DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

SUBJECT: STRENGTH OF MATERIAL

B.TECH- 3rd Semester BRANCH: - ME

KCT COLLEGE OF ENGG & TECH, FATEHGARH

Punjab Technical University

LIST OF EXPERIMENTS

Sr. No.	EXPERIMENTS	Date Of Performance	Date Of Submission.	Teacher's Signature
1.	To find out brinell hardness number of given test piece.			
2.	To test the hardness of the given specimen with a rockwell hardness testing machine.			
3.	To study the impact testing machine & perform the impact test (Izod & Charpy).			
4.	To study the universal testing machine & perform the tensile test.			
5.	To perform compression & bending tests on UTM.			
6.	To study the torsion testing machine & perform torsion test.			
7.	To determine the mechanical advantage, velocity ratio and efficiency of worm and worm wheel			
8.	To determine the value of coefficient of friction between screw and nut of jack. (a) While raising load (b) While lowering load			
9.	To determine the mechanical advantage, velocity ratio and efficiency of single and double purchase crab winch.			
10	To perform the fatigue test on given test piece.			

BRINELL HARDNESS
EXPERIMENT NO. 1

OBJECTIVE: To find out Brinell Hardness Number of given test piece.

REQUIREMENTS:

1. Brinell Hardness Tester
2. Test Piece
3. Hardened steel ball 10mm diameter
4. Microscope

THEORY:
Hardness represents the resistance of a material to indentation, and involves the measurement of plastic deformation caused when a loaded ball or diamond is applied to the surface of material.

Refer to Fig. 6.

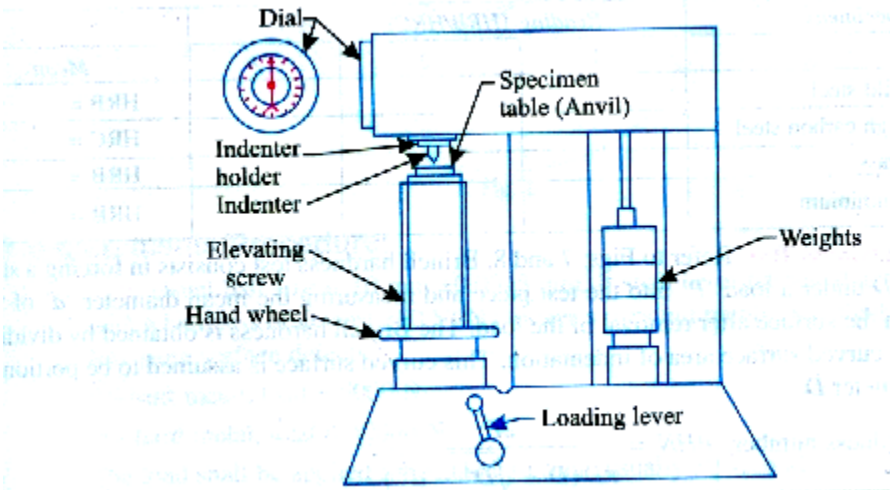

Fig. 6. Rockwell hardness tester.

BRINELL METHOD:
In this a hardened steel ball is pressed into the surface under a specified load which is held on for a fixed period and then released.
Brinell hardness is defined as the quotient of the applied force F, divided by the spherical area of impression.

FORMULAE USED:

Brinell hardness, HB = Test load/Surface area of indentation

$$= 2F/\pi D\,(D-\sqrt{D^2-d^2})\ N/mm^2$$

OBSERVATION TABLE:

Specification	Reading 1	Reading 2	Reading 3
Force Apply			
Material of test piece			
Diameter of ball			
Load 'F'			
Load application time			
Diameter of Impression 'd'			

CALCULATIONS:

RESULT:

Brinell hardness =

CONCLUSION:

ROCKWELL HARDNESS
EXPERIMENT NO. 2

OBJECTIVE: To Test the hardness of the given specimen with a Rockwell Hardness testing machine.

REQUIREMENTS:

Rockwell Hardness Testing Machine, diamond cone Penetrator, steel ball Penetrator and given specimen.

THEORY:

Hardness represents the resistance of a material to indentation, and involves the measurement of plastic deformation caused when a loaded ball or diamond is applied to the surface of material.

Rockwell Method: Hardness of a body is its property by virtue of which it resists indentations or the penetration of other bodies in it. In the Rockwell hardness testing machine, there are two scales on the dial, B is marked in red and C in blank. The zero scale is opposite to the fig. 30 on the B scale so that there is a difference of 30 hardness numbers between the two scales point. There are two types of Penetrator used in the machine.

Ball Penetrator (1.5875 mm dia. ball): It is used for soft material e.g. mild steel, cast iron, aluminum and brass etc.

Cone Penetrator: It is used for hard material e.g. high carbon steel, high speed steel etc.

DIAGRAM:

(1) Ball Penetrator (2) Cone Penetrator

PROCEDURE:

OBSERVATIONS TABLE:

S. No.	Material	Penetrator used	Minor load + Major load	Rockwell Hardness Number
1				
2				
3				
4				
5				

RESULT: Rockwell hardness =

CONCLUSION:

IMPACT TESTING

EXPERIMENT NO. 3

Date of Performance _____

OBJECTIVE: To study the Impact Testing Machine & perform the Impact Test (Izod & Charpy).

REQUIREMENTS:

1. Impact Testing Machine
2. Specimen

THEORY:

Impact Test: The test is to determine the behavior of materials when subjected to sudden loading.

(1) Charpy Impact Test: It is single blow Impact test, in which the notched specimen is supported at both ends, as a simple beam & broken by a falling pendulum on face opposite to and immediately behind the notch.

(2) Izod Impact Test: It is a single blow Impact test, in which the notched specimen is fixed at one end and broken by a falling pendulum.

(3)Impact Strength: Energy absorbed by specimen during impact test is known as impact strength.

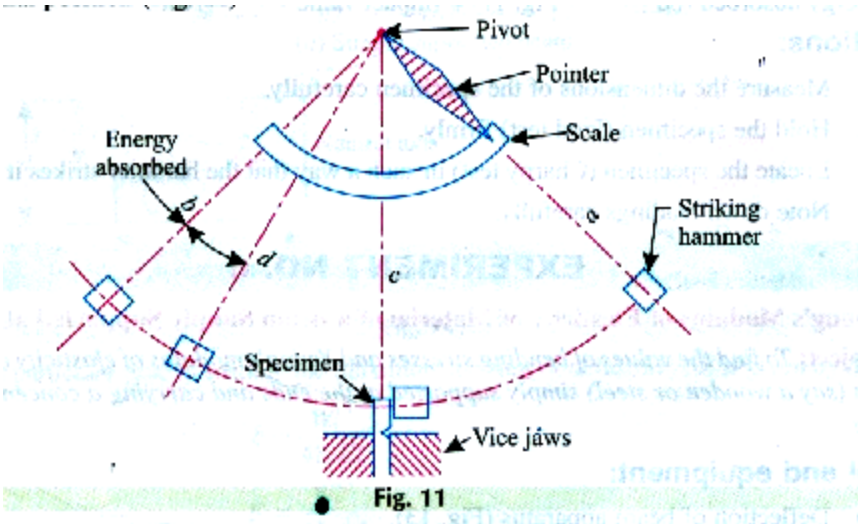

Fig. 11

OBSERVATION:

S. No.	Material of test piece	Dimension of test piece	Initial Energy (E1):	Residual Energy (E2)
1				
2				
3				
4				
5				

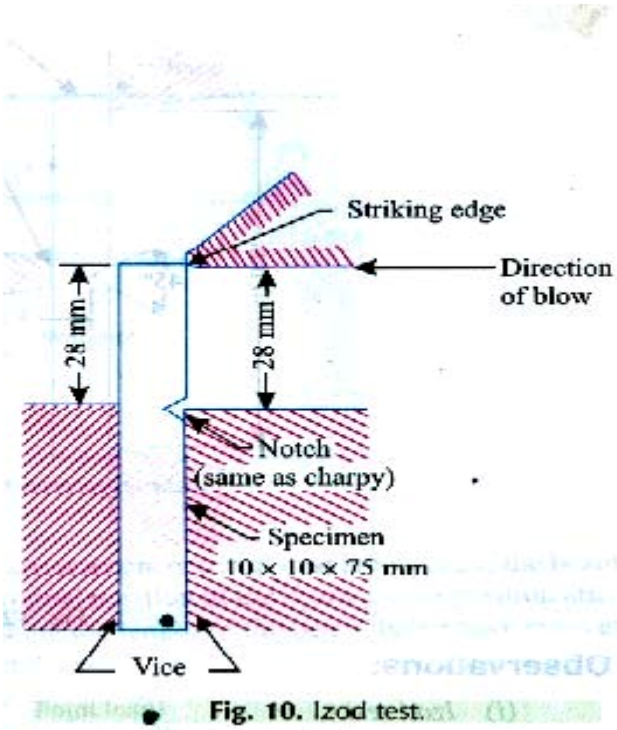

Fig. 10. Izod test.

CALCULATION:

RESULT:
Impact Strength of specimen = -------- kgm

CONCLUSION:

PRECAUTIONS:

TENSILE TEST
EXPERIMENT NO. 4

OBJECTIVE: To study the Universal Testing Machine & perform the Tensile Test.

REQUIREMENTS:
1. Universal Testing Machine
2. Test specimen
3. Micrometer
4. Steel scale

THEORY:
When a metal piece is loaded by tensile force, metal piece get strained due to which tensile stress is induced in test specimen. Tensile test consists in straining a test piece by tensile stress, generally to fracture, with a view of determining one or more of the continuously properties. This test is done on UTM.

OBSERVATION:

S. No.	Original diameter of specimen (d)	Diameter after fracture (du)	Gauge length (Lo)	Total length after fracture (Lu
1				
2				
3				
4				
5				

Least count of micrometer =

CALCULATIONS:

Stress (Strength) = Load/Area
Percentage elongation = 100(Lu-Lo)/Lo
Percentage reduction in area = 100(Su-So)/So

GRAPH: Plot load vs. extension diagram

RESULTS:
Proportional limit, MPa =
Yield strength, Mpa =
Ultimate Strength, MPa =
Breaking strength, MPa =
Modulus of elasticity (GPa) =
Percentage elongation =
Percentage reduction in area =

CONCLUSION:

COMPRESSION & BENDING TEST

EXPERIMENT NO . 5

OBJECTIVE: To perform compression & bending tests on UTM.

REQUIREMENTS:

1. Universal Testing Machine
2. Test piece

THEORY:

Compression Test consists in straining a test piece by compressive loading. Specimen for metallic compression test are usually circular, and for concrete square in-section. To prevent failure by buckling, the length should be of about the same order as the minimum width. In the ductile material distortion takes place while in case of brittle materials, they usually fail by shearing.

OBSERVATIONS:

Ultimate load =
Average diameter of test piece (D) =

CALCULATIONS:

Cross-sectional area =
Ultimate compressive strength =

PRECAUTIONS:

RESULT:
Ultimate Compressive Strength =

CONCLUSION:

TORSION TEST
EXPERIMENT NO . 6

OBJECTIVE: To study the Torsion Testing Machine & perform Torsion test.

REQUIREMENTS:
1. Torsion Testing Machine
2. Specimen
3. Micrometer

4. Steel Scale
5. Caliper

THEORY:

The modulus of rupture is equal to shear stress corresponding to maximum torque. A circular cylinder shaft is to be subjected to pure torsion when the torsion is caused by a couple, so that the axis of the applied couple coincides with the axis of the shaft. In such a case the state of stress at any point in the cross section of the shaft is pure shear.

TORSIONAL FORMULA:

OBSERVATION TABLE:

S. No.	Material of test specimen	Parallel length of test specimen	Diameter	Maximum torque (N-m)	Breaking torque (N-m)	Angle of twist Ø
1						
2						
3						
4						
5						

CALCULATIONS:

Modulus of rupture $ts = Tr/J$
Modulus of rigidity $G = Tl/J\theta$
Where: T= Maximum twisting moment.
r= Original outer radius of specimen
J= Polar moment of inertia of the original cross-section
θ= Angle of twist
l= Parallel length of specimen.

GRAPH: Plot a torque twist graph.

RESULTS:

1. Maximum torque=

2. Breaking torque=

3. Total angle of twist to fracture

4. Modulus of rupture=

5. Modulus of rigidity=

CONCLUSION:

WORM AND WORM WHEEL

EXPERIMENT NO . 7

OBJECTIVE: To determine the mechanical advantage, velocity ratio and efficiency of worm and worm wheel

REQUIREMENT:

Worm and worm wheel, strings, a set of weights, scale pans, threads and meter scale.

THEORY:

For lifting heavy loads, a machine named worm and worm wheel is used. A worm and worm wheel consists of square threaded screw (worm) and the toothed wheel (worm wheel) geared with each other. Wheel is attached to the worm over which passes a rope. The effort is applied at

the end of this rope. A load drum is squarely mounted on the worm wheel. Load is connected to the string wound round the load drum worm wheel both rotate together.

OBSERVATION:

S. No.	**Load (W) kg**	**Effort (P) (gm)**	**M.A=W/P**	**N =M.A./V.Rx100**
1				
2				
3				
4				
5				

CALCULATION:

1. Number of teeth on worm wheel = T
2. Circumference of effort wheel = μ D
3. Diameter of load drum = d
4. Circumrence of load drum = μd
5. V.R.= L.T./r = DT/d

   Where: D = Effective diameter of effort wheel (Actual diameter + rope thick)

   d =Effective diameter of load drum

RESULT:

Mechanical Advantage =
Velocity Ratio =
Efficiency =

CONCLUSION:

COEFFICIENT OF FRICTION

EXPERIMENT NO . 8

OBJECTIVE: To determine the value of coefficient of friction between screw and nut of jack.

(a) While raising load

(b) While lowering load

REQUIREMENT:

Square threaded screw jack apparatus, weights, cotton spring, meter scale, vernier caliper etc.

THEORY:

This machine is used for lifting heavy load with application of a smaller effort. It may have different shapes but principle is same i.e. it works on the load W. The nut is fixed and screw is rotated by means of lever the effort P is applied at end of lever.

OBSERVATIONS:

S.No.	Load lifted upward w	P_1	P_2	Total effort $P = P_1 + P_2$	$\varphi = \tan^{-1}(P/W) + \alpha$	$\mu = \tan\varphi$

CALCULATION:

1. Circumference of screw thread = $2\mu R$
2. Pitch of the Screw Thread = p

RESULT:

The value of coefficient of friction between screw and nut of jack μ.....

CONCLUSION:

PRECAUTIONS:

SINGLE AND DOUBLE CRAB WINCH

EXPERIMENT NO .

OBJECTIVE: To determine the mechanical advantage, velocity ratio and efficiency of single and double purchase crab winch.

REQUIREMENT:

Double purchase crab winch, strings, a set of weight, scale pans and meter scale.

THEORY:

For obtaining increased velocity ratio double purchase winch crab are used. From such machines increased mechanical advantage is obtained. In such machines velocity ratio is found in two stages by two pairs of gears.
A double purchase winch crab consists of an effort axle, load axle and an intermediate axle. On the effort axle, a pinion is attached whereas on the load a spur wheel is attached. The pinion of the intermediate axle gears with the spur wheel of the load axle. Spur wheel of the intermediate axle gears with the pinion of the effort axle. The effort is applied at the effort wheel by means of rope & weight.

EXPERIMENTAL SET UP:

Apparatus consists of an effort axle, load axle and an intermediate axle. On the effort axle, a pinion is attached whereas on the load axle a spur wheel is attached. The pinion of the intermediate axle gears with the spur wheel of the load axle. Spur wheel of the intermediate axle gears with the pinion of the effort axle.

OBSERVATION TABLE:

S.No	Load W (kg)	Effort	M.A=W/P	n=M.A./V.R. x100
1				
2				
3				
4				
5				

CACULATION:

1. Number of teeth on the pinion of effort axle, T_1 =
2. Number of teeth on spur wheel of intermediate axle, T_2 =
3. Number of teeth on pinion of intermediate axle. T_3 =
4. number of teeth on spur wheel of load axle, T_4 =
5. Actual radius of effort wheel , L=
6. Effective radius of effort wheel = L_1 = L+T
7. Diameter of load axle, D =
8. Effective diameter of load axle D_1= D+T
9. Circumference of effort pulley = 2 L
10. Circumference of load drum = D

V.R.= $(2L\ T_2.\ T_4)/ D_1\ T_1.\ T_3$

RESULT:

Mechanical Advantage =

Velocity Ratio =
Efficiency =

CONCLUSION:

FATIGUE TEST

EXPERIMENT NO . 10

OBJECTIVE: To perform the Fatigue test on given test piece.

REQUIREMENTS:

1. Fatigue Testing Machine

2. Mild steel specimen
3. Slide watch

THEORY:

Components which have to withstand static load can be easily designed on the basis of the Yield Strength of the materials of which these components are to be made. But these situations in which a component has to withstand cyclic loading i.e. repeated application of loads. Under such conditions the materials fails at a much lower stress than one required for its failure through fracture under static loads. This phenomenon of material failure, under the condition describe above, is known as Fatigue.

FATIGUE STRENGTH:

OBSERVATIONS TABLE:

Diameter of test piece d(mm)	Load W (N)	No. of cycles (n)	Length (mm)

CALCULATIONS:

Stress σ (N\mm

RESULT:

Stress σ (N\mm²) =

CONCLUSION: