MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

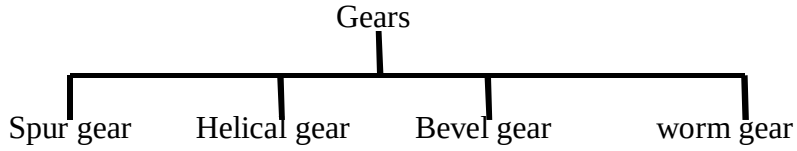
SUMMER 2013 EXAMINATION

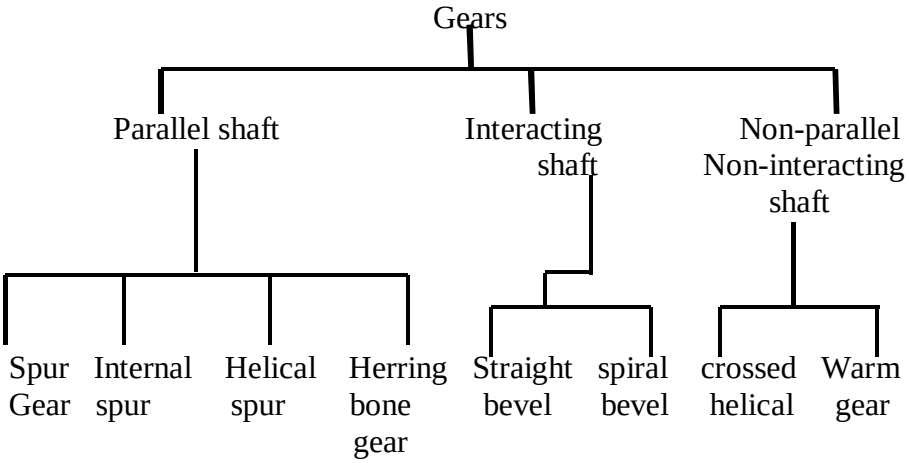
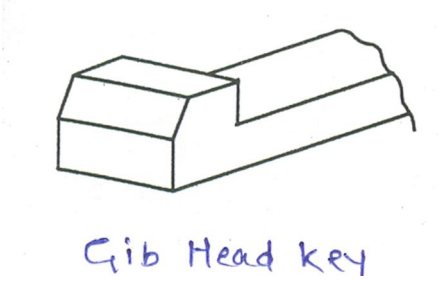
Model Answer

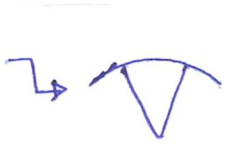
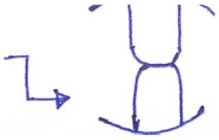
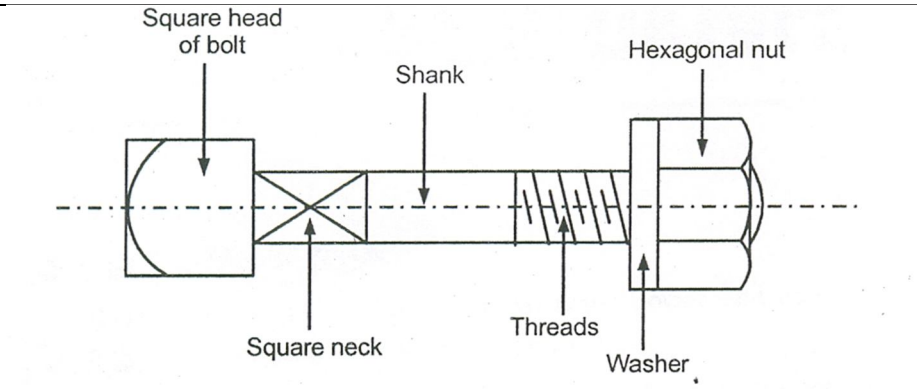
Subject & code:MET(12130)

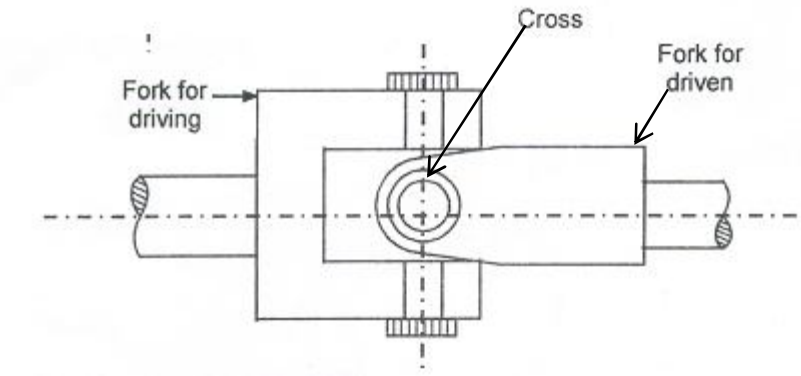
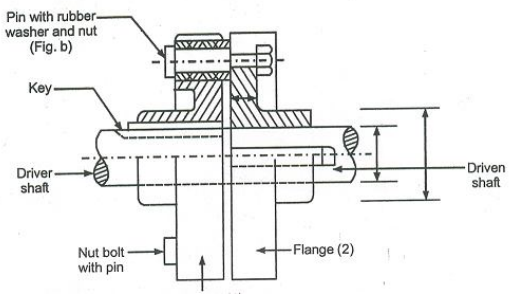
Important instructions to examiners :

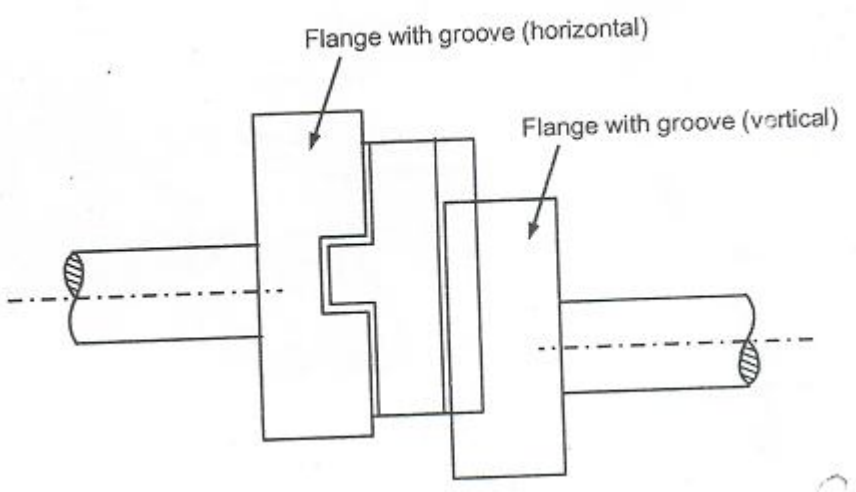
1. The answers should be examined by keywords and not as word to word as given in the model answer scheme.
2. The model answer and the answer written by candidate may vary, but the examiner may try to assess the understanding level of the candidate.
3. The language errors such as grammatical, spelling errors should not given more importance.
4. While assessing figures, examiner may give credit for principal components indicated in a 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 answer and model answer.
6. In case of some questions credit may be given by judgment of relevant answer based on candidates understanding.

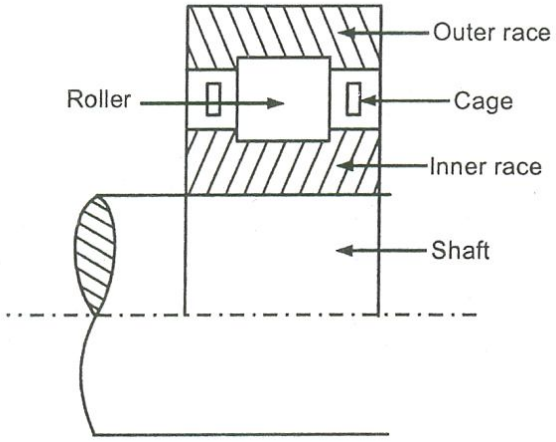
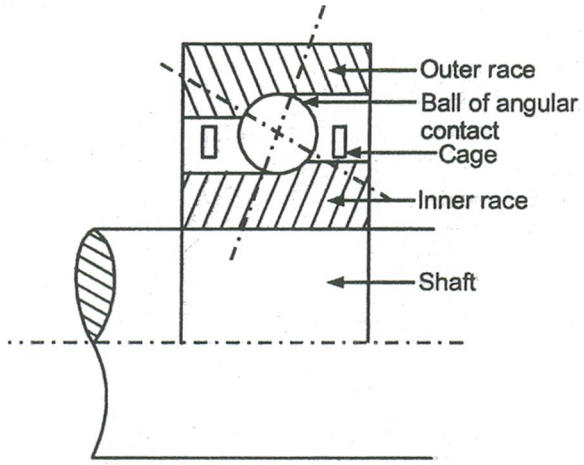
1-a-i	**Material used for belt :** Leather (oak-tanned or chrome tanned), cotton or fabric, Rubber Balata gum etc.	2	2
1-a-ii	Gear can be classified by two methods : a) According to work performed / teeth :  	1	2

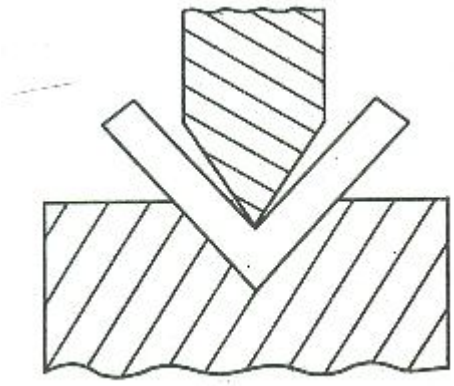
	b) According to shaft axis position :  	1	
1-a-iii	Gib Head Key : Gib headed key is considered as 'flat sunk key with gib head'. This head helps in facilitating the removal of key from keyway. This key also has a taper in ratio of 1:100. Taper provided, helps in tightness of the fit and it also makes removal more easy. But cost of taper is more because of which gib headed key is costly.  	2	2
1.a-iv	Advantages of bearing 1. Provides free rotation. 2. Generates minimum friction. 3. Support shaft. 4. Transmits forces on the shaft to base	2	2
1.a-v	**Seal** : Defn. mechanical machine element which functions as a sealing agent between a sump flow and environment is called as seal".	1	2

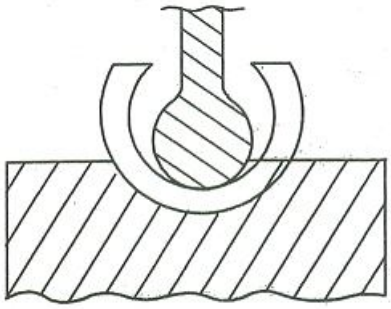
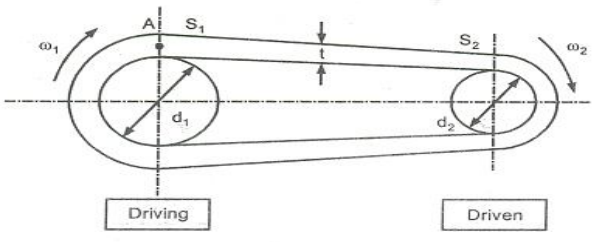
	Application : To avoid the leakage of water tank, oil sump, pressurized pipe line of oil, LPG pipe line etc.	1	
1.a.vi	Welding symbol : 1) Single V – butt joint  2) Double U-butt joint. 	1 1	2
1.a.vii	Hand tools used in sheet metal : Trommel, steel rule, wire gauge, bench shear, snip, engineer's square , hammers, stakes, files , chisels etc.	2	2
1.a.viii		2	2
1.b-i	**Advantages of gear drives are as follows** : (a) Gear drive does not slip (b) It is positive drive. (c) It is used to transmit very large power. (d) The efficiency of transmission of gear drive is high, upto 99%. (e) Low velocity transmission is also possible in case of gear drives.	½ mark each for any 4	4

	(f) Changing a velocity ratio can be possible by arranging different gears in mesh as in case of gear box. (g) No requirement of tension adjustment as in case of belt drive. **Disadvantages of gear drives** : Following are disadvantages of gear drives : (a) Gears need lubrication for smooth running. (b) Cost of gear drive is more as compared to other drives. (c) Manufacturing process of gears is complicated. (d) Gear operation may be noisy. (e) Gears require perfect alignment of the shafts.	½ mark each for any4	
1.b-ii	Flexible coupling : 1) Hook's coupling, OLDHAM'S coupling  2) Bushed pin (3.13 to 3.15)  	4 marks any 1	4

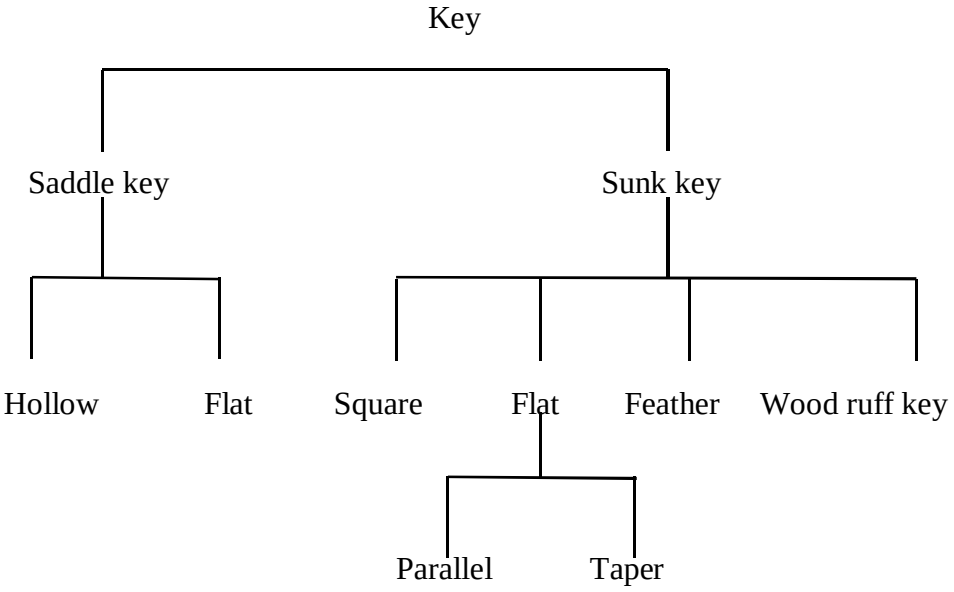
	3. OLDHAM'S COUPLING  		
1.b-iii	Given : Centre distance C = 1000 mm Diameter of larger pulley D = 200 mm Diameter of Smaller pulley d = 40 mm find Lopen & Lcross i) Lopen $= 2c + \frac{\pi (D+d)}{2} + \frac{(D-d)^2}{4c}$ $= 2 \times 1000 + \frac{\pi (200+40)}{2} + \frac{(200-40)^2}{4 \times 1000}$ $= 2000 + 376.99 + 6.4$ $= 2383.39$ mm ii) Lcross $= 2c + \frac{\pi (D+d)}{2} + \frac{(D-d)^2}{4c}$ $= 2 \times 1000 + \frac{\pi (200+40)}{2} + \frac{(200-40)^2}{4 \times 1000}$ $= 2000 + 376.99 + 14.4$	1 1 1	4

	= 2391.39 mm	1	
2.a	Cylindrical roller bearing  Angular contact ball bearing  	3 marks for diagram 1 mark for labelling	4
2.b	**Gear terminology** : (Any 4) 1) **Pitch circle** : It is the circle related to equivalent pitch cylinder by a plane normal to axis of gear, the diameter of which is a 'pitch circle diameter'. 2) **Top land** : It is the surface at the top of the gear.	1 mark each	4

	3) **Bottom land** : It is the surface of gear between flanks of adjacent two teeth. 4) **Addendum circle** : It is an imaginary circle that is at the topmost edge of gear teeth in th cross-section. 5) **Dedendum** Circle : It is an imaginary circle that is at the bottommost position of gear teeth in the cross section. 6) **Tooth Thickness :** Thickness measured along with the pitch circle. 7) **Module :** It is the ratio of pitch circle diameter to number of teeth. 8) **Circular Pitch :** Distance along with the circumference of pitch circle from one to another adjacent tooth.		
2.c	**V-Bending** : V bending indicates the shape of job after bending is like Vee.  V-bending **U- Bending** : In U bending process the shape of job after operation is of U type	2 2	4

	 U-bending		
2.d	**Welding :** It is the process of joining two different materials by melting them at their melting point. **Classification of welding** : Welding processes can be classified on the basis of : a) **Source of heat** : Heat is to be supplied for melting of metals. This could be by using flame, arc, electricity etc. b) **Interaction** : Liquid - Liquid i.e. fusion or Solid - Solid (solid stable welding)	2 2	4
2.e	**Slip** : The basic cause by which power is transmitted by using belts and ropes is the friction between them and pulleys. But they are considered as a non positive drive because of slip, due to which velocity ratio of belt does not remain constant .  If power transmitted exceeds the frictional force, belt moves over pulleys	2 1	4

	called slip. When more length of the belt approaches the driving pulley then the length that leaves the belt slips back over the driving pulley called as 'creep' of belt. Slip can be minimized by maintaining the speed at neutral section of the belt.	1	
2.f	Sheet metals are used for many applications in engineering work and also for day to day needs. In chemical industries, various parts of systems are manufactured by using sheet metals like boiler steel, tubes, pipelines, storage tanks, covers, insulation covers, etc . Depending upon need, the thickness and the material of the sheet metal is to be selected. Selection of sheet metal depends upon following factors. : 1. Design strength requirement. 2. Chemical composition of metal. 3. Chemical composition of fluid/storage material. 4. Quantity required. 5. Cost of material. 6. Joining process selected for two sheets. 7. Life of unit. 8. Weight of unit accepted. 9. Surface finish of element needed. 10. Coating requirement if any on the surface. 11. Easyness of sheet working. 12. Cleaning method used when in service. 13. Geometric considerations. 14. Ease of availability. 15. Ease of handling etc.		4
3.a	**Chain Drives** : Chain is series of links connected by pin joints and mounted on sprockets for	2	4

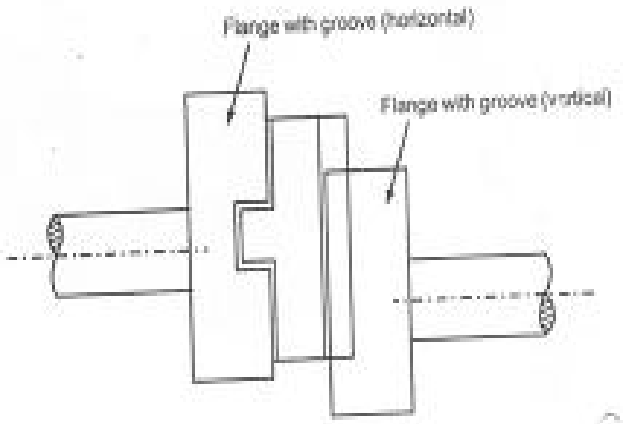
	power transmission. The chain does not slip over sprockets. They give constant velocity ratio. It is suggested to replace belt and rope if possible to get positive drive like chain. Chains are made up of metals, that is why they take less space and they can be used for longer distance between shafts. The wheel with teeth, which fit in to recesses of chain is known as sprocket. These are used for velocity ratio less than 10:1. **Advantages** : 1) No slippage between chain and sprocket . 2) Maximum heavy load can be carried. 3) Long operating life. 4) Operates in hostile environment like oily, dusty, water etc. 5) High efficiency up to 98% can be obtained.	2	
3.b	**Key** : Key is the machine element used to enable the transmission of torque from the shaft to be shaft supported elements like gears, pulley etc. Key is also used for preventing rotational motion between shaft and supporting element. **Classification of key** :  	2 2	4
3.c	**Static seal** : Static seal exist where there is no relative motion between the matting surfaces being sealed. Static seal are easier to design, they can handle wider tolerances, rougher surface finish and used up to higher pressure limits.	2	4

<table>
<tr><td></td><td>Dynamic seal : Dynamic seal exist where there is relative motion between the matting surfaces being sealed.</td><td>2</td><td></td></tr>
<tr><td>3.d</td><td>
<table>
<tr><th>TIG welding</th><th>MIG welding</th></tr>
<tr><td>Electrode of tungsten are used</td><td>Electrode wires are used</td></tr>
<tr><td>Electrodes are non consumable</td><td>Electrodes are consumable</td></tr>
<tr><td>Electrode generate arc and does not melt.</td><td>Electrode generate arc, but they melt</td></tr>
<tr><td>Used for thin and small size of jobs.</td><td>Used for parts above 4 mm thick</td></tr>
<tr><td>Used for joining dissimilar metals</td><td>Used for joining similar metals</td></tr>
</table>
</td><td>1 mark each</td><td>4</td></tr>
<tr><td>3.e</td><td>Soldering : It is common process for joining steel, copper etc. at low temperature (450^{0}C below). It is a group of joining processes where in coalescence is produced by heating to suitable temperature.
Brazing : Brazing is a process of joining two pieces of metals in which a non ferrous alloy is introduced in a liquid state between the pieces of metal to be joined and allowed to solidify. Brass is usually the main constituent of this solder. Brazing is performed at high temperature (500-800^{0}C)</td><td>2

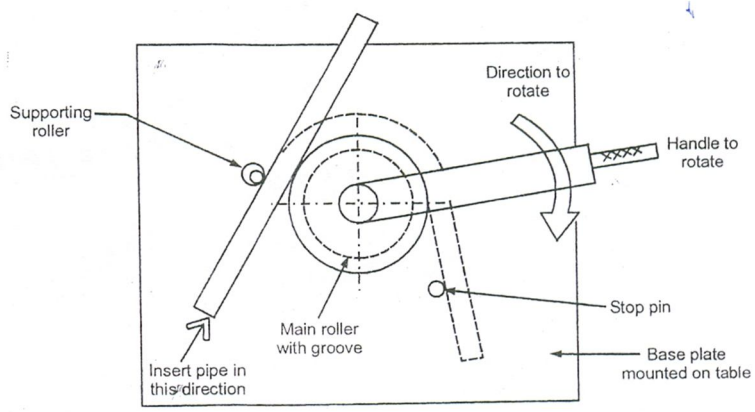
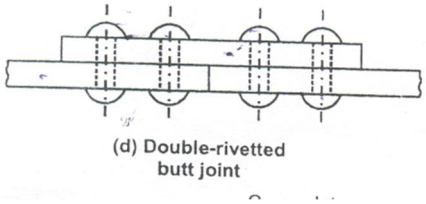
2</td><td>4</td></tr>
<tr><td>3.f</td><td>Composite material : Composite material are formed by combining two or more material that have quite different properties. The different materials work together to give the composite unique properties.
Cladded material : Sheet of metal or other material bonded electrically , mechanically or through other process to another metal or material (called substrate) to enhance its durability or other properties.</td><td>2

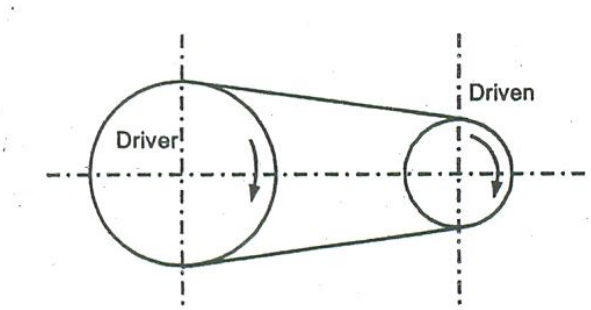
2</td><td>4</td></tr>
<tr><td>4.a</td><td>Advantages of Nuts
1. Easily disassembled
2. They can be designed to take tension load
3. Can not change the properties of metal to be joined
4. Bolted joints are not particularly sensitive to the condition of parent material.</td><td>4</td><td>8</td></tr>
</table>

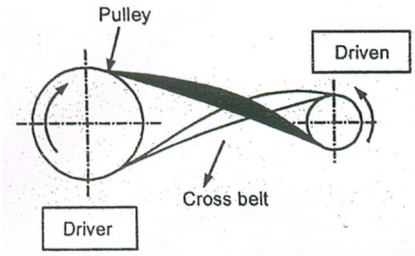
<table>
<tr><td></td><td>5. Offers much better joint quality than screw.
Disadvantages
1. Require access to both sides of joint
2. They can become loose over time as the nut backs off.
3. They require holes, which introduce stress concentration and more failure modes.
4. Complexity.
5. Damage to a threaded hole is tough to replace.</td><td>4</td><td></td></tr>
<tr><td>4.b</td><td><table><tr><th>Regid Coupling</th><th>Flexible Coupling</th></tr><tr><td>1. The rigid coupling does not permit misalignment between axes of two shafts.</td><td>1. The flexible coupling tolerate misalignment of two shafts by a small amount</td></tr><tr><td>2. Zero misalignment is permitted.</td><td>2. 0.50 angular misalignment and 5 mm axial displacement between two shafts is tolerated.</td></tr><tr><td>3. Used if rotary motion is free from socks and vibrations.</td><td>3. These couplings are used in rotations of shaft with shocks and vibrations.</td></tr><tr><td>4. It is simple coupling.</td><td>4. Complicated design and have number of parts.</td></tr><tr><td>5. The cost of rigid coupling is less.</td><td>5. The cost of flexible coupling is more.</td></tr><tr><td>6. Not much more popular, used for special applications only.</td><td>6. More popular type of coupling.</td></tr></table></td><td>2mark each for any 4 points</td><td>8</td></tr>
<tr><td>4.c</td><td>A Flux is a material used to prevent, dissolve or facilitate removal of oxides and other undesirable substances.
Function-
1. During welding, flux chemically reacts with oxides and a slag is formed that floats to and cover the top of molten puddle of metal and thus helps keep out atmospheric oxygen and other gases.
2. During welding, if the metal is heated in air, oxygen from the air combines with the metal to form oxides which result in poor quality, low strength welds or, in some cases, may even make welding impossible. In order to avoid this difficulty, a flux is used during</td><td>2
6</td><td>8</td></tr>
</table>

	welding. 3. Fluxes are available as powders , pastes or liquids. 4. Flux may be used either by applying it directly on the surface of the base metal to be welded. 5. After welding the slag from over the welded joint can be removed by chipping , filing or grinding .		
5.a	**OLDHAM'S COUPLING** Oldham's coupling consists of three parts; two flanges and one central disc. It is used for joining two shafts which are lateral misalignment between them. A flange is fitted on the shaft. It has a groove (let it be horizontal) of rectangular cross-section. Other flange with vertical groove of rectangular cross-section is fitted on the driven shaft. It is to be noted that before doing so, central disc is to be inserted between the two flanges. Central disc has two projections coming out from two opposite sides. They are crossing each other and are of rectangular cross-section.  When driving shaft rotates, the motion is transferred to central disc. Disc will reciprocate in two grooves provided on the flanges. Then disc transfers power to driven flange and to driven shaft. The central disc is not welded or bolted to any flange. It is free to reciprocate. It will not fall down because of projections coming out in right angle to each other. Proper care of lubrication is to be taken in between flanges and disc.	2 2	4

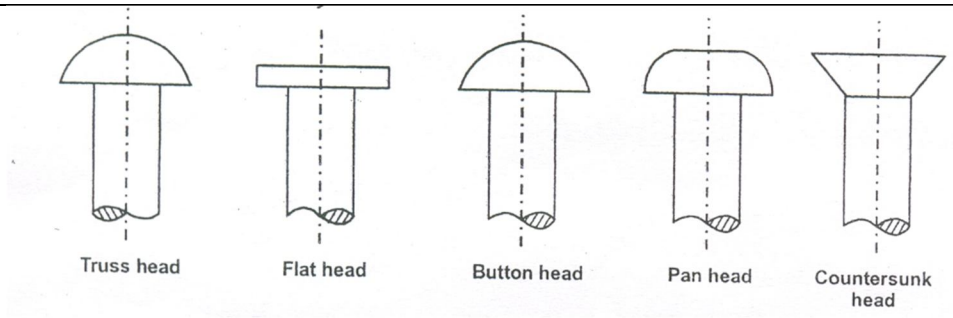
5.b	There are different equipment used in chemical industries where sheet metal work applications are required. i) Heat exchangers ii) Boilers iii) Evaporators iv) Condensers v) Cooling towers vi) Pipe vessels vii) Pipe feltings viii) couplings	½ mark each	4
5.c	**Gear Trains** When small space is available as well as to rotate number of shafts at a time gear trains are used. More number of gears used for the drive to transfer power from driver to driven shaft is called as gear train. Following are different types of gear trains : 1. Simple gear train. 2. Compound gear train. 3. Reverted gear train. 4. Epicyclical gear train.	1 3	4
5.d	Distortion in welding is prevented or minimized in a weldment, strategies must be used in the design and in shop practices to overcome the effect of the heating and cooling cycles. Contraction can not be prevented , but it can be controlled. Ways for minimizing the distortion : 1. Keep the contraction forces as low as possible by using only that amount of weld metal as is require by the joint. 2. Use as few weld passes as possible. 3. Place welds near the neutral axis. 4. Balance welds around the neutral axis. 5. Use of back step welding or skip method of welding.	½ mark each for Any eight	4

	6. Make shrinkage forces but in the desired direction. 7. Balance shrinkage forces with opposing forces. 8. Removable shrinkage force during or after welding. 9. Welding sequences.		
5.e	Lubrication is needed for : 1. Reducing friction between balls and races. 2. To dissipate frictional heat. 3. To prevent corrosion. 4. To protect bearing from foreign particles.	1 mark each	4
5.f	 Steps : 1. On the base plate a roller with grove is mounted . 2. Some supporting guide pins are provided . 3. Insert the pipe on the gap of guide pin and roller 4. Lever is then rotated in clockwise direction bending pipe as per the requirement of angle of bend	2 2	4
6.a			4

<table>
<tr><td>6.b</td><td>Open Belt drive system.
 

Cross belt drive system.
 
</td><td>2

2</td><td>4</td></tr>
<tr><td>6.c</td><td>Gas welding is the process of fusion welding. In this metals are melted by using heat. Heat is generated with the help of combustion of an oxygen or air and fuel gas like acetylene mixture. Flame is generated by using above gas combination which melts both metals and they can be joined by adding third metal, called as filler metal. It is to be noted that acetylene should be mixed with oxygen in correct proportion. The tip of the flame is sufficiently hot upto 3200^0 C by which all materials get melted during welding. To generate more strength, a filler metal rod is added. Oxygen supports higher combustion and acetylene is the fuel for the combustion.</td><td>4</td><td>4</td></tr>
<tr><td>6.d</td><td><table>
<tr><td>Screw joint</td><td>Rivetted joint</td></tr>
<tr><td>1. Does not require drilling and kaulking</td><td>require drilling and kaulking</td></tr>
<tr><td>2. Less cost</td><td>More cost</td></tr>
<tr><td>3. Not leak proof</td><td>Leak proof</td></tr>
<tr><td>4. Noise is not generated during</td><td>Noise is generated during operation</td></tr>
</table></td><td>1 mark each for any 4 ponts</td><td>4</td></tr>
</table>

	operation			
	5. Easily dismantled	Not easily dismantled		
	6. Used for industrial and automobile parts	Used for boilers and bridges		
6.e	**Failure in bending pipes/Rods** 1. **Wrinkle:** If the undersize mandrel is used, wrinkles are generated on the inner surface of the bend i.e. the side of compression. 2. **Breaking:** If tube breaks repeatedly, it indicates tube material is too hard. Hard material does not have ability to get stretched. 3. If mandrel is placed too far back than the point of pressure, then the material gets more stretched. Tube gets buckled due to this. 4. If mandrel is placed too far forward, humps appear on the outside of the bend and a step on inside of the bend. Depending upon forces and process of bending, these may/may not occur at the same time.		1 mark each	4
6.f			1 mark each for any 4	4