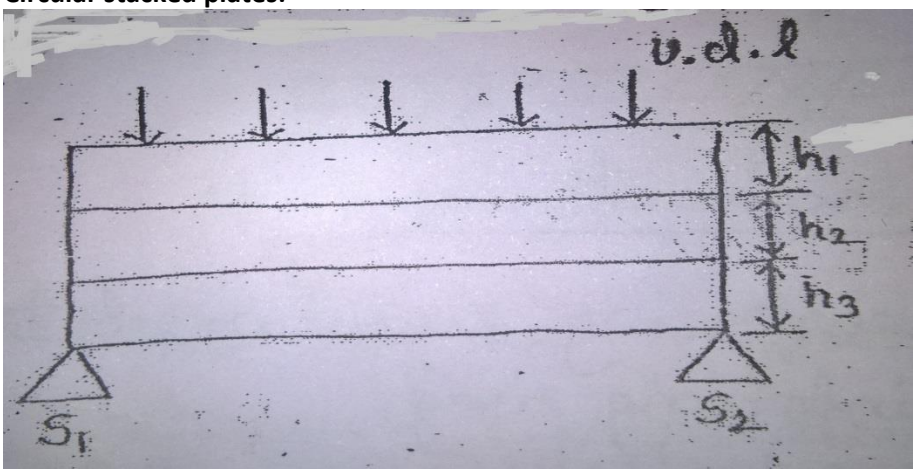
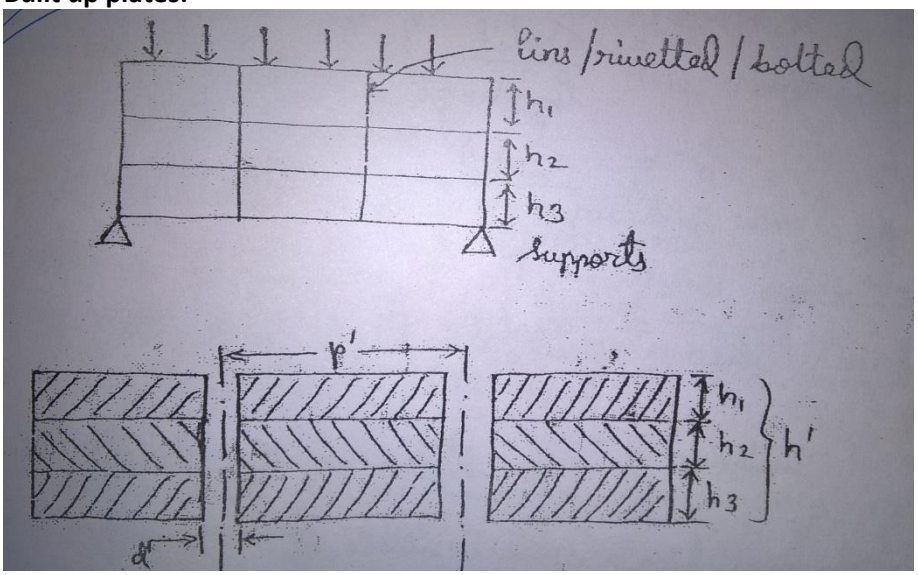
WINTER – 15 EXAMINATIONS

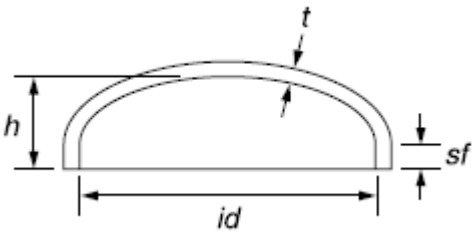
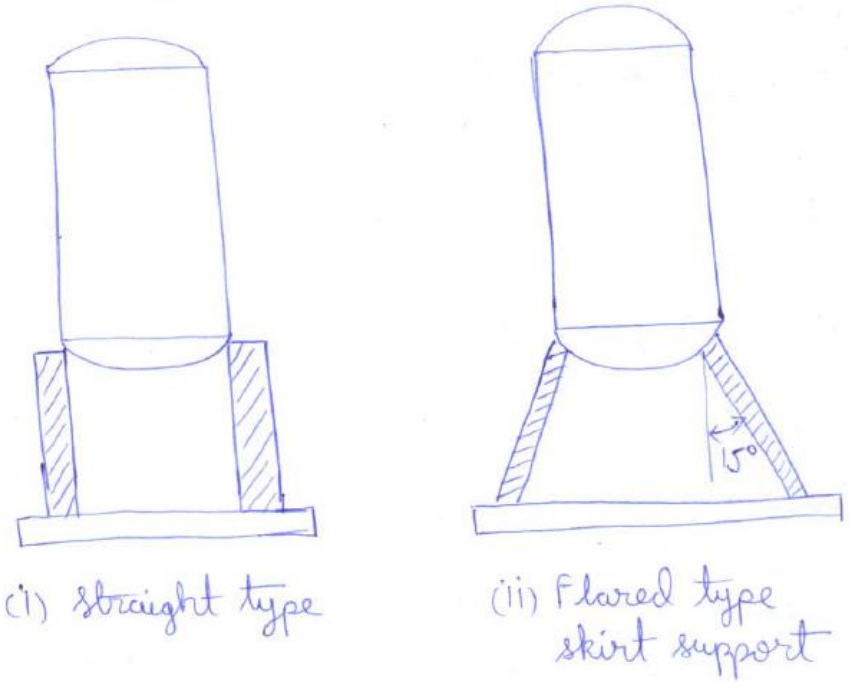
Subject Code: **17457** **Model Answer** Page No: ____/ N

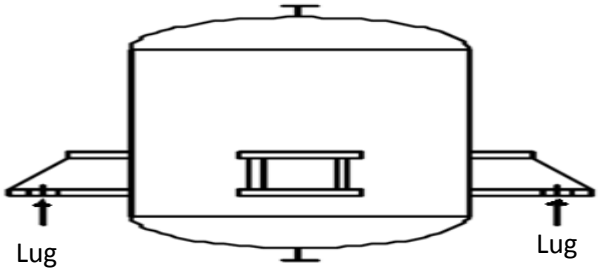
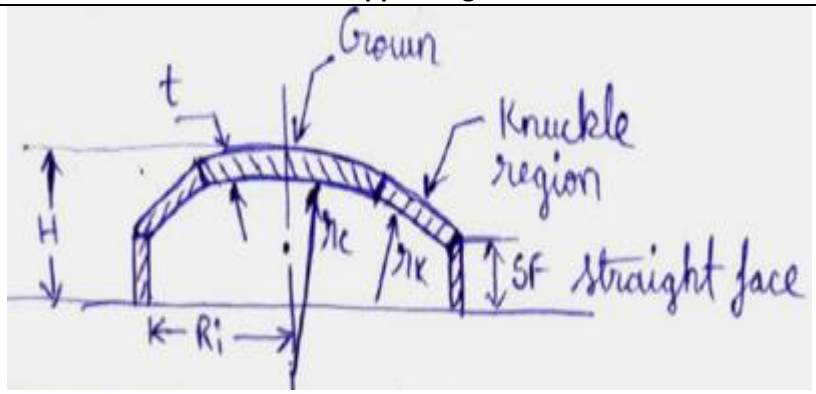
Important Instructions to examiners:

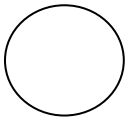
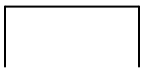
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

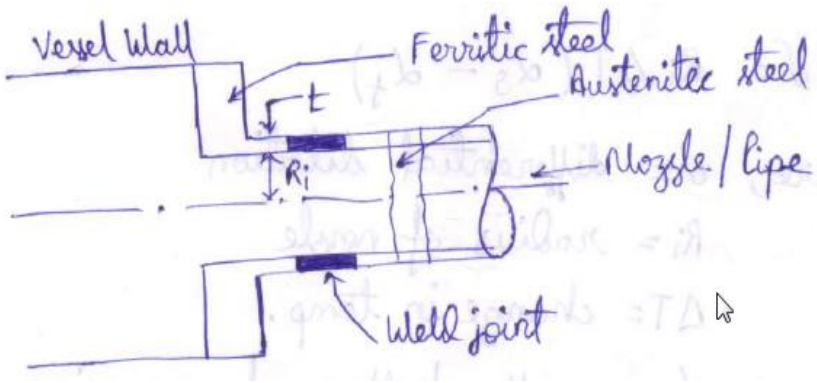
Q. NO.	MODEL ANSWER	MARKS	TOTAL MARKS
1.	**Attempt any TEN of the following:**	10*2	20
a)	The boiler mountings are the part of the boiler and are required for proper functioning. In accordance with the Indian Boiler regulations, of the boiler mountings these are essential fittings for safe working of a boiler. Some of the important mountings are: Pressure Gauge, Safety Valve, Fusible Plug, Blow-Off Cock, etc. The boiler accessories are mounted on the boiler to increase its efficiency. These units are optional on an efficient boiler. With addition of accessories on the boiler, the plant efficiency also increases. Some of the important accessories are: Economizer, Super heater, Air pre heater, Feed water pump, Steam injector, etc. Boiler may operate with/without accessories but should not operate without mountings.	01 Mark 01 Mark	02 Marks
b)	Wind load: A highly turbulent flow of air sweeping over the earth surface with a variable velocity and resisted by an obstacle in this case a pressure vessel is termed as wind load (moment load) on the vessel.	02 Marks	02 Marks
c)	It is the pressure used to determine the minimum required thickness of each vessel shell component. It denotes the difference between internal and external pressure i.e. P design = P internal - P external = P internal (since, P external is negligible, mostly atmospheric) Also, P design = Operating pressure + 10% (Operating pressure)	01 Mark 01 Mark	02 Marks
d)	Piping load: It is that compressive/tensile load on the pressure vessel consisting of the weight of pipe sections supported by nozzles into the vessel shells and the load due to thermal expansion of pipes.	02 Marks	02 Marks
e)	Poisson ratio is the ratio of unit lateral contraction to the unit axial elongation and constant within the elastic limit for a given material. It is denoted by μ and for pressure vessel material, assume μ=0.3	02 Marks	02 Marks
f)	Multi shell construction - these vessel are built up by curapping series of sheets over a core tube.the construction involves the use of several layers materiala usaually for the purpose of quality control and optimu property and for safety purpose - each layer must be sufficiently thick and is considered as a thick walled cylinders. - For corrosive application,the inner layer is made special material and is not considered for strength criteria	Any Four (½ Marks for each)	02 Marks

	- The outer load bearing shells cab be made of high tensile carbon steel - These vessel are constructed upto (1)230MPa(2)400^{0}c to -20^{0}c (3)300mm thickness wall.		
g)	**Circular stacked plates:**  Flat pates are stacked oneo on the other and are frequently used to support loads.This may be done because the construction arrangement doesnot permit a single plate of equivalent thickness to be used or because a single plate of required thickness is not available. **Built up plates:**  It sliding of one stached plate on the other is to be prevented through the use of pins,rivets,bolts or keys to take shear at the p;ate interfsaces,this arrangement is called as builtup plates which is stiffer and stronger than the same stack weled.The shear pins,rivets,bolts or keys used in the builtup p;ate should have a tight fot in order to prevent high local deformation and intial deflection.	**½ Mark** **½ Mark** **½ Mark** **½ Mark**	**02 Marks**

h)	Given Data Type of vessel= Elliptical $P=1.5N/mm^2$ t=18mm Φ=3m=3000mm r=1500mm μ=0.3 $E=2 \times 10^5 N/mm^2$ a/b =2/1 for elliptical vessel $\delta=[(pr^2)/(tE)] [1-(a^2/2b^2)-(\mu/2)]$ $=[(1.5 \times 1500^2) /(18 \times 2 \times 10^5)][1-(4/2)- (0.3/2)]=0.9375 \times (-1.15)=-1.078$ = app.-1.08mm	**02 Marks**	**02 Marks**
i)		**02 Marks**	**02 Marks**
j)	 **Support Skirt**	**01 Mark for each**	**02 Marks**
k)	Given Data Φ=2m=2000mm r=1000mm t=10mm $p=1.6N/mm^2$ $E=200GPa=200 \times 10^3 N/mm^2$	**02 Marks**	**02 Marks**

	μ= 0.3 For spherical shell $\delta = [pr^2/2t\backslash E] (1-\mu)$ $=[(1.6 \times 1000^2)/(2 \times 10 \times 200 \times 10^3)] \times (1-0.3)$ =0.28mm		
l)	 **Support lug:**	**02 Marks**	**02 Marks**
m)	 **Torispherical Head**	**02 Marks**	**02 Marks**
n)	Properties of alloying element i) Chromium- Molybdenum Alloy Steel: -These are suitable for temperature from 800°F up to 1200°F -These are suitable for high temperature high pressure conditions -It contains 9% carbon and 1% Molybdenum -It resists oxidation and hydrogen attacks ii) Stainless Steel: -Stainless Steel is the corrosion resistant material used for pressure Vessels -It contains chromium as a major non corrosive ingredient. -For heat exchangers small diameter pipes(tubes) where internal Insulation is not possible, stainless steel is used -Stainless steel finds application as internal cladding material -It is stain free material therefore is called as stainless steel	**Any one for 02 Marks** **(½ Mark for each Point)**	**02 Marks**

	iii) High Silicon Cast Iron with Nickel and Copper: -It is also called as Haste alloy -It has good mechanical properties -It has good resistance to organic compounds -It has good corrosion resistance iv) Gray Cast Iron: - Compressive strength is 3-4 times the tensile strength - It is resistant to acid or acidic solution. - Used for component (part) which are complex to fabricate. - It is used where resistance to corrosion or abrasion (wear out) is desired. v) High silicon Cast Iron: - Hard and brittle. - Absorb shock - Corrosion resistance. - Unaffected by sulphuric acid, nitric acid and chlorine containing chemical. vi) Nickel alloy cast Iron: - It contains high nickel + Copper + Chromium - They are corrosion resistant, wear resistant and heat resistant. - They have good strength, toughness, good castability and good machinability. - Alkalies and natural salt solution are handled by this material. vii)Alloy steel: Steel with alloying element like Ni,Cr,,Sn,Mo,Mn,Be,Vn,Titanium,Co etc is called as alloy steel. - Mn is used for improving abrasion resistance,toughness and elasticity. - Ni and Cr are used for corrosion resistance and high temperature resistance. - Cr,Vn,Mo and Co are used for imparting good cutting action.		
o i)	Spot Weld 	**01 Mark**	**02 Marks**
ii)	Plug Weld 	**01 Mark**	

2.	**Attempt any TWO of the following:**	**2*8**	**16**
a)i	Thermal stress: Stresses which result from contraction or expansion of a material due to temperature change are called as thermal stress. $\sigma T = \pm (\alpha E \Delta T/ (1-\mu)$ where, σT = Thermal stress α = Co-efficient of thermal expansion E = Modulus of elasticity ΔT = Change in temperature μ = Poisson's ratio (± sign indicates that the material is in expansion/contraction)	**02 Marks** **02 Marks**	**08 Marks**
ii)	Stresses induced in bi-metallic joints:  Special conditions often require that a pressure vessel be constructed of several materials of different metallurgical and physical properties, whose incompatibility induces stresses when the vessel is subjected to its operating environment. This occurs in the piping (nozzle) of boilers and turbines where austenitic steels such as 18-8 (18%Cr and 8%Ni) are required in the high temperature zones whereas in the cooler zones the more economical ferritic steels are used. Local discontinuity stresses are produced in the region where these dissimilar materials are welded together, due to the fact that the coefficient of thermal expansion of the austenitic steels is 50% greater than that of the ferritic steels.	**02 Marks** **02 Marks**	
b)	Data: I. Shell = Cylinder II. Heads = Hemispherical III. ε = 100% (Assume) IV. Inside diameter = 1m, Therefore inside radius, R_i = 0.5m = 500mm V. Design pressure, P = 2N/mm² VI. σult.= 420N/mm² Factor of Safety = 6, Therefore		**08 Marks**

Permissible stress, S = σult. / Factor of Safety = 420 / 6 = 70N/mm²

I) Thickness of shell:

t = (P*Ri) / (Sε – 0.6P)
= (2*500) / (70*1 – 0.6*2)
= (1000) / (70 – 1.2)
= (1000) / (68.8)
= 14.53mm

Consider the chart:

VESSEL DIAMETER (m)	MINIMUM SHELL THICKNESS (mm)
Upto 1.0	5
Above 1.0 to 2.0	7
Above 2.0 to 2.5	9
Above 2.5 to 3.0	10
Above 3.0 to 3.5	12

04 Marks

So shell thickness as per chart is suggested as 5mm
But designed value is obtained as 14.53mm
Consider the larger value of 14.53mm ~ 15mm
Now, consider the rounded off even value 16mm as thickness of shell for further calculations.

2) Thickness of head:

t = (P*Ri) / 2Sε
= (2*500) / 2*70*1
= 1000 / 140
= 7.14mm

Consider the rounded off even value 8mm as thickness of hemispherical head.

04 Marks

c) i

Stress concentration:

Whenever in a part there is a change in the shape of its cross-section, then the stress distribution changes. This irregularity in the stress distribution caused by the abrupt changes of form is called as stress concentration.

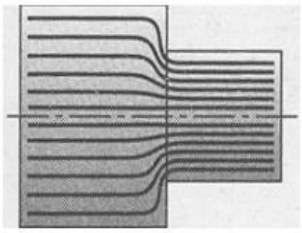
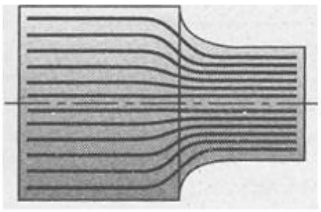
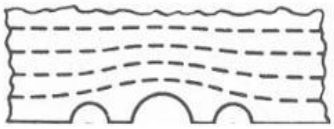
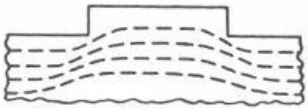
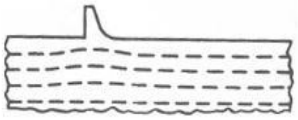
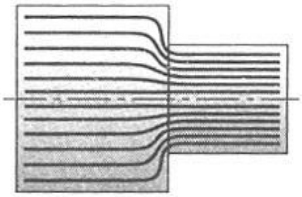
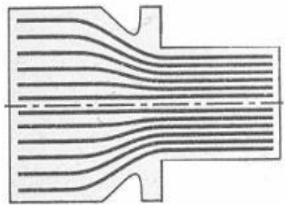
02 Marks

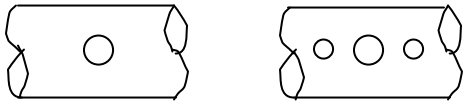
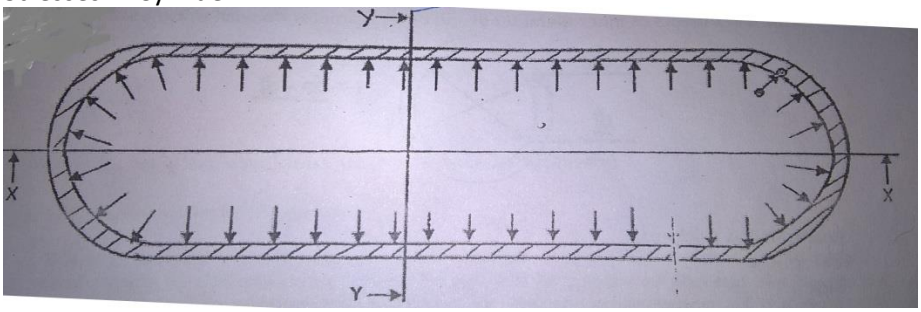
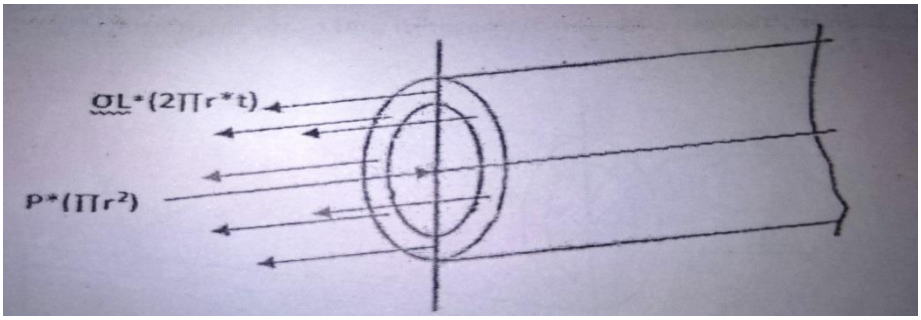
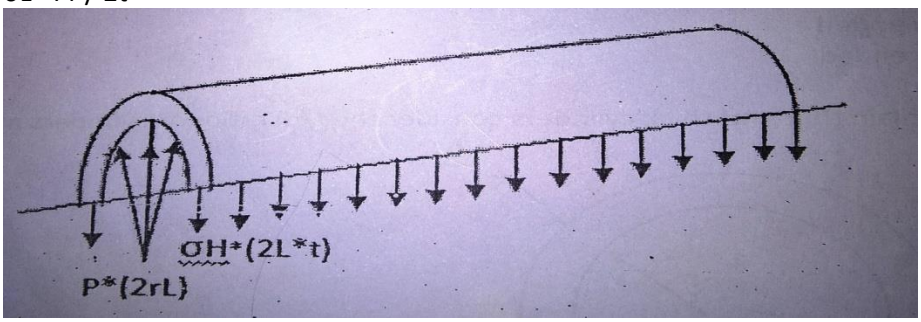
It reduces the strength, durability, stress resistance of a component.

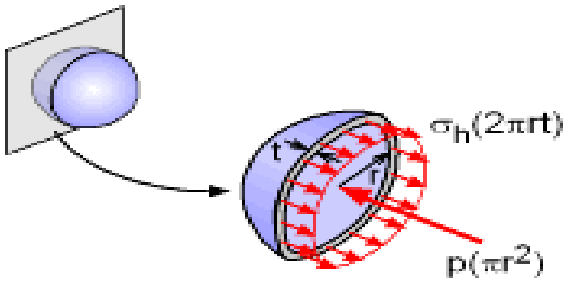
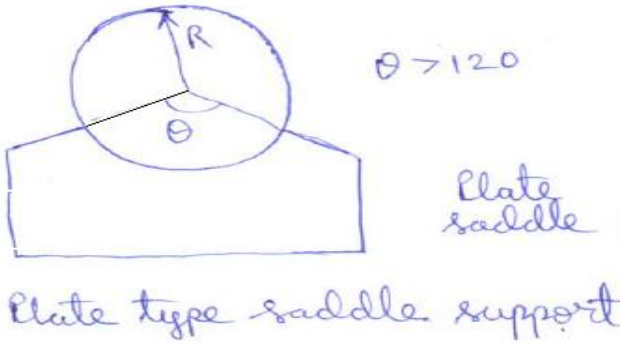
It occurs because of stresses in the presence of notches, fillets, holes, keyways, splines, surface roughness, shoulders, scratches, etc.

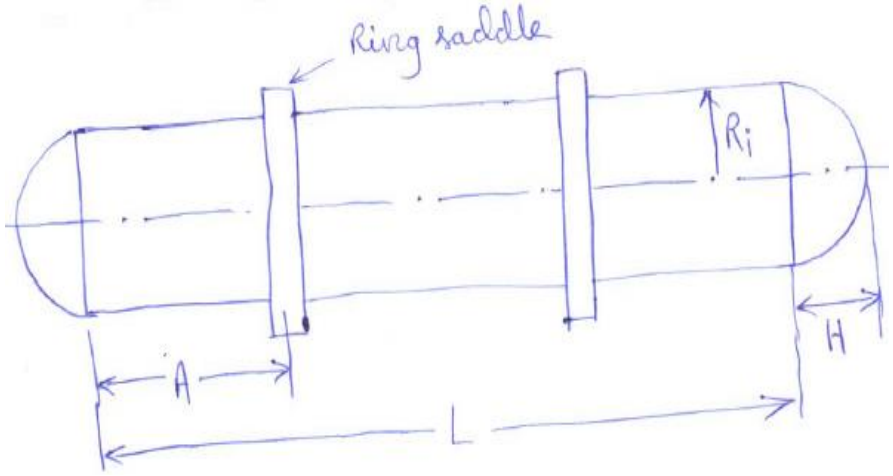
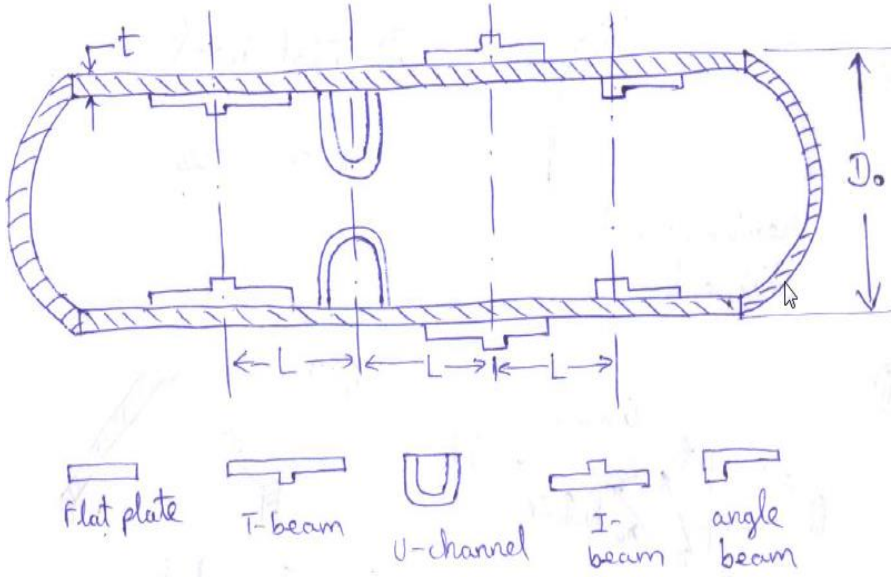
02 marks

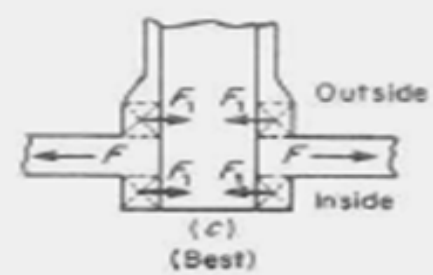
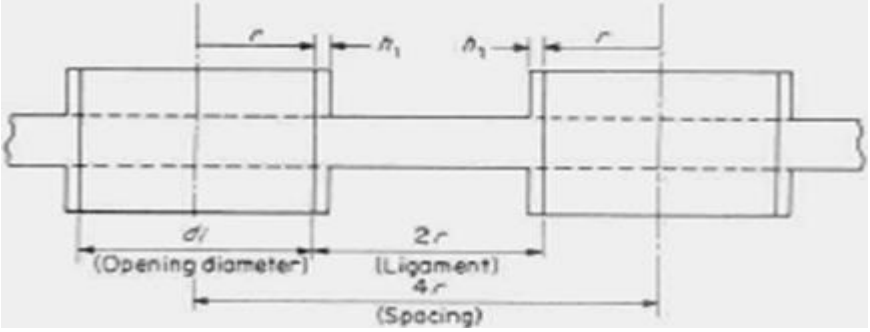
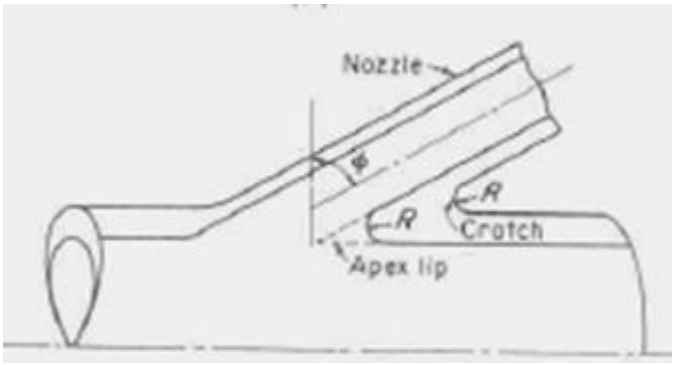
08 Marks

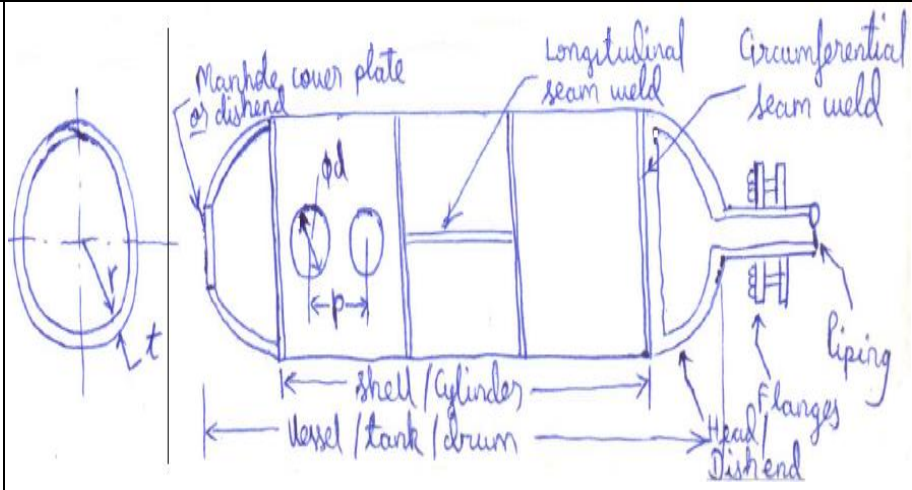
ii	Methods of reducing stress concentration 1.   (a) Force flow around a sharp corner Force flow around a corner with fillet: Low stress concentration. 2.   (b) Force flow around a large notch Force flow around a number of small notches: Low stress concentration. 3.   (c) Force flow around a wide projection Force flow around a narrow projection: Low stress concentration. 4.   (d) Force flow around a sudden change in diameter in a shaft Force flow around a stress relieving groove. 5. Steep and sharp corners be eliminated  6. Selecting materials which are tolerant to cyclic loading (ductile /tough materials)	**04 Marks** **Attempt Any Two** **02 Marks for Each**	

	7.  8. Specifying manufacturing processes to provide fatigue resistance (Peening /shot blasting/Cold Working) 9. Specifying heat treatment to provide fatigue resistance- (Carburising /Nitriding) or Overdesigning part to reduce stress Levels.		
3.	**Attempt any TWO of the following:**	**2*8**	**16**
a)i	Stresses in Cylinder  	**01 Mark**	**08 Marks**
	 	**01 Mark**	
	Considering the free body digram cut by section YY above we have for the cylinder material;appled force due to internal pressure P = Resistive force due to longitudinal stress σL P(πr²)= σL*(2πr*t) σL= Pr / 2t	**½ Mark**	
	 	**01 Mark**	
	Considering the free body diagram cut by section XX above we have for cylinder material;Appled force due to internal pressure P= Resistive force	**½ Mark**	

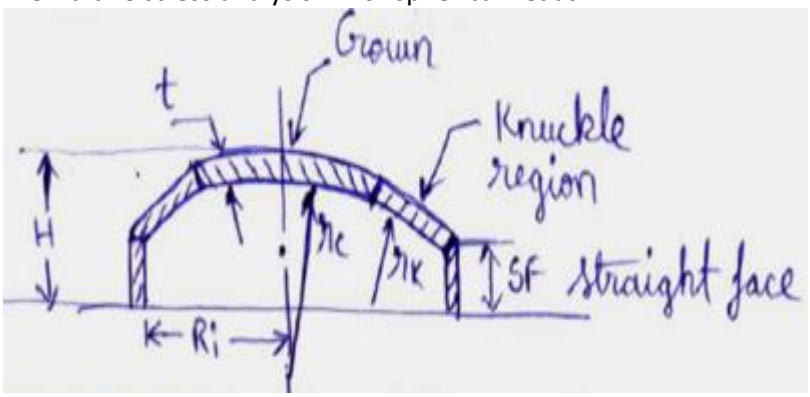
	due to Hoop/Circumferential stress σH P*(2rL)= σH*(2L*t) σH=Pr/t σH=2* σL		
ii)	Stresses in Sphere:  Spherical Pressure Vessel Cut in Half A spherical pressure vessel is really just a special case of a cylindrical vessel. No matter how the sphere is cut in half, the pressure load perpendicular to the cut must equal the shell stress load. This is the same situation with the axial direction in a cylindrical vessel. Equating the two loads gives; $p(\pi r^2) = \sigma h\ (2\pi rt)$ This can be simplified to: σh= σa = pr / 2t (Notice, the hoop and axial stress are the same due to symmetry)	**02 Marks** **02 Marks**	
b) i	**Saddles:** Horizontal cylindrical vessels are supported on saddles. These are placed at minimum two positions. The shell of a vessel is strengthened by stiffeners and supported by using saddle supports. These are used for large thin walled vessels or vessels under vacuum. Supports in the form of rings are preferable for vessels in which supports at more than two positions are essential. Types are; 1) Plate type saddle support: In this included angle θ should be greater than 120^0  Plate type saddle support	**02 Mark** **01 Mark**	**08 Marks**

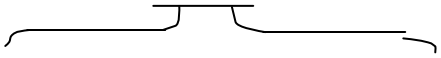
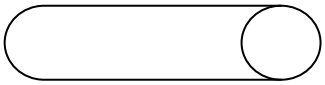
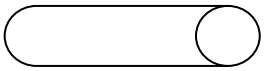
	2) Ring type saddle support: In this support, distance A = (0.4 to 0.5) times Ri or A < 0.2L 	**01 Mark**	
ii	 Stiffners: Considerable saving in weight and material can be made by use of stiffening rings (reinforcing rings). Stiffening rings are attached on the inside or outside surface of the shell. These rings extend over the whole circumference and serve the purpose of end supports. T- beams, flat plate rings, I-beam, U-channel, angles, etc. bolted/ riveted/welded to the shell can be used as stiffening rings.	**02 Marks** **02 marks**	

c)	Nozzle reinforcement is a means to provide compensation for weakening due to the hole made on the shell by providing sufficient additional materials. The reinforcing material being placed adjacent to the hole such that it should not introduce any stress concentration. Nozzle reinforcement: 1. Single nozzles  2. Multiple nozzle arrangements  3. Non radial nozzles 	**02 Marks** **02 Marks** **02 Marks** **02 Marks**	**08 Marks**

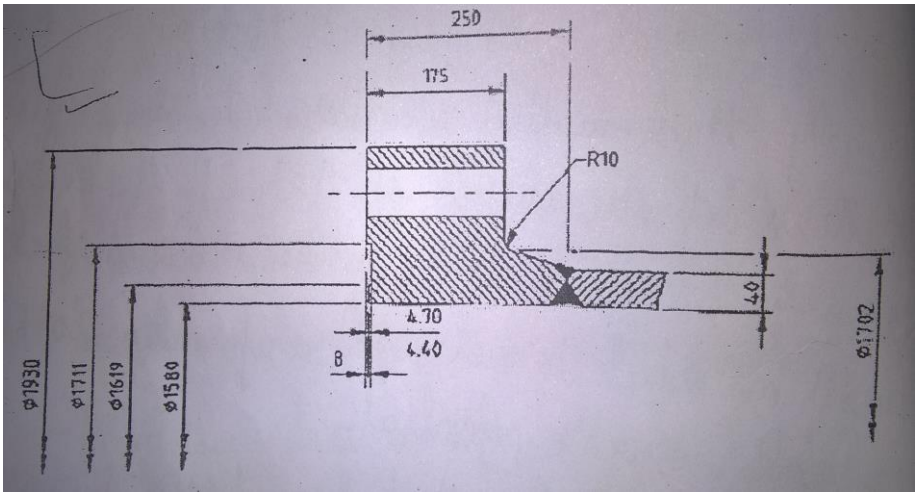
4.	**Attempt any TWO of the following:**	**2*8**	**16**
a)	 Pressure vessel consists of basic parts such as; Cylinders/shell, Rings, Baffle plates, Curved shape dish ends/ heads/ closure ends Nozzles, Flanges, Pipings, etc.	**06 Marks** **02 Marks**	**08 Marks**
b)	Ferrous metals used for corrosive services in pressure vessel construction: • Steel a. Low carbon steel b. Medium carbon steel c. High carbon steel d. Alloy steel Low alloy steel viz. Carbon Molybdenum steels High alloy steels viz. Chromium steels, Chromium nickel steels also called as Stainless steels Commonly used material is Low carbon steels or also called Mild steels: Properties: • Good strength and ductility • Good weldability, machinability and fabricability • Rolled, forged and drawn • Low corrosion resistance • etc. Application: Used in normalised condition for; • Pressure vessel components, • Pipes and fittings, • Machine components, • Structural sections	**02 Marks** **02 marks** **02 Marks** **02 Marks**	**08 Marks**

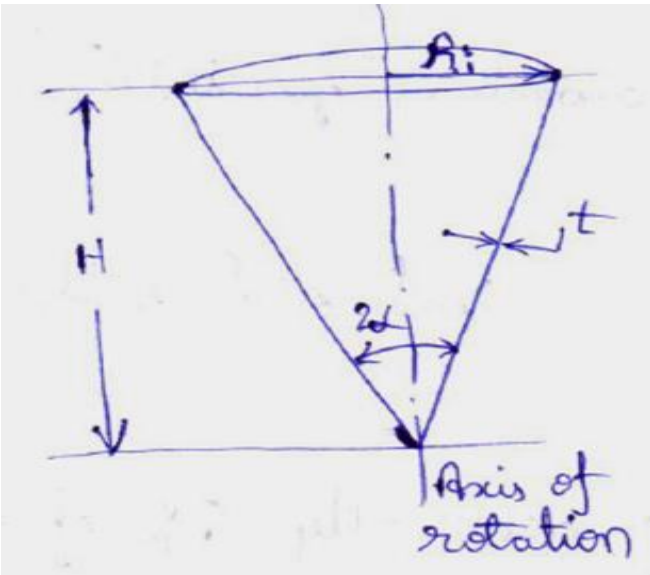
c)	Weld defects with their causes are: 1. Poor weld shape due to misalignment of parts being welded 2. Cracks in welds due to thermal shrinkage 3. Pin holes on the weld surface 4. Slag inclusion when slag covering a run is not totally removed after every run before the following run. 5. Porosity in the form of voids (cavity) when gases are trapped in the solidifying weld metal 6. Incomplete fusion between the weld and base metal resulting from too little heat input and / or too rapid traverse of the welding torch (gas or electric). 7. Undercutting groove adjacent to the weld left unfilled by weld metal due to incorrect settings / procedure 8. Insufficient penetration of the weld metal in joints arises from too high heat input and / or too slow traverse of the welding torch (gas or electric) Remedies for Weld defects: 1. Prorper Aligning of weld elements before starting the welding process 2. appropriate current, voltage setting according to the size of electrode. 3. Proper Pre-heating and post-heating of weld element if the thickness is higher 4. Regular checking of temperature and thermal changes in case of pre-heating or post-heating 5. Welding to be carried out by skilled labour as per welder qualification. 6. In case of underctut flush grind method should be ikmplementged followed by welding. 7. Maintaining proper gap between the joining metals during fitup and alignement of weld metal in avoid insufficient penetration.	**Any 04** **01 Mark Each** **Any 04** **01 Mark Each**	**08 Marks**
5.	**Attempt any FOUR of the following:**	**4*4**	**16**
a)	Ligament efficiency: It is the ratio of Area of ligament to the Area of normal section expressed in Percentageage. Ligament Efficiency= Area of Ligament x 100 Area of normal section factors to be considered in determining ligament efficiency are: -Pitch of the holes(P). -Diameter of the hole. -Stresses in ligament. -Area of the Ligament.	**01 Mark** **01 Mark** **02 Marks (½ marks for each)**	**04 marks**

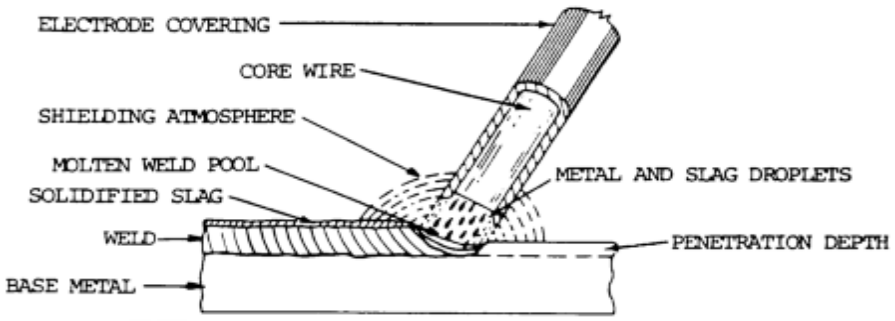
b)	Design Approach for Pressure Vessel: 1) Proper selection of factor of Safety (F.O.S.). 2) Proper material Selection: There is no perfect pressure vessel material suitable for all environments, but material selection must match application & environment. This is specially important in chemical reactors because of embrittlement effect of gaseous absorption and in nuclear reactors because of the irradiation damage from neutron bombardment(attack). 3) Need of Heat Treatment: Proper heat treatment is used to improve qualities/properties of materials by reducing their cost. 4) Economy: Design Engineers should be cautious to control the cast of the product.	**01 Mark Each**	**04 Marks**
c)	Membrane stress analysis in Torispherical heads  Torispherical heads has a region formed by two circular areas, a knuckle section with radius r_k and a spherical crown with crown radius r_c. The local stresses of the thin torispherical head will occur in the knuckle region. The knuckle radius is generally 6% of the crown radius i.e. $r_k = 0.06\ r_c$ If r_c is not given, assume $r_c = R_i$ $S\varepsilon = (P*r_c*M / 2t) + 0.1P$ $S\varepsilon - 0.1\ P = (P*r_c*M / 2t)$ $t = (P*r_c*M) / (2S\varepsilon - 0.2\ P)$ where, r_c = crown radius M = Correction Factor = 1.77 for torispherical head	**02 Marks** **02 marks**	**04 Marks**
d)	Openings in vessels (nozzles) are made by making holes in the wall of the vessel. Nozzles are then formed and welded around these holes. Holes cause discontinuity in the vessel wall. Due to the pressure, a stress	**01 Mark**	**04 Marks**

	concentration is created near the holes, the maximum value of the stress being at the edge of the holes. To reduce this stress concentration and chances of failure at the hole edge reinforcement of nozzle is done. Types/Shapes of nozzles: • Integral nozzle: These are fabricated from a part of the shell and/head by cutting and shaping the material to obtain the contour of a nozzle.  • Fabricated nozzle: These are short pieces of pipes, tubes or plates cut to a specific length from standard fittings and welded to the vessel wall opening.  • Formed nozzle: These are fabricated to a specific shape/size preferably with flanges by rolling/forging methods and welded to the vessel wall opening. 	**01 mark** **01 Mark** **01 Mark**	
e)	Methods of attaching protective coatings: 1. Integral cladding Low carbon steels or low alloy steels (base plates) also called as backing plates and corrosion resistant steel (liners) are welded at the edges. This is then passed through steel mills for hot rolling operations. The high temperature and high pressure creates a solid bond between the plates. Thickness of the liners is about 2mm to 4mm or 8% to 20% thickness of base metals. 2. Sheet lining The corrosion resistant layer is attached to a vessel shell by welding. Thickness of sheet is 2mm to 4mm. Types are; i) Strip type lining of 3' to 5' X 3" to 6" wide strips are welded on base material by spot welding. ii) Sheet type lining of several feet in length and width are welded on base materials by spot, plug or seam welding. The linings are attached to the vessel after the vessel is entirely completed. Sometimes sheets are attached to the base plates before rolling or forming. Carbon steel surfaces (base plates) are ground to provide suitable surface for application of the liner. 3. Protective coatings Coatings should be applied only on clean surfaces free from grease, oil, dirt, scale, etc. i) Metallic coatings – Common methods are electroplating, mechanical cladding (most important), metal spraying, cementation, hot dipping, and	**Any one method** **04 marks**	**04 Marks**

	condensation of metal vapors. ii) Inorganic coatings – Chemical dipped methods are used to create protective oxide films on iron, steel, stainless steel, copper, aluminum and some of their alloys. Such films are very thin and colored. e.g. Electrolytic coating iii) Organic coating – Different synthetic resins, pigments, oils and solvents are used in coating formulations. A continuous adherent inert film is formed between the metal and environment. They change the appearance of the metal e.g. paint enamel, lacquer.		
f)	Visual inspection: Visual-weld-inspection represents the immediate **critical observation** of the external features visible on all welds. It is the first and most important assessment of quality to be performed as soon as the welding operations are accomplished. Other inspection procedures may be required to detect discontinuities not visible to the eye or present below the external surface. Whatever additional non destructive inspection methods are applied, they are performed **only after** visual inspection is successfully completed. -The first is the visual asseeement of the external look of the weld. Its appearance has to correspond to engineering drawing requirements and to be evaluated in comparision with that of the best obtainable practice by anyone looking with critical eye at its chatateristic features. -The second has to do with the formal documented assessment of the visual Weld Inspector. -Visual inspection is intended to find and mark for repair obvious visual defects such as cracks, surface porosity, dimensional discrepancies, excess concavity or convexity, unfilled areas, undercut, misalignment, craters, unacceptable arc striking spots and any other objectionable visual features.	**01 Mark** **01 Mark** **01 Mark** **01 Mark**	**04 marks**
6.	**Attempt any FOUR of the following:**	**4*4**	**16**
a)	A pressure vessel is a closed container designed to hold gases or liquids at a pressure substantially different from the ambient pressure. Pressure vessels are leak proof containers. They may be of any size, shape and range. Pressure vessels are classified as; Function: Storage tank, Process vessel, Reactor, Heat Exchanger, etc. Geometry: Cylindrical, Spherical, Conical, Non circular, Horizontal, Vertical,etc. Construction: Monowall, Intersecting, Multishell, Cast, Forged, etc. Service: Cryogenic, Steam, Vacuum, Fired/Unfired, Stationery/Mobile, etc.	**02 Marks** **02 Marks**	**04 Marks**

b)	 Criterion, adopted for flange design and stress analysis, is carried out according to ASME code, in which following assumptions have been adopted. 1. For hub and shell sections of the flange, local pressure acting on their surfaces is neglected. 2. The effect of the external moment applied to the flange, equal to the product of the bolt load and the lever arm, is independent of the location of the bolt-loading circle and of the forces balancing the bolt load. Stresses in flanges and flanged joints: For understanding of design and stress analysis of flange, integral weld neck flange has been taken in to consideration. In which, flange is divided into three sections with various loads and moments on each viz. i. Annular ring section: Overturning moment Internal hydrostatic pressure ii. Tapered hub section Shear force and bending moment Internal hydrostatic pressure iii. Shell ring section Discontinuity shear force and bending moment	**02 Marks** **01 Mark** **01 Mark**	**04 Marks**

c)	Membrane stress analysis in Conical heads  Conical heads are generated by the rotation of a straight line (generator) intersecting the axis of rotation at an angle α which is half of the apex angle of the formed plane i.e. cone. $\sigma_c = (pr/t)*(1/\cos\alpha)$ $\sigma_L = (pr/2t)*(1/\cos\alpha)$ Therefore, $S\epsilon = (p*R_i / t)*(1/\cos\alpha) + 0.6P$ $S\epsilon - 0.6P = (p*R_i / t)*(1/\cos\alpha)$ $t = p*R_i / (S\epsilon - 0.6P)*(1/\cos\alpha)$ where, α = ½ apex angle and α varies from 30^o to 60^o	**02 Marks** **02 Marks**	**04 Marks**
d) i)	Fatigue concentration Factor: Stress concentrations produced by irregularities are damaging in case of fluctuating stresses. All failures as a result of fatigue are in the areas of high localized stresses. Hence all stresses including localized stresses should be taken into account when designing the pressure vessel.	**02 Marks**	**04 Marks**

ii	Stress concentration Factor: In design under fatigue loading,stress concentration factor is used in modifying the values of endurance limit while in design under static loading it simply act as stress modifier.This means Actual stress = Kt X Calculated stress i.e Kt = Actual stress/ Calculated stress For ductile materials under static loading effect of stress concentration is not very serious but for brittle material even for static loading it is important. Stress concentration factor depends upon material and shape of irregularity.	**02 marks**	
e)	Many high temperature petroleum refining processes are carried out under high partial pressures of hydrogen. Therefore steps for material selection in vessel construction for such service so as to withstand hydrogen which causes deterioration of the material and subsequent failure depends upon identifying some factors like; • Temperature • Hydrogen pressure • Time, • Composition of materials, • etc.	**04 Marks**	**04 Marks**
f)	 Shielded metal arc welding.	**04 Marks**	**04 Marfks**