Ref No:

# SRI KRISHNA INSTITUTE OF TECHNOLOGY, BANGALORE

## COURSE PLAN

## Academic Year 2019-20

| | |
|---|---|
| Program: | Mechanical Engineering |
| Semester : | 3 |
| Course Code: | 17MEL37A |
| Course Title: | Material Testing Lab |
| Credit / L-T-P: | 2/ 1-2-0 |
| Total Contact Hours: | 32 Hrs |
| Course Plan Author: | Mr. Paramesha M |

Academic Evaluation and Monitoring Cell

No. 29, Chimney hills, Hesaraghatta Road, Chikkabanavara
BANGALORE-560090, KARNATAKA , INDIA
Phone / Fax :+91-08023721315/23721477, Web: www.skit.org.in

## INSTRUCTIONS TO TEACHERS

- Classroom / Lab activity shall be started after taking attendance.
- Attendance shall only be signed in the classroom by students.

- Three hours attendance should be given to each Lab.
- Use only Blue or Black Pen to fill the attendance.
- Attendance shall be updated on-line & status discussed in DUGC.
- No attendance should be added to late comers.
- Modification of any attendance, over writings, etc is strictly prohibited.
- Updated register is to be brought to every academic review meeting as per the COE.

# Table of Contents

Note : Remove “Table of Content” before including in CP Book
Each Laboratory Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

# 18ME37A: Material Testing Lab

# A. LABORATORY INFORMATION

## 1. Laboratory Overview

| | | | |
|---|---|---|---|
| *Degree:* | BE | *Program:* | ME |
| *Year / Semester :* | 2 / III | *Academic Year:* | 2019-20 |
| *Course Title:* | Material testing Lab | *Course Code:* | 18MEL37A |
| *Credit / L-T-P:* | 2/ 1-2-0 | *SEE Duration:* | 180 Minutes |
| *Total Contact Hours:* | 32 Hrs | *SEE Marks:* | 60 Marks |
| *CIA Marks:* | 40 | *Assignment* | Practical record |
| *Lab. Plan Author:* | Mr. Paramesha M | *Sign* | Dt : |
| *Checked By:* | ShankareGowda K C | *Sign* | Dt : |

## 2. Laboratory Content

| Expt. | Title of the Experiments | Lab Hours | Concept | Blooms Level |
|---|---|---|---|---|
| 1 | Metallographic examination of plain carbon steel, tool steel, gray cast iron, brass, bronze | 03 | Microstructure | L2 |
| 2 | Heat treatment like annealing, normalizing, Harding and tempering of steel | 03 | Improvement of properties | L3 |
| 3 | Hardness test like Brinnel, Rockwell, Vickers hardness | 06 | Resistance of material | L3 |
| 4 | Ultrasonic flaw detection, magnetic crack detection | 03 | NDT | L3 |
| 5 | Using U T M conduct tensile test, shear and compression test. | 06 | Material behavior | L3 |
| 6 | Impact test for mild steel and CI specimen | 04 | strength | L3 |
| 7 | Torsion test on steel bar | 03 | torsional strength | L3 |
| 8 | Wear characteristics of ferrous and non ferrous materials under different parameters | 04 | wear | L3 |

## 3. Laboratory Material

Books & other material as recommended by university (A, B) and additional resources used by Laboratory teacher (C).

| Expt. | Details | Expt. in book | Availability |
|---|---|---|---|
| **A** | **Text books (Title, Authors, Edition, Publisher, Year.)** | - | - |
| 1 | Smith, foundations of materials science engineering ,4th edition,McGraw Hill 2009 | | In Lib |
| 2 | Willam D Callister material science engineering and introductin Wiley 2006 | - | In Lib |
| **B** | **References books(Title, Authors, Edition, Publisher, Year.)** | | |
| 1 | Donald R Askland and pradeep p phule the science and engineering of materials ,cengage learing 4th Ed 2003 | - | In Lib / In dept |
| | | | |
| **C** | **Concept Videos or Simulation for UnderstandingNptel** | | |
| | https://www.youtube.com/watch?v=NpS9QEOVGRA -2:31 Mins | | |
| | https://www.youtube.com/watch?v=wEDumU8dHg0 -5:39 mins | | |
| | https://www.youtube.com/watch?v=NlWVmp_q_XE -3:35 | | |
| | https://www.youtube.com/watch?v=XSPWWpcZYS0 -3:19 | | |
| **D** | **Software Tools for Design** | - | - |
| **E** | **Recent Developments for Research** | - | - |
| **F** | **Others (Web, Video, Simulation, Notes etc.)** | - | - |
| 1 | ww.nptel.ac.in | | |

## 4. Laboratory Prerequisites:

## 4. Lab Prerequisites:

| | | | | | |
|---|---|---|---|---|---|
| - | - | Base Course: | | - | - |

| SNo | Course Code | Course Name | Topic / Description | Sem | Remarks |
|---|---|---|---|---|---|
| 1 | | | | | |

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

### 5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

| Expt. | Topic / Description | Area | Remarks | Blooms Level |
|---|---|---|---|---|
| 1 | | | | |

## B. Laboratory Instructions

### 1. General Instructions

| SNo | Instructions | Remarks |
|---|---|---|
| 1 | Students must always wear uniform and shoes before entering the lab. | |
| 2 | Enter the lab on time and do not leave the lab without the permission of teaching staff | |
| 3 | Before you turn on a switch, think of the consequences | |
| 3 | Check for the electrical connections and inform if any discrepancy found to the attention of lecturer/lab instructor. | |
| 4 | perform the experiment under the supervision/guidance of a lecturer/lab instructor only | |
| 5 | After the observations are noted down switch off the electrical connections. | |
| 6 | In case of fire use fire extinguisher/throw the sand provided in the lab. | |
| 7 | In case of any physical injuries or emergencies use first aid box provided. | |
| SNo | Instructions | Remarks |
| 1 | Students must always wear uniform and shoes before entering the lab. | |
| 2 | Enter the lab on time and do not leave the lab without the permission of teaching staff | |
| 3 | Before you turn on a switch, think of the consequences | |

### 2. Laboratory Specific Instructions

| SNo | Specific Instructions | Remarks |
|---|---|---|
| 1 | Do not operate any experimental setup to its maximum value | |
| 2 | Do not touch/ handle the experimental setups/Test Rigs without their prior knowledge, | |
| 3 | Never overcrowd the experimental setup/Test Rig, Leave sufficient space for the person to operate the equipments | |
| | Note down the specifications of the experimental setup before performing the experiment. | |
| 4 | Never rest your hands on the equipment or on the display board, because it has fragile measurement devices like thermometers, manometers, etc | |
| 5 | Any unsafe conditions prevailing in the lab can be brought to the notice of the lab in charge | |

## C. OBE PARAMETERS

### 1. Laboratory Outcomes

| # | Lab Code # | COs | Teach. Hours | Concept | Instr Method | Assessment Method | Blooms' Level |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| - | - | **At the end of the experiment, the student should be able to . . .** | - | - | - | - | - |
| 1 | 18MEL 37A.1 | Understand the micro structure of materials | 03 | Micro structure | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L2 |
| 2 | 18MEL 37A.2 | Improve the material properties | 03 | Heat treatment | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L3 |
| 3 | 18MEL 37A.3 | Analyze the material | 06 | hardness | Chalk & board, Demonstrate | Practical record + IA | L3 |
| 4 | 18MEL 37A.4 | Explore the difference NDT method | 03 | NDT | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L3 |
| 5 | 18MEL 37A.5 | Predict the material behavior | 06 | Mechanical behavior | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L3 |
| 6 | 18MEL 37A.6 | Access the strength of material | 04 | strength | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L3 |
| 7 | 18MEL 37A.7 | Predict the material behavior | 03 | Rotational force | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L3 |
| 8 | 18MEL 37A.8 | The predict wear rate of different material | 04 | wear | Chalk & board, Demonstrate | Practical record + IA+Viva -voice | L3 |
| - | | **Total** | **32** | - | - | - | - |

## 2. Laboratory Applications

| SNo | Application Area | CO | Level |
|---|---|---|---|
| 1 | A Metallurgical microscope is essentially utilized in the industries to watch flat and glossy metals and other area like Archaeometallurgy,Gemology Forensic Metallurgy, Mineralogy | CO1 | L2 |
| 2 | Heat treatment are useful to improve the mechanical properties | CO2 | L3 |
| 3 | Rockwell, Brinell, and Vickers for measuring the metal hardness | CO3 | L3 |
| 4 | NDT methods is to find discontinuities in the material | CO4 | L3 |
| 5 | Universal testing machine is designed for testing the material under tension compression and bending | CO5 | L3 |
| 6 | determining the amount of forces that are absorbed by materials when it reaches the point of fracture. | CO6 | L3 |
| 7 | To determine the behavior a material | CO7 | L3 |
| 8 | Wear test is commonly used as a simple measure of workability of material in service. | CO8 | L3 |

Note: Write 1 or 2 applications per CO.

## 3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

| Expt | Mapping | | Mapping Level | Justification | Level |
|---|---|---|---|---|---|
| | **CO** | **PO** | - | **'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'** | |
| | CO1 | PO1 | L2 | Knowledge is required to Understand the micro structure of Engineering materials | |
| | CO2 | PO1 | L3 | Knowledge is required to Understand the heat treatment methods | |
| | CO2 | PO4 | L3 | Analyzing is required to behavior on materials at different temperature | |
| | CO3 | PO1 | L3 | Knowledge is required to Understand the hardness of the material | |
| | CO4 | PO1 | L3 | Knowledge is required to Understand the different type of NDT Methods | |
| | CO4 | PO5 | L3 | Analyzing is required to Different modern technique are used to find out | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | the defects | |
| | CO5 | PO1 | L3 | Knowledge is required to Understand behavior of Engineering materials | |
| | CO5 | PO9 | L3 | Knowledge is required to Experiments conduct by group member to find out different behavior of the materials | |
| | CO6 | PO1 | L3 | Knowledge is required to Understand the behavior of Engineering materials | |
| | CO6 | PO9 | L3 | Knowledge is required to Understand Experiments conduct by group member to find out different behavior of the materials | |
| | CO7 | PO1 | L3 | Knowledge is required to Understand the behavior of Engineering materials | |
| | CO7 | PO9 | L3 | Knowledge is required to Experiments conduct by group member to find out different behavior of the materials | |
| | CO8 | PO1 | L3 | Knowledge is required toUnderstand the knowledge of behavior of Engineering materials | |
| | CO8 | PO9 | L3 | Knowledge is required to Experiments conduct by individual or group member to find out losses of material | |

## 4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

| - | Course Outcomes | Program Outcomes | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | Level |
| 1 | Understand the micro structure of materials | 3 | | | | | | | | | | | | L2 |
| 2 | Improve the material properties | 3 | | | 2 | | | | | | | | | L3 |
| 3 | Analyze the material | 3 | | | | | | | | | | | | L3 |
| 4 | Explore the difference NDT method | 3 | | | | 2 | | | | | | | | L3 |
| 5 | Predict the material behavior | 3 | | | | | | | | 2 | | | | L3 |
| 6 | Access the strength of material | 3 | | | | | | | | 2 | | | | L3 |
| 7 | Predict the material behavior | 3 | | | | | | | | 2 | | | | L3 |
| 8 | The predict wear rate of different material the material behavior | 3 | | | | | | | | 2 | | | | L3 |
| **CS501PC.** | Average | **3** | | | **1** | **1** | | | | **1.2** | | | | |

## 5. Curricular Gap and Experiments

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

| Expt | Gap Topic | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|---|---|---|---|---|---|
| 1 | | | | | |

Note: Write Gap topics from A.4 and add others also.

## 6. Experiments Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

| Expt | Gap Topic | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|---|---|---|---|---|---|
| 1 | | | | | |

# D. COURSE ASSESSMENT

## 1. Laboratory Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

| Unit | Title | Teaching Hours | No. of question in Exam | | | | | | | CO | Levels |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CIA-1 | CIA-2 | CIA-3 | Asg-1 | Asg-2 | Asg-3 | SEE | | |
| 1 | Metallographic examination of plain carbon steel, tool steel, gray cast iron, | 03 | 1 | - | - | - | - | - | 1 | CO1 | L2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | brass, bronze | | | | | | | | | | |
| 2 | Heat treatment like annealing, normalizing, Harding and tempering of steel | 03 | 1 | - | - | - | - | - | 1 | CO2 | L3 |
| 3 | Hardness test like Brinnel, Rockwell, Vickers hardness | 06 | 1 | - | - | - | - | - | 1 | CO3 | L3 |
| 4 | Ultrasonic flaw detection, magnetic crack detection | 03 | - | 1 | - | - | - | - | 1 | CO4 | |
| | Using U T M conduct tensile test, shear and compression test. | 06 | - | 1 | - | - | - | - | 1 | CO5 | L3 |
| 6 | Impact test for mild steel and CI specimen | 04 | - | - | 1 | - | - | - | 1 | CO6 | L3 |
| 7 | Torsion test on steel bar | 03 | - | - | 1 | - | - | - | 1 | CO7 | L3 |
| 8 | Wear characteristics of ferrous and non ferrous materials under different parameters | 04 | - | - | 1 | - | - | - | 1 | CO8 | L3 |
| - | **Total** | **32** | **3** | **2** | **3** | | | | **8** | - | - |

## 2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

| Evaluation | Weightage in Marks | CO | Levels |
|---|---|---|---|
| CIA Exam – 1 | 30 | CO1,CO,CO3,CO4,CO5,CO6,CO7,CO8 | L2,L3 |
| CIA Exam – 2 | 30 | CO1,CO,CO3,CO4,CO5,CO6,CO7,CO8 | L2,L3 |
| CIA Exam – 3 | | | |
| | | | |
| Assignment - 1 | 10 | | |
| Other Activities – define – IA | | CO1 to Co8 | L2, L3, |
| **Final CIA Marks** | **40** | - | - |

-

| SNo | Description | Marks |
|---|---|---|
| 1 | Observation and Weekly Laboratory Activities | 10 Marks |
| 2 | Record Writing | 10 Marks |
| 3 | Internal Exam Assessment | 20 Marks |
| 4 | Internal Assessment | 40Marks |
| 5 | SEE | 60 Marks |
| - | **Total** | **100 Marks** |

# E. EXPERIMENTS

## Experiment 1 : Metallurgical Microscope

| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Metallurgical microscope** | | | | | | |
| 2 | Course Outcomes | Understand the micro structure of materials | | | | | | |
| 3 | Aim | Preparation of specimen for Metallographic examination of different engineering materials To report micro structures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites | | | | | | |
| 4 | Material / Equipment Required | ➓ Metallurgical microscope ( magnification at least up to 500X)<br>➓ Polishing and grinding machine.<br>➓ Specimens | | | | | | |
| 5 | Theory, Formula, Principle, Concept | micro structure | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | Following are the steps involved in the preparation of specimen :<br>➓ Step 1:Prepare the specimen.<br>➓ Step 2: Mount the specimen on the table of metallurgical microscope. Record the objective magnification and eye piece magnification and determine total magnification.<br>➓ step 3: Focus the surface of polished and etched specimen using coarse adjustment and then fine adjustment | | | | | | |

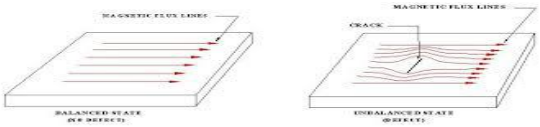
| | | |
|---|---|---|
| | | ➓ step 4:Observe the micro structure and record it.<br>➓ step 5:Compare the micro structure with the standard<br>➓ step 6: the same procedure is repeated for other specimens |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |   |
| 8 | Observation Table, Look-up Table, Output | ➓<br>➓ |
| 9 | Sample Calculations | ➓<br>➓<br>➓ |
| 10 | Graphs, Outputs | ➓<br>➓ |
| 11 | Results & Analysis | |
| 12 | Application Areas | ➓ A Metallurgical microscope is essentially utilized in the industries to watch flat and glossy metals and other area like Archaeometallurgy,Gemology Forensic Metallurgy, Mineralogy |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

## Experiment 2 : Heat Treatment

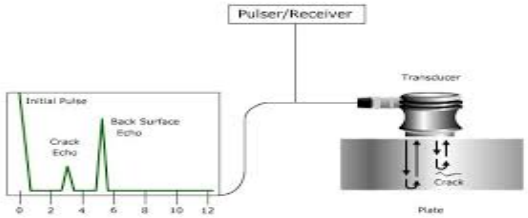
| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | Heat treatment | | | | | | |
| 2 | Course Outcomes | Improve the material properties | | | | | | |
| 3 | Aim | To find the effect of heat treatment (annealing, normalizing & hardening & tempering of medium carbon & alloy steel) by measurement of hardness. | | | | | | |
| 4 | Material / Equipment Required | ➓ Muffle furnace with on-off controller & temp.<br>➓ indicator- temp up to 1000 0 C Oil quenching tub,<br>➓ water quenching tub & fan.<br>➓ Tongs, safely gloves & goggles Rockwell hardness tester | | | | | | |
| 5 | Theory, Formula, Principle, Concept | Heat treatment of steel is a process of heating and cooling in the solid state to achieve desired mechanical properties. This involves heating the steel to a specific temperature, soaking it for a certain period & then cooling it at a suitable rate. The different types of heat treatment process<br>in this experiment covered are process annealing to soften the steel by heating below critical temp. (650-700 0 C) & air cooling; hardening for increasing hardness & mechanical properties by heating above upper critical temp (830-860 0 C) and quenching in oil/ water. | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | Measure the Rockwell hardness of steel specimen as follows:<br>➓ Step 1: Place the semi polished specimen on the platform.<br>➓ Step 2: Insert the diamond cone indentor for C scale & 1/16 “steel ball for B scale inside the sleeve & tighten the screw. Check that there is no movement of indentor.<br>➓ Step 3: Set the required load (150kg for C scale & 100kg for B scale) by turning the knob provided by the side of the machine.<br>➓ Step 4: Bring the specimen into contact with indentor by rotating the elevating screw by rotating the star handle. By further elevating the specimen, the minor load of 10kg is applied such that pointer indicates ‘σ’ on the smaller graduated arc scale & the longer pointer indicates on the outer C scale & ‘B 30’ on the inner ‘B’ scale.<br>➓ Step 5: Now turn the lever away from the observer slowly. The longer pointer moves away & when it comes to rest, wait 8 to 10 seconds for the entire application of major load.<br>➓ Step 6: Now turn the lever slowly to-words the observer i.e., to the original position. Now the entire load is being off from the specimen.<br>➓ Step 7: Now the longer pointer moves back and when it comes to a rest position, note the reading on the outer black dial ( C scale) & on the inner red dial (B scale).<br>➓ Step 8: The reading on the 3 trial readings are taken at separate locations on the surface of the specimen. The average value of these three readings gives the true Rockwell | | | | | | |

<table>
<tr><td></td><td></td><td colspan="7">hardness number which is reported as HRC & HRB for Rockwell in C scale & Rockwell in B scale respectively.</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td>Sl. No</td><td>Material</td><td>Temp 0 C</td><td>Cooling / Quenching Medium</td><td colspan="2">Hardness RHN</td><td>Remarks</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Before heat treatment</td><td>After heat treatment</td><td></td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td colspan="7"></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td colspan="7"></td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td colspan="7"></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td colspan="7"></td></tr>
<tr><td>12</td><td>Application Areas</td><td colspan="7">Heat treatment are useful to improve the mechanical properties</td></tr>
<tr><td>13</td><td>Remarks</td><td colspan="7"></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td colspan="7"></td></tr>
</table>

## Experiment 3 : Non-Destructive Test (Magnetic – Crack Detector)

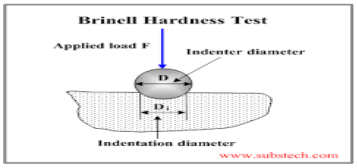
| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | Magnetic crack detector | | | | | | |
| 2 | Course Outcomes | Explore the difference NDT method | | | | | | |
| 3 | Aim | To detect the surface or subsurface crack of the given ferromagnetic material | | | | | | |
| 4 | Material / Equipment Required | Magnetic field generator, and ferromagnetic powder. | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ When a piece of metal is placed in a magnetic field and the lines of magnetic flux get intersected by a discontinuity, such as a crack or slag inclusion in a casting, magnetic poles are induced on either side of the discontinuity. A surface crack is indicated by a line of fine particles following the crack outline and a subsurface defect by a fuzzy collection of the magnetic particles on the surface near the discontinuity | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | Clean the surface of the test specimen to remove scales, oils and grease.<br>➓ Step 1: Apply a thin layer of ferromagnetic particle over the surface to be tested.<br>➓ Step 2:Magnetize the test piece.<br>➓ Step 3:Observe the shape and size of the magnetic particles collected, which is the shape and size of the defect | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction Equation,Expected Graph |  | | | | | | |
| 8 | Observation Table, Look-up Table, Output | | | | | | | |
| 9 | Sample Calculations | | | | | | | |
| 10 | Graphs, Outputs | | | | | | | |
| 11 | Results & Analysis | | | | | | | |
| 12 | Application Areas | NDT methods is to find discontinuities in the material | | | | | | |
| 13 | Remarks | | | | | | | |
| 14 | Faculty Signature with Date | | | | | | | |

## Experiment 3.1 : Non-Destructive Test (Ultrasonic Flaw Detector )

| - | Experiment No.: | 1 | Marks | | Date Planned | | Date Conducted | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | Ultrasonic flaw detector | | | | | | |
| 2 | Course Outcomes | Explore the difference NDT method | | | | | | |
| 3 | Aim | To study the ultrasonic flow detector and to determine the location of the interior crack or cavity in the given specimen. | | | | | | |
| 4 | Material / Equipment Required | Ultrasonic flow detector | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ Ultrasonic flaw detector is a device, which is used to detect internal discontinuities in the material by nondestructive means. It makes use of phenomenon of back reflection(echo) of waves by surfaces. When ultrasonic waves are made to pass through the test material, portion of the material, portion of the sound is immediately reflected form the surface at which they enter as a very large echo. Part of the sound will continue on into the test material, until it is partially reflected from the back surface as a sound echo. If there is a discontinuity in the material, a portion of sound will be reflected from the discontinuity and will return to the receiver as a separate echo between the echoes received from the front and back surface. The signals received are shown on the cathode ray tube, which also as a time base connected to it, so that the position of the signal on the screen gives an indication of the distance between the crystal generator and the surface from which the echo originates. | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1 :Clean the surface of the test rest piece.<br>➓ Step 2:Place the probe against the surface of test piece using thin oil film.<br>➓ Step 3: Switch on the power supply of the ultrasonic wave generator.<br>➓ Step 4: Adjust the number of cycle of transmitting and receiving the signals to the desired value.<br>➓ Step 5: Select the segment of tine, which contain the echo pips.<br>➓ Step 6:Observe the echo from the cavity if any on the CRT and measure the relative distance of pips on the time. | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |  | | | | | | |
| 8 | Observation Table, Look-up Table, Output | | | | | | | |
| 9 | Sample Calculations | | | | | | | |
| 10 | Graphs, Outputs | | | | | | | |
| 11 | Results & Analysis | | | | | | | |
| 12 | Application Areas | NDT methods is to find discontinuities in the material | | | | | | |
| 13 | Remarks | | | | | | | |
| 14 | Faculty Signature with Date | | | | | | | |

## Experiment 4 : Hardness Test (Brinell Hardness Test)

| - | Experiment No.: | 1 | Marks | | Date Planned | | Date Conducted | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | Brinell Hardness test | | | | | | |
| 2 | Course Outcomes | Analyze the material | | | | | | |
| 3 | Aim | To determine the brinell hardness number of given specimen | | | | | | |
| 4 | Material / Equipment Required | Hardness testing machine, specimens & brinell microscope | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ Hardness is usually defined as the resistance to permanent indentation. Hardness test consists of measuring the resistance to plastic deformation of layers of metal near the surface of the specimen. In the process of hardness determination when the metal is | | | | | | |

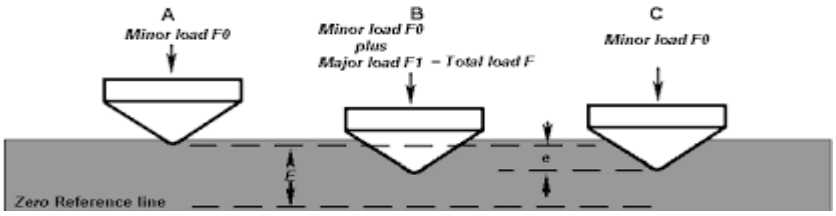
| | | |
|---|---|---|
| | | indented by a special tip(steel ball), the tip first overcomes the resistance of the metal to elastic deformation and then a small amount of plastic deformation. Upon deeper indentation of the tip, it overcomes large plastic deformation. This fact enables relation to be established between the hardness and ultimate tensile strength of ductile metals.<br>$BHN = \frac{F}{\frac{\pi}{2} D \cdot (D - \sqrt{D^2 - D_i^2})}$<br>Where, F= load in kgf, D is the diameter of the ball in mm, $D_i$ is the diameter of the impression in mm |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1: Place the specimen to be tested on the anvil<br>➓ Step 2: Raise the anvil by steel screw operated by the large hand wheel<br>➓ Step 3: Make the contact between the specimen and the ball indentor by turning the hand wheel<br>➓ Step 4: Apply the load by pumping the oil into the main cylinder which forces the main piston downwards and presses the ball into the specimen.<br>➓ Step 5:When the desired load is applied, the balance weight on the top of the machine is lifted by action of small piston, to avoid overload to the ball.<br>➓ Step 6:After applying the load on the ball for particular time(30sec), remove the load and measure the diameter of the indentation using a micrometer, microscope. |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |  |
| 8 | Observation Table, Look-up Table, Output | |

| Material | Load F kgf | Diameter of indentation on the specimen (d) in mm | BHN in $kgf/mm^2$ | Avg.BHN |
|---|---|---|---|---|
| aluminum | | 1)<br>2)<br>3) | | |
| Copper | | 1)<br>2)<br>3) | | |
| Mild stell | | 1)<br>2)<br>3) | | |

| | | |
|---|---|---|
| 9 | Sample Calculations | |
| 10 | Graphs, Outputs | |
| 11 | Results & Analysis | |
| 12 | Application Areas | measuring the metal hardness |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

## Experiment 4.1: Hardness Test (Rockwell Hardness Test)

| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Rockwell hardness test** | | | | | | |

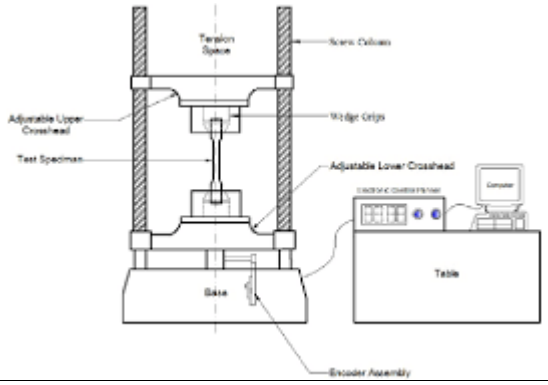
| | | |
|---|---|---|
| 2 | Course Outcomes | Analyze the material |
| 3 | Aim | To find the Rockwell hardness number of the given specimen |
| 4 | Material / Equipment Required | ➓ Rockwell hardness tester.<br>➓ Cone diamond indentor (120 0 included angle) 'C' scale.<br>➓ Ball indentor (1/16" dia. Hardened steel ball ) for 'B' scale.<br>➓ Hardness testing specimen.<br>➓ Standard hardness test block. ( for B& C scales). |
| 5 | Theory, Formula, Principle, Concept | ➓ Hardness is a material characteristic which can be defined as resistance to deformation (penetration, wear, compression etc.) In Rockwell hardness test, a standard load (based on type of material) is applied through a standard indentor (cone or ball) for a specified duration, on the material & depth of impression / indentation is directly measured and read as hardness number on a dial gauge |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step1: Keep the loading and unloading lever at position "A" which is unloading position.<br>➓ Step 2: Select the suitable indentor & weights according to the scale.<br>➓ Step 3: Place the specimen on testing table anvil.<br>➓ Step 4: Turn the hand wheel to raise a job until it makes contact with indentor & continue turning till the longer pointer at the dial gauge makes 2 1⁄2 rotations. Then it stops at zero continue turning slowly till the small pointer reaches the red spot at „3", this is automatic zero setting dial gauge.<br>➓ Step 5: Turn the lever position „A" to „B" i.e. from unloading to loading position. So that the total load will act.<br>➓ Step 5: When the longer pointer of the dial gauge reaches steady position, take back the lever to the unloading position „A". [Avoid sudden release at the lever]<br>➓ Step 7: Now note down the reading in the last dial indicator by notifying the large pointer<br>➓ Step 8:Turn back the hand wheel and remove the job.<br>➓ Step 9: Similarly repeat the step from 1-9 for different trials and for different metals. |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |  |
| 8 | Observation Table, Look-up Table, Output | |

| Type of material | Load in Kgf | Ball indenter dia in mm | Rockwell hardness number | Avg RHN |
|---|---|---|---|---|
| aluminum | | | 1)<br>2)<br>3) | |
| Copper | | | 1)<br>2)<br>3) | |
| brass | | | 1)<br>2)<br>3) | |

| | | |
|---|---|---|
| 9 | Sample Calculations | |
| 10 | Graphs, Outputs | |
| 11 | Results & Analysis | |
| 12 | Application Areas | measuring the metal hardness |
| 13 | Remarks | |

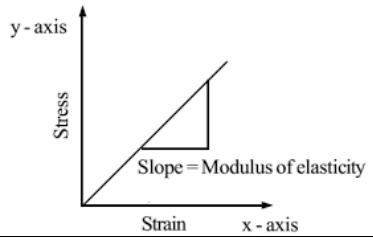
| | | |
|---|---|---|
| 14 | Faculty Signature with Date | |

## Experiment 5 : Tensile Test

| - | Experiment No.: | 1 | Marks | | Date Planned | | Date Conducted | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Tensile test** | | | | | | |
| 2 | Course Outcomes | Mechanical behavior | | | | | | |
| 3 | Aim | **To conduct tensile test in ductile material and to determine the following; i) Ultimate tensile stress (UTS) ii) Yield stress (YS) iii) Breaking stress iv) % Elongation v) Youngs modulus (E) vi) % Reduction in area** | | | | | | |
| 4 | Material / Equipment Required | ➓ Universal testing machine.<br>➓ Tensile test specimens.<br>➓ Extensometer dial gauge.<br>➓ Steel scale, slide calipers & micrometer.<br>➓ Support blocks. | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ The tensile test is widely used to provide basic design information on the strength of materials and as acceptance test for specification of materials. In the tensile test, a tensile specimen as per agreed standard is subjected to continually increasing uni-axial tensile force while simultaneous observations are made of the constructed from the load, elongation measurement. The following parameters are found from stress-strain curves. | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1: Measure the initial diameter(d1)and mark the initial gauge length(I1)on the specimen.<br>➓ Step 2 : Fix the upper end of the specimen inside the shackles of the upper cross head and bring the shackle of the intermediate cross head into contact with bottom of the specimen and the bottom end is fixed inside the shackle.<br>➓ Step 3:Mount the extensometer dial gauge (L.C=0.01mm) on the lower cross head bring the indicator of external dial gauge , elongation scale and load dial gauge to zero reading .<br>➓ Step 4: Start the machine and for every 400 kg increase, note the elongation (count the number of division on dial gauge X L.C).<br>➓ Step 5: When the load crosses the elastic point or yield point (this could be observed by the rapid movement of indicator of the extensometer dial gauge )note the reading on the elongation scale . Continue loading decreases the area of specimen and fails at particular load . Note the breaking load and elongation .<br>➓ Step 6: Remove the fractured specimen and measure the final gauge lengths(I2)and final diameter(d2)and observe the fracture.<br>➓ Step 7: Plot a graph of load V/s elongation . The results are tabulated as given below | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |  | | | | | | |

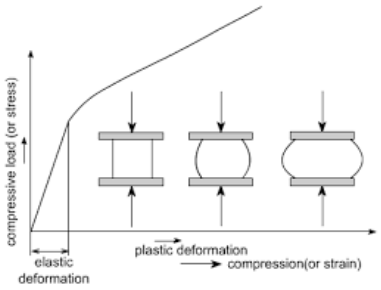
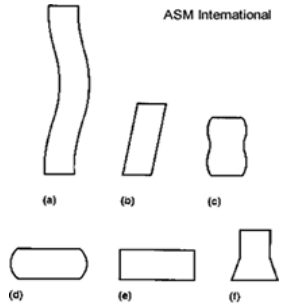
| | | |
|---|---|---|
| 8 | Observation Table, Look-up Table, Output | |

| Sl no | material | Initial gauge length (11)mm | Initial Dia (d1)mm | Final Gauge length (l2)mm | Final dia (d2)mm | Original Cross section area mm 2 | Final area mm 2 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |

| | | |
|---|---|---|
| 9 | Sample Calculations | ➓ initial diameter of specimen = d1 mm<br>➓ Final diameter of specimen = d2 mm<br>➓ Initial gauge length = L1 mm<br>➓ Final gauge length = L2 mm<br>➓ Initial area of specimen(A1) = Πd 12 /4 mm 2<br>➓ Final area of specimen (A2) = Πd 22 /4 mm 2<br>➓ %Elongation = (L 2 -L 1 ) / L 1 x 100<br>➓ %Reduction in area = A1-A2 / A1 x 100<br>➓ Yield stress = Yield load /original area of cross section, N/mm 2<br>➓ Ultimate tensile stress = maximum load /original area of cross section (UTS) N/mm 2<br>➓ Breaking stress or failure stress = Breaking load /Original area of cross section, N/mm 2 |
| 10 | Graphs, Outputs |  |
| 11 | Results & Analysis | ➓ |
| 12 | Application Areas | ➓ Universal testing machine is designed for testing the material under tension |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

## Experiment 5.2 : compression strength test

| - | Experiment No.: | 1 | Marks | | Date Planned | | Date Conducted | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Compression strength test** | | | | | | |
| 2 | Course Outcomes | Mechanical behavior | | | | | | |
| 3 | Aim | To study the behavior of the given material under Compressive load and to determine the following:<br>1) Modulus of elasticity<br>2) Maximum Compressive strength or ultimate stress<br>3) Percentage Decrease in length<br>4) Percentage Increase in area | | | | | | |
| 4 | Material / Equipment Required | ➓ Universal testing machine.<br>➓ Compression test specimens.<br>➓ Extensometer dial gauge.<br>➓ Steel scale, slide calipers & micrometer.<br>➓ Support blocks. | | | | | | |

| | | |
|---|---|---|
| 5 | Theory, Formula, Principle, Concept | The compression test is just opposite to tension test, with regard to direction. However, there are certain practical difficulties which may induce error in this test. They are: Difficulty in applying truly axial load.<br>There is always a tendency of the specimen to bend in addition to Contraction. To avoid these errors, usually the specimen for this test shall be short in length (not more than 2 time the diameter) |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step1: Fix the lower and upper compression plate above the bottom cross head and below the intermediate cross head.<br>➓ Step2: Measure the initial diameter (d1) and height of specimen (h1)<br>➓ Step3. Place the compression specimen at the center of bottom plate and bring the top of specimen in contact with the top plate by moving the intermediate cross head downwards<br>➓ Step 4: Mount the compression dial gauge on the lower cross head bring the indicator to zero.<br>➓ Bring the indicator of load dial gauge also to zero<br>➓ Step 5: Load the specimen in intervals of 400 kg for MS and 200 kg for brittle material like cast iron and record the compression dial gauge reading(No. of division on dial gauge XLC).<br>➓ Step 6:The experiment is continued till the specimen attains a barrel shape on reaching max load for ductile metals or fracture for brittle materials.<br>➓ Step 7: Measure the final Dia d2 and final height h2 for ductile metals.<br>➓ Step 8:The readings are tabulated as follows.<br>➓ Step 9:Plot a graph of stress v/s strain. Calculate Young's Modulus in compression (for ductile materials and failure compressive stress for brittle materials). |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |   |
| 8 | Observation Table, Look-up Table, Output | |

| Sl no | Load (F) in KN | Deformation mm | Stress KN/mm$^2$ | Strain | Young's modulus KN/mm$^2$ |
|---|---|---|---|---|---|
| | | | | | |

| | | |
|---|---|---|
| 9 | Sample Calculations | Initial diameter of specimen = d1 mm<br>Final diameter of specimen = d2 mm<br>Initial height of specimen = h1 mm<br>Final height of specimen = h2 mm<br>initial area of specimen (A1)= ɪd 12 / 4 mm 2<br>Final area of specimen (A2)= ɪd 22 / 4 mm 2<br>% increase in area = Compression stress = (A2- A1) / A1 x 100<br>% decrease in height =(h1- h2) / |

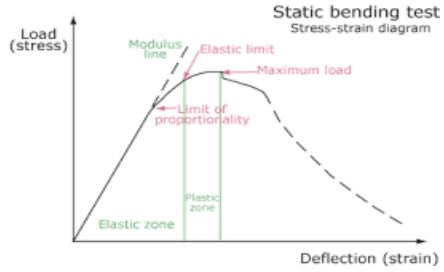
| | | |
|---|---|---|
| | | h1<br>Compression strain=load up-to elastic point / A1<br>Compression strain = σh/h1 σ h = h1-h2<br>Young's modulus in compression=compressive stress / compressive strain N/mm 2 (slope of load v/s compression graph).<br>Max compressive stress (for ductile materials) = Max compression load /<br>Original area of cross section = N/mm 2<br>Max compressive stress at failure (for brittle material) = Failure load / A1=N/mm 2 |
| 10 | Graphs, Outputs | |
| 11 | Results & Analysis | |
| 12 | Application Areas | ➓ Universal testing machine is designed for testing the material under compression |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

## Experiment 5.3: Bending test

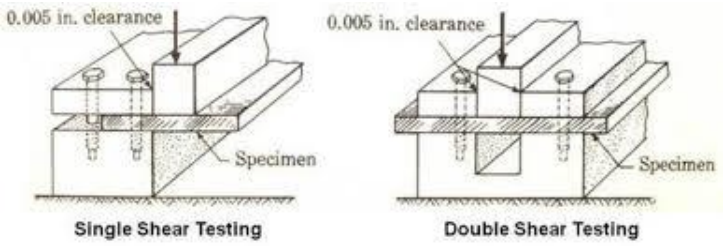
| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Bending test** | | | | | | |
| 2 | Course Outcomes | Mechanical behavior | | | | | | |
| 3 | Aim | To study the behavior of wood specimen for bending load and to determine the elastic streng5th modulus of elasticity & toughness | | | | | | |
| 4 | Material / Equipment Required | UTM, scale,dial guage | | | | | | |
| 5 | Theory, Formula, Principle, Concept | | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1 : Observe the specimen and measure its cross sectional dimensions.<br>➓ Step 2 :Select a suitable span.<br>➓ Step 3 :Mark the mid span point and two point loading locations at 1/3 span distances<br>➓ Step 4 :Mark the cross section lines at these locations.<br>➓ Step 5 :Select a proper range of loading (i.e. 0 to 4 tonnes )<br>➓ Step4: Move the adjustable blocks and fix them at positions corresponding to selected span. | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph | | | | | | | |
| 8 | Observation Table, Look-up Table, Output | | | | | | | |

| Sl no | Load (f) in KN | Deflection in mm |
|---|---|---|
| | | |
| | | |

| | | |
|---|---|---|
| 9 | Sample Calculations | ➓ Material = _____<br>➓ Cross sectional dimension = b x d = _____cm<br>➓ Span length = _____ mm<br>➓ Moment of inertia of the beam(I)=$BH^3/12$= _____$mm^4$<br>➓ bending moment at yield point($M_{by}$)=$F_y$*L/4=_____KN-m<br>➓ Elastic strength = $M_{by}$ * C/I = _____$KN-mm^2$<br>➓ maximum bending = $M_u$= $F_y$*L/4 = _____KN/m<br>➓ toughness = $2F_fY_y/3AL$= _____$KN/mm^2$ |

| | | |
|---|---|---|
| | | ➓ modules of elasticity E = [$l^3$/48I]* slope of straight line portion of the graph |
| 10 | Graphs, Outputs |  |
| 11 | Results & Analysis | Elastic strength,modulus of elasticity, toughness |
| 12 | Application Areas | ➓ The bend test is a simple and inexpensive qualitative test that can be used to evaluate both the ductility and soundness of a material |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

## Experiment 5.4 : shear strength test

| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Shear strength test** | | | | | | |
| 2 | Course Outcomes | Mechanical behavior | | | | | | |
| 3 | Aim | To determine ultimate shear strength in single & double shear for ductile material. | | | | | | |
| 4 | Material / Equipment Required | 1) UTM<br>2) Shear shackles for single and double shear<br>3) Vernier / Micrometer<br>4) Shear specimen of MS, Brass & Aluminium. | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ Shear stress is caused by a force which acts parallel to an area of cross section and tends to produce sliding of one portion part another portion. If the force in resisted by failure through a single area then the material is said to be in single shear. If two areas resists the fracture, then thematerial is said to be in double shear. | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1:The diameter of specimen is measured using vernier / micrometer.<br>➓ Step 2: The specimen is then inserted inside appropriate shear shackles and the specimen with shackles is placed inside the shear center plate.<br>➓ Step 3:The entire assembly is placed on the lower cross head of UTM<br>➓ Step 4:The adjustable intermediate cross head is then moved down till it makes contact with the top of the center plate.<br>➓ Step 5: The machine is started and the load is applied gradually.<br>➓ Step 6:The load at which two specimen brakes in single shear / double shear is recorded from the load dial gauge. | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph |  | | | | | | |
| 8 | Observation Table, Look-up Table, Output | Sl no | material | Type of shear | Dia of the specimen (d) in mm | Fracture load (f) in N | Area of the specimen (A) in $mm^2$ | Ultimate shear strength in $N/mm^2$ |
| | | | | | | | | |
| 9 | Sample Calculations | ➓ In single shear, shear strength = 4P/ пd 2 | | | | | | |

| | | |
|---|---|---|
| | | ➓ In double shear, shear strength = 2P/πd 2<br>➓ Where d = Dia of specimen in mm P= Failure load in N. |
| 10 | Graphs, Outputs | ➓<br>➓ |
| 11 | Results & Analysis | ➓ |
| 12 | Application Areas | ➓ To determine the behavior a material |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

## Experiment 6 : Torsion test

| - | **Experiment No.:** | 1 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Torsion test** | | | | | | |
| 2 | Course Outcomes | Mechanical behavior | | | | | | |
| 3 | Aim | To determine the behavior of Mild steel when subjected to Torsion & obtain the following torsional properties: (1) Modulus of rigidity (2) Elastic shear strength | | | | | | |
| 4 | Material / Equipment Required | 1) Torsion testing machine<br>2) micrometer<br>3) vernier caliper & piece | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ A method of finding the shear properties of a material is by the use of torsion test. Torsional shear stress on circular cross section varies from zero at the axis of twist to a maximum at the extreme fibres | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1:Measure the diameter d of the specimen at several sections micrometer to get mean value.<br>➓ Step 2: Measure the gauge length 1.<br>➓ Step 3: Adjust the torsion machine to read zero and then insert the specimen into two chucks.<br>➓ Step 4: Apply the load at load at slow speed(15rpm).<br>➓ Step 5: Note down the reading of wattmeter and simultaneously calculate torque T and angle of twist θ until failure occurs. | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph | Sl. No. | Length of Specimen 1mm | Diameter of Specimen/ mm | Watt meter Reading | Torque T= 60p PW 2πN | No. of revolutions on counter N | No. of division on circular scale (CSD) | θ= {n+ (csd)}2 π 100 |
| | | | | | | | | | |
| 8 | Observation Table, Look-up Table, Output | | | | | | | | |
| 9 | Sample Calculations | ➓ | | | | | | | |
| 10 | Graphs, Outputs | ➓<br>➓ | | | | | | | |
| 11 | Results & Analysis | ➓ | | | | | | | |
| 12 | Application Areas | ➓ To determine the behavior a material | | | | | | | |
| 13 | Remarks | | | | | | | | |
| 14 | Faculty Signature with Date | | | | | | | | |

## Experiment 7 : Impact test( Charpy test)

| - | **Experiment No.:** | 7 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Impact test( charpy test)** | | | | | | |
| 2 | Course Outcomes | Impact strength | | | | | | |
| 3 | Aim | To determine the impact strength of the given by Chapy test method | | | | | | |
| 4 | Material / Equipment Required | ➓ impact testing machine.<br>➓ Charpy impact testing specimen with U Groove. | | | | | | |

| | | |
|---|---|---|
| | | ➓ Vernier scale. |
| 5 | Theory, Formula, Principle, Concept | ➓ Specimen with U notch supported at both ends as a single beam is broken by a falling pendulum striking the face opposite to and immediately behind the notch. The energy absorbed by<br>specimen is determined by subsequent rise of pendulum as a measure of impact strength or notch toughness and expressed as Joules J(N/mm 2 ) |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1: measure the dimension of the given specimen at full section and at the notch<br>➓ Step 2: without specimen rise the pendulum to its full level &release its weight note down the initial reading on the graduated scale<br>➓ Step 3: place the specimen accurately for charpy test<br>➓ Step 4: release the pendulum from the initial level & release it and note down the final reading on the graduated scale<br>➓ Step 5: calculated the impact strength and imapct velocity of the given material |
| 7 | Block, Circuit, Model Diagram, Reaction Equation, Expected Graph | <table><tr><td>Material</td><td>Angle of fall (α)</td><td>Fracture energy from scale(U) jouls</td><td>Impact strength K= U/A J/mm$^2$</td></tr><tr><td></td><td></td><td></td><td></td></tr></table> |
| 8 | Observation Table, Look-up Table, Output | |
| 9 | Sample Calculations | ➓ Area below the notch of the specimen (A) = ……...mm$^2$<br>➓ weigth of the pendulum (W) =……...Kg<br>➓ lenth of the pendulum (r) ……...Deg.<br>➓ Angle of fall (α)= …….Deg<br>➓ angle of Rise (β)=…...Deg |
| 10 | Graphs, Outputs | |
| 11 | Results & Analysis | |
| 12 | Application Areas | determining the amount of forces that are absorbed by materials when it reaches the point of fracture. |
| 13 | Remarks | |
| 14 | Faculty Signature with Date | |

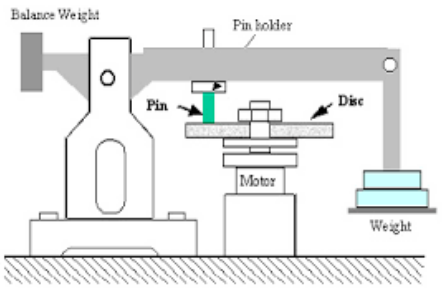
## Experiment 7.1 : Impact test( Izod test)

| - | **Experiment No.:** | 7 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Impact test( Izod test)** | | | | | | |
| 2 | Course Outcomes | Impact strength | | | | | | |
| 3 | Aim | To determine the impact strength of the given by Chapy test method | | | | | | |
| 4 | Material / Equipment Required | ➓ impact testing machine.<br>➓ Izod impact test specimen with V groove.<br>➓ Vernier scale. | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ Specimen with U notch supported at both ends as a single beam is broken by a falling pendulum striking the face opposite to and immediately behind the notch. The energy absorbed by<br>specimen is determined by subsequent rise of pendulum as a measure of impact strength or notch toughness and expressed as Joules J(N/mm 2 ) | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1: measure the dimension of the given specimen at full section and at the notch<br>➓ Step 2: without specimen rise the pendulum to its full level &release its weight note down the initial reading on the graduated scale<br>➓ Step 3: place the specimen accurately for izodtest<br>➓ Step 4: release the pendulum from the initial level & release it and note down the final reading on the graduated scale<br>➓ Step 5: calculated the impact strength and imapct velocity of the given material | | | | | | |
| 7 | Block, Circuit, Model Diagram, Reaction | <table><tr><td>Material</td><td>Angle of fall (α)</td><td>Fracture energy</td><td>Impact strength</td></tr></table> | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Equation, Expected Graph | | | from scale(U) jouls | K= U/A J/mm$^2$ |
| | | | | | |
| 8 | Observation Table, Look-up Table, Output | | | | |
| 9 | Sample Calculations | ➓ Area below the notch of the specimen (A) = ……...mm$^2$<br>➓ weigth of the pendulum (W) =……...Kg<br>➓ lenth of the pendulum (r) ……...Deg.<br>➓ Angle of fall (α)= …….Deg<br>➓ angle of Rise (β)=…...Deg | | | |
| 10 | Graphs, Outputs | | | | |
| 11 | Results & Analysis | | | | |
| 12 | Application Areas | determining the amount of forces that are absorbed by materials when it reaches the point of fracture. | | | |
| 13 | Remarks | | | | |
| 14 | Faculty Signature with Date | | | | |

## Experiment 8 : wear studies

| - | **Experiment No.:** | 8 | **Marks** | | **Date Planned** | | **Date Conducted** | |
|---|---|---|---|---|---|---|---|---|
| 1 | Title | **Wear studies** | | | | | | |
| 2 | Course Outcomes | The predict wear rate of different material | | | | | | |
| 3 | Aim | To determine the wear of the given specimen | | | | | | |
| 4 | Material / Equipment Required | ➓ Pin on disc machine.<br>➓ Electronic weighing machine.<br>➓ Ultrasonic cleaning device.<br>➓ Brass /Aluminum specimen.<br>➓ Hardened disc | | | | | | |
| 5 | Theory, Formula, Principle, Concept | ➓ Wear is the progressive loss of substance from the operating surface. The usual classification of types of wear is abrasive wear ; most examples in practice are a combination of two or more of these. “Abrasive wear”– abrasion is virtually a cutting action which may result from loose, hard particles sliding between two mating surfaces. It can also arise when one pair of rubbing surfaces is itself rough. The loose particles may be dirt from the environment or wear debris. | | | | | | |
| 6 | Procedure, Program, Activity, Algorithm, Pseudo Code | ➓ Step 1: Clean the surface of disc and the specimen (brass, aluminum)<br>➓ Step 2:Weigh the specimen accurately by using electronic weighing machine (W1)<br>➓ Step 3:Fix the specimen (pin) on the horizontal arm and measure the track radius by a scale.<br>➓ Step 4:specimen should be in contact with disc.<br>➓ Step 5:Switch on the motor and note the speed of the (rpm)on the indicator.<br>➓ Step 6:Load the specimen and note the force.<br>➓ Step 7:Run the motor for a specified time interval(say 15min).<br>➓ Step 7:Clean the specimen and weigh the same Note down the final weight (W2).<br>➓ Step 8:Calculate the total sliding distance for the specified running time.<br>➓ Step 9:Repeat the experiment for different rpm, load and material. | | | | | | |

<table>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td colspan="8"> 
</td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td>Material</td><td>Frictional Load in (N )</td><td>Load in (gm)</td><td>Speed in rpm</td><td>Time in see</td><td>$W_i$ in gm</td><td>$W_f$ in gm</td><td>% wt loss $(W_i-W_f/w_i)$ 100</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td colspan="8"></td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td colspan="8"></td></tr>
<tr><td>11</td><td>Results & Analysis</td><td colspan="8"></td></tr>
<tr><td>12</td><td>Application Areas</td><td colspan="8">Wear test is commonly used as a simple measure of workability of material in service.</td></tr>
<tr><td>13</td><td>Remarks</td><td colspan="8"></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td colspan="8"></td></tr>
</table>

# F. Content to Experiment Outcomes

## 1. TLPA Parameters

**Table 1: TLPA – Example Course**

| Expt-# | Course Content or Syllabus (Split module content into 2 parts which have similar concepts) | Content Teaching Hours | Blooms' Learning Levels for Content | Final Blooms' Level | Identified Action Verbs for Learning | Instruction Methods for Learning | Assessment Methods to Measure Learning |
|---|---|---|---|---|---|---|---|
| *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* |
| 1 | Metallographic examination of plain carbon steel, tool steel, gray cast iron, brass, bronze | 03 | L2 (Understand) | L2 (Understand) | Summarize | Demonstrate | Viva & presentation |
| 2 | Heat treatment like annealing, normalizing, Harding and tempering of steel | 03 | L3 (Apply) | L3 (Apply) | Develop | Demonstrate | Viva & presentation |
| 3 | Hardness test like Brinnel, Rockwell, Vickers hardness | 06 | L3 (Apply) | L3 (Apply) | Develop | Demonstrate | Viva & presentation |
| 4 | Ultrasonic flaw detection, magnetic crack detection | 03 | L3 (Apply) | L3 (Apply) | Develop | Demonstrate | Viva & presentation |
| 5 | Using U T M conduct tensile test, shear and compression test. | 06 | L3 (Apply) | L3 (Apply) | Develop | Demonstrate | Viva & presentation |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | Impact test for mild steel and CI specimen | 04 | L3 Apply | L3 Apply | Develop | Demonstrate | Viva & presentation |
| 7 | Torsion test on steel bar | 03 | L3 Apply | L3 Apply | Develop | Demonstrate | Viva & presentation |
| 8 | Wear characteristics of ferrous and non ferrous materials under different parameters | 04 | L3 Apply | L3 Apply | Develop | Demonstrate | Viva & presentation |

## 2. Concepts and Outcomes:

**Table 2: Concept to Outcome – Example Course**

| Expt - # | Learning or Outcome from study of the Content or Syllabus | Identified Concepts from Content | Final Concept | Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome) | CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark) | Course Outcome **Student Should be able to ...** |
|---|---|---|---|---|---|---|
| *A* | *I* | *J* | *K* | *L* | *M* | *N* |
| 1 | Metallographic examination | Microstructure | Microstructure | Will be able to understand the basic microstructure | Action Verb : Understanding Knowledge : microsture | Understand the micro structure of materials |
| 2 | Heat treatment | Improvement of properties | Improvement of properties | Will be able to understand the properties of materials | Action Verb : Analyzing Knowledge :properties | Improve the material properties |
| 3 | Hardness test l | Resistance of material | Resistance of material | Hardness of the material | Action Verb : Analyzing Knowledge :resistance | Analyze the material |
| 4 | Ultrasonic flaw detection, magnetic crack detection | NDT | NDT | Non destructive methods | Action Verb : Analyzing Knowledge :destructive and non destructive | Explore the difference NDT method |
| 5 | Using U T M conduct tensile test, shear and compression test. | Material behavior | Material behavior | Comparison of different material behavior | Action Verb : Analyzing Knowledge : behavior of material | Predict the material behavior |
| 6 | Impact test for mild steel and CI specimen | strength | strength | Strength of the material | Action Verb : Analyzing Knowledge : strength of material | Access the strength of material |
| 7 | Torsion test on steel bar | torsional strength | torsional strength | Strength of the material | Analyzing Knowledge : strength of material | Predict the material behavior |
| 8 | Wear characteristics of ferrous and non ferrous materials | wear | wear | Behavior of the material | Analyzing Knowledge : wear of the material | The predict wear rate of different material |