WINTER – 15 EXAMINATIONS

Subject Code: **17555** **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.

<table>
<tr><th>Q. No.</th><th>MODEL ANSWER</th><th>MARKS</th><th>TOTAL MARKS</th></tr>
<tr><td>1</td><td>Attempt any five</td><td>5 x 4</td><td>20</td></tr>
<tr><td>1. a</td><td><u>Requirement of good comparator.</u>

1) The comparators must be of robust design and construction so as to withstand the effect of ordinary usage without impairing its measuring accuracy.

2) The indicating devices are such that readings are obtained in the least possible time.

3) Provision is made for maximum compensation for temperature effects.

4) The scale is linear and having straight line characteristic.

5) Measuring pressure is low and constant.</td><td>1mark-1 point (any four point)</td><td>4 mark</td></tr>
<tr><td>1. b</td><td><u>Advantages of Quality Control</u>

1) To improve company's income by making the product force acceptable to the customers.

2) To achieve interchangeability in manufacturing in large scale production.

3) To produce optimum quality at minimum price.

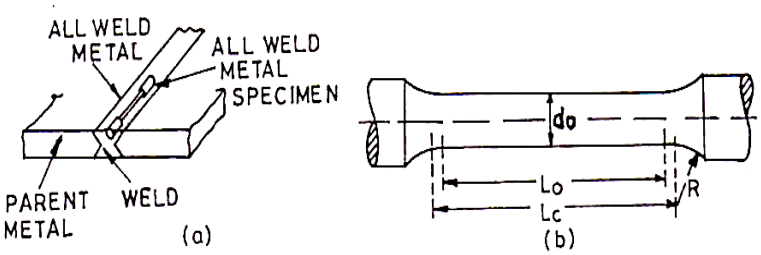
4) To reduce company's cost through reduction of losses due to defects.

5) Developing quality consciousness in the organization.

6) To ensure customer's satisfaction with products of services of higher quality level, thus to build customer's goodwill, confidence and reputation of manufactures.</td><td>1mark-1 point

(any four point)</td><td>4 mark</td></tr>
<tr><td>1. c</td><td>
<table>
<tr><th>Parameters</th><th>Inspection</th><th>Quality control</th></tr>
<tr><td>Scope</td><td>Inspection is a part of quality control.</td><td>Quality control is a broad term, it involves Inspection at particular stages.</td></tr>
<tr><td>Definition</td><td>Inspection is an act of checking materials, parts, components, or products at various stages in manufacturing</td><td>QC is an effective system for integrating Quality development, maintenance and improvement efforts of</td></tr>
</table>
</td><td>1mark-1 point (any four point)</td><td>4mark</td></tr>
</table>

		and sorting out the faulty or defective items from good ones.	various groups 111 an organization to enable the productions to be carried out at most economic level.		
	Devices used	It involves use precision measuring devices like venire callipers, micrometre, etc. and devices such as tool maker's, microscope, profile projector, flaw detector, etc.	QC uses devices such as statistics, control charts, acceptance sampling, process capability study, YQR,YR, quality audits, etc.		
	Application	It is concerned with quality of past production to judge conference with specifications and sorting out defective items from good ones.	It is concerned with quality of future production. What is learnt from inspection is used as a basis to ascertain. Whether the quality meets the specifications or not.		
1. d	<u>Objectives of Non-destructive testing.</u> • Non-destructive tests are applied to welded components to determine their suitability for the service conditions to which they will be subjected. • These tests neither break nor alter the structure or appearance of the welded component. • Non-destructive tests have the ability to detect invisible subsurface defects. • Non-destructive tests make components more reliable and safe. • Although non-destructive tests do not provide direct measurement of mechanical properties, yet they are extremely useful in revealing defects in components that could impair their performance when put in service.			1mark-1 point (any four point)	**4 mark**
1. e	All weld metal test: • A transverse Tensile Test specimen is cut from a welded butt joint (at right angle to the weld direction and is used to determine its transverse tensile strength. • In an all-weld metal tensile test, the specimen is prepared from all-weld metal [Fig. (a)]. This type of specimen is prepared by machining a groove in a plate of steel and then completely filling the groove with deposited weld metal. The surrounding steel is then machined away leaving a specimen of weld metal.			SKETCH -2 MARK Explanation- 2 MARK	4 mark

			
1. f	Note: Any other code rather than above are accepted. Codes for pressure vessels • ASTM A516/A516 M.0.6.Standard specification for pressure vessel plates, carbon steel for moderate and lower temperature service. • ASTM E1139.Practical for continuous monitoring of acoustic emission from metal boundaries. • ASTM E1001-84.Practice for detection and evaluation of the discontinuities by the immersed pulse-echo ultrasonic method using longitudinal waves. • ASTM E309-87.Eddy current examination of steel tabular products using magnetic saturation. • REG 1 – Regulation 1 is set for short title,extents,application and commencement • REG 8 - set for use of welding • REG 7 - Boiler shells not in accordance with standard condition • REG 15 – Tensile test piece • REG 19 – Bend test • DIN 2616-2:1991 • Steel butt-welding pipe fittings; reducers for use at full service pressure • DIN 2618:1968 • Butt welding steel fittings; welding saddles, nominal pressure • DIN 2619:1968 • Butt welding steel fitting; bends for welding, nominal pressure 16 • **Codes for pipes:** ASME Codes for pipes • B31.1 - 2001 - Power Piping • B31.2 - 1968 - Fuel Gas Piping • B31.3 - 2002 - Process Piping	1 CODE - 1mark (2 code – pressure vessel) (2 code – pipe) (any four point)	4 mark

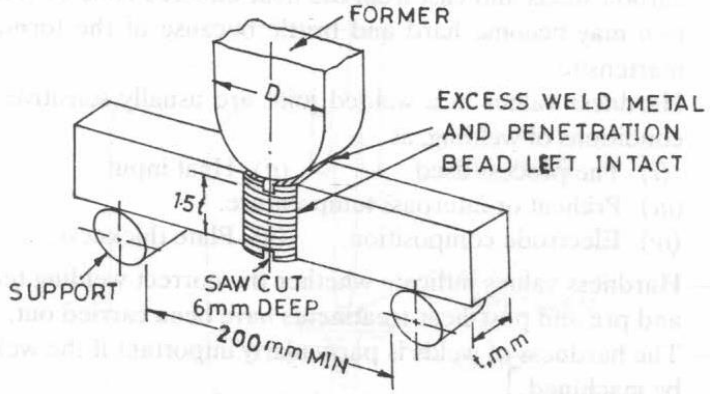
<table>
<tr><td></td><td>

- B31.4 - 2002 - Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
- DIN 2980:1977
- Screwed steel pipe fittings
- DIN 2981:1982
- Threaded steel pipe fitting; fittings with long screw thread
- DIN 2982:1977
- Screwed steel pipe fitting; parallel nipples, taper nipples
- B31.8 - 2003 - Gas Transmission and Distribution Piping Systems
- B31.8S-2001 - 2002 - Managing System Integrity of Gas Pipelines
- B31.9 - 1996 - Building Services Piping
- B31.11 - 2002 - Slurry Transportation Piping Systems
- B31G - 1991 - Manual for Determining Remaining Strength of Corroded Pipelines

Any other code rather than above are accepted.
</td><td></td><td></td></tr>
<tr><td>1. g</td><td><u>Acoustic emission (AE)</u> is defined as the class of phenomenon where by transients elastic waves are generated by the rapid release of energy from localized source like places of transient relaxation of stress and strain fields.

<u>Principle of AET:</u> AE signals generated by discontinuities in material under a stimulus such stress, temperature etc. Proper analysis of these signals can be providing information concerning detection.</td><td>4 mark</td><td>4 mark</td></tr>
<tr><td>2</td><td>Attempt any two</td><td>2 x 8</td><td>16</td></tr>
<tr><td>2. a</td><td>
<table>
<tr><th>PNEUMATIC COMPARATOR</th><th>ELECTRIC COMPARATOR</th></tr>
<tr><td>1. Limited range available.</td><td>1. Wide range of magnification.</td></tr>
<tr><td>2. The apparatus is not portable.</td><td>2. The apparatus is portable</td></tr>
<tr><td>3. Different gauges are required for different dimension.</td><td>3.Different gauges are not required for different dimension</td></tr>
<tr><td>4. It is not widely used compare to electric comparator.</td><td>4. It is widely used compare to pneumatic comparator.</td></tr>
<tr><td>5. Working media is air.</td><td>5. Working media is a.c or d.c power.</td></tr>
<tr><td>6. Maintance cost is more.</td><td>6. Maintance cost is less.</td></tr>
<tr><td>7. The accuracy is affected by compressor and fluid media.</td><td>7. The accuracy is affected by temperature and humidity variation.</td></tr>
</table>
</td><td>1 point - 2mark (any four point)</td><td>8 mark</td></tr>
</table>

2. b	**Advantages of Radiography** • A permanent record of defects in a welded object is obtained. • Reference standards for defects are available. • Technique is not limited by material type or density. • Can inspect assembled components. • Minimum surface preparation required. • Sensitive to changes in thickness, corrosion, voids, cracks, and material density changes. • Detects both surface and subsurface defects. • Provides a permanent record of the inspection. **Disadvantages of Radiography** • Trained operator is required. • The method involves radiation hazards. • Skilled worker is required. • Many safety precautions for the use of high intensity radiation. • Access to both sides of sample required. • Orientation of equipment and flaw can be critical. • Determining flaw depth is impossible without additional angled exposures. • Expensive initial equipment cost.	1 point - 1mark (4mark-advantages) (4mark-dis advantages)	8 mark
2. c	THE NICK-BREAK TEST Purpose A nick-break test involves breaking the weld joint to examine the fractured surfaces for internal defects such as: (i) Gas pockets (ii) Slag inclusions (iii) Porosity. The test also determines weld ductility and the degree of fusion.	4mark-Purpose 2mark-Diagram 2mark-Procedure	8mark

	 Fig. 38.14 Nick-break test specimen. Procedure • The test specimen shall be cut transversely to the welded joint and shall have the full thickness of the plate t at the joint. The excess weld metal and penetration bead shall be left intact. • Slots are sawed at each end of the specimen to be tested. • The specimen is then placed upright on two supports and the force on the weld is applied either by a press or by the sharp blows of a hammer until a fracture occurs between the two slots. • A visual inspection of the fractured surfaces is carried out in order to find defects (as mentioned earlier), if any. • If any defect exceeds 1.5 mm in size or the number of gas pockets exceeds one per square cm, the piece has failed the test.		
3	**Attempt any four**	4 x 4	**16**
3. a (i)	**Quality of design** refers to the differences in the specification for products which have the same use. Quality of conformance on the other hand refers to the ability to maintain the specified quality of design.	2mark	4mark
3. a) ii)	**Quality of Performance:** It is concerned with, 'how well the manufactured product gives its performance'. It deals with the total performance of product. It can be a best design possible, but poor conformance control can cause poor performance, conversely the best conformance control cannot make the product to function correctly, if design itself is not correct	2mark	4mark
3. b	Duties of Inspector; (1)Interpretation of specification (2)Measurement of product	1mark-1 point (any four point)	4mark

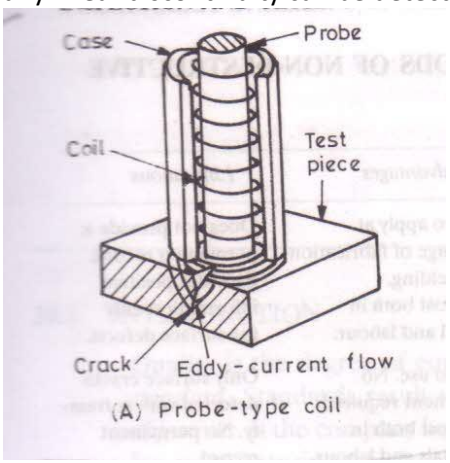
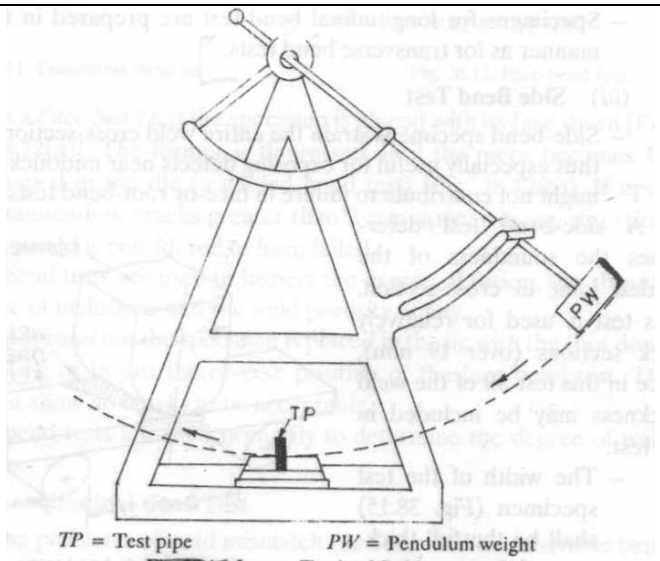
	(3)Comparison with standards (4)Judging conformity (5)Recording data (6)Disposition of product		
3. c	MAGNETIC PARTICLE INSPECTION : (i)Basic principle: When a piece of metal is placed in magnetic field and the lines of magnetic flux get intersected by a discontinuity such as a crack or slag inclusions in a job, magnetic poles are induced on either side of the discontinuity. The discontinuity causes an abrupt change in the path of magnetic flux flowing through the job normal to the discontinuity, resulting a local flux leakage field and interference with the magnetic lines of force is local flux disturbance can be detected by its effect upon magnetic particles which are attracted to the region of discontinuity and pile up and bridge over the discontinuity	4mark	4mark
3. d	Applications of ultrasonic inspection. 1. Inspection of large weldments, castings and forging, for internal soundness, before carrying out expensive machining operations. 2. Inspection of moving strip or plate (for laminations) as regards its thickness. 3. Routine inspection of locomotive axles and wheel pins for fatigue cracks. 4. Inspection of rails for bolt-hole breaks without dismantling rail-end assemblies	1mark-1 point (any four point)	4 mark
3. e	Principal of COMPRESSION TEST • Theoretically, compression test is merely the opposite of the tension test with respect to the reaction of applied stress. • The compression test can be done on the same machine on which the tension test is done like universal testing machine or some other machine which is designed specifically for the purpose. • In general, brittle materials are good in compression than in tension and therefore, they are used for compressive loads. Due to this, compression test is mainly used to test brittle materials such as cast irons, concrete, stones, bricks and ceramic products. • During testing, fracture occurs in brittle materials and therefore, the ultimate strength is determined corresponding to the fracture point; but no fracture occurs for ductile materials and hence ultimate strength is found out for some arbitrary amount of deformation. Practical aspects: It has been observed that some are always bounds to come in the	2 mark-PRINCIPLE 2 mark-Practical aspect.	4mark

	compression test due to the following practical difficulties: 1. Since the top and bottom faces of the specimen are perfectly parallel to each other and there is always tendency for bending the specimens during testing, it is very difficult to apply truly axial load. 2. Since the length of the specimen is kept short enough (not more than twice its diameter to avoid its bucking. 3. The friction between the ends of the specimen and the heads ends of the testing machine prevent the deformation of specimen.		
3. f	**ASME** • American Society of Mechanical Engineers is a 120,000-member professional organization focused on technical, educational and research issues of the engineering and technology community. • ASME conducts one of the world's largest technical publishing operations, holds numerous technical conferences worldwide, and offers hundreds of professional development courses each year. • ASME sets internationally recognized industrial and manufacturing codes and standards that enhance public safety. **ASTM** • ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. • Today, some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence	2 mark-ASME 2 mark-ASTM	4 mark
4	**Attempt any four**	4x4	**16**
4. a	**TQM** Total quality management refers to the total involvement of staff in an organization together with suppliers, distributors and even customers in bringing about quality satisfaction by promoting quality cultures through quality circles, job enrichment and effective purchasing. TQM can be ensured in an organization through following steps : (a) Team effort of all the constituents towards achieving the common goal of enrichment in the quality standard. (b) Satisfying workers emotional and intellectual needs for providing them to have better working conditions which ultimately results in better quality of the product. (c) Installing motivation system, to include collective achievement and quality excellence. (d) Integrating and coordinating the activities of various departments in the organization to attain the desired goals economically. (e) Maintaining a sound quality system, to ensure each task, is performed correct.	4 mark	4 mark

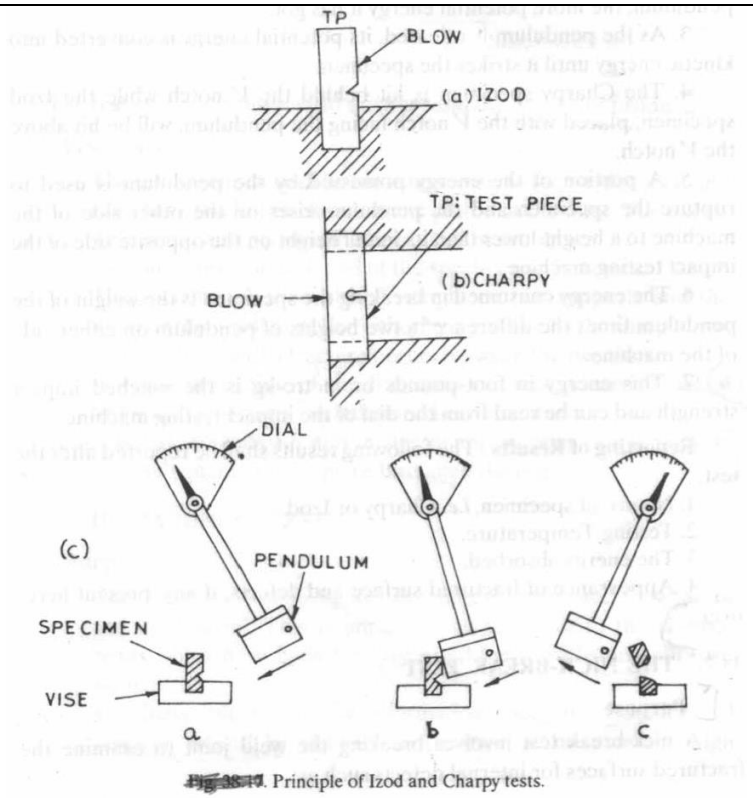
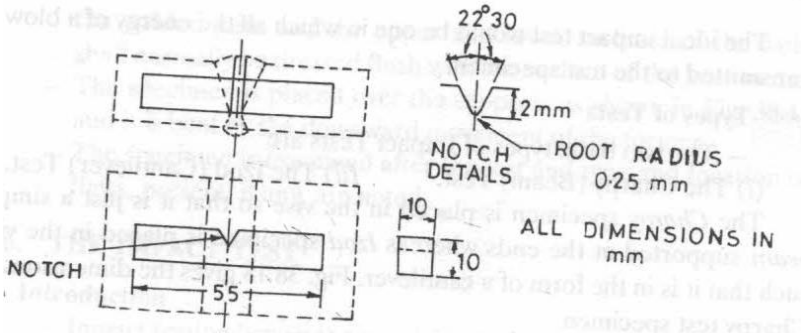
4. b	**Inspection planning:** Inspection planning is an essential aspect in the inspection function, enough inspection is absolutely essential, it does not add to the value of the product. It's the activity of Selection of type for different stage in production flow. a) Planning inspection operation in detail. b) Designating the station at which inspection should take place. c) Providing inspectors with the inspection specification, gauges, tools, test equipment and other information necessary for inspection.	4mark	4mark
4. C	Advantages of gamma radiography: 1. A permanent record of defects in a welded object is obtained. 2. Reference standards for defects are available. 3. Low initial cost. 4. This is a very good method for testing at the site.	1mark-1 point (four point)	4mark
4. d	Disadvantages of gamma radiography: 1. Trained operator is required. 2. The method involves radiation hazards. 3. ϒ-ray source loses strength continuously. 4. ϒ-ray radiography possesses lower sensitivity and definition than X-ray radiograph	1mark-1 point (four point)	4mark
4. e	Types of Bend Tests Bend tests may be categorized as (a) Free Bend Test (b) Guided Bend Test Bend tests may be further classified as Root bend test (i) Transverse bend test - Face bend test -Root bend test (ii) Longitudinal bend test (iii) Side bend test. Purpose of bend test: Bend tests may be used to find a number of weld properties such as (i) Ductility of the welded zone (ii) Weld penetration (iii) Fusion (iv) Crystalline structure (of the fractured surface) (v) Strength. . • The bend test assists in determining the soundness of the weld metal, the weld junction and the heat -affected zone. • The test shows the quality of the welded joint.	2mark-purpose 2mark-types	4mark

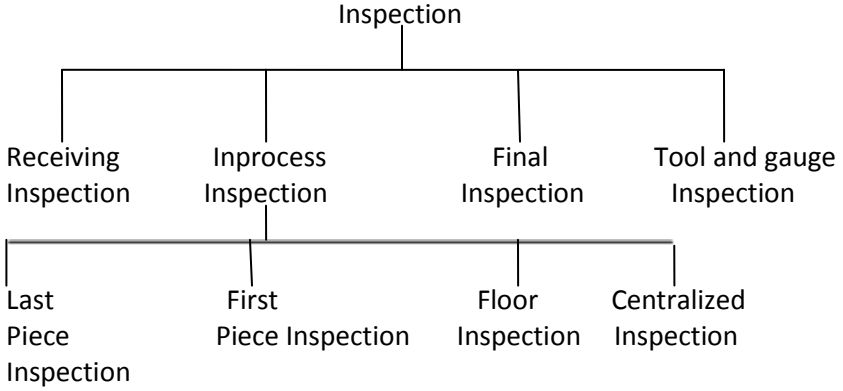
<table>
<tr><td></td><td>• Any cracking of the metal will indicate false fusion or defective penetration.</td><td></td><td></td></tr>
<tr><td>4. f</td><td><u>DIN: Deutsches Institute for Normung</u>
➢ In English-German institute for standardization.
➢ It is the German national organization for standardization.
➢ There are currently thirty thousand DIN standards, covering almost all fields of technology.
<u>IBR : INDIAN BOILER REGULATION</u>
➢ REG 1 – Regulation 1 is set for short title, extents ,application and commencement
➢ REG 8 - set for use of welding
➢ REG 7 - Boiler shells not in accordance with standard condition
➢ REG 15 – Tensile test piece
➢ REG 19 – Bend test</td><td>2 mark-DIN
2 mark-IBR</td><td>4mark</td></tr>
<tr><td>5</td><td>Attempt any two</td><td>2 x 8</td><td>16</td></tr>
<tr><td>5. a</td><td><table><tr><td>Hole base system</td><td>Shaft base system</td></tr><tr><td>1. Lower deviation of hole (Fundamental deviation) is zero.</td><td>1. Upper deviation of shaft (Fundamental deviation) is zero.</td></tr><tr><td>2. Limits on the hole are kept constant and those of the shaft are varied to obtain desired type of fit.</td><td>2. Limits on the shaft are kept constant and those on hole are varied to have necessary fit.</td></tr><tr><td>3. System is preferred in mass production, because it is easy, Convenient and less costly to make a correct hole size.</td><td>3. System is not suitable in mass production, because it is inconvenient and costly to make a Shaft of correct size.</td></tr><tr><td>4. It is much easy to vary the shaft Sizes according to the fit required.</td><td>4. It is rather difficult to vary the hole sizes according to the fit required.</td></tr><tr><td>5. It requires less amount of capital and storage needed to produce Shafts of different sizes.</td><td>5. It needs large amount of capital and space for tools storage, because. Large number of tools of different sizes is required to produce holes of different sizes.</td></tr><tr><td>6. Gauging of shafts can be easily done with the help of adjustable gap gauges.</td><td>6. Being internal measurement, gauging of holes cannot be easily done.</td></tr></table></td><td>2mark-1 point (four point)</td><td>8mark</td></tr>
<tr><td>5. b</td><td>EDDY CURRENT TESTING
<u>Principle of Operation</u>

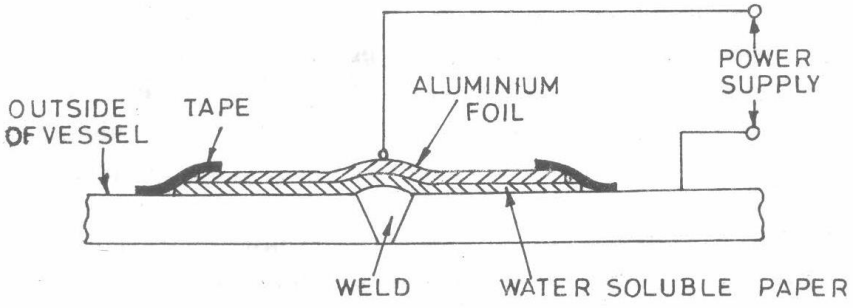
An A.C. coil is brought up close to the weldment to be tested. The A.c. Coil induces eddy currents in the welded object. These eddy currents produce their own magnetic field which opposes the field of the A.C. coil. The result is an increase in the impedance (resistance) of the A.c. Coil. Coil impedance</td><td>4mark-principle
4mark-application.
(any four point)
1mark-1 point</td><td>8mark</td></tr>
</table>

	can be measured. If there is a flaw in the weldment, as soon as the coil passes over the flow, there is a change in the coil impedance which can be wired to give a warning light or sound and thus the flaw and its location can be determined. Flaws Indicated Flaws at or close to the surface such as cracks, weld porosity, poor fusion or any linear discontinuity can be detected  (A) Probe-type coil <u>APPLICATION:</u> 1. It can be applied to round,flat and irregularity shaped object. 2. Eddy current testing can be conducted sucessfully employed for online testing wires,rodes and tubes. 3. It can be useful setting material mesurement and control of dimension of tube,sheet an rods. 4. Different varible like conductivity,hardness strenght,dimension and heattreatment variable discontinuties,coating thickness can be removed by eddy current testing.		
5. c	 *TP* = Test pipe *PW* = Pendulum weight Impact Testing Machine.	4mark-explain 4mark-sketch.	8mark

	The two basic types of Impact Tests are (i) The Charpy (Beam) Test. (ii) The Izod (Cantilever) Test. The Charpy specimen is placed in the vise so that it is just a simple beam supported at the ends whereas lzod specimen is placed in the vise such that it is in the form of a cantilever. Fig. Gives the dimensions of Charpy test specimen. Test Procedure (Refer to Figs.) 1. The swinging pendulum weight is raised to standard height depending upon the type of specimen to be tested. 2. With reference to vise holding the specimen,the higher the pendulum, the more potential energy it has got. 3. As the pendulums released, its potential energy is converted into kinetic energy until it strikes the specimen. 4. The Charpy specimen is hit behind the V notch while the lzod specimen, placed with the V notch facing the pendulum, will be hit above the V notch. 5. A portion of the energy possessed by the pendulum is used to rupture the specimen and the pendulum rises on the other side of the machine to a height lower than its initial height on the opposite side of the impact testing machine. 6. The energy consumed in breaking the specimen is the weight of the pendulum times the difference in two heights of pendulum on either side the machine. 7. This energy in foot-pounds or metre-kg is the notched impact strength and can be read from the dial of the impact testing machine. Reporting of Results: The following results shall be reported after the test: 1. Nature of specimen, i.e. Charpy or Izod. 2. Testing Temperature. 3. The energy absorbed. 4. Appearance of fractured surface and defects, *if any, present hereover*.		

	 Fig. 38.17. Principle of Izod and Charpy tests.  Fig. 38.18. Dimensions of Charpy test specimen.		
6	**Attempt any two**	2 x 8	**16**
6. a (i)	Limit • The limits of a size of a dimension of a part are two extreme permissible sizes between which, the actual size of that dimension is contained. • Limits are two extreme permissible sizes for a dimension, there being a higher limit and a lower limit. The greater of these two sizes is called as maximum limit or high limit of size, while the smaller size is called as the minimum limit or low limit of size.	2mark	**4 mark**

6. a ii)	Fit • The relation between the two parts, where one is inserted into the other with a certain degree of tightness or looseness is known as fit. • When two parts are to be assembled, the relation resulting from the difference between their sizes before assembly is called fit. • Fit is the degree of tightness or looseness between two mating parts to perform a definite function	2 mark	
6. b		4 marks	4marks

6. c	TYPES OF LEAK TEST : (any one method) • Leak test by water soluble paper with Aluminium foil. • Leak test by gas or fluid. • **Leak test by gas or fluid.** Procedure: The welded vessel, after closing all its outlets; is subjected to internal pressure using water, oil, air or gas (e.g. CO2), Hydraulic pressure, using water as the fluid, is the usual medium employed in this test. Oil if it is thin/hot will penetrate leaks that do not show up with water under equal pressure. Air will leak out more readily than water and gas (e.g. Hydrogen) will escape where air will not. Where feasible, it is better to use water or oil because there will be very less tendency for the parts to be violently thrown out in case of a sudden release of pressure. When using air/gas, failure of vessel can cause injuries to persons around. • **Leak test by water soluble paper with Aluminium foil.** In this method the vessel to be tested is pressurized with water and Al foil is laid over the widest strip of water soluble paper and bath are struck with a tape over a welded seam. If a leak exists the water soluble strip will dissolve and the Al foil strip will be in electrical contact with the vessel the flow of current indicates leakage in the pressure vessel.  	1mark-types of leak test 3mark-explanation of any one method.	4mark
6. d.	Factors involved in the ultrasonic testing 1) Frequency of operation of an ultrasonic testing device. 2) Metallurgical characteristics of the material. 3) Pattern of signal processing. 4) Type of discontinuity in the material. 5) The capacity of the background to receive the signals in the form of echo indicating the discontinuities. 6) The way of propagation of stress waves in the material	1mark-1factors (any 4)	**4MARK**

<table>
<tr>
<td>6.
e.</td>
<td>
<table>
<tr><td>Macro Etch test</td><td>Micro Etch Test</td></tr>
<tr><td>1. It is examined either by naked eye or by low power magnification up to X15.</td><td>1. It is examined under a microscope at magnifications from magnification up to X20 to X2000.</td></tr>
<tr><td>2. Macro-examination gives a broad picture of the specimen by studying relatively large sectioned areas.</td><td>2. Micro-etch examination involves areas much smaller than those considered in macro-etch examination and brings out information that can never be revealed by macro-examination.</td></tr>
<tr><td>3. Macro-examination reveals in welded specimen: Cracks, Slag inclusion, Blowholes, Shrinkage porosity, Penetration of the weld, The boundary between the weld metal and the base metal, etc.</td><td>3. Micro-examination determines in a welded specimen Cracks and inclusions of microscopic size. Grain boundaries and solidification structures of weld metal, heat affected zone and the base metal Distribution of micro-constituents in the weld metal. The quality of heat-treatment, etc.</td></tr>
</table>
</td>
<td>02mark- 1 point
(any 2 point)</td>
<td>4mark</td>
</tr>
<tr>
<td>6
.f.</td>
<td><u>HARDNESS TEST</u>
<u>Introduction:</u>

The hardness test gives an idea of the resistance to wear of the weld metal. This is important with respect to the components which have been built up' and have to withstand abrasive wear.
Hardness values can give information about the metallurgical changes caused by welding. In the case of medium-and high carbon steels and cast iron, the heat-affected zone or weld junction may become hard and brittle because of the formation of martensite.
Hardness values in a welded joint are usually sensitive to such conditions of welding, as (i) The process used. (ii) Heat input.(iii) Preheat or interp ass temperature.(iv) Electrode composition. (v)Plate thickness.
Hardness values indicate whether the correct welding technique and pre and post-heat-treatments have been carried out.
The hardness of welds is particularly important if the welds must be machined.

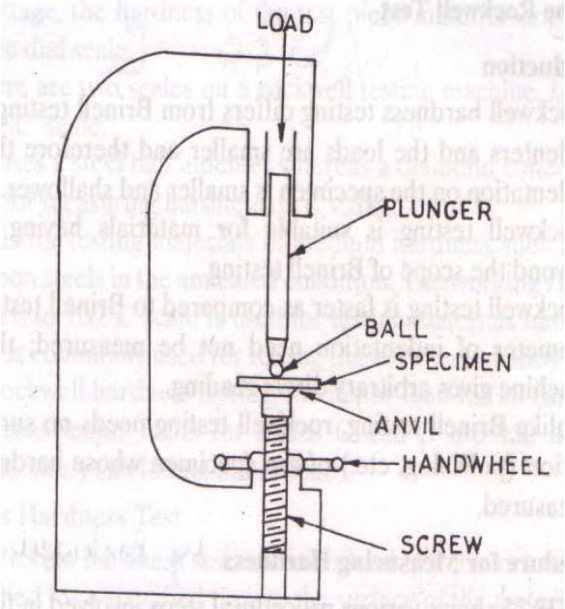
<u>Method of hardness test:</u>
(1)The Brinell Test
(2) the Rockwell test
(3) Vickers test

<u>NOTE: Explanation of any one method is also allowed.</u></td>
<td>4 mark- only explanation of introduction or Explanation of any one method.</td>
<td>4 mark</td>
</tr>
</table>

(1)The Brinell Test

The Brinell Test

- It consists of pressing a hardened steel ball into a test specimen.
- According to ASTM specifications, a 10 mm diameter ball is used for the purpose. Lower loads are applied for measuring hardness of soft materials and vice versa.
- Procedure of Hardness Testing;
- -Specimen is placed on the anvil; the hand wheel is rotated so that the specimen along with the anvil moves up and contacts with the ball.
- The desired load is applied mechanically (by a gear driven screw) or hydraulically (by oil pressure) and the ball presses into the specimen.
- The diameter of the indentation made in the specimen by thepressed ball is measured by the use of a micrometer microscope, having a transparent engraved scale in the field of view.
- The indentation diameter is measured at two places at right angles to each other, and the average of the two readings is taken.
- The Brinell hardness number (BH) which is the pressure per unit surface area of the indentation in kg per square metre, is calculated as follows:
- BHN= W/[(πD /2)(D-√{D2-d2})]
- Where W is load on indenter, kg
- D is diameter of steel ball, mm
- d is average measured diameter of indentation, mm
- Brinell hardness test is best for measuring hardness of gray cast iron consisting of soft flake graphite, iron and hard iron carbide.



- **Rockwell hardness test:**

Introduction

– Rockwell hardness testing differs from Brinell testing in that the indenters and the loads are smaller and therefore the resulting indentation on the specimen is smaller and shallower.
– Rockwell testing is suitable for materials having hardnesses beyond the scope of Brinell testing.
– Rockwell testing is faster as compared to Brinell testing because diameter of indentation need not be measured; the rockwell machine gives arbitrary direct reading.
– Unlike Brinell testing, rockwell testing needs no surface preparation (polishing, etc.) of the specimen whose hardness is to be measured.

- Test piece is placed upon the machine. The machine dial is showing any reading.
- Hand wheel is turned, thereby raising the test piece up against the steel ball indenter till the needle on the dial reads zero. This applies minor load.
- Major load is applied by pressing the crank provided on the right-hand side of the machine.
- Crank is turned in the reverse direction thereby withdrawing major load. But leaving minor load applied.
- Hand wheel is rotated and the test piece is lowered.
- At this stage, the hardness of the test piece material can be directly read from the dial scale.

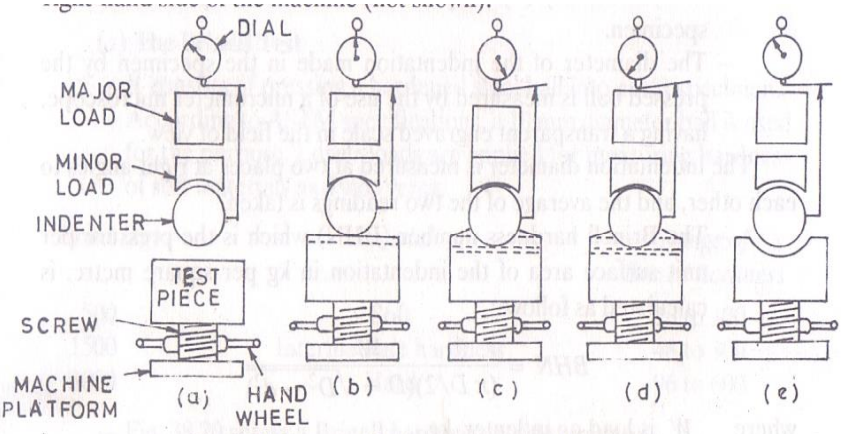


Fig. 38.21. Procedure for measuring rockwell hardness.

VICKER HARDNESS TESTVICKER HARDNESS TEST

– There are two scales on a rockwell testing machine, *i.e.* *'B'* scale and *'C'* scale.

B scale uses a steel ball indenter whereas a diamond cone penetrator is employed for measuring hardness on *C* scale.

B scale is for testing materials of medium hardness such as low and medium carbon steels in the annealed condition. The working range of this scale is from 0 to 100. *C* scale is used for testing materials harder than *B* 100. *C* scale is commonly used for testing the hardness of alloy cast irons.

– In rockwell hardness testing, the minor load for all cases is 10 kg whereas major loads for scales *C* and *B* are 150 and 100 kg respectively (including minor load).

VICKER HARDNESS TEST

– In Vickers hardness test, a known load (P) (from 1 to 120 kg) is applied for a specified time to the surface of the material through a square-base-pyramid diamond having 136° between opposite faces.
– The two diagonals of the resulting square indentation on the test piece are measured with a micrometer macroscope and averaged, (D, mm).
– The Vickers hardness number is calculated as follows

$$VHN = \frac{1.854\,P}{D^2}$$

– Before conducting Vickers hardness test, the surface of the specimen should be flat and of sufficient polish so that any remaining scratches do not cause difficulty in locating the corners of the indentation when diagonals are measured.
– The impression of Vickers indenter on the specimen being very small, peak (and not average) values of hardness can be determined on the weld from root to face.

In the same length of the specimen, more hardness readings can be taken with Vickers hardness test than with Brinell or Rockwell hardness tests.