WINTER-16 EXAMINATION

Model Answer Subject Code **17455**

WINTER – 16 EXAMINATIONS

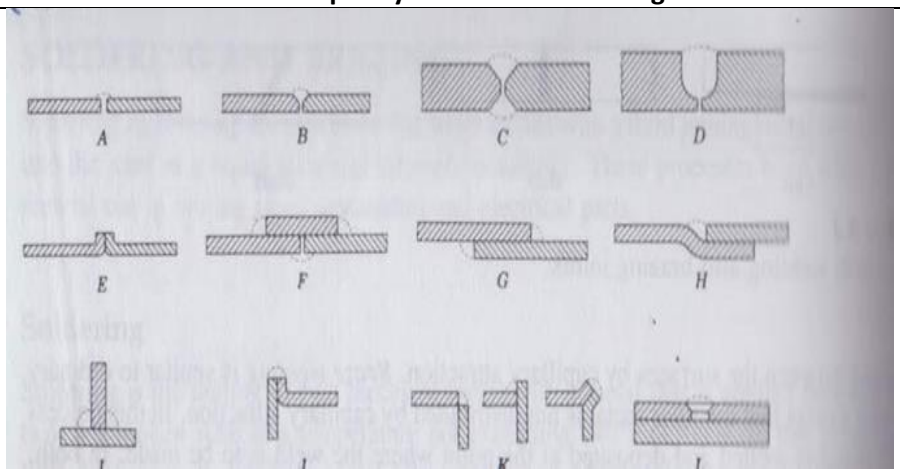
Subject Code: **17455** **Model Answer** Page No: ____/ N

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 judgment 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.

WINTER-16 EXAMINATION

Model Answer Subject Code **17455**

`Q	MODEL ANSWER . NO.	MARKS	TOTAL MARKS
1.	**Attempt any FIVE of the following:**		**20**
a)	 A, Butt weld. B, Single vee. C, Double vee (heavy plates.) D, U-shaped (heavy casting). E, Flange weld (thin metal). F, Single strap butt joint G, Lap joint (single- or double-fillet weld). H, Joggled lap joint (single or double weld, I, Tee joint (fillet welds). J, Edge weld (used on thin plates). K, Corners weld metal). L, Plug or rivet butt joint	2m for state 2m for sketch	4m
b)	Selection of factors for power sources.The following factors influence the selection of a power source: 1. Available power (AC or DC, single phase, etc.). Where no power is available, a diesel engine driven DC generator may be used. 2. Available floor space. 3. Initial costs and running costs. 4. Location of operation (whether in the plant or in the field). 5. Personnel available for maintenance. 6. Versatility of equipment. 7. Required output. 8. Duty cycle.	1m per point	4m

<table>
<tr><td></td><td>9. Efficiency.
10. Type of electrodes to be used and metals to be welded, (e.g. non-ferrous materials and stainless steels are welded more effectively with DC than with AC).
11. Type of work</td><td></td><td></td></tr>
<tr><td>c)</td><td>Weldability is the capacity of a material to be welded under the fabrication conditions imposed into a specific suitably designed structure and to perform satisfactorily in the intended service.

Factors effecting are:
•Composition of the metal
•Brittleness and strength of metal at elevated temperature
•Thermal properties of metal
•Welding techniques,fluxing material and filler material
•Proper heat treatment before and after the deposition of the metal.</td><td>2m for state

2m for Factors</td><td>4m</td></tr>
<tr><td>d)</td><td>1. Remedies of cracking
<table>
<tr><td>1</td><td>Preheat,Relieve residual stresses mechanically, Minimize shrinkage stresses using backstep or block welding sequence.</td></tr>
<tr><td>2</td><td>Change welding current and travel speed,Weld with covered electrode negative; butter the joint faces prior to welding</td></tr>
<tr><td>3</td><td>Change to new electrode; bake electrodes to remove moisture</td></tr>
<tr><td>4</td><td>Reduce root opening; build up the edges with weld metal</td></tr>
<tr><td>5</td><td>Increase electrode size; raise welding current, reduce travel speed</td></tr>
<tr><td>6</td><td>Use filler metal low in sulfur</td></tr>
<tr><td>7</td><td>Fill crater before extinguishing the arc; use a welding current decay device when term~nating the weld bead]</td></tr>
</table>
2.Remedies of Inadequate joint penetration
<table>
<tr><td>1</td><td>Use proper joint geometry</td></tr>
<tr><td>2</td><td>Follow welding procedure
Adjust electrode or work position</td></tr>
<tr><td>3</td><td>Use small electrodes in root or increase root opening</td></tr>
<tr><td>4</td><td>Improve visibility of backgouge</td></tr>
<tr><td>5</td><td>Backgouge to sound metal if required in welding</td></tr>
</table></td><td>1m for each defect

(any two remedies for each defect) (1/2 m per point)</td><td>4m</td></tr>
</table>

	procedure specification		
	6 Use wider root opening or smaller electrode in root pass		

3. Remedies of slag inclusions

1	Clean surface and previous weld bead
2	Power wire brush the previous weld bead
3	Avoid contact between the electrode and the work; use larger electrode
4	Increase groove angle of join t
5	Provide proper gas shielding
6	Reposition work to prevent loss of slag control
7	Change electrode or flux to improve slag control
8	Use undamaged electrodes

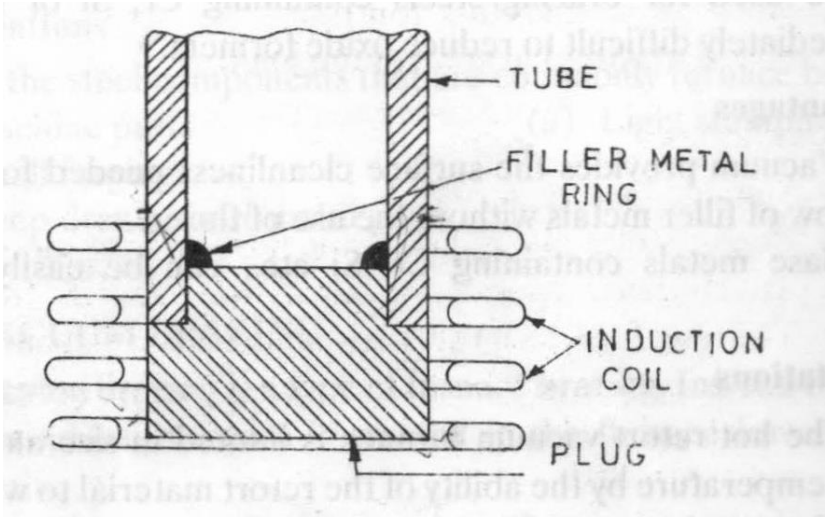
4. Remedies of porosity

1	Use low-hydrogen welding process; filler metals high in deoxidizers; increase shielding gas flow
2	Use preheat or increase heat input
3	Clean joint faces and adjacent surfaces
4	Use specially cleaned and packaged filler wire, and store it in clean area
5	Change welding conditions and techniques Use copper-silicon filler metal; reduce heat input
6	Use E6010 electrodes and manipulate the arc heat to volatilize the zinc ahead of the molten weld pool
7	Use recommended procedures for baking and storing electrodes Preheat the base metal
8	Use electrodes with basic slagging reactions

5.Remedies of incomplete fusion

1	Follow correct welding procedure specification
2	Maintain proper electrode position
3	lower current. or increase weld travel speed
4	Clean weld surface prior to welding

e)		4m	4m



INDUCTION BRAZING

- Induction brazing is used where

(i) Very rapid heating is desired.

(ii) Production rate is high.

(iii) Parts are self jigging.

- The components to be brazed are fluxed, filler metal is preplaCed (in the form of a ring, washer etc.) in proper position and this assembly is placed within (or near) an induction coil. When highfrequency electric current is passed through the induction coil, the energy is transmitted to the assembly/workpiece by induction rather than by electric connection. Heating of the workpiece surface takes place as a result of eddy currents or PR losses in the work metal which, by virtue of its electrical resistivity and the flow of induced alternating current through it, generates heat. In addition, on ferromagnetic materials, a further increase in heating
results from hysteresis.The interior of the workpiece is heated by thermal conduction from the hot surface.

- The depth into the work piece to which it is heated depends u the frequency of the alternating current employed. As a rule. the higher the frequency, the shallower the heating.

- High frequency current is obtained with thehelp of

(i) The motor generator set (3,600 to 10,000 Hz).

(ii) The tube-operated oscillator (450 kHz and higher).

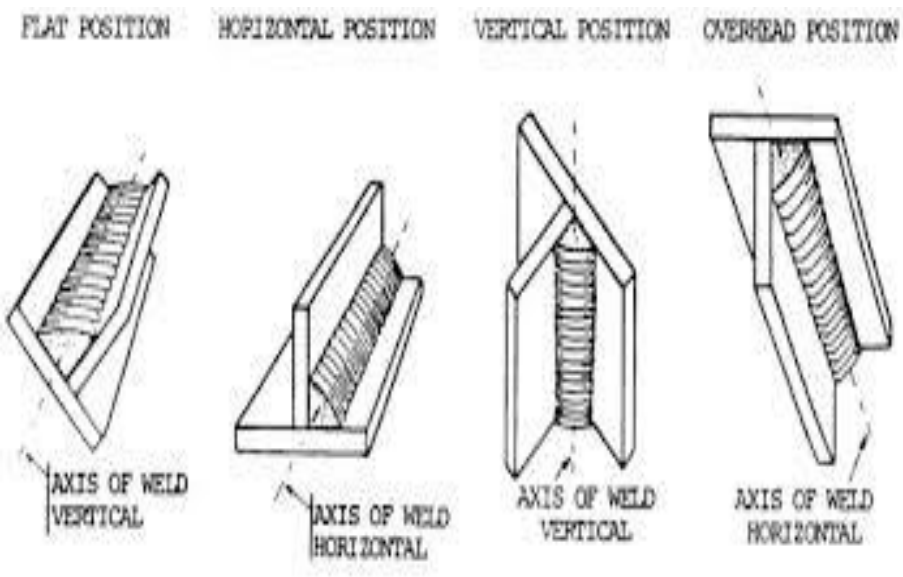
- A flux or a special gaseous atmosphere is necessary to prevent oxidation during brazing

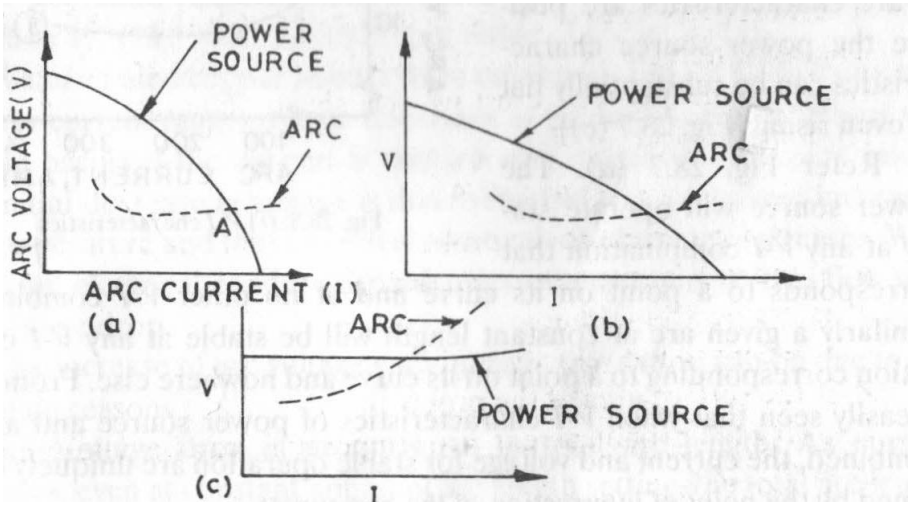
f)	Advantages of Gas welding: 1.It is the probabity the most versatile process 2.It can be applied to a wide variety of manufacturing and maintenance situation 3.Welder has considerable control over the temperature of the metal in the weld zone 4.The rate of heating and cooling is relatively slow 5. This equipment is versatile, low cost. Self-sufficient and usually notable. 6. The cost and maintenance of the welding equipment id low when compared to that of other welding process.	any four (1m per point)	4m
g)	Processes for Welding Cast Iron The following processes are employed for welding cast iron are: (a) Metal Arc Welding (b) Oxy-acetylene Welding (c) Braze Welding (d) Brazing (e) Thermit Welding (a) METAL-ARC WELDING OF CAST IRON Procedure - A Veejoint with included angle of 60° to 90° may be formed (on the workpieccs to be joined) by chipping or machining. Notching or studding may be adopted to increase the strength of the weld joint - The joint is carefully cleaned of all dust, dirt, oil, grease and paint. - Electrodes of cast iron, mild steel, austenitic stainless steel, nickel alloys etc., may be employed for welding cast iron. - The arc is struck by touching the electrode with the job. As the molten pool forms, the welding is carried out in the normal way. In order to minimize the stresses set up in the workpiece, the welds may be laid in short runs (skip welding) and then each allowed to cool. Peening the weld while hot also relieves stresse. OR (b)OXY-ACETYLENE WELDING OFCAST IRON Introduction - Cast iron is successfully welded by gas welding but it requires massive inputs of heat, both in preheating and during the welding operation. -This large heat input may cause distortion or dimensional	2m for listing 2m for any one process	4m

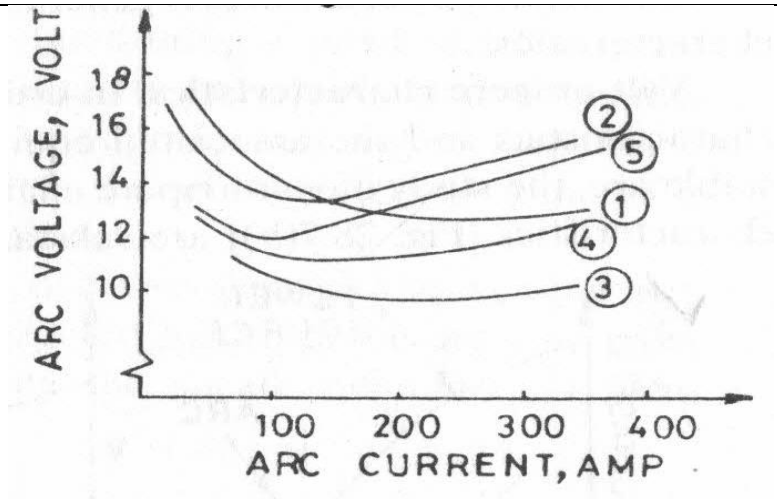
	changes of the components. T-he slower cooling rate resulting from gas welding, however, lessens the tendency for hardening of the heat affected zone. -Joint Preparation -A 60° to 90° Vee groove should be ground or chipped out or cut with a cutting torch or cutting electrode. This groove should not pass completely through the casting as otherwise alignment would be difficult. -For thin sections, a 75° to 90° Vee joint is generally used. For very heavy sections of25 mm and above, a 90° double- Vee joint is often recommended. -When welding can be made from one side only, the groove angle' should be increased to about 120 degrees. -When the groove extends through the casting, backing up with a graphite backing plate should be provided. -When repairing cracks, a hole should be drilled at each end of the crack prior to welding to prevent further propagation of the crack. Preheating the job - The job, before welding, is preheated at 620°C in a furnace and then covered with asbestos cloth, exposing only the cavity to be welded. -If a furnace is not available, the casting can be covered with asbestos cloth and locally heated by gas name. -Thin sections may be preheated locally, whereas heavy sections should be preheated in their entirety in a furnace. OR (c)BRAZE WELDING OF CAST IRON - Braze welding is used for making field repairs. New castings are generaIly not repaired by braze welding because of poor colour match. - Joints preparation for braze welding of gray cast iron is same as used for gas welding. - Filler rod materials may be Naval brass Manganese bronze Nickel bronze For better colour match, instead of naval brass or manganese-bronze welding rods, nickel-bronze welding rods are preferred. - Flux may be added manually by dipping filler rod's heated end into it or the filler rod itself may be flux covered. - Preheating is not necessary unless the casting is heavy or		

	complicated, in which case preheating between 316 and 4000C is sufficient. - The use of a salt bath is best for cleaning any of the cast irons prior to braze welding. If a salt bath is not available then, ground groove surfaces of cast iron are heated with a slightly oxidizing flame to dulI red colour, cooled and wire brushed. This removes graphitic smear from the groove surface. - Slightly oxidizing flame is used for braze welding gray cast iron. - After welding, the job should be covered with a thermal protection and allowed to cool slowly. OR (d)BRAZING OF CAST IRON - Brazing of gray cast iron is done to repair casting defects where strength and colour match are not of primary importance. - Brazing of cast iron: (i) Requires special precleaning methods" to remove graphite from the surface of iron; because the presence of graphite on the cast iron surface would prevent wetting and adhesion of the brazing alloy. (ii) Is carried out at temperature as low as feasible, in order to avoid reduction in the strength of iron. - Filler rod. Most copper and copper-base alloys are not satisfactory for brazing cast iron because their high melting points may embrittle the cast iron through copper penetration. -A 6% tin-bronze brazing rod, melting at about 925°C can be successfully employed for brazing gray cast iron. Silver-brazing alloys are frequently used as filler rods. A typical composition of such alloys is: Ag-44 to 46% Cu-14 to 16% Zn-14 to 18% Cd-23 to 25% Brazing temperature-620 to 760°C. Silver brazing rods containing nickel produce greater bond strengths. - Process. -Brazing is generally done with an oxyacetylene torch and a neutral or slightly carburizing flame. -Other methods such as furnace brazing, resistance brazing, induction brazing etc., are also commercially used for the production of small parts. -Preheating between 205 and 427°C before torch or induction brazing may produce better result.		

	OR (e) THERMITWELDING OF CAST IRON - Heavy structures such as machinery basis or frames are therrnitwelded. - Since therrnit metal shrinks as much as cast iron, any weld longer than eight times the sectional thickness may develop minute hairline cracks. Thus the designer must make suitable allowances for contraction cooling.		
h)	Arc Stability:- Arc is said to be stable if it is uniform and steady. A stable arc will produce good weld bead and a defect-free weld nugget. Defects commonly introduced by unstable arc slag entrapment, porosity, blow holes and lack of proper fusion. The stability of a welding arc is governed by many factors,as mentioned below:- (a) Suitable matching of arc and power source characteristics. A little variation in arc length, i.e., arc voltage should not extinguish the arc. (b) Position and movements of cathode and anode spots. (c) Arc length and arc current. . (d) Electrode tip geometry in TIG welding. (e) Conditions promoting Arc Blow. (f) Presence of dampness, oil, grease etc. on the surface of workpiece. (g) Limited practice on the part of the welder. ARC BLOW The unwanted deflection or the wandering of a welding arc from its intended paths termed as arc blow or arc bow. Arc blow is the result of magnetic disturbances which unbalance the symmetry of the self-induced magnetic field around the electrode, arc and workpiece.	2m Arc stability 2m Arc blow	4m
2.	**Attempt any FOUR of the following:**		**16**
a)	Filler metal. -Filler Metal is the material that is added to the weld pool to assist in filling the gap {or groove). Filler metal forms an integral part of the weld. - Filler metal is usually available in rod form. These rods are called Filler Rods. -Metallic wire used to fill the gap between the base metals to be joined. It need not be a part of the electrical circuit. - Filler rods have the same or nearly the same chemical composition as the base metal.	**4m**	4m

	- Welding filler rods are available in a variety of compositions (for welding different materials) and sizes. A filler metal is a metal added in the making of a joint through welding, brazing, or soldering.		
b)	 Flat In a flat position, a weld is performed along largely a horizontal access and from above the joint.The welding is performed from the upper side of the joint, and the face of the weld is approximately horizontal. Horizontal In the horizontal position, the weld's axis is the horizontal plane. Horizontal welding is often used for fillet or groove welds. The axis of a weld is a line through the length of the weld, perpendicular to the cross section at its center of gravity. *Vertical* With a vertical position, the weld's axis is largely in a vertical or upright position. In vertical position pipe welding, the axis of the pipe is vertical. *Overhead* In this welding position, the welding is performed from the underside of a joint.	1m for each position	4m

c)	ARC CHARACTERISTICS  V-I characteristics of arc super-imposed on power sources characteristics. The behaviour of the arcs is generally described with the details of arc characteristics. Characteristics:- -In order to design power sources, their characteristics and the associated equipment to initiate and maintain a stable arc, the study of volt-ampere characteristics is necessary. - If the arc characteristics [Fig.(b)] are substantially flat, then to impart a high degree of self adjustment of arc consistent with stability, the volt-ampere characteristics of the power source must be slightly negative.If arc characteristics are positive the power source characteristics can be substantially flat or even rising The fig bellow shows V-I characteristics under different welding conditions. 1. Tungsten electrode lIB" (3 mm) diameter, electrode extension V2' (12.5 mm), normal mode of arc in argon. 2. Tungsten electrode lIB" (3 mm) diameter electrode extension V2" (12.5 mm), cathode spot mode of arc in argon. 3. Tungsten electrode lIB" (3 mm) diameter, electrode extension 1V4" (31 mm), normal mode of arc in argon. 4. Thoriated tungsten electrode 3V32" (2.38 mm), electrode extension V2' (12.5 mm), normal mode of arc in argon. 5. Thoriated tungsten electrode 5/32" (3.97 mm) diameter, electrode extension V2' (12.5 mm), cathode spot mode of arc in argon.	**2m for diag** **2m for exp**	**4m**

			
d)	NEED OF HEAT TREATMENT USED IN WELDING:- 1) The purpose of heat treatment is to remove any internal or residual stresses that may be present from the welding operation 2) Heat treatment after welding, is often used to improve properties of a weldment. 3) the Post weld heat treatment can encompass many different potential treatments fabrication, the two most common procedures however, in steel used are post heating and stress relieving.Other desired results from Post weld heat treatment may include hardness reduction, and material strength enhancements. 4) Post heating is used to minimize the potential for hydrogen induced cracking (HIC). 5)Stress relief heat treatment is used to reduce the stresses that remain locked in a structure as a consequence of manufacturing processes.	**1m per point**	**4m**

e)	1)Size limitation of the parts to be brazed is of major importance,since area to be brazed must be heated, large cast sections or large heavy plates cannot be easily brought up to temperature. 2). Brazing requires tightly mating parts to ensure capillary flow of the filler metal. This involves expensive machining to attain the desired fit. 3). Flux residues if not properly removed can cause corrosion. 4). Brazed joints do not give satisfactory results when used at elevated temperatures. 5). A certain degree of skill is required to perform the brazing operations; personnel limitations may rule out the process. 6). Very large assemblies, although brazable, may be made more economically by welding . 7) Brazing fluxes and filler rods may evolve toxic fumes and poisonous vapours.	**1m per point**	**4m**
f)	TIG WELDING - TIG welding is the most commonly used method of welding aluminium today. Thinner gauges of aluminium can be joined without a filler metal. - TIG welding involves striking an arc between a tungsten (alloy) electrode and the workpiece to provide heat for joining. A separate filler rod is employed when welding thicker workpieces. TIG welding resembles gas welding because both employ a heat source independent of the filler (metal) electrode. -Gas welding employs a flux whereas TIG welding makes use of an inert gas to prevent any reaction between the molten weld metal and the atmosphere. Edge preparation- Thicknesses of aluminium alloys commonly welded by TIG process range from 1 to 10 mm for manual welding and from 0.25 mm to 25 mm for automatic welding Preweld Surface Cleaning- Oil, grease, paint, moisture, oxide coating and all other contaminants should be thoroughly removed from the surfaces to be welded by mechanical or chemical means in order to obtain high quality weld. Power Supply and Equipment- Welding power source is either a DC Motor-driven generator, a rectifier or a transformer. For TIG welding aluminium either AC or DC (both DCRP and DCSP) is employed	**4m**	**4m**

	Shielding Gas- - Argon is generally used for TIG welding aluminium. - Helium is sometimes employed with higher speeds and for thicker sections. - Mixtures of argon and helium are also used for welding aluminium where a balance of characteristics is desired Welding Electrode- - For AC welding, unalloyed tungsten and tungsten-zirconium electrodes are recommended. Zirconiated electrodes are less likely to be contaminated by aluminium and have a slightly higher current rating. Unalloyed tungsten electrodes minimize inclusions in the weld bead and current unbalance		
3.	**Attempt any TWO of the following:**		**16**
a)	Following are the equipment used in gas welding:- • Oxygen gas cylinder • Acetylene gas cylinder • Oxygen and acetylene pressure regulator • Oxygen gas hose • Acetylene gas hose • Welding torch • Trolley • Filler rod • Flux • Protecting cloths 1. Oxygen Gas Cylinder - Oxygen cylinders are painted black and the valve outlets are screwed right-handed. - The usual sizes of oxygen cylinders are 3400, 5200 and 6800 litre. - Oxygen cylinder is a solid drawn cylinder out of mild steel or alloy steel. Mild steel cylinder is charged to a pressure of 13660KN/m^2 (136.6 bar) and alloy steel cylinders to 17240 KN/m^2 (172 bar) -The oxygen volume in a cylinder is directly proportional to its pressure. - Because of the possibility of the oxygen pressure becoming high enough to rupture the steel cylinder in case the temperature rises,an oxygen cylinder is equipped with a safety nut that allows the oxygen to drain slowly in the event the temperature increases the gas pressure beyond the safety load of the cylinder.	3 M for listing 5m for its expl	**8m**

	- An oxygen cylinder has an inside diameter of 805" (21.6 cm),wall thickness0.260" (0.650 mm) and length 51"(127.5 cm). - In order to protect cylinder valve from getting damaged, a removable steel cap is screwed on the cylinder at all times when the cylinder is not in use. -The cylinder valve is kept closed when the cylinder is not in use and even when cylinder is empty 2. Acetylene Gas Cylinder - An acetylene cylinder is painted maroon and the valves are screwed-left handed; to make this easily recognisable they are chamfered or grooved. - An acetylene cylinder is also a solid drawn steel cylinder which is charged to a pressure of 1552 KN/m2 (15.5 bar)* - The usual size of acetylene cylinders are 2800 and 5600 litre. - An acetylene cylinder has an inside diameter of 12" (30 cm), wall thickness 0.175" (0.438 mm) and a length of 40.5" (101.25 cm). - An acetylene cylinder is filled with a spongy (porous) material such as balsa wood or some other absorptive material which is saturated with a chemical solvent called acetone. -Since high pressure acetylene is not stable, it is dissolved in acetone, which has the ability to absorb a large volume of the gas and release it as the pressure falls. -The small compartments in the porous material (filled in the cylinder) prevent the sudden decomposition of the acetylene throughout the mass, should it be started by local heating or other causes. -An acetylene cylinder is always kept upright for safety device reasons. The acetone in the cylinder must not be permitted to enter the blowpipe, otherwise an explosion could result. - The acetylene cylinder valvecan only be opened with aspecial wrench and thiswrench is kept in place wheneverthe cylinder is in use. - An acetylene cylinder has anumber of fusible plugs, atits bottom, designed to melt at 220^0F (104°C). These plugs melt and release the pressure in case the cylinder is exposed to excessive heat 3 Oxygen and Acetylene Pressure Regulators - The pressure of the gases obtained from cylinders/generators is considerably higher than the gas pressure used to operate the welding torch.		

	- The purpose of using a gas pressure regulator is, therefore (i) to reduce the high pressure of the gas in the cylinder to a suitable working pressure, and (ii) to produce a steady flow of gas under varying cylinder pressurespressure regulator is fitted with two pressure gauges. - A pressure regulator is connected between the cylinder/generatorand the hose leading to welding torch. 3.) Hoses - The hose for the supply of oxygen (from the pressure regulator) to the welding torch is coloured blue and has right-handed thread connections, whereas the acetylene hose is coloured red and has left-handed thread connections with chamfers or grooves on the nuts. - For welding purposes, the hoses to be used should be strong, nonporous, flexible and not subject to kin king. - Welding hose has a seamless lining which is manufactured from rubber (or a rubber compound) which is reinforced with canvas or wrapped cotton plies. -The hose is resistant to the action of gases normally used in welding. -The outer casing is made of tough abrasion resistant rubber. The hose is very robust and capable of withstanding high pressure. Welding Torch or Blow-pipe - Oxygen and the fuel gas having been reduced in pressure by.the gas regulators are fed through suitable hoses to a welding torch which mixes and controls the flow of gases to the welding nozzle or tip where the gas mixture is burnt to produce a flame for carrying out gas welding operation. - There are two types of welding torches, namely: (i) High pressure (or equal pressure type. (ii) Low pressure (or injector) type Protective cloths of welders Protection of Welders from Sparks and Spatter (Protective Clothing).The welder's body and clothing are protected from radiation and burns caused by sparks and flying globules of molten metal with the help of the following: , (i) Gloves protect the hands of a welder. (ii) Leather or asbestos apron is very useful to protect welder's clothes and his trunk and thighs while seated he is doing welding.		

(iii) For overhead welding, some form of protection for the head is required. Leather skull cap or peaked cap will do the needful.
(iv) Leather jackets and leather leggings are also available as clothes for body protection.
(v) If cutting or deep gouging is being carried out by metal arc processes, the amount of spatter is considerably greater than with normal arc welding and leather spats would be particularly useful to prevent burns to the ankles and feet.
(vi) Safety boots are necessary to protect the feet of the welder from hot slag and, in particular, from falling off-cuts

Filler rod and flux-

-Filler Metal is the material that is added to the weld pool to assist in filling the gap {or groove). Filler metal forms an integral part of the weld.

- Filler metal is usually available in rod form. These rods are called Filler Rods.

-During welding air combines with the metal to form oxides which results in defects so flux is used during welding

- Filler rods have the same or nearly the same chemical composition as the base metal.

- Welding filler rods are available in a variety of compositions (for welding different materials) and sizes.

Trolley

-Trolleys should be capable of accommdating one oxygen cylinder and one acetylene cylinder.

-Cylinders are normally be mounted on a trolley side by side.

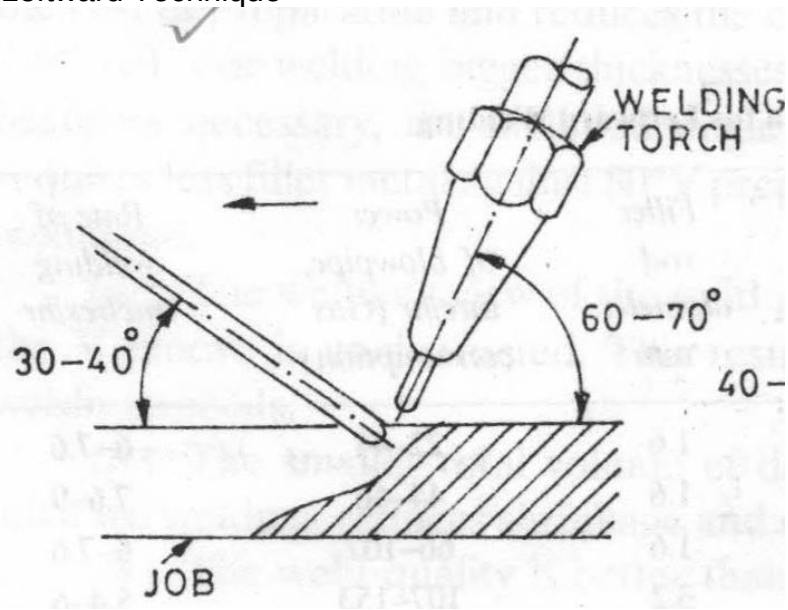
b)

SR. NO	WELDING	BRAZING	SOLDERING
1	These are the strongest joints used to bear the load. Strength of a welded joint may be more than the strength of base metal.	These are stronger than soldering but weaker than welding.These can be used to bear the load up to some extent	These are weakest joint out of three. Not meant to bear the load. Use to make electrical contacts generally.
2	Temperature required is upto	It may go to 600^{o}C in brazing	Temperature requirement is

1m Each point

8m

			3800oC of Welding zone.		upto 450^{o}C.	
		3	Work piece to be joined need to be heated till their melting point.	Work pieces are heated but below their melting point.	No need to heat the work pieces	
		4	Mechanical properties of base metal may change at the joint due to heating and cooling.	May change in mechanical properties of joint but it is almost negligible	No change in mechanical properties after joining	
		5	Heat cost is involved and high skill level is required.	Cost involved and sill required are in between others two	Cost involved and skill requirements are very low.	
		6	Heat treatment is generally required to eliminate undesirable effects of welding	No heat treatment is required after brazing.	No heat treatment is required	
		7	No preheating of workpiece is required before welding as it is carried out at high temperature.	Preheating is desirable to make strong joint as brazing is carried out at relatively low temperature	Preheating of workpieces before soldering is good for making good quality joint.	
c)	Welding processes employed for welding mild steels are listed below. 1. Oxy-acetylene Welding 2. Flux Shicided Metal Arc Welding 3. Submerged Arc Welding 4. Gas Metal Arc Welding (MIG) 5. Gas Tungsten Arc Welding (TIG) 6. Plasma Arc Welding 7. Thermit Welding 8. Resistance Welding				3m for listing and 5m for exp	8m

	9. Electroslag Welding 10. Brazing etc. METEL INERT GAS (MIG) -It is an arc welding process wherein coalescence is roduced by heating the job with an electric arc established between a continuously fed metal electrode and the job. - No flux is used but the arc an-d molten metal are shielded byan inert as, which may be argon, helium, carbon dioxide or a gas mixture. -Before igniting the arc, gas and water flow is checked. Proper current and wire feed speed is set and the electrical connections are ensured. -The arc is struck by anyone of the two methods. In the first method current and shielding gas flow is switched on and the electrode is scratched against the job as usual practice for striking the arc. -In the second method, electrode is made to touch the job, is retracted and then moved forward to carry out welding; but. before striking the arc, shielding gas, water and current is switched on.		
4.	**Attempt any FOUR of the following:**		**16**
a)	Leftward Technique  - The welder holds welding torch in his right hand and filler rod in the left hand. - The welding flame is directed away from the finished weld, i.e., towards the unwelded part of the joint. Filler rod, when	2m for diag and 2m for exp	4m

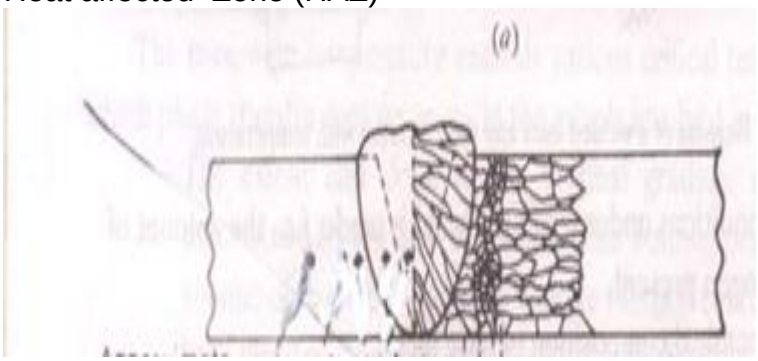
	used, is directed towards the welded part of the joint (Fig.). - The weld is commenced on the right-hand side of the seam, working towards the left-hand side. The blowpipe or welding torch is given small sideways movements, while the filler rod is moved steadily across the seam. The filler rod is added using a backward and forward movement of the rod, allowing the flameto melt the bottom edges of the plate just ahead of the weld pool. -Since the flame is pointed in the direction of the welding, it preheats the edges of the joint. - Good control and a neat appearance are characteristics of the leftward method. - Leftward technique is usually used on relatively thin metals, i.e., having thicknesses less than 5 mm. - When work piece thickness is over 3 mm, it is necessary to bevel the plate edges to produce a V-joint so that good root fusion may be achieved. -The included angle of V-joint is 80-90°. This large volume weld is uneconomical in terms of time, weld metal deposited and quantity of gases used and may also over-distort the weldment when welding thick materials. -Long welding time also leads to overheating of the weld area and thus the weld metal may have coarse grain.When welding materials over 6.5 mm thick, it is difficult to obtain even penetration at the bottom of the V and therefore the quality of the weld decreases as plate thickness increases. - The leftward technique requires careful manipulation to guard against excessive melting of the base metal, which results in considerable mixing of base metal and filler metal. The influence of the base metal on the properties of the weld metal can be very great.		
b)	PRINCIPLE OF BRAZING - Brazing involves the melting of a comparatively Iow melting point filler material against the base metal pieces to be joined while they are clean and free from oxides, oil, grease, etc. It is not necessary to melt the base metal. - The molten (brazing) filler material (i) Wets the base metal surfaces, (ii) Spreads along the joint (to be brazed) by capillary action, (iii) Adheres and solidifies to from the brazed joint. - Capillary flow plays a major role in producing good brazements,provided the base metal surfaces are wet by the molten filler material.	4m	4m

	The flux which is employed during brazing melts at a lower temperature than the brazing filler material, wets the surfaces to be brazed, removes the oxide film and gives clean surfaces. -Since the capillary attraction between the base metal and the fillermaterial is at least several times higher than that between the base metal and the flux, the filler material replaces the flux and flows into the narrow space or joint between the surfaces by capillary attraction. - The narrower the joint the better will.be the capillary flow. -The joint (thus filled with liquid filler material) upon cooling to room temperature, will be foundfilled with solid filler material and the flux, now also solidified, will be found on the joint periphery. -The high fluidility of the molten filler material is also an important factor in obtaing successful brazing joints.		
c)	1) When welding the properties of metal its microstructure changes 2) If the cooling rate is not proper it may cause weld defects like distortion and cracks. 3) The cooling rate depends upon the preheat the thickness and the geometry of the part 4) welding of structure with small thickness, with the pulling rate is normally slow,which decreases the mechanical properties that is 0.2 % proof strength and the impact properties 5) When high strength steel is welded, non-uniform heating and cooling in weld metal and base metal generate harder heat affected zone (HAZ), cold crack susceptibility and residual stress in weldments. 6) If the deformation process does not act uniformly on all the parts of the metal being rolled or drawn then the internal stresses may be setup. 7) If the deformation process is carried to its limit the metal loses all of its ductility and breaks in brittle manner	1m per point	4m
d)	CARE AND STORAGE OF ELECTRODES Utmost care is required in handling and storage of electrodes. 1). Electrodes with damp coating will produce a violent arc, porosity and cracks in the joint.Electrodes with damaged coating will produce joints of poor mechanical properties. 2). To avoid damage to coating, (a) electrodes during storage should neither bend nor deflect, (b) electrode packets should not be thrown or piled over each other. 3). Electrodes should be stored in dry and well-ventilated store	4m	4m

	rooms. 4)Storage temperature should be about 12°C above that of external air temperature with 0--60% humidity. 5)Cellulose electrodes are not so critical but they should be protected against condensation and stored in a humidity of 0-90%. 6). Before use the electrodes may be dried as per manufacturer's recommendations e.g. BS : E 616 H or IS: M 616478H electrodes may be dried at lS0°C for 1 hour before use. 7). All electrodes, and especially costlier ones, should be used till they are left hardly 4O-50mm. 8). Electrodes should preferably be retained in original (manufacturer's) packing for identification. 9) Loss of identity of electrodes can waste a lot of time in recognizing them correctly. 10) Electrodes coating should neither get damped nor be damaged or broken.		
e)	TORCH BRAZING - Torch brazing is the most versatile method and it finds wide application in industry in both fabrication and repair work. - Heat is usually provided by ordinary gas welding equipment by burning gas combinations such as air and acetylene, oxygen and acetylene, oxygen and hydrogen and air and propane. - Air-gas torches provide the lowest flame temperature as well as the least heat, depending on the size of the torch. Oxy-hydrogen torches are often used for brazing aluminium and other non-ferrous alloys. - To braze, the operator plays the torch flame (which is neutral or slightly reducing) on the thoroughly cleaned parts, being careful to heat the heavier sections first. - A flux is applied to the joint area to prevent oxidation of the parts during heating. As the flux becomes molten, it cleans the joint area of oxides etc., and prepares the surfaces for wetting by the filler metal. -The filler metal is then hand-fed to the joint area as soon as the joint is up to the brazing temperature. - In many cases filler rods instead of being hand-fed,are preplaced in the form of a ring, washer, or insert to fit the contour of the joint. - Commonly used filler metals need a joint clearance(at brazing temperature) of 0.05 to 0.125 mm for capillary flow. Lap joints are usually preferred.	4m	4m

	- To bring all members of the assembly to brazing temperature at the same time, torch may be directed more on the heavier member or on the member having greater thermal conductivity. - Initial cost of equipment is low. Localized healing can be obtained. It is a very flexible process. -This method is relatively slow.Flame cannot be easily applied to assemblies with inaccessible joints. - Torch brazing can be used to join ferrous and non-ferrous metals,for maintenance as well as fabrication purposes		
f)	FURNACE BRAZING - Furnace brazing is most suited for mass-production of brazing components 1 to 1.5 kg each. - The use of furnace brazing is preferred over other methods of brazing when: (i) A number of joints are to be brazed simultaneously. (ii) Components to be brazed can be preassembled. (iii) Filler metal can be preplaced in contact with the joint before brazing. (iv) Many like assemblie arc to be brazed. - Furnace brazing requires the use of a suitable furnace for heating and a suitable atmosphere to protect the steel assemblies against oxidation, or oxidation and decarburization, during brazing and during cooling, which is accomplished in chambers adjacent to the brazing furnace. -Proper atmosphere also makes possible the proper wetting of the joint surfaces by the molten eopper filler metal, usually with use of a brazing flux. -The types of furnace used for bazing are box type,wire mesh type,roller hearth type -The furnace should be operated at a temperature above the liquidus of the filler metal. --Brazing temperature can be controlled accurately in the furnace -Initial cost of the furnace and atmosphere generator is high compared with that of most other types of brazing equipment. -steel components that are commonly furnace brazed are machine parts,small forging,light stamping, casting etc.	4m	4m
5.	**Attempt any TWO of the following:**		**16**
a)	-When an electric arc is struck between the job and the consumable electrode, the arcing end of the electrode starts melting, takes approximately a spherical shape, hangs towards the job, and ultimately drops down on the same, either with a	2m for statement	8m

	free flight through the arc or by shortcircuiting the job. -The size of the droplet and the metal (drop) transfer rate affects weld bead geometry, weld metal micro-structures and the strength of the welded joint. Metal transfer has also got a significant effect upon the stability of arc discharge, ability to carry out welding in different positions (vertical, overhead, etc.) and the amount of spatter. -Control of metal transfer through different factors affecting it can increase the efficiency of a welding process. -A correct understanding of metal transfer phenomena will develop improved welding techniques - In MIG welding, metal transfer is clearly visible and has been studied with the help of high speed movie cameras (3000-7000frames/sec.) -In flux shielded metal arc welding, a movie camera does not help much because arc and mctal transfer arc not clear because of fumes and slag particles. -Similarly in submerged arc welding, the arc remains hidden under flux and thus metal transfer cannot be studied by ordinary camera. In both these processes however X-rays have been used to study metal transfer	6m for exp.	
b)	Various processes used for welding stainless steels are 1. Oxy-acetylene welding 2. Arc welding -Shielded metal arc welding - Inert gas metal arc welding - Gas tungsten arc welding - Submerged arc welding - Plasma arc welding 3. Resistance welding 4. Brazing Oxy-acetylene Welding . - The most suitable processes for welding stainless steel are those that produce a rapid localized heat. -Since gas welding generally heats rather slowly and does not confine the heat to a narrow zone, it is not particularly suitable for welding austenitic stainless steels. - Since gas welding cannot be carried out as fast as arc welding, there is a greater liability to warping. Distortion may be minimized by reducing the size of the flame. - Nozzle tip one or two sizes smaller than that used for ordinary steel with neutral/just slightly reducing flame is employed for welding austenitic stainless steels .	3m for listing 5m for exp	8m

	- Before welding, the plate surfaces are cleaned with fine sand paper, stainless steel wool, wire brush etc. - Filler rods for welding may either (i) be obtained by cutting strips from the base metal, or (ii) they may be of columbium 18-8 type. - The filler rod should contain 1 to 1.5% more chromium (than the parent metal) to compensate any oxidation losses that occur during welding: - During welding, torch is kept at an angle of 45° to the work and the tip of the inner cone of flame is kept within 1.5 mm of the molten puddle to avoid oxidation. -The flame is played on the work until the edges melt and mingle with the metal from the filler rod. -Welding speed is kept uniform. The forehand technique is preferred on thinner sheets and the backhand technique is employed when welding thicker sheets. -At no time, the filler rod is withdrawn from the flame, as otherwisethere is certain to be some oxidation of the metallic droplets. Puddling of the weld metal is not desirable. The success of welding depends upon keeping the heat to a minimum and completing the wefd in one pass.		
c)	Heat affected Zone (HAZ)  - Adjacent to the weld metal zone is the heat-affected zone that is composed of parent metal that did not melt but was heated to a high enough temperature for a sufficient period that grain growth occurred. - Heat -affected zone is that portion of the base metal whose mechanical properties and microstructure have been altered by the heat of welding - HAZ, usually contains a variety of microstructures. In plain carbon steels these structures may range from very narrow	2m for diag and 6m for exp	8m

	regions of hard martensite t6 coarse pearlite. This renders HAZ, the weakest area in a weld. - The HAZ in low carbon steel of normal structure welded in one run with coated electrodes or by submerged arc process comprises three metallurgically distinguished regions. 1. The grain growth region 2. The grain refined region, . 3. The transition region a)The grain growth region. - Grain growth region is immediately adjacent to the weld metal zone (fusion boundary). - In this zone parent metal has been heated to a temperature well above the upper critical temperature. (b) The grain refined region - Adjacent to the grain growth region is the grain refined zone. The refined zone indicates that in this region, the parent metal has been heated to suitable temperature where grain refinement is completed and the finest grain structure exists. (c) The Transition zone In the transition zone. a temperature range exists between the lower critical temperature and upper critical temperature transformation temperatures (d) Unaffected Parent Metal - Outside the heat affected zone is the parent metal that was not heated sufficiently to change its microstructure.		
6.	**Attempt any TWO of the following:**		**16**
a)	1. Crack 2. Distortion. 3. Incomplete penetration/ fusion 4. Inclusions 5. Porosity and blow holes. 6. Poor fusion 7 Spatters. 8. Undercutting. 9. Overlapping 10. Heat affected zone 11. Poor weld bead apperance 1. Common causes of cracking 1. Highly rigid joint 2. Excessive dilution 3. Defective electrodes	2m for listing. 6m for causes	8m

4.	Poor fit-up
5.	Small weld bead
6.	High sulfur base metal
7.	Angular distortion
8.	Crater Cracking

2 Causes of heat affected zone

1	Hydrogen in welding atmosphere
2	Hot cracking
3	Low ductility
4	High residual stresses
5	High hardenability
6	Brittle phases inthe microstructure

3.Caueseof Inadequate joint penetration

1	Excessively thick root face or insufficient root opening
2	Slag flooding ahead of welding arc
3	Electrode diameter too large
4	Misalignment of second side weld
5	Failure to backgouge when specified
6	Bridging of root opening

4. Causes of slag inclusions

1	Failure to remove slag
2	Entrapment of refractory oxides
3	Tungsten in the weld metal
4	Improper joint design
5	Oxide inclusions
6	Slag flooding ahead of the welding arc
7	Poor electrode manipulative technique
8	Entrapped pieces of electrode covering

5. Causes of porosity

1	Excessive hydrogen,nitrogen, or oxygen in welding atmosphere
2	High solidification rate
3	Dirty base metal
4	Dirty filler wire

5	Improper arc length, welding current, or electrode manipulation
6	Volatization of zinc from brass, Galvanized steel
7	Excessive moisture in electrode covering or on joint surfaces
8	High sulphur base metal

6.Causes of incomplete fusion

1	Insufficient heat input, wrong type or size of electrode, improper joint design, or inadequate gas shielding
2	Incorrect electrode position
3	Weld metal running ahead of the arc
4	Trapped oxides or slag on weld groove or weld face

7. Causes of distortion:-
1)more number of passes with small diameter electrode
2)slow arc travel speed
3)High residual stresses in plates to be welded
4) welding sequence being improper

8. Poor weld bead apperance
1)Limited practice on the part of welder
2)Arc length being not constant
3)improper welding technique
4)damaged electrode coating

9) Causes of Spatter
1)Excessive arc current
2)Longer arcs
3) Damp electrodes
4)Electrode being coated with improper flux ingredents

1) Causes of under cutting
1)Too large electrode diameter.
2) Higher currents
3) Faster arc travel speed
4) Longer arcs

2) Over lapping
1)Lower arc current
2) Slower arc travel speed
3)Longer arcs

	4)Improper joint geometry		
b)	-The solidification of metals is usually considered to be a nucleation and growth process i.e., the transformation of a liquid phase to a solid normally occurs by a process of nucleation and growth -Nucleation involves the creation of critical sized particles, (j.e. nuclei) of the new, (i.e., solid) phase and considerable supercoiling is usually necessary before the first solid nuclei are formed from which growth may proceed. This is true in the case of ingots and castings. - In fusion welding processes, however, the nucleation event is not significant since the molten metal is contained in the base metal mold and therefore a solid-liquid interface is always present. -This leads to the epitaxial growth of the weld metal from the adjacent, incompletely-melted grains of the base metal. - In all metallic systems, solidification is accompanied by the evolution of heat. -In a pure metal the rate of growth is determined solely by the rate of heat extraction from the solid-liquid inter- face. -This situation, however, is of purely academic interest in welding.	**8m**	**8m**
c)	(1) American (AWS-ASTM) System (2)British (BS) System (3)Indian (IS) System Indian Coding system:- L X X X X X X L 1st 1st 2nd 3rd 4th 5th 6th Last letter Letter DIGITS Example: E307411 Various digits and letters indicate the following: 1st Letter -It can be E or R. E indicates that electrode is solid extruded and R means an electrode extruded with reinforcement. 1st Digit - It indicates the Glass of covering. It can be 1, 2, 3, 4, 5, 6 or 9 and has the meaning same as that of the first digit of British system, discussed earlier. 2nd Digit - It indicates the positions in which electrode can weld satisfactorily. Second digit may be 0, 1,2,3,4, or 9. 0 and 1 signify that the electrode can be used for welding in all positions,	2m for stating 6m for exp	8m

	and in flat, horizontal, overhead and vertical positions respectively.4 indicates flat and horizontal fillet positions. 2, 3 and 9 have the same meaning as in British standard. 3rd Digit - It has the same meaning as that of the third digit of British standard, except that the open circuit voltage is 90 in place of 95 volts, and 50 instead of 45. 4th and - They indicate range of tensile strength and value of minimum 5th Digit yield stress., e.g. 41 (fourth and fifth digits) and 51 mean that tensile strength ranges from 410-510 and 510-610 N/mm^2andminimum yield stress is 330 and 360 N/mm^2 respectively. 6th Digit - It tells percentage elongation and impact value. Last Letter- P indicates a deep penetration electrode, H hydrogen control led electrode, and J, K, L indicate electrodes with iron powder coating and metal recovery 110-130%, 130-150% and above 150%, respectively. Example: E 307411 means (a) It is a solid extruded electrode. (b) Its covering contains appreciable amount of titania; a fluid slag. (c) It is all position electrode, (d) It can be operated on DCRP, DCSP or AC with a power sourcehaving, open circuit voltage 50 volts, (e) Weld metal tensile strength ranges between 410 and 510 N/rnm^2 and minimum yield stress is 330 Nzmm", (10 N/mm2 = 1.02 kgf/mrn^2). (f) Minimum percentage elongation of weld metal (in tension) is 20% of 5.65 v'SO and impact value of weld metal at 27°C is 4.8 kgf m (or 47 J). Where Sois the cross-section area of the specimen being tested		