SHAMBHUNATH INSTITUTE OF ENGINEERING AND TECHNOLOGY

Subject Code: RME-080 Subject : Non-Destructive Testing

B.Tech. VIII SEMESTER

FIRST SESSIONAL EXAMINATION, EVEN SEMESTER, (2019-2020)

Branch : Mechanical Engineering

Time –1hr 30 min Maximum Marks – 30

SECTION – A

1. Attempt all questions in brief. (1*5 = 5)

Q a.	**What is defect?**
Ans.	A flaw or discontinuity that is rejectable i.e. does not meet acceptance criteria is called defect. Defects are removed or repaired. It may be introduced during production stage, Caused during various manufacturing process or caused during the use of end product due to environment and load.
Q b.	**Enlist various Non-Destructive testing methods used.**
Ans.	1. Visual and Optical Testing (VT). 2. Penetrant Testing (PT). 3. Magnetic Particle Testing (MT). 4. Eddy Current Testing. 5. Radiography Testing (RT). 6. Ultrasonic Testing. 7. Acoustic Emission Testing (AE).
Q c.	**Define contrast associated with visual inspection.**
Ans.	Contrast is the difference in luminance that makes an object distinguishable from its environment. Contrast is determined by the difference in the color and brightness of the object and other objects within the same field of view.
Q d.	**What is dwell time?**
Ans.	Dwell or dwell time is certain amount of time for which penetrant is left to be in contact with surface of job till it dries. This dwell period varies according to type of penetrant used, material on which penetrant is applied, type of defect for which it is applied, specimen size, temperature, etc. Generally minimum dwell period varies upto 60 minutes.
Q e.	**Define viscosity.**
Ans.	The viscosity of a fluid is a measure of its resistance to fluid flow. For liquids, it corresponds to the informal concept of "thickness". Viscosity can be conceptualized as a quantity expressing the magnitude of internal friction in a fluid that arises between adjacent layers of fluid that are in relative motion. . The SI unit of viscosity is the pascal-second (Pa·s).

SECTION – B

2. Attempt any TWO parts of the following: (2*5 = 10)

Q a. **Differentiate between Destructive and Non-Destructive testing.**

Ans. **Differences between Destructive and Non-Destructive testing may be established as;**

Destructive	Non-Destructive
1.) Destructive testing will render the part unusable for its intended purpose.	1. Non-Destructive testing will allow the part to be used for its intended purpose, after testing.
2.) Destructive testing is generally performed when the component or material sample can no longer be used in service or is readily replaceable.	2.) NDT can be performed on component during manufacturing as well as in service.
3.) It includes measuring various mechanical or chemical properties such as tensile strength or chemical composition.	3.) It includes non-invasive techniques to determine the integrity of a material or component.
4.) Examples of destructive test: Tensile test, Compression test, Shear and Bending test, Torsion test, Impact test, Creep test, Fatigue test, hardness test.	4.) Examples of NDT test: Visual and optical inspection, Penetrant test, Magnetic particle testing, Eddy-Current testing, Radiographic methods, Ultrasonic testing, Acoustic Emission test.
5.) Result interpretation is easy.	5.) Result interpretation is difficult.
6.) Can be performed without very high skilled personnel.	6.) Skilled personnel are required.
7.) No environmental hazards associated.	7.) Some methods involve environmental hazards.
8.) Equipments are less costly.	8.) Equipments are expensive.
9.) Equipments are not portable.	9.) Equipments are portable.

Q b. **Define Machine Vision. What are the steps involved in inspection via machine?**

Ans. It is the technology and method which uses an imaging system and a computer to analyze an image and provide imaging based automatic inspection. It can analyze for automatic inspection, process control and other industry related tasks. Machine can support to

a) Lessen Human effort

b) Eliminate Human error

c) Do complex and patience tasks.

	d) Utilize Equipments for 24 hours a day if required. Following are the steps involved in inspection via machine; 1. **Image Acquisition:** Image is gathered and converted into a digital form, and is then stored into the memory of computer. 2. **Image processing:** Element of images are enhanced by using various algorithms. 3. **Feature Extraction:** Critical features of images are quantified and extracted and are send to control program. 4. **Decision and control:** On the basis of data received regarding features of images various decisions are made via control programs.
Q c.	**Explain the working principle of liquid penetrant testing in brief.**
Ans.	**Basic steps of the working principle of Liquid Penetrant Testing are:** **1.) Surface preparation:** Surface must be free from dust, rust, water, oil, grease or other foreign particles. If metal is machined, forged, casted or blasted, then etching is required to make penetrant enter in the surface. **2.) Application of penetrant:** After cleaning, penetrant is applied by immersing the job into penetrant dilution or by brushing or by spraying. **3.) Dwell:** Dwell or dwell time is certain amount of time for which penetrant is left to be in contact with surface of job till it dries. This dwell period varies according to type of penetrant used, material on which penetrant is applied, type of defect for which it is applied, specimen size, temperature, etc. Generally minimum dwell period varies upto 60 minutes. **4.) Removal of excess penetrant:** This is a very complicated step, where precise level of care is required to remove excess penetrant from the surface while leaving penetrants for defects also. It can be done by direct rinsing with water, by cleaning with a solvent, or first treating it with emulsifier then rinsing with water. **5.) Application of Developer:** For clear visualization of defect, a thin layer of developer is applied on the surface of job, which draws out the penetrant trapped in flaws back to the upper surface. Developer may be used in dry or wet form. **6.) Development of Indication:** After application of developer the surface is left over for some standing time, which will lead extraction of trapped penetrant from the core of flaw. **7.) Inspection:** Visual inspection is processed under the effect of light. This light helps in detecting indications coming from flaw. **8.) Clean Surface:** At last, cleaning of developers from the surface of job is done.

Q d.	**Write the advantages and disadvantages of Penetrant Test.**
Ans.	**The advantages and Disadvantages of Penetrant Test can be enlisted as below:** **Advantages of Penetrant Test** 1. Portable to use. 2. Low cost is involved. 3. Highly sensitive to small surface defects. 4. Easy to inspect large areas and volumes. 5. Complex parts can be inspected routinely. **6.** Proper visualization of defect is provided as indications are directly produced on the surface of part. **Disadvantages of Penetrant Test** a) Defects must be open to the surface. b) Only Non-porous surfaces can be inspected. c) Surface films such as coatings, scale and smeared metal visually may mask defects. d) Pre-cleaning and post-cleaning is required. e) Multiple operations in a controlled mode is required. f) Proper chemical handling and its disposal is required. g) Smooth surface is required because rough surface may affect its sensitivity.

SECTION - C

3. Attempt any ONE part of the following: (1*5 = 5)

Q a.	**Discuss the scope and advantages of Non-Destructive testing.**
	NDT can save both money and time in product evaluation, troubleshooting and research. These techniques help a lot in monitoring objects during their services as well as during manufacturing stage. It helps in locating and characterizing material conditions and flaws that might cause planes to crash, reactors to fail, pipelines to burst and variety of less visible but equally troubling events. Precision in measurement depends upon the quality of NDT equipments used and testing process followed. NDT methods are significant in finding and troubleshooting- a) Cracks in skin of aircraft. b) Cracks in pressure vessels. c) Stress corrosion cracking in underground pipelines.

	d) Erosion and corrosion of pipes in industries. e) Porous bubble inside the welds. f) Damage in industrial components during service. g) Cracks in wheels of locomotives. h) Corrosion of inner reinforcing steel in structures. i) Damage in wire ropes in suspension bridges. j) Missing pieces in assembled finished machined parts. **Advantages of Non-Destructive Testing** 1. Analysis of parts without breaking them. 2. Cost saving procedure. 3. Improves the quality of production. 4. Saves time in product evaluation. 5. Evaluation can be done at manufacturing or in service stage. 6. Portable mode of inspection. **7.** Surface defects and inside defects can be easily evaluated.
Q b.	**Describe in brief Hammer Test.**
Ans.	Casting contain many defects such as internal shrinkage, porosity, blowholes, slag inclusions, etc. which may effect the soundness of the casting. However, they may not affect the functioning of the casting under certain applications and the casting may be suitable for many such applications. Hammer Test or Ringing Test is one such test method which is used for checking the healthiness of such casting. The working principle of this test is based on the difference between the pitch and sound quality of sound emanating from a healthy and unhealthy casting. The procedure for Hammer test is conducted in following manner; **1.** The casting is suspended in the air, clear from all sides and floor. **2.** The casting is then stuck gently with a hammer at different locations of the casting. **3.** The action will produce a ringing sound from the casting. This sound is carefully noted either by ear or with the help of an electronic device. **4.** Presence of a defect in the casting will produce a sound that will be different from the sound produced by a healthy one. Hammer test is effective only when there are large defects in the casting. It is not suitable to detect small defects.

4. Attempt any ONE part of the following : (1*5 = 5)

Q a.	**Describe in brief Chalk Test.**
Ans.	**Chalk Test** (Oil Whitening test or Oil and Whitening Test) can be said as the earliest application of penetrant based inspection. The method involved use of an oil usually made of a dark lubrication oil to find surface defects. This test was used to inspect rail road axles, wheel couplers and locomotive parts. The test can be summarized as follows: **1.** A dark heavy oil is diluted with kerosene stored in large tanks and the part to be inspected is submerged in the oil bath. **2.** Appropriate dwell time is permitted to allow the oil mixture to enter the defects. **3.** The part is removed from the oil bath and the surface is cleaned to remove the excess oil. **4.** Surface of the part is now coated with a fine coating of chalk powder. A fine suspension of chalk powder in alcohol or kerosene is used for this purpose. The part is then left for sometime so that kerosene evaporates. **5.** Evaporation of the kerosene leaves a very fine thin white powder coating of the chalk on the surface. **6.** The part is then struck with mallets. This cause the oil trapped in the discontinuities to come out. The oozed oil leaves a blackish stain on the chalk coating showing the presence of the discontinuities in the parts. **7.** This test continued upto 1940's. Its replace by magnetic particle test.
Q b.	**Define Penetrant and describe the types of Penetrants.**
Ans.	Penetrant is a liquid capable of wetting the entire surface and being drawn into fine openings. The penetrant material consists of the indicating (tracer) dye and the carrier (vehicle) fluid. **Penetrant materials are basically categorized in two headings on the basis of type of dye used as tracer:** **Type 1- Fluorescent penetrants:** Fluorescent penetrants are generally green in colour and they contain a dye or several dyes that fluoresce when exposed to ultraviolet radiation. It requires darkened area and ultraviolet radiations for inspection. They are vulnerable to contamination. **Type 2- Visible penetrants:** Visible dye consists of red dye, which produces a fine range of contrast against the white developer background. It doesn't require any darkened area and ultraviolet radiations for inspection. They are less vulnerable to contamination.

	Further these penetrants are categorized on the basis of method of removal of penetrants from the part. 1. **Method A – Water washable:** Also referred as self-emulsifying penetrants. It consists of an emulsifying agent namely detergents, which help it, get removed from part by rinsing with water only. 2. **Method B – Post-emulsifiable, Lipophilic:** Lipophilic are oil soluble, it interacts with oil based emulsifier to make removal possible. 3. **Method C – Solvent Removable:** Uses solvent's for penetrant removal from surface. 4. **Method D – Post-emulsifiable, hydrophilic:** Hydrophilic are water soluble, it interacts with detergent based emulsifier to remove the excess penetrant with water wash only. **Furthermore penetrants are categorized on the basis of strength or sensitivity of indication produced by flaws.** 1. **Level ½ -** Ultra low sensitivity. 2. **Level 1 –** Low sensitivity. 3. **Level 2 –** Medium sensitivity. 4. **Level 3 –** High sensitivity. 5. **Level 4 –** Ultra-High sensitivity.

5. Attempt any ONE part of the following: (1*5 = 5)

Q a.	**Define Developer and explain its type.**
Ans.	Developer's role is to pull the trapped penetrant out of defects and to spread the penetrant out there, on the surface of test specimen which helps in getting information of clear indication of flaw. It also increases the contrast between the flaw indication and the background. When exposed in ultraviolet radiation, it reflect and refract the incident ultraviolet light. This causes brighter indications than the indication of penetrants only. Developer types are classified into categories as; **1.) Dry Powder:** Dry developer are white powders which can be applied on the surface to be inspected by some of the following ways: a) By using electrostatic powder spray guns. b) By putting it into a dust cabinet. c) By using puffers to dust parts with powder.

	d) By dipping parts in container of developers. The only aim of all the above ways is to allow the developer to come in contact with surface to be inspected. **2.) Water Soluble:** these developers consist of some chemicals that are water soluble and develops layer when water evaporates away. Water soluble developers may be applied by dipping, pouring or brushing, but the best method of application is by spraying it onto the surface to be inspected. In these developers drying is a big issue. **3.) Water suspendable:** these developers consist of insoluble developer particles suspended in water. Similarly, as water soluble developers were applied, it is also applied but with frequent stirring or agitation. These developers require forced drying. **4.) Non Aqueous:** These developers are volatile solvents and are applied generally by spray gun fitted on aerosol can. These developer's don't require forced drying as it consist of highly volatile solvents and it should be applied thoroughly so that it can produce slightly translucent white coating. These are further sub-categorized as; **Type 1-** Non-aqueous fluorescent solvent based. **Type 2-** Non-aqueous visible dye solvent based. **5.) Special Application:** Special developers like plastic or lacquer are used when permanent inspection record is required.
Q b.	**Define the characteristics of good Penetrant.**
Ans.	**The Penetrant must possess important characteristics like:** i. It should spread completely, evenly and easily on the surface to be inspected. ii. It should easily draw into defect surface by the action of capillary. iii. It should be easier to remove it from surface without coming out from defect surface i.e. it should remain there. iv. It should be clearly visible. v. It should not affect the material which is to be inspected. vi. It should remain in fluid state, so that its removal could be processed or can be drawn back to the surface of the part through the drying and developing steps.