MODEL ANSWER

SUMMER– 18 EXAMINATION

Subject Title: Subject Code: 17303

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

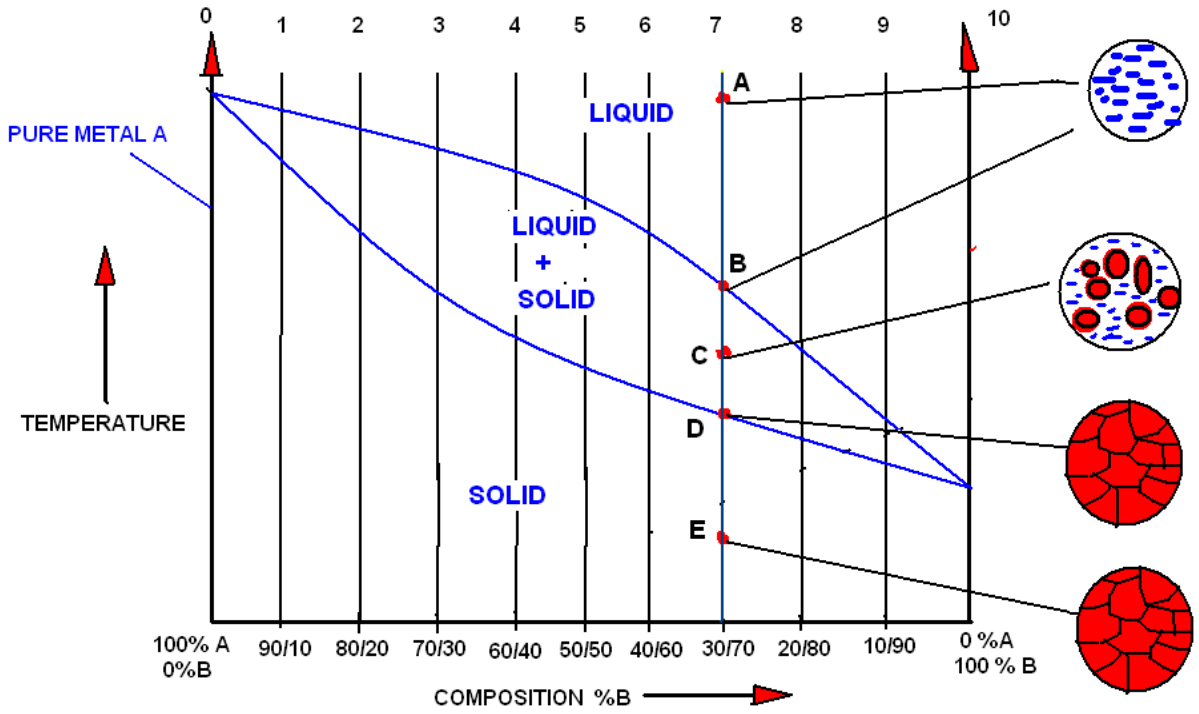
Q. No.	Sub Q. N.		Marking Scheme
1	a	**Define i)Thermal conductivity ii)Toughness** i)**Thermal conductivity**:- The rate at which heat can flow through a material under the influence of a given temperature gradient is determined by the thermal conductivity ii)**Toughness**:-It is the ability of the material to absorb energy during plastic deformation up to fracture.	1 Mark each
	b	**State any four applications of grey cast iron.** i) frames for electric motors ii) Machine tool structures iii) Engine frames iv) Drainage pipes v)Cylinders & piston & piston rings vi) Fly wheels etc.	Any four ½ Mark each
	c	**Define i)Hypoeutectoid steel ii)Hypereutectoid steel** i**) Hypoeutectoid steel** :-The steel which contains carbon percentage from 0.008% to 0.8% is called as hypoeutectoid steel ii) **Hypereutectoid steel**:- The steel which contains carbon percentage from 0.8% to 2% is called as hypereutectoid steel	1 Mark each

	d	**State the objectives of heat treatment** i) To increase hardness, wear resistance and cutting ability of the steel. ii) To alter the physical, mechanical or chemical properties of steels iii) To reduce or eliminate internal residual stresses. iv) To modify grain size of the steel v) To improve ductility & toughness vi) To improve electrical and magnetic properties vii) Improve machinability viii) Increase corrosion resistance of the steel	Any four ½ Mark each
	e	**List any four surface heat treatment processes** i)Carburizing ii)Nitriding iii)Cyaniding iv)Flame Hardening v)Induction Hardening	Any Four ½ Mark each
	f	**State the purpose of normalizing** i)To eliminate coarse grained structure. ii)To refine grain structure. iii)To produce harder and stronger steel than annealing. iv)To obtain required mechanical properties. v)To relieve internal stresses in some cases.	Any four1/2Mark each
	g	Pure metal:-A pure metal only consist of a single element. This means that it only has one type of atom in it. They have metallic bond between their atoms. Alloy:-It is a mixture of two or more elements of which at least one element is a metal and mixture shows metallic properties.	1 Mark each
	h	**State any four advantages of alloy steel** i)Greater hardness & hardenability ii) Greater high temperature strength iii)Better machinability iv)Less grain growth v)Less distortion & cracking vi)More cutting ability	Any four ½ Mark each

	i	**Classify copper alloys** Brass-Alloy of copper & zinc α brass, cap copper ,gliding metal ,cartridge brass ,Admiralty brass ,Naval brass,brazing brass Bronzes- Alloy of copper other than zinc Aluminium bronze, Tin bronzes, coinage bronze, gun metal, Phosphor bronze, Beryllium bronze, silicon bronze	2 Marks
	j	**State any four applications of high carbon steel.** Applications tools, knives, files, chisels, agricultural implements, forging dies, punches, hammers, springs, clutch discs, car bumpers, chisels, vice jaws, shear blades, drills, leaf springs, knives, razor blades, balls and races of ball bearings, mandrels, cutters, files, reamers, wire drawing dies, metal cutting saws.	Any four ½ Mark each
	k	Surface hardening:-Heating the surface of steel by oxyacetylene flames or by using high frequency current followed by water spray quenching to increase surface hardness. Case hardening:- consists heating of a steel in the presence of solid, liquid or gas, rich in carbon nitrogen in order to enable the surface to be hardened, while retaining a tough ductile core	1 Mark each
	l	**State any two properties of tool steel** i) high wear resistance and cutting ability. ii)These are characterized by high hardness (60-65 HRC at 600-650°C), high red hardness, wear resistance, iii) reasonable toughness iv)good hardenability	Any Two 1 Mark each
	m	**Define the term solid solubility** A solid solution forms when the solute atoms are added to the solvent provided that the solvent crystal structure is maintained. It occurs when the components have similarities in crystal structure and atomic diameter. The dissolving ability of solute in the solvent is called solid solubility.	2 Marks

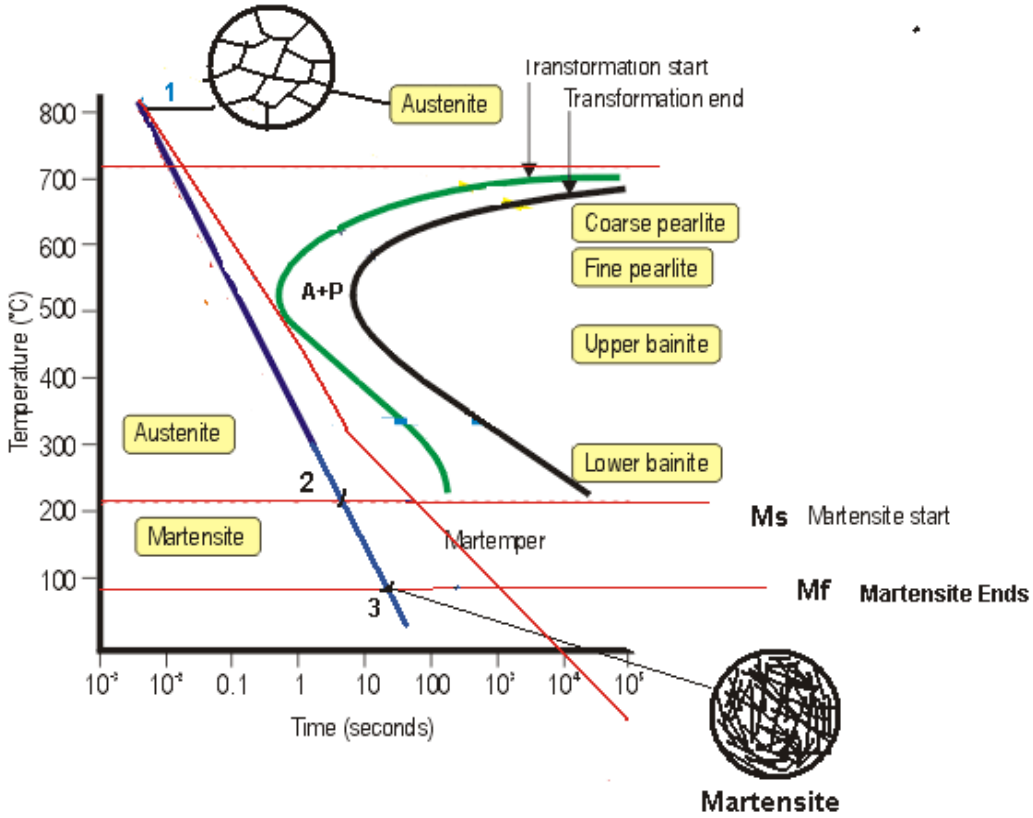
	n	**State any four characteristics of polymers** i) Low density ii) Good corrosion resistance iii) Low coefficient of friction iv) Good mouldability v) can be produced with close dimensional tolerances vi) Excellent surface finish can be obtained vii) Can be produced transparent or in different colours viii) Economical, low mechanical properties	Any four ½ Mark each
Q2	a	**Differentiate between amorphous & crystalline solids**	4 Marks
	b	ISOMORPHOUS SYSTEM • alloy system of two metals a and b which are completely soluble in the liquid stage as well as in solid stage. • both the type of metals have same unit cells and space lattice EXAMPLES; Cu-Ni, Au-Ag, Mo-W. Isomorphous binary phase diagrams are found in a number of metallic and ceramic systems. In the isomorphous systems, only one solid phase forms; the two components in the system display complete solid solubility. Typically, the isomorphous system has a liquid area, a solid area, and an area that is a mixture of both liquid and solid. Typically, a binary isomorphous phase diagram consists of two phase boundaries: the liquidus and the solidus.	Description -2 Marks Diagram-2 Marks

crystalline	amorphous
Shows no. of crystals in microstructure	No crystals in microstructure
Regular repetitive arrangement of atoms	No regular and repetitive arrangement of atoms
Meallic bond exists	No metallic bond
Example-All metals and alloys	Example-Wood, plastic, glass



c **Draw Time-Temperature isothermal Transformation (TTT) diagram for plain carbon steel & show various regions on it.**

Neat sketch- 4 Marks

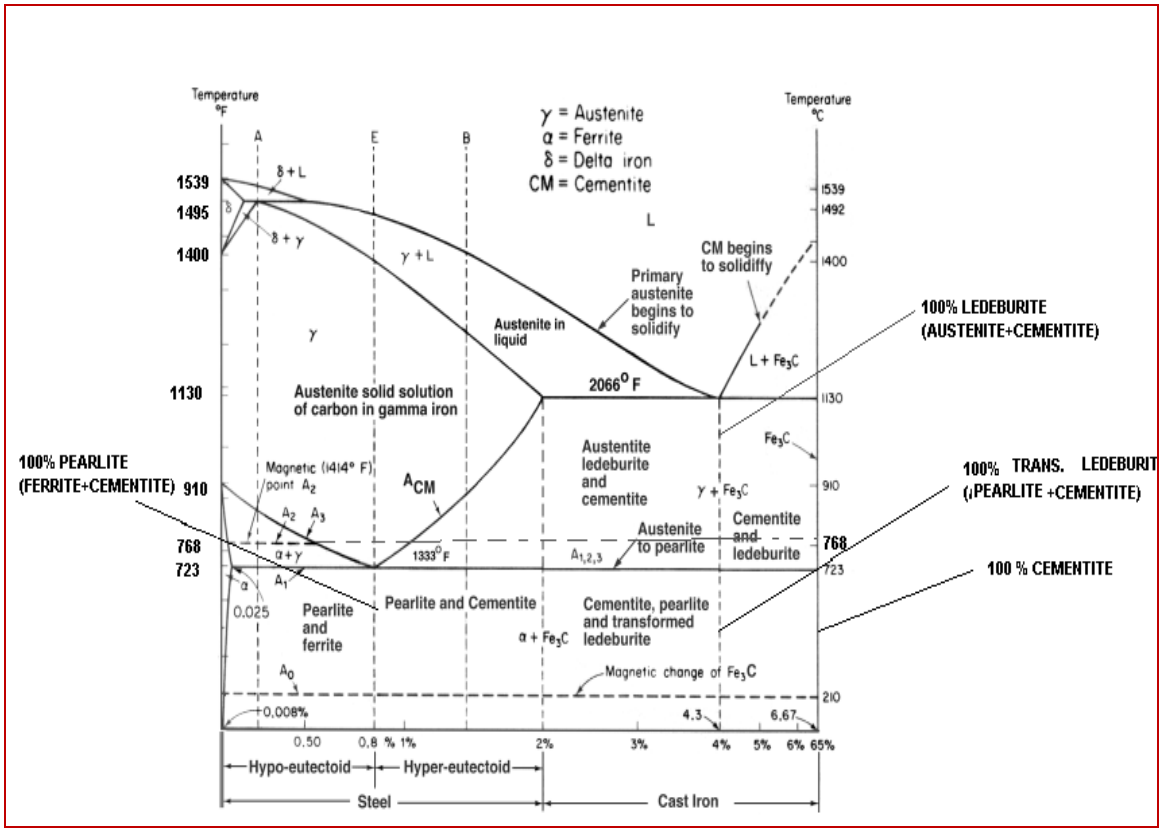


	d	**State the effect of following alloying elements on steel** **Molybdenum**: - It increases red hardness of steel. Increases hardness, hardenability & wear resistance, reduces temper brittleness ,increases strength, Mo-carbides help increase creep resistance at elevated temps **Tungsten**:- increases creep resistance and hardenability of steel, imparts secondary hardness to the steel, improves heat resistance, helps to form stable carbides and carbides inhibit the grain coarsening ,increases hot hardness, Refines the grain size	2 Marks 2 Marks
	e	**State chemical composition, properties & applications of cartridge brass** Chemical composition:-It contains about 30% zinc and 70% Cu Properties:-Has maximum ductility and malleability, greater % elongation, greater strength over 300N/mm2, Applications:-cartridge cases, radiator fins, lamp fixtures, rivets ,springs, shell cases,	Composition:-1 Mark Properties:-2 Marks Applications:-1 Mark
	f	**State properties & applications of neoprene rubber.** **Properties:-** i)It is chemically and structurally similar to natural rubber ii) Its resistance to oils, chemicals, sunlight, weathering, aging is outstanding . iii)Does not support combustion although consumed by fire iv)It has excellent resistance to permeability by gases v)It has superior resistance to compression vi)Relatively low in dielectric strength **Applications:-** i)Heavy duty conveyor belts ii)V-belts iii)Hose covers iv)footwear v)brake diaphragm vi)Motor mounts, rolls & gaskets	Any four properties - 2 Marks Any four applications-2 Marks
Q3	a)	Differentiate between destructive & non destructive testing on any four criteria	Any four 1Mark each

Destructive Testing	Non destructive Testing
1. The component breaks or damages during or after testing the component.	1. The component does not break or damage even after testing the component.

2. The component is not useful for further purpose 3. Properties like tensile strength, compressive strength, bending strength, fatigue strength, toughness, and ductility can be assessed. 4. 100% inspection is not possible. 5. Not economical and safe. 6. Engineers get more useful information regarding designing of the component. 7. Examples :- Tensile test, compression test, impact test, bend test, torsion test, fatigue test.	2. The component can be used for the purpose it was made. 3. It can detect surface or subsurface defects like cracks, porosity, and inclusion blow holes, flaws, cavities etc. 4. 100% inspection is possible. 5. More economical and safe. 6. By this test whether a component to be accepted or rejected can be decided. 7. Examples :- Radiography (X ray or γ rays) ultrasonic inspection, dye penetrate test, magnetic inspection test.

b) **Draw neat sketch of iron-carbon equilibrium diagram & show important temperature & phases on it.** 4 Marks



c) Differentiate between annealing and normalizing on following criteria — 1Mark for each criteria

Annealing	Normalising
1.Furnace cooling rate is used	1. Air cooling rate is used
2. Corse Pearlite structure is formed in steel in steel	2. Fine pearlite structure is formed
3. Less hardness is retained	3. More hardness is retained
4. Annealed component has more ductility	4.Normalized component has less ductility

d) **Explain tempering & state the purpose of tempering** — 1 Mark

Tempering cycle consists of heating of hardened component to a temperature well below ac1 (100 to 700 º c)temperature and holding for a period of 1 to 2 hours then steel is cooled to room temperature in air or in salt bath.

Purpose of Tempering — Any three -3 Marks

i. to relieve internal stresses produced during hardening.

ii. to reduce hardness.

iii. to improve ductility and toughness.

iv. to reduce retained austenite.

v. to obtain a spheroidal structure which improves machinability.

e) **State chemical composition, properties & applications of high chromium high carbon (HCHC)tool steel.**

Chemical composition:-carbon-1.50% to 2.35%,Chromium-12%,Tungsten-1%,Mo-1%,V-4% — Composition:- 1 Mark

Properties:- — Properties:- 1 Mark

i)They have high hardenability
ii)Their distortion during hardening is less
iii)High hardness & wear resistance
iv)They are difficult to machine

Applications:-They are used for drawing dies, blanking dies, forming dies, coining dies ,thread rolling dies, trimming dies, bushings, shear blades ,punches, cold forming rolls, cutting tools, gauges — Applications:- 2 Marks

Q4	f)	**State the type of steel with its chemical composition of following IS specifications** i) **40Cr4Mo3**:- Steel with average carbon of 0.4 %,chromium 1% and molybdenum 0.3% ii) **XT75W18Cr4V1**:- High alloy Tool steel with average composition Carbon-0.75% ,Tungsten W- 18%, Chromium- 4%, Vanadium- 1%	2 Marks each
	a)	**State chemical composition, properties & applications of white metal** **Chemical composition(Any one of the following)** % Composition / Sn / Pb / Sb / Cu / Others Pb –based: 1%-10% / Balance / 10%-15% / 1.5%-3.5% / Cd-1.25%-1.75% ,As-0-1% Sn-based: Balance / Upto 10% / 5%-12% / 3%-5% / As-0-0.1% **Properties**:-Hard & wear résistance, have a low coefficient of friction, tough, high fatigue résistance, good corrosion resistance **Applications:** a) Used for diesel engine crank shafts bearings b) Bearings of heavy duty vehicle. c) High capacity Presses. d) Cranes, hoists	Composition- 2 Marks Properties- 1 Mark Applications:-Any two 1Mark
	b)	**State characteristics and applications of ABS** **Characteristics of ABS are as under**, • ABS plastics are copolymers of acrylonitrile butadiene and styrene. • Resistant to acids , alkalis and to some organic solvents. • Good Strength and Toughness. • Hard and Rigid. • Good insulators to heat and electricity. • Good Impact resistance. **Applications of ABS are as under,** • Automobile panels and parts. • Radiator Grills. • TV Cabinets and cameras • Telephones • Refrigerator Liners.	Characteristics -Any four ½ Mark each Applications-Any four ½ Mark each

	c)	**List various methods of powder making & explain any one** **Powder making process.** 1. Mechanical : Machining, crushing, milling, shotting , graining etc. 2. Atomization. 3. Chemical reaction process 4. Electrolytic process. **i) Automisation :-** In atomization process a high pressure steam, or liquid impinges on the molten metal which is passed through orifice causing it to atomize into fine particles. This method is used for the metal which has low melting point. **ii) Reduction :-** In reduction process, the compound of metals are reduced with CO and H_2 gas in controlled atmosphere at temperature below the melting point of the metal. The reduced product is then crushed and ground. Powders of copper, iron, tungsten, molyb denum, nickel are manufactured by the reduction process. **iii) Electrolysis :-** Electrolysis is used for the production of metal powder of copper and iron. The process is similar to electroplating, In this process anode and cathode are placed in the electrolyte bath. As anode is going to deteriorate, so copper plates are placed at anodes and aluminium plates are placed at cathodes. High intensity current produces deposits of copper powder on cathode plates. Then cathode plates are taken out and scrapped off to collect copper powder. **iv) Crushing :-** This is totally mechanical process. The brittle metal or alloy is easily crushed by this method. It requires crushing machinery like stamps, hammer, jaw crusher etc. **v) Milling :-** It requires ball mill, impact mill, eddy mill, disk mill or vortex mill. Milling process can be used to hard, soft, ductile or brittle materials. A ball mill is widely used which horizontal barrel-shaped container is holding number of balls which being free to tumble about as the container rotates. Then it crushes or grind the material to give fine powder.	Methods-1 Mark Explanation of any one process -3 Marks
	d)	**List any eight mechanical properties of engineering materials & define any two in detail** **i)Toughness** is defined as the amount of energy a material can absorb without breaking or fracture. ii) **Creep** (sometimes called **cold flow**) is the tendency of a solid material to move slowly or deform permanently under the influence of mechanical stresses, especially at elevated temperature.	List of properties-2 Marks

iii) **Fatigue** is the weakening of a material caused by repeatedly applied loads. It is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading.

iv) **Ductility:-**It is the property of material by virtue of which it can be drawn into thin wires.

v) **Plasticity:-**It is the ability of material to be permanently deformed without fracture even after the load is removed. It is the property of material, which retains the deformation ,produced under load permanently

vi) **Strength:-**It is defined as the capacity of material by virtue of which it can withstand an external force

vii) **Hardness:**-The ability of a material to withstand scratching, wear and abrasion or penetration by harder bodies is known as hardness.

viii) **Malleability:-**Malleability is the ability of a material to exhibit deformation when compressive force is applied

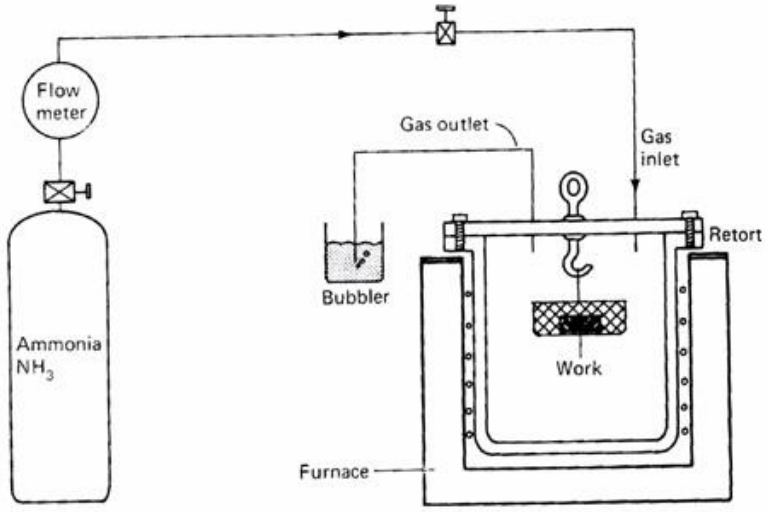
Definition of any two properties- 2 Marks

e) **Explain nitriding process with neat sketch.State advantages & disadvantages of it.**

Explanation:-1Mark

NITRIDING

• process of heating of alloy steels in contact with nitrogen gas environment to a temperature of 500 to 550 degree centigrade and held for a long period of time (25 to 100 hours) in the furnace.
• during holding period ,there is a chemical reaction in the gas and the free nitrogen atoms are liberated.
• these atoms penetrate into outer surface of the steel component and combine with alloying elements to form "hard alloy nitride particles" in the outer surface of the steel, due to which outer surface becomes extremely hard and wear resistant.
• hard outer surface is formed without quenching.
• maximum case depth achieved is around 0.03 mm to 0.6 mm.



Sketch-1 Mark

Advantages of nitriding

- high corrosion resistance
- increased fatigue resistance.

Any two advantages 1/2 Mark

- very hard outer layer
- wear resistance.

Disadvantages of nitriding

• long cycle times (25 to 100 hrs)
• brittle case
• only special alloy steels containing Al, Mo, V. Cr as alloying elements can only be nitrided.
• plain carbon steels cannot be effectively nitrided.
• high cost.
• technical control required.
• if nitrided part gets accidently overheated.(above 500 0c) then the hardness will be lost completely.

each

Any two disadvantages 1/2 Mark each

Any four

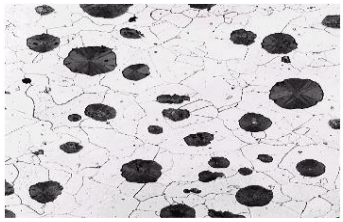
f) **Differentiate between flame hardening &induction hardening(Any four)**

1 Mark each

FLAME HARDENING	**INDUCTION HARDENING**
• surface of steel is heated rapidly by oxyacetylene flame , then quenching to convert austenite into martensite • Success depends on skill of operator. • Suitable for large shaped components or irregular shape components. • Internal surfaces may be heated and hardened • Cheaper method • Applications:-Large gear shafts, lathe ways, spline shaft etc OPERATING VARIABLES ARE • distance between flame & work piece. • gas pressure, • flame or work travel rate, • type, volume and application of quench. • any shaped parts are suitable for	• steel is heated by high freq. electric induction current and cooled rapidly to convert austenite into martensite • Success is related to selection and design of proper work coil. • Suitable for round shaped components • Internal surfaces are difficult to heat. • Costly method • Applications:-Piston rods, cams, shafts etc OPERATING VARIABLES ARE • induced voltage • flow of current • resistance offered by work • shape and design of coil & • rate of heating. • irregular shaped parts are

Q5 a) **Draw Microstructure of nodular CI, state its advantages and applications.**

sketch 1m



GLOBULES OR NODULES

Graphite spheres surrounded by ferrite

Advantages :
The ductile iron family offers the designer and engineers a unique combination of strength, wear resistance, fatigue resistance, and toughness, as well as excellent ductility characteristics.
high fluidity, gives sound castings. Widely used in cast parts where density and pressure tightness are highly desirable. Several grades can be used in the as-cast condition without additional heat treatments.

advantages 1m

Applications:

- hydraulic cylinders
- valves
- pipe and pipe fittings
- cylinder head for compressors
- diesel engines
- rolls for rolling mills

applications 2m

b) **State Chemical composition of duralumin, properties and applications**

Chemical composition : it is a al-cu-mg alloy. Modified form of duralumin- 4%cu, 0.4-0.6%mg, 0.7%mn , 94%-95% Aluminium. It is widely used. Further high strength alloy developed with
4.4%cu, 0.5%mg, 0.09%si, 0.8%mn. Designated as 2014.

Chemical composition 1M

Properties :

- better strength to weight ratio
- extremely ductile and soft
- good malleability & formability
- good corrosion resistance
- high electrical and thermal conductivity.
- tensile strength 13000 psi

good machinability and workability

properties and applications 3M

Applications: in wrought condition used for forging, stamping, bars, sheets, tubes and rivets. Artificial ageing widely used for aircraft bodywork.

c) **Explain Nature, properties and applications of nano materials.**

Nano material is defined as a "material with any external dimension in the nano scale or having internal structure or surface structure in the nano scale", with nano scale defined as the "length range approximately from 1 nm to 100 nm". This includes both nano-objects, which are discrete pieces of material, and nano structured materials, which have internal or surface structure on the nano scale;

Nature 1M

Properties:
Physical properties

- Size, shape, specific surface area, aspect ratio
- Agglomeration/aggregation state
- Size distribution
- Surface morphology/topography

properties and applications 3M

- Structure, including crystallinity and defect structure
- Solubility

Chemical properties

- Structural formula/molecular structure
- Composition of **nanomaterial** (including degree of purity, known impurities or additives)
- Phase identity
- Surface chemistry.

Applications:

Nano materials are used in a variety of, manufacturing processes, products and healthcare including paints, filters, insulation and lubricant additives. As a lubricant additive, nano materials have the ability to reduce friction in moving parts. Nano materials are being used in modern and human-safe insulation technologies,

d) **Explain Liquid carburising , state any two merits and demerits.**

Explanation 2M

Liquid carburising:

steel part is heated in molten salt bath in contact with liquid carbon rich material like sodium cynide or potassium cynide to a temperature of 870 – 950 degree centigrade

steel parts in the wire baskets are held in the bath for a period of 5 minutes to one hour depending upon case depth required. At this temperature carbon as well as nitrogen diffuses into outer surface of steel part.

on subsequent quenchung martensite is formed in the outer case of the component**.**

Merits:

merits and demerits 1M each

- rapid heat transfer and heating.
- low distortion.
- no oxidation and decarburisation.
- rapid absorption of carbon & nitrogen in outer surface.
- uniform case depth and carbon content.
- reduced cycle time.
- flexibility to handle range of parts of varied design and varied case depths.

Demerits

- Cyanide baths are highly poisonous when cyanide fumes are taken internally or when in contact with wounds.
- Molten cyanide explodes when comes in contact with water. So all work has to be dried before it comes in contact with bath.
- Parts need thorough washing after treatment to prevent rusting.

e) **State Chemical composition , advantages and disadvantages and applications of Mild Steel.**

composition 1M

Chemical composition: very low almost nil carbon, with smaller amount of S,P, Si.

element	Content
Carbon, C	0.25 - 0.290 %
Copper, Cu	0.20 %
Iron, Fe	98.0 %
Manganese, Mn	1.03 %
Phosphorous, P	0.040 %
Silicon, Si	0.280 %
Sulfur, S	0.050 %

advantages and disadvantages 1M

Advantages

1. **Efficiently Malleable**

One of the most beneficial properties of mild steel is it can be bent, cut and twisted to create the desired shape easier than other metal.

2.Weight

Compared to high carbon steel mild carbon steel is lighter. The proportion of carbon is the main influencing factor for the weight.

3.Greatly Affordable

While working on a low budget, mild carbon steel proves to be the best. It is an ideal material that keeps project cost as low as possible.

Disadvantages

1. **Comparatively Less Stronger**

Mild steel is suitable for mechanical engineering and general purpose fabrication. Its strength makes it a terrific choice of material for the construction of cages, frames, fencing and in other applications where it will not be subjected to high stress.

2. Limitation To Heat Treatment

Treating mild steel through heat mechanism can affect the carbon content. Usually, heat treatment is used to change the characteristics of steel. But once originally fabricated in the mill and cooled off there are no significant changes after heat treatment.

Applications:

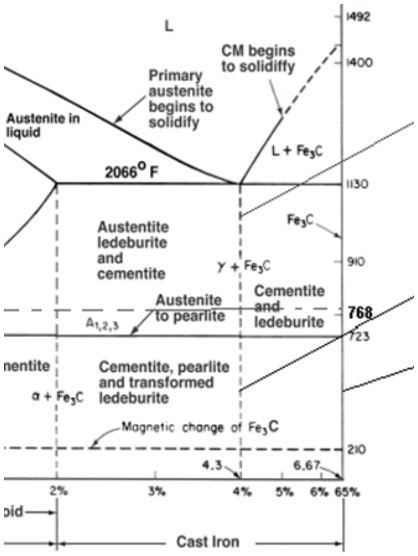
applications 2M

It is used in bolted, riveted or welded construction of bridges, buildings and oil rigs.

- It is used in forming tanks, bins, bearing plates, fixtures, rings, templates, jigs, sprockets, cams, gears, base plates, forgings, ornamental works, stakes, brackets, automotive and agricultural equipment, frames, machinery parts.
- It is used for various parts obtained by flame cutting such as in parking garages, walkways, boat landing ramps and trenches.

f)

Explain Eutectic reaction with phase diagram.



Ledeburite:

It is an eutectic mixture of austenite and cementite contains 4.3% C at 1140 ^{0}c

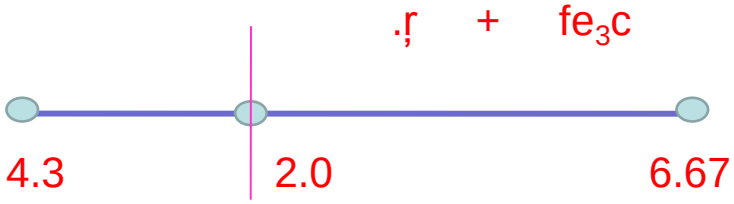
Phase diagram-2 Marks

.Eutectic reaction:

1140 ^{0}c.

L $\rightleftharpoons$ austenite + cementite

.ṛ + fe_3c



And below 723 ^{0}c. This austenite transforms to ferrite + cementite.
And some of the ledeburite transformed as it is, called as transformed ledeburite.

Eutectic reaction

-2 Marks

Q6 a)

Write short note on i) austenite ii) cementite

i)Austenite : ṛ –gamma solid solution. :-It is an interstitial solid solution of carbon dissolved in ṛ gamma iron (FCC structure). solubility of C is 0.8% at 723 ^{0}c and this limit increases up to 2 % at 1140 ^{0}c.

Austenite is stable only above 723 ^{0}c. As temp. drops below a1, it transforms in other phases.(i.e. in ferrite, pearlite). It is not useful for part manufacturing at this temp. range (it is stable from 723 to 1400 ^{0}c). Rather it can be transformed in different phases. On fast cooling autenite transform to martensite phase.

But it can be retained at room temp. by the addition of alloying elements.

E.g. Ni helps in retaining austenite at normal temp. Hardness Rockwell C 40, and has high toughness. TS 150000 PSI, elongation 10% in 2 in. it is non magnetic.

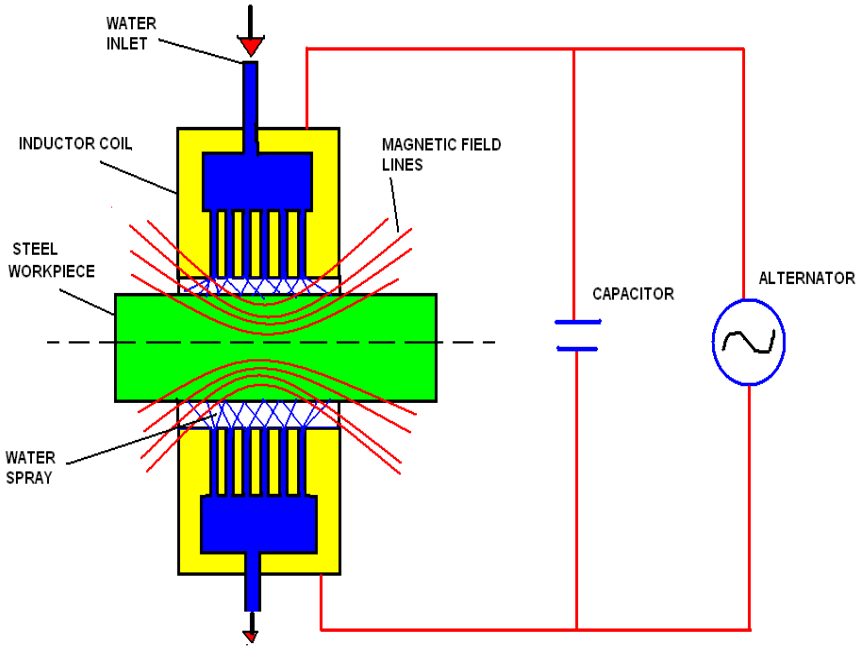
Austenitic stainless steel (18/8, 18% Cr ,8% Ni) shows austenite phase retained at room temp. Which is non magnetic.

2 Marks

		ii) cementite: also called as iron carbide, CM, fe_3c. Cementite contains 6.67 % C by wt. It is a intermetallic stable carbide compound. Crystal structure is orthorhombic. Very hard and brittle interstitial compound. Low TS @ 500 PSI. but high compressive strength. It is the hardest structure on the diagram. 1400 BHN, ferromagnetic below 210 ^{0}c & in the form of round particles. It is the hardest phase on the diagram.	2 Marks
	b)	**state any four types & applications of tool steel.** **types of tool steels:** • shock resisting tool steel • cold-worked tool steels : i) oil-hardened, ii)air-hardened iii) high carbon, high chromium • hot-worked tool steels: i) chromium-based ii) tungsten-based iii) molybdenum-based • high-speed tool steels : i) tungsten-based ii)molybdenum-based • water-hardened tool steels **applications**: Tool steel offers better durability, strength, corrosion resistance and temperature stability, These are used in applications such as Blanking, die forging, forming, extrusion and plastic molding etc. Chisels Pneumatic chisels Punches Shear blades Scarring Tools River sets Driver bits. End mills, drills, lathe tools, planar tools. Punches, reamers, Routers, taps, saws. Broaches, chasers, and hobs.	types 2M applications 2M
	c)	**Explain induction hardening process with neat sketch.** • heating the medium carbon steel with alternating magnetic field by the phenomenon of electromagnetic induction to austenitic temperature(750-800 centigrade) • followed by rapid quenching so that austente in the outer case converts to martensite, producing a hard outer layer and soft inner layer of ferrite + pearlite. • magnetic field lines thread via surface of workpiece in the inductor coil. they induce "eddy currents "by electromagnetic induction in the steel component of the same frequency but revered in direction. • heating results due to resistance of the steel part. • intensity of eddy current is maximum in the outer surface and slowly decreases towards centre this effect is called as "skin effect". • depth of hardening is inversely proportional to frequency of current supplied to inductor coil by high frequency generator.	Explanation 2M

- as the frequency increases the depth of hardening decreases and vice versa
- Desired frequency of the current can be set to get the required case depth.

sketch 2M



d) **State Chemical composition, characteristics and advantages of 18:4:1 HSS with any two applications.**

Chemical composition 1M

18:4:1 HSS Chemical composition:

18% tungsten, 4% chromium, 1% vanadium

Characteristics and Advantages:

These are characterized by high hardness (60-65 HRC at 600-650°C), high red hardness, wear resistance, reasonable toughness and good hardenability.

They contain 0.6 % carbon, 4% Chromium, 5-12% Cobalt.

Carbon imparts hardness of at-least 60 HRC of martensite formed. Chromium increase hardenability & corrosion resistance. Cobalt increases the thermal conductivity, melting point, red hardness & wear resistance of high speed steels.

characteristics and advantages 2M

Applications:

i) End mills, drills, lathe tools, planar tools.
ii) Punches, reamers,
iii) Routers, taps, saws.
iv) Broaches, chasers, and hobs.

applications 1M

e) **Differentiate between thermoplastic and thermosetting plastic.** — Any four- 1Mark each

Thermo plastics	**Thermosetting Plastics**
1.Composed of chain molecules	1.Composed of cross linked molecules
2.Can be repeatedly softened by heat and hardened by cooling	2.Can be softened only first time when Heated. But cannot be softened on subsequent cooling
3. Comparatively softer and less strong	3.Stronger and Harder
4.Cannot be used at Higher Temperatures	4.Can be used at Higher Temperatures
5.Produced by additional Polymerization	5.Produced by Condensation and Polymerization.
6.Can be easily Moulded and remoulded into any shape	6. Cannot be moulded and remoulded into new shape.
7. Used for Toys,combs,toilet goods, tapes receivers,cabinets, Hoses,pipes	7.Used for Telephone Camera bodies.

f) **State any four applications of powder metallurgy.** — each application 1M

automotive applications:

in motor car industries, porous bearings are used for starter, sliding doors, wipers, clutches and brakes of cars .

sintered gears widely used in cars and trucks.

electrical contacts, piston rings, brake linings etc are other p/m parts

defence applications-

Metal powders are used in rockets, missiles, bullets and military pyrotechnics such as tracers and incendiaries.

aerospace applications-

p/m parts used in rockets, missiles, satellites and space vehicles.

tungsten parts are used in plasma jet engines.

atomic energy applications-

p/m components are used in atomic reactors, magneto-hydrodynamic generators, high temp. gas turbines. High temp. applications-

refractory metals and carbides find applications in high temp. service. Refractory metals carbides used for dies, rolls , cutting tools at high temp.