ is called C. Sinking.

* Reaming: operaⁿ of enlarging a machined hole to proper size with a smooth finish. A reamer is an accurate tool & not designed to remove much metal.
Hence allowance should not exceed 3 to 5 mm.
~~Other machine too~~

* Classificaⁿ of drilling machines. [Table ①].

→ Portable
→ Sensitive (Bench mounted)

30.3.17.

* Measurement & Measuring instruments:

* Measurement ~~is made~~ has played an imp. role in many scientific & technological advancement

Measuring instruments, tools & gauges are used for measurement & inspection to establish the manufacturing accuracy of parts. They help to detect ~~timely~~ inaccurately machined parts & to avoid or minimise defects which is the job of inspecⁿ departments.

They are also helpful in other ways:

→ to layout the posiⁿ of surfaces to be machined.
→ to set & adjust tools
→ to align machines for effective utilisaⁿ of all parameters of producⁿ.

* Definitions:

① Measuring Instru: a device that may be used to obtain a dimensional or surface measurement.

② A gauge is a device used for quick checking of parts in producⁿ. It determines whether or not a dimension is within the specified limits.
A gauge usually doesn't reveal the actual size ~~of~~ or dimension. Unfortunately, many measuring instr. used for obtaining the exact values of dimensions, also have well established names which include the term gauges. Therefore, causing confusion.

Date ___/___/___
Page ________

*my*companion

* Standards of Measurement:

* The basis of Measurements is the provision of a fundamental unit (1 metre for length.) (MKS system). together with primary standards from which working standards can be derived

→ The earliest method used for measuring the dimensions of a part consisted in comparing its dimension with a known standard - This concept of measurement has not changed ever since.

→ Standards are material representa^ns of the fundamental units as the legal & scientific bases to which all measurements must be referred. However 2 widely used length standards are ① International Standard Metre.
② Imperial Standard Yard.

① International Standard Metre:

Since 1960, it has changed, by mutual agreement, the metre has been defined in terms of λ of light being the length equal to 1650763.73 vacuum wavelengths of orange radiation of a Krypton (85) under given reference conditions.

Before 1960, the interna^nal prototype metre was defined as the dis. at 0°C b/w the centre portions of 2 lines graduated on the polished surface of a bar of pure platinum-iridium alloy (90%, 10%), having a cross sec^n of 16 $(mm)^2$, length 1020 mm.

The unit has 2 lines engraved on it, one on each end.

② Imperial Std. Yard:

In its current form, was setup in 1845, it is made up of a solid square bronze bar, 38 inches long & 1(inch)² section. At one inch from each end there is a round recess (blind hole) cut at the centre of the bar & at the bottom of the hole, a gold plug of diameter 1/10 inch is inserted in a smaller hole made for this insertion. the surface of each gold plug is scribed with 3 centrally located fine transverse lines about 1/100 inch apart & 2 lines at right angles. All this is given in fig ②.

1 yard = 3 ft.

Measure of the yard is the dis. b/w centre of the middle transverse line, dis. midway b/w 2 longitudinal lines, at 62° F.

* Length standards:

Can be classified as the line standards & end standards.

micrometer, vernier callipers.

End std: accurate more, easier to read.

→ Line standards:
unit of length is defined as the dist. b/w the centres of 2 engraved lines as in a steel rule.

→ End std:
dist. b/w end face of the standard as in a micrometer.

* 1 hectometre = $\frac{1}{10}$ x 1 Kilometre
* diagonal scales connect upto 2 places of decimal for metre, in.

Date ___/___/___
Page ________
my companion

The international prototype, Imperial Std. yard are line standards & not end std. ∴ measure of length is determined b/w centre pos^n s of 2 engraved lines. This form of measurement not very convenient to use.

→ commercial line std. have disadvantages that there is a limit to the accuracy with which lines can be produced & their environment involves the use of microscopes & other special equipments ∴ for all imp. works in the shops we employ end standards. For eg: strip gauges, length bars, ends of micrometer, gap gauges, distance b/w end faces directly gives the length.

→ End faces are lapped & parallel to give you a high degree of accuracy.

3.4.17.

* Precision Measuring Instruments:

→ Acc. to Accuracy (indicated by least count of the instrument)

① Vernier scales: which connect 2 units (Ex: hectometre & km) (1 & $\frac{1}{10}$)

Like diagonal scales (connect 3 units 1, $\frac{1}{10}$ & $\frac{1}{100}$) (plain scales) are used to read

→ Retrograde Principle (if VSD are larger than MSD)
→ Direct Principle (if VSD are smaller than MSD)

a very small unit of length with great accuracy

V.S. consists of 2 parts, a fixed scale called the main scale & the movable graduated scale called the vernier.

The graduated edge of the vernier moves along the graduated " of the main scale (fixed & long).
A V.S. may either be straight or curved.

* Types of Vernier:

① Retrograde / Backward Vernier:
② Direct / Forward Vernier.

① Retrograde V.: fig. ③ shows a part of Main Scale in which the length AO represents 10 cm.
If we divide AO into 10 equal parts, each part will represent 1 cm, i.e. 10 mm. If we take a length BO on the Vernier Scale (Movable) which is equal to $(10+1) = 11$ cm & divide it into 10 equal divisions each division will represent $11/10 = 1.1$ cm $= 11$ mm.
The diff. b/w ~~the portion~~ 1 div on AO & 1 div on BO equals $1.1 - 1$ cm $= 0.1$ cm $= 1$ mm. $= \underline{L.C}$

Similarly, diff. b/w 2 parts of each = 2mm
Upper scale BO is the Vernier & combinaⁿ of V.S + MS = Vernier Scale.

If a line representing n units is divided into n parts on the M.S. then each part will show 1 unit.
But if the vernier you choose a length $(n+1)$ units & divide into n parts, length of 1 part $= \frac{n+1}{n} = 1 + \frac{1}{n}$ units.

The diff. b/w 1 part on V & 1 part on MS
$= \frac{1}{n}$ units

& for m parts, diff $= \frac{m}{n}$ units.

(2) Direct Vernier: fig (4) shows the M.S. exactly same as earlier, its each of 10 parts represents 1 cm. On Vernier, the length BO equals $(10-1)$ cm = 9 cm divided into 10 parts, each div = 9 mm. Diff b/w 1 part of AO & 1 part of BO equal 1 mm. & b/w 2 parts its 2 mm.

$\boxed{L.C.}$ of a vernier scale is the smallest distance that can be measured accurately by V.S. = diff b/w 1 MSD & 1 VSD..

$$L \cdot C = |1 MSD - 1 VSD|.$$

* Vernier Callipers:

primarily meant for measuring both inside & outside ~~measure~~ dimensions, holes, shafts, thickness of parts to an accuracy of 0.02 mm. By a V.S. attached to a callipers.

We know that the V.S. is a name given to a callipers. which are nearly alike but not quite alike for obtaining small measurements.

fig (5). comprises of a beam / M.S. that carries fixed gradua^n s, 2 measuring jaws, a vernier head, an auxillary heads etc.

The vernier & Auxillary Head can be locked to the M.S. by the ~~N~~ ^ screws attached to each ~~head~~ head.

An enlarged diagram of a metric V.S. is given in fig (6). (using Direct Principle). ~~L.C = 0.~~

On main scale 1 cm is divided into 10 parts, then again divided into 2 parts of 0.5 mm each. There are 25 div. on MS., ~~width~~ the length of 25 divs on V.S = 12 div. on M.S.

$\therefore$ each V.S.D $= \frac{12}{25}$ mm $= 0.48$ mm.

We know, 1 MSD $= 0.50$ mm.

$\therefore$ L.C. = 1 MSD − 1 VSD

$= 0.02$ mm. $= \frac{1}{50}$ mm.

To read the dimension first note the cm, then mm, then half mm then shifting of 0 of the V.S. has moved from 0 of MS

Reading

* 50 div. on V.S.: ~~MS~~ ~~mm~~

Least div on MS = 1mm.

* Vernier Height gauge: L.C $= 0.02$ mm

* Micrometers: L.C. $= 0.01$ mm. (fig-9)

pitch length $= 0.5$ mm.

$$L.C. = \frac{\text{Pitch}}{\text{no. of C.S. divisions}} = \frac{\cancel{0.5}\ 0.1}{\cancel{50}\ 10} = 0.01 \text{ mm.}$$

Internal Micrometer: fig (10).

The inside Micrometer is intended for internal measurements to an accuracy of 0.01mm. In principle its similar to an external micrometer & is used for measuring holes with a diameter over 50mm. The instrument comprises of a measuring unit, an extension rod & a handle. When the micrometer screw is turned in the barrel the distance b/w measuring faces of the micrometer can vary from 50 to 63 mm. To measure the holes with a diameter over 63 mm, the micrometer is fitted with extension rods of the following sizes:

13 mm, 25 mm, 50 mm, 100 mm, 150 mm, 200 mm, 600 mm

Reading: it has a pitch of 0.5 mm. The barrel or is provided with a scale 13 mm Long only & graduated into 0.5 mm & 1 mm divisions as in external micrometer. A second scale is engraved on the bevelled edge of the thimble. Its divided into 50 div. round the circumference. Thus, on going through 1 complete turn, thimble moves forward/backward by 1 pitch (0.5 mm) & 1 div on the circular scale will be equal to $\frac{0.5}{50}$ mm.

$= 0.01$ mm $=$ L.C. of Micrometer.

* Comparators / Dial indicators :

L.C = 0.01mm

These are instruments which derive their name from the fact that they are used for simple & accurate comparison of parts. These are designed in several types for various condi^ns. ~~for~~ comparators of every type incorporate some type of magnifying device to magnify how much a dimension deviates from an ideal dimension. Most comparators indicate actual measurement. But some only indicate whether a dimension deviates within a given tolerance range. They provide rapid means of expecting small articles made in large quantities.

Classifica^n: Acc. to the principles used for obtaining magnifica^n :

→ Mechanical → Optical
→ electrical →

Mechanical: employs mech. means for magnifying a small movement of the measuring stylus brought about due to difference b/w the standards and the actual dimension.
In Mech. comp., it has got through levers, gear pins or a combina^n of these elements.
They are available having magnifica^ns from 300 to 1 upto 5000 to 1 & used mostly for inspection of small parts.
machines.

Scanned by CamScanner

→ Dial indicators may be called as mechanical comparators as they have multiplying mechanism.

* Construction of Dial Indicator (fig 12).

It is like a small clock ~~lik~~ with a plunger projecting at the bottom. Very slight upward pressure on the plunger moves it upwards & this is indicated by the dial pointer / needle. Dial is graduated into 100 divisions. In full revolution of the pointer, it corresponds to 1mm travel of the plunger. Thus, in turn of the hand by 1 scale div only, represents the spindle travel of 0.01 mm.

A revolution counter or small dial indicates the travel of a plunger in whole mm is sometimes incorporated in the gauge on the big dial. The mechanism of such an instrument (fig 12). Movement of stem ① is transmitted by means of 2 think ~~m~~ through a compound chain of gears 2, 3 & 4 & this movement is transferred to a pointer 1' which moves around a dial face. The required measuring pressure b/w the workpiece & the stylus pt. is provided with a small spring incorporated in the mechanism.

13.4.17.

* **Gauges:**

① Standard G.
② Limit G.

① **Standard G**: made acc. to the nominal size (along with tolerance), single dimension gauge. It has the measuring ~~mean~~ member equal to the mean of permissible tolerances. It should mate with the part with some snugness.

② **Limit G:** ~~gauges with~~ go/no-go gauges.
One of the sides/ends of the gauge is made to correspond to the maximum & other to the min. permissible size. The fn of L.G. is to determine whether the actual dimensions of the work are within or outside the specified limits.

→ **Double ended**: it has the go member at one end & no-go member at the other end. The go member must pass into
The no go member shouldn't plug in nor pass
The progressive gauge has go & no-go next to each other & is applied to workpiece.

Some gauges are fixed only for one set of limits called solid gauges (most of the spanners).

Others are adjustable for various ranges, as fixed spanners for a nut or adjustable wrenches are.

To promote consistency in manufacture & inspecⁿ the gauges are classified as:

① Working Gauge : used by Mechanic

② Inspection " : used " inspectors

③ Reference / Master " : " for making gauges themselves.

* **Based on form of Gauge:** (Depending on objects to be checked)

→ for holes or any square holes. (Plug gauges).

→ for checking shafts (ring gauges)

→ for checking tapers (taper ring gauge).

→ for threads (pitch of threads) (Ex: for V-shaped threads).
↳ no. of threads in 1 unit distance.
(Plug screw gauges) → for internal threads.
(ring type " ") → " external threads.

→ form gauges.

* **Gauge Materials:**

① High Carbon steels.
② Alloy steels have been the principal materials used for many years.

Objec^n to steel gauges: they are subjected to some distortion because of the heat treatment given to them to impart an appropriate hardness, etc.

But inspite of that, their surface hardness ↓.

These objections are overcome by use of chrome-plating or cemented carbide tips as surface material. then hardness ↑ more than usual components. Some gauges made entirely of cemented carbide or can have cemented carbide inserts at certain wear points.

→ Form gauges: may be used to check the contours of the profile of the workpiece for conformance to certain shape or form specifications.

→ Screw pitch gauges: serve as everyday tools used in picking out a required screws for checking the pitch of screw threads. They consist of a no. of flat blades which are cut count to a given pitch. & pivoted in a holder. as shown in fig (3.0). Each blade is stamped with the pitch or the no. of threads per unit length

The sets are made for metric threads with an angle of 60°. A set for measuring metric threads has pitches from 0.4 to 6.