DAV UNIVERSITY

(Empowering Students with 21st Century Skills)

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

FOR

STRENGTH OF MATERIALS LAB (MEC-212)

Vision of the Department

The Mechanical Engineering Department aims to be recognized as an outstanding educational centre to develop innovative engineers who are proficient in advanced fields of engineering and technology and can contribute effectively to the industry as well as for socio-economic upliftment of the society.

Mission of the Department

M1: To impart outcome-based education with a research orientation to the students to develop them as globally competitive engineers.

M2: To imbibe the students with academic, leadership and entrepreneurship skills needed by the industry in particular and society in general.

M3: To adopt flexibility and dynamism in designing the programme structures to cope up with emerging market needs.

M4: Establishment of liaison with top R & D organizations/Industries and leading educational institutions for practical exposure of the students and faculty as well as to the state of the art.

Programme Educational Outcomes (PEOs)

After the successful completion of undergraduate course, Mechanical Engineering, Graduates will be able to:

PEO1: Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable.

PEO2: Apply analytical, computational and experimental techniques to address the challenges faced in mechanical and allied engineering streams.

PEO3: Communicate effectively using conventional platforms as well as innovative / online tools and demonstrate collaboration, networking & entrepreneurial skills.

PEO4: Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career, organizational and societal goals.

Program Outcomes (POs) - B. Tech. Mechanical Engineering

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO) - B. Tech. Mechanical Engineering

PSO1: Academic Competence: Apply mechanical and interdisciplinary knowledge to analyze, design and manufacture products to address the needs of the society.

PSO2: Professional Competence: Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

Mapping of COs with PO(s)

CO's / PO's	CO-1	CO-2	CO-3	CO-4
PO-1	3	3	3	3
PO-2	3	3	3	3
PO-3	2	2	2	2
PO-4	1	1	1	1
PO-5	1	1	1	1
PO-6	3	3	3	3
PO-7	3	3	3	3
PO-8	2	2	2	2
PO-9	1	1	1	1
PO-10	1	1	1	1
PO-11	1	1	1	1
PO-12	2	2	2	2

1- Slight (Low) 2- Moderate (Medium) 3- Substantiate (High)

Mapping of COs with PSO(s)

COs / PSOs	CO-1	CO-2	CO-3	CO-4
PSO-1	3	3	2	3
PSO-2	3	3	2	3

1- Slight (Low) 2- Moderate (Medium) 3- Substantiate (High)

Department of Mechanical Engineering

L	T	P	Credits
0	0	2	1

Course Code	MEC 212
Course Title	**Strength of Materials Lab**
Course Outcomes	On the completion of the course the student will be able to: **CO1:** To determine the mechanical properties and modulus of rigidity for given specimen. **CO2:** To determine the impact strength and fatigue strength for given specimen. **CO3:** To determine the hardness, stiffness and modulus of rigidity for given specimen/spring. **CO4:** To perform Bending Test and shear test on given sample.
Examination Mode	Practical

Assessment Tools	Continuous Assessment (CA)				MSE	MSP	ESE	ESP	Total
	Quiz	Assignment/ Project Work	Attendance	Lab Performance					
Weightage	-	-	-	20%	-	30%	-	50%	100

S. No.	LIST OF EXPERIEMENTS	CO Mapping
1.	To perform tensile test in ductile and brittle materials and draw stress-strain curve and to determine various mechanical properties.	CO1
2.	To conduct torsion test on a given specimen and to find the modulus of rigidity.	CO1
3.	To Determine Impact Strength on Mild Steel Specimen by IZOD and CHARPY Test	CO2
4.	To determine the fatigue strength of mild steel specimen.	CO2
5.	To perform Rockwell Harness test on a given specimen.	CO3
6.	To determine the stiffness and modulus of rigidity of a close coiled helical spring in tension and compression.	CO3
7.	To perform Bending Test on beam (any material) and to determine the Young's Modulus and Modulus of rapture.	CO4
8.	To perform Shear Test on different materials and determine ultimate shear strength.	CO4

EXPERIMENT NO: 1

EXPERIMENT 1: To perform tensile test in ductile and brittle materials and draw stress-strain curve and to determine various mechanical properties.

1.0 OBJECTIVES:

To perform tensile test in ductile and brittle materials and draw stress-strain curve and to determine various mechanical properties.

2.0 APPARATUS:

1. Universal Testing Machine. (UTM)
2. Digital Display Unit with Computer.
3. Steel Rule.
4. Veneer Calliper.

3.0 DESCRIPTION & APPARATUS:

a. **Loading Unit**: In this unit, actual load for specimen takes place. It consists of these cross-section namely upper load, middle load and lower load, bending load with help of different instruments can be applied.

b. **Hydraulic Power Unit**: Hydraulic power unit circuit consists of hydraulic power pack having directly connected to radial plunger pump which gives a continuous non flashy flow of oil pressure up to 250 bar. Oil filter, oil strainer, air breather, oil level indicator, drain plug are provided to control the oil flow to cylinder their by achieving desired piston speed, variable speed can also be obtained with the help of valves.

c. **Electro Indicating Unit**: It shows the load resting during the test. Different measurement made by selecting the range from the selection knob. An overload trip switch is incorporated witch automatically cuts out when the load range in use is exceeded.

4.0 THEORY:

The tensile strength of mild steel is of prime importance to an engineer. Mild steel is used in many of the Mechanical and civil Engineering like, shafts, fabrication work, gear box, nut & bolts, washers, pins, stud etc. In civil engineering, like bridges, industrial buildings, railways, water tank and transmission tower etc. it is subjected to direct tension due to bending in some of the components used in the fore said structures.

Determination of shape and size of these components require the knowledge of permissible stresses in the materials and the capacity to deform content with specification for safety. These are obtained from stress-strain curve of the materials.

5.0 PROCEDURE:

1. Tensile test is performed on round bars or flats to find out yield strength, maximum tensile strength, ultimate tensile strength at rapture and maximum elongation.
2. Choose the right set of jaws in accordance with the specimen to be tested and grease the back side of jaws.
3. Slides the hinged plate on the top of the crossed head and lower the jaws very carefully and insert the jaws in the middle cross head.
4. Fix the two strips with the help of the bolts. They are hinged at one end and open at other. Slide them to one side and insert the jaws.
5. Open the jaws opening by rotating pinion jaw handle clockwise slightly and let the jaws to loose. They will automatically grip the specimen. Raise the middle head and tighten the jaws by rotating handle anti-clockwise.
6. Enter the specimen data in the computer software and in the electronic indicating unit.

7. Close the relies valve and load the specimen up to 3 to 4 Newton to get strong grip on the specimen. Then unload the specimen by pressing TARE on the display unit.
8. Close the relies valve and load the specimen up to 3 to 4 Newton to get strong grip on the specimen. Then unload the specimen by pressing TARE on the display unit.
9. Start loading the specimen until the specimen fails. On the failure stop the hydraulic pump and open the release valve.
10. Get the load displacement data and plot stress-strain curve and load displacement curve.

6.0 OBSERVATIONS & RESULTS:

(1) Record the data in the following table:

Material		**Dimensions**	
Original length	=	Final length	=
Original Diameter	=	Final Diameter	=
Original Area	=	Final Area	=

TABLE:

S No	load (N)	extension (mm)	original gauge length	stress	strain
1					
2					
3					
4					
5					
6					
Stress =load / area N/ mm sq strain = increase in length / original length					

(2) Plot the stress strain curve and determine the following:

1. Limit of proportionality	= load at limit of proportionality/ original area of cross section	(N / mm^2)
2. Elastic limit:	= load at elastic limit/ original area of cross section	(N / mm^2)
3. Yield strength:	=Yield load / / original area of cross section	(N / mm^2)
4.Ultimate strength:	=Maximum tensile load/ / original area of cross section	(N / mm^2)
5.Young's modulus	= stress below proportionality/ corresponding strain	(N / mm^2)
6.Percentage elongation:	= final length – original length/ original length	(%)
7.Percentage elongation:	= original area – area at fracture/ original area	(%)

7.0 PRECAUTIONS:

1. Apply the load at uniform rate and without any jerk.
2. Close the release valve on starting of the pump.
3. Clamp the specimen on the grip jaws properly.
4. Immediately switch off the pump after failure of the specimen.

EXPERIMENT NO: 2

EXPERIMENT 2: To conduct torsion test on a given specimen and to find the modulus of rigidity.

1.0 OBJECTIVE:

To conduct torsion test on a given specimen and to find the modulus of rigidity.

2.0 APPARATUS:

Torsion testing machine, specimen.

3.0 THEORY:

A torsion test is performed to determine the value of modulus of rigidity of a metallic specimen. The value of modulus of rigidity can be find out through observations made during the experiment by using following torsion equation:

$$T/I_p – C\theta/l \quad \text{OR} \quad C = Tl/ I_p\theta$$

Where: T	=	Torque applied	
	I_p	=	Polar moment of inertia = $\pi/32\ d^4$
	C	=	Modules of rigidity
	Θ	=	Angle of twist (radius)
	l	=	Gauge length = 305mm (given)

4.0 INTRODUCTION:

The torsion testing machine is fabricated to test the torsion of metallic bars. The machine has horizontal test space and can be fitted with various kind of grips to hold the specimen during a test. The specimen suitable for torsion test can take many forms like

round, flat or square. This machine has maximum capacity of 500Nm. Samples up to 32mm Dia, 40mm Square and 40mm Flat can be tested by this machine

5.0 DESCRIPTION:

Torsion Testing Machine consists of heavy fabricated base The Horizontal bed of the machine is machined to flat. The bed supports and guides a sliding carriage. It carries the motorized gear box on its top and the control panel on its front. The output shaft of gear box bears the moveable chuck and to its other end fitted a rotary encoder to measure the degree of rotation of the specimen under test. Both the fixed and moveable chucks have the cavity to hose a pair of jaws and covered with lid, so that the jaws cannot escape to outside. Two screws with square heads are provided for each chuck to tight the specimen inserted in it.

To extreme left end of the machine, a bracket is welded which carries the torque sensor. To the other end of torque sensor, the fixed chuck is bolted. The sensor and the fixed bracket are placed in the cabinet bolted to the machine end. A place is provided on the top of the cabinet to hold the digital display unit.

6.0 OPERATION:

Keep the machine on level plat form. Choose the suitable jaws as per the specimen under test. Unscrew the lids of both fixed and movable chucks. Now place a pair of the jaws in the cavities of each chuck and lid the chucks. Insert the one end of the specimen into the fixed chuck first and then bring the movable chuck nearer and then insert the other end of the specimen into it. While inserting the test specimen into the jaws it is important that the openings in the chucks should be concentric to each other horizontally. The specimen fitted into the jaw must be right in the center so as to get accurate & processional results. The eccentricity of the test specimen into the jaws can be done manually with the help of a scale. It should be equidistant horizontally & vertically. Now tight the square headed screws of the chucks so that the specimen can be tightly gripped into the jaws. Place the digital display unit into its seat and connect it with its chord. Now plug the main head of the motor to 220V, 50Hz A.C. supply. Now the unit is ready to start.

7.0 RESULTS:

By switching on the torque is applied to the sample. Torque load and angle of twist go on increasing with time. Digital display unit shows both torque and angle of twist with high resolution. Torque goes on increasing and at certain point failure occurs. Torque load at failure as well as the degree of rotation of the test simple is stored in the memory. Torque is measured by using torque sensor and angle is measured by rotary encoder. Accuracy of the torque indication is ±1% of the true torque. Torque ranges can be adjusted & applied to the specimen by geared motor through gear box.

8.0 PRECAUTIONS:

Keep the machine neat and clean. Lubricate the grips with grease and protect it from the dust and filth.

9.0 OBSERVATIONS & RESULTS:

1. gauge length of the specimen l =
2. Diameter of specimen d =
3. Polar moment of inertia I_P = 3.141/ 32xd^4

Torque	1	2	3	4	5	6	7	8	9	10
Angle of twist in rad ɵ										

Angle of twist is measured in degrees. It should be converted into radians before plotting a graph. (Ө° * π / 180)

S. No.	Description
1	BASE
2	MACHINE BASE
3	SLIDING CARRIAGE
4	GEAR BOX
5	MOTOR
6	MOVABLE CHUCK
7	ROTARY ENCODER
8	SPECIMEN UNDER TEST
9	FIXED CHUCK
10	LID
11	SQUARE HEAD SCREW
12	CONTROL PANEL
13	BRACKET FOR TORQUE SENSOR
14	DIGITAL DISPLAY
15	FUSE
16	FORWORD
17	REVERSE
18	OFF
19	CABINET FOR BRACKET

EXPERIMENT NO: 3

EXPERIMENT 3: To Determine Impact Strength on Mild Steel Specimen by IZOD and CHARPY Test.

1.0 OBJECTIVE: To Determine Impact Strength on Mild Steel Specimen by IZOD and CHARPY Test.

2.0 APPARATUS:

Impact testing machine, Specimen 10 x 10 x 75 mm for Izod and 10 x 10 x 55mm for Charpy Impact test, Veneer calliper.

3.0 SPECIFICATION:

Ranges:

Izod = 0-164 Joules, Minimum graduation = 2 Joules.

Charpy = 0-300 Joules, Minimum graduation = 2 Joules.

4.0 DESCRIPTION:

The machine consists of a heavy cast iron base on which is bolted a vertical column. On the top of the column is mounted the bearing housing on the extended shaft of which is mounted the swinging pendulum. The combined vice cum test piece support for both types of tests are bolted to the heavy base. The latching tube can be fixed on the bearing housing in two positions viz. One for Izod test and the other for Charpy test. And an Allen Key is provided the purpose. The strider has to be changed to suit the desired test. The scale is mounted on the bracket fixed to bearing housing and the maximum pointer (reading pointer) is also mounted over the hum attached to this bracket with a spring load to produce friction just enough to hold the pointer at its maximum position after the pendulum swing. A pointer carrier is fixed to the extended pendulum shaft. Braking mechanism with operating handle is provided to stop the pendulum after the test swing. A safety guard is provided on the front side to protect the operation.

A safety latch is also provided to inter lock the latching tube and pendulum pipe while, fixing the specimen of working near the test piece vice. The base has four foundation bolt holes and four tapped holes for levelling bolts, so that the machine can be levelled while fixing to the foundation. The piece setting gauge for V-notch test pieces are also provided for both Izod and Charpy test.

5.0 THEORY:

During the first part of 20th century, a metallurgist named Izod invented an impact test for determining the suitability of various metals to be used as cutting tools. The test involved a pendulum with a known weight at the end of its arm swinging down and striking the specimen as it stood clamped in a vertical position.

Some years later another metallurgist named Charpy modified the slightly by orienting the specimen in a horizontal position. These pendulum impact test methods proved to be very useful, providing reliable, qualitative impact data throughout WWII up until the early 70's. It then became apparent that higher velocities and impact energies could be achieved with vertical style drop towers and thus the trend began to shift. Pendulum machines remained popular with those testing to izod and Charpy while more high speed, product-oriented impact applications became the dominion of the drop tower.

W = weight of pendulum

h1 = fall of hammer

h2 = rise of hammer

R = length of pendulum

α = angle of fall

β = angle of rise

Initial energy = W h2 = WR (1 – cos α)

Potential energy after rapture = W h1 – W h2 = WR (cos β-cos α)

6.0 PROCEDURE:

IZOD TEST

1. Check that the latching tube is fitted in horizontal position for Izod test and fully tightened in place.
2. Also check that the Izod striker is fitted with the hammer. Otherwise change it and tightened fully all the bolts of the striker and the clamping wedge.

3. With the help of wedge-shaped setting gauge, position the test piece correctly (in the direction of strike) and tighten the alien bolt fully to clamp the test piece tightly.
4. Bring the reading pointer to maximum scale reading latch the hammer in the raised position and allow it to swing freely by pulling the release handle.
5. After the completion of this residual swing, the pointer will stay at the maximum position.
6. During the second swing of the pendulum due to residual energy, apply the brake just when it reaches near the vice/specimen support to stop it.
7. Note down the reading as absorbed energy. Carry out the impact test on three specimens and take average value of energy absorbed.

<u>CHARPY TEST</u>

1. For charpy test, the latching tube is to be in the upper inclined position.
2. Remove it from the izod position and refax for the charpy test, taking care to tighten the clamping bolts fully.
3. The striker has also been changes. Remove the izod striker and fit charpy striker tightening fully the alien bolts of both the striker and clamping wedge.
4. The notched face being opposite to the direction of hammer striker. Centre it properly.
5. Being the reading pointer to maximum scale reading latch the hammer in the raised position and allow it to swing freely by pulling the release handle.
6. The striker will strike the specimen and rise on the left side carrying the reading pointer upwards.
7. After the completion of this residual swing, the pointer will stay at the maximum position.
8. During the second swing of the pendulum due to residual energy, apply the brake just when it reaches near the vice /specimen support to stop it.
9. Note down the reading as absorbed energy. carry out the impact test on three specimens and take average value of energy absorbed.

7.0 <u>OBSERVATION</u>:

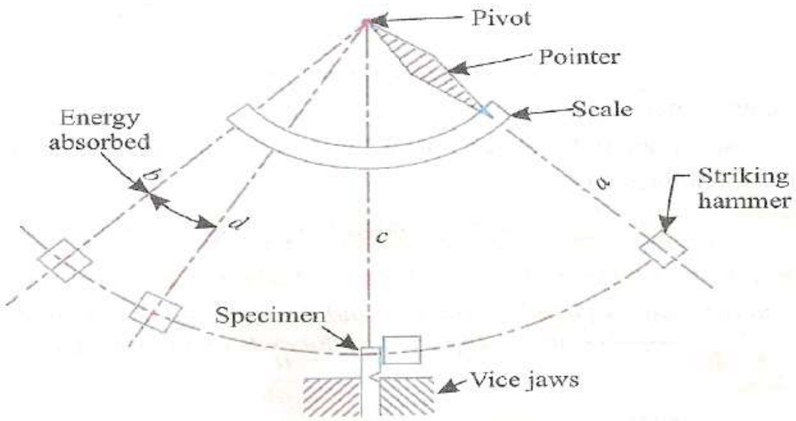
(1) Izod test
 Energy absorbed = impact value= ……..N-m

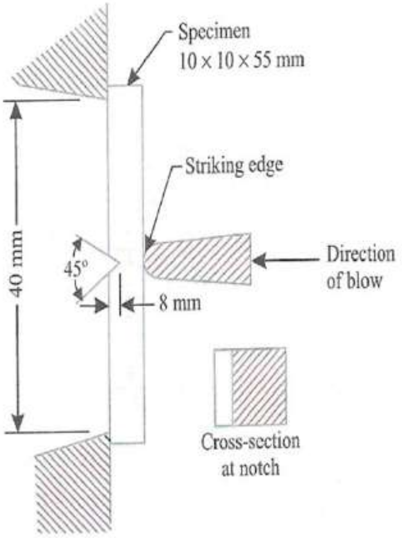
(2) Charpy test
 Energy absorbed = impact value= ……..N-m

8.0 <u>APPLICATION</u>:

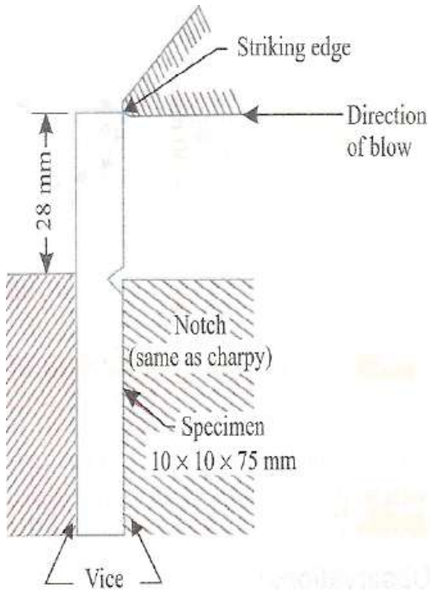
Determining the suitability of various metals to be used as cutting tools.

<u>FIGURE</u> :





Charpy test.



Izod test.

EXPERIMENT NO: 4

EXPERIMENT 4: To determine the fatigue strength of mild steel specimen.

1.0 OBJECT:

To determine the fatigue strength of mild steel specimen.

2.0 APPARATUS:

Fatigue Testing Machine, Weight Hanger, Balancing Weight, Set of Weights, Thin Lubricating oil, Steel Specimen, Steel rule.

3.0 THEORY:

Fatigue can be defined as failure of material under varying loads well below the ultimate static load after a finite number of cycles of loading and unloading. This is very frequent cause of failure of working parts of machines and load bearing parts of air craft structure, rockets and missiles etc subject to repetitive loading.

Basically, it should consist of some way to produce alternating load on the specimen, some counting arrangements for number of load cycles and some lad measuring device. Control devices like stopping the motor once the specimen breaks and keeping the load amplitude constant, etc may also be incorporated.

4.0 PROCEDURE:

1. Fit the standard specimen in collect tightly.
2. Place the counter weight on the one end of the weight arm and place the desired loading weight on the weight hanger.
3. Fill the oil cup with lubricating oil and open the oiling lever.
4. Release the cam selector to apply load on the specimen.
5. Select the electric counter to zero and fix predetermine limit of revolution on other manual counter and start the machine.
6. The specimen is now, subjected to cantilever loading and to alternate tension and compression at the specimen rotate in the machine.
7. When the specimen fails to load hanger comes down to actuate the micro switch, which will stop the motor.
8. Plot the graph between 10^6 no. of revelation (N) to failure on x-axis and the maximum stress (s) in kg/mm² on y-axis.
9. Turn back the hand wheel remove the specimen piece and carry on the same procedure for further specimen.

A graph is plotted between the reversal it failure (N) and the maximum stress (S) is drawn to represent the result of the fatigue teat performed on the steel test specimen.

5.0 RESULT:

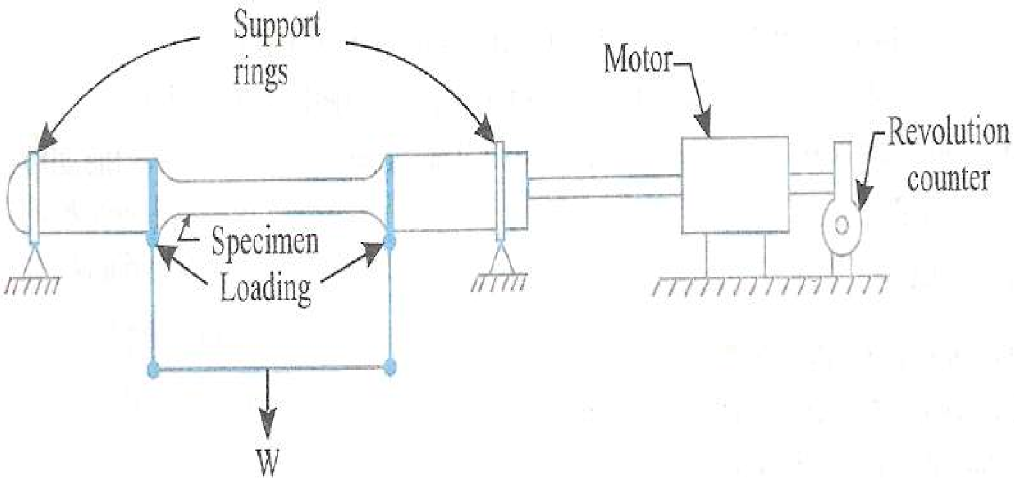
Endurance limit (10^6 cycles) =

6.0 PRECAUTIONS:

a. Apply the load on test piece for exactly 15 seconds and without any jerk.
b. The specimen should be held firmly i.e. collects at both ends.
c. The counter weight should be added on its lever ends to balance weight hanger and its brackets.
d. The cam selector should be released during the test.
e. The oil cup should be filled with thin lubricating oil.
f. The testing machine should be protecting against shock and vibrations.
g. Test piece should be free from any stress concentration and surface imperfection.

7.0 OBSERVATIONS:

Diameter of a test piece d(mm)	Load (W)	Number of cycles (N)	Stress (N/mm2)



Rotary bending fatigue machine.

EXPERIMENT NO: 5

EXPERIMENT 5: To perform Rockwell Harness test on a given specimen.

1.0 AIM:

To perform Rockwell Harness test on a given specimen.

2.0 APPARATUS:

Rockwell Hardness Testing Machine, Set of Weights, test specimens, steel ball and diamond cone indenter, work supporting platforms, series of standard weight.

3.0 DESCRIPTION:

Hardness of a material is its resistance to penetration under a localized pressure or resistance to abrasion. Hardness test provide an accurate rapid and economical way of determining the resistance of materials to deformation. There are three general types of hardness measurements depending upon the manner in which he test is conducted. (1) Scratch hardness measurement, (2) Rebound hardness measurement, (3) indentation hardness measurement. The general means of judging the hardness is measuring the resistance of a material to indentation. The indenter is usually a ball, cone or pyramid of a material much harder than that being used. Hardened steel, sintered tungsten carbide or diamond indenters are generally used. In indentation tests load is applied by pressing the indenter at right angles to the surface being tested. The hardness of a material depends upon the resistance which it exerts during a small amount of yielding of plastic straining. The resistance depends upon friction, elasticity, viscosity and the intensity and distribution of plastic strain produced by a given tool during indentation.

4.0 ROCKWELL HARDNESS TEST:

The test consists in forcing an indenter of standard cone or ball into the surface of piece in two operations and measuring the permanent increase of depth of indentation of this indenter under specified condition. From it, Rockwell hardness is deduced. The ball B is used for soft materials (e.g. mild steel, cast iron, aluminum, brass etc.) and cone C for hard ones (High carbon steel and high-speed steels etc.)

HRB means Rockwell hardness measured on B scale
HRC means Rockwell hardness measured on C scale

S. No.	Rockwell 'B'	Rockwell 'C'
1	Diameter of ball=1.5875mm (1/16") (Hardened and tempered steel 65.5 HRC)	Angle of tip of a diamond cone=120^0
2		Radius of curvature at the tip of the cone=0.2mm
3	Preliminary load=100N ± 2 N	Preliminary load=100N ± 2 N
4	Additional load=900N	Additional load=1400N
5	Total load=1000N ± 6.5 N	Total load=1500N ± 9 N

5.0 TEST BLOCKS:

(1) Standardized metal block shell be of a thickness not less than 6 mm. block, if made of steel be magnetized.
(2) Upper and lower surface of blocks shell be flat with point 0.005mm and parallel in thickness such that it should not vary more than 0.01mm per 50 mm.
(3) Surface should be ground and polished

6.0 TEST REQUIREMENTS:

1. Test should be carried out at an ambient temperature of 20C $\pm 2^0$ in temperature climate and 27C $\pm 2^0$ in typical climates
2. The testing machine shell be protected thought out the test from shock and vibration
3. Test piece shell be placed on a rigid support. The contact surface shell be clean a free from foreign metals.
4. The thickness of test piece shall be atlas 8 times the permanent indentation of depth. No deformation shell be visible at the back of the test piece after the test.

5. The distance between the centres of the two adjacent indentation shell at least 4 times the diameter of the indentation and distance from the centre of any indentation to the edge of the test piece shell be at least 2.5 times the diameter of indentation unless agreed otherwise.

7.0 PROCEDURE:

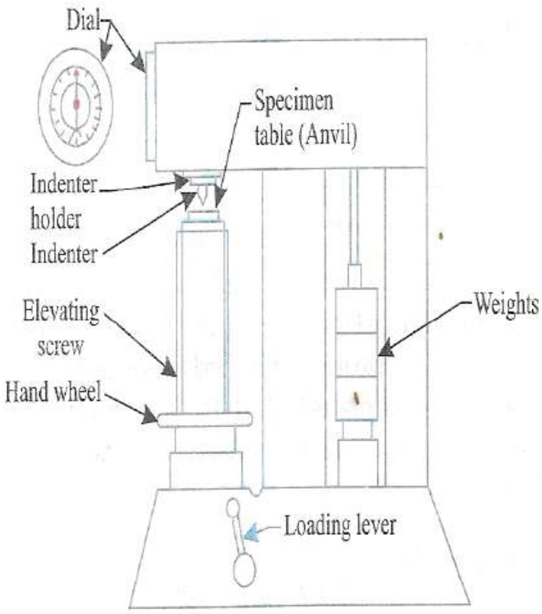
(1) Place the specimen securely upon the anvil
(2) Elevate the specimen so that it comes into contact with penetrate and put the specimen under a preliminary or minor load of 100 +-2N without shock (By moving hand wheel).
(3) Apply the major load 900N by loading lever
(4) Watch the pointer until it comes to rest
(5) Remove the major load
(6) Read the Rockwell hardness number on hardness scale

8.0 PRECAUTIONS:

(1) Successive impressions should not be superimposed on another nor be made too close together when making hardness determinations
(2) Nor should be a measurement be made too close to the edge or a specimen so thin that impression comes through the other side
(3) Small irregularities dirt and scale should be avoided because of greater sensibility of the Rockwell test.

9.0 OBSERVATIONS

S.No.	Specimens	Reading (HRB/HRC)			
		1	2	3	Mean
1	Mild steel				HRB=
2	High carbon steel				HRC=
3	Brass				HRB=
4	Aluminum				HRB=



Rockwell hardness tester.

EXPERIMENT NO: 6

EXPERIMENT 6: To determine the stiffness and modulus of rigidity of a close coiled helical spring in tension and compression.

1.0 OBJECTIVE:

To determine the stiffness and modulus of rigidity of a close coiled helical spring in tension and compression.

2.0 APPARATUS:

5 Ton Spring testing machine with digital display unit, steel rule, closed coil helical spring in tension & compression.

3.0 DESCRIPTION OF APPARATUS:

The spring testing machine is fabricated to test spring specimen in compression and tension up to a maximum of 5 ton. The machine is mechanically and electrically driven as well as hand operated with the help of wheel provided.

The spring test machine is consisting of loading frame with a uniform vertical load screw movement. Hand wheel is provided for initial setting of the unit as well as for hard operation on the machine. The loading plates screwed on top of the load screw on in the centre of tension load. A reversible switch is provided for giving the upward and downward movement of load screw. The upward or downward movements restricted by limits switches inside the cabinet. The motor will automatically stop at the limiting positions and will only operate to reverse the moment to the load screw and the switch is operated. Two hooks are provided to test the tension the springs.

These hooks in case of test for tension, replace both the upper plates and the lower plates. Plates are used for testing the compressive strength of the spring.

A LVDT mounted to a bracket fitted to one of the tension rod. The bracket can slide along the tension rod and can be locked at any designed position. An anvil ( ) for LVDT is provided when is bolted to lead screw.

4.0 PROCEDURE:

1. Fix the hooks/plates on the lead screw and load all for tension/ compression respectively.
2. Switch ON the machine and set the reading for displacement to zero by adjusting the LVDT (Linear Variable Displacement Transfer) and the reading for load to zero by rotating hand wheel.
3. For test in compression keep the lower plate at the lowest position and for load to zero by rotating hand wheel.
4. For test in compression keep the lower plate at the lowest position and for tension keep the lower hook at the highest position.
5. Place the spring between the plates for compression and between spring hooks for tension.
6. Select the load from display unit and switch the hydraulic ram to move forward for compression and backward for tension.
7. Note down the reading of load applied and their corresponding displacement at regular interval for loading and unloading conditions.
8. Determine the stiffness (k) of spring from the graph.

5.0 OBSERVATIONS:

1. Least count of micrometre =…………..mm
2. Diameter of spring wire d =………….mm
3. (Mean of three readings)
4. Least count of vernier calliper =…….........mm
5. Diameter of the spring coil, D = …………mm
6. (Mean of three readings)
7. Mean coil diameter, D_m = D-d = …...mm
8. Number of turns, n =…….

S. No	Load, W(N)	Deflection δ(mm)	Stiffness k=W/δ (Nl mm)
1			
2			
3			
4			
5			

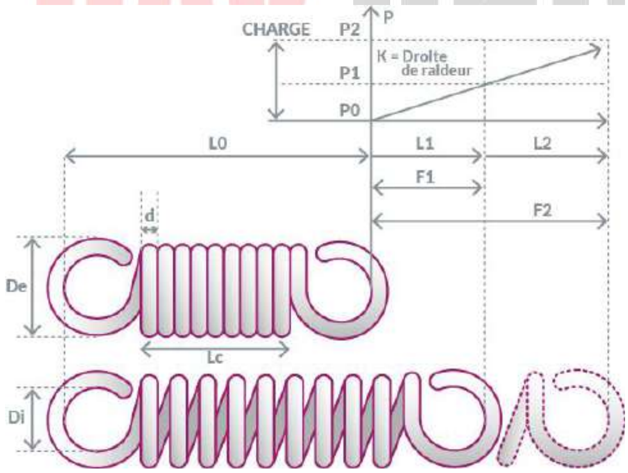
Mean k =……..

Modulus of rigidity, C = $8WD_m^3 n / \delta d^4$

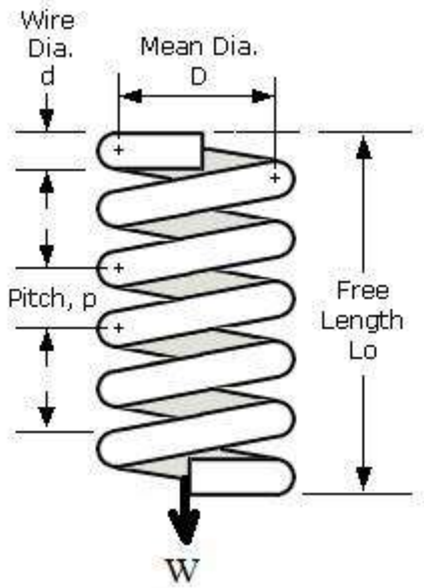
(Spring index = D_m / d)   Plot of graph between W & δ

9. PRECAUTIONS:

1. Apply the load gradually without any jerks.
2. Place the spring centrally between the compression plates.
3. Fix LVDT to tension rod. Do not disturb LDTV during the operation and keep it in cover when not in use.
4. For calculation of displacement always take absolute value of final and initial displacements.
5. Before caring out test ensure that the load screw is at its proper height for the required test.



Closed Spring



Open Spring

EXPERIMENT NO: 7

EXPERIMENT 7: To perform Bending Test on beam (any material) and to determine the Young's Modulus and Modulus of rapture.

1.0 OBJECTIVE:

To find the values of bending stresses and young's modulus of elasticity of the material of beam simply supported at the ends and carrying a concentrated load at centre.

2.0 MATERIAL AND EQUIPMENTS:

(1) Deflection of beam apparatus
(2) Weight
(3) Beam of different cross sections and materials (wooden or steel)

3.0 THEORY:

YOUNG'S MODULUS OF ELASTICITY

If beam is simply supported at the ends and carries a concentrated load at centre, the beam bends concave upwards. The distance between the original position of beam and its position after bending is different points along the length of the beam, being maximum centre in this case. This difference is known as deflection. In this particular type of loading the maximum amount of deflection is given by relation

$\delta = Wl^3 / 48EI$

W= Load acting at the centre, N

l = length of beam between the supports, mm

E = young's modulus of material of beam, N/ mm sq

I= Second moment of area of cross section of beam, about the neutral axis, mm^4

BENDING STRESS

As per bending equation $M / I = \sigma_b / y$

M= Bending moment, N-mm

I = Moment of inertia mm4

σ_b = bending stress N / mm sq

y = Distance of top fiber of beam from neutral axis.

4.0 PROCEDURE:

1. Adjust cast iron blocks along the bed so that they are symmetrical with respect to the length of bed.
2. Place the beam on the knife edges on the blocks so as to project equally beyond each knife edge. See that load is applied at centre of beam.
3. Note the initial reading of vernier calliper.
4. Add a weight 20N (say) and again note the reading of vernier calliper.
5. Go on taking readings adding 20N each time till you have minimum six readings.
6. Find the deflection in each case by subtracting the initial reading of vernier scale.
7. Draw a graph between load and deflection. On graph choose any two convenient points and between these points find the corresponding values of W and δ. Putting these values in relation $E = WL^3 / 48\,\delta I$
8. calculate the bending stress for different loads using relation:
   $\sigma_b = My / I$ Repeat the experiment for different beams.

5.0 PROCEDURE FOR MODULAS OF RAPTURE:

(1) Measure the dimension of wooden beam (depth of beam should be greater than width of the beam)
(2) Fix the beam depth wise symmetrically on rollers
(3) Measure the distance centre to centre between the roller supports

(4) Set the load indicator at zero (0)
(5) Increase the load gradually till the wooden beam raptures/ fails
(6) Note down the load indicated by the pointer.

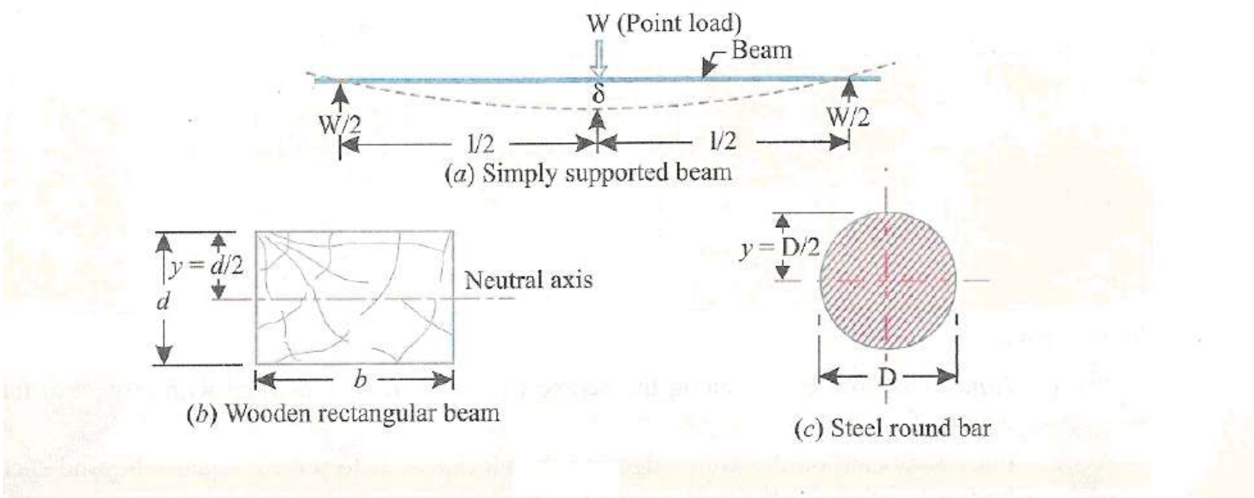
6.0 OBSERVATION AND RESULTS:

Width of beam b = mm (for rectangular cross section)
Depth of beam d = mm
Diameter of beam = mm (for circular cross section)
Moment of inertia for rectangular section = $\pi d^4 / 64$ mm^4
Initial reading of vernier r = mm
(It should be subtracted from the reading taken after putting load)

S. No.	Load W (N)	Bending moment M =Wl/4 Nmm	σ_b = My/I N / mm^2	Deflection δ(mm)	Young's modulus of elasticity E = $Wl^3/ 48 \delta I$
1					
2					
3					
4					

7.0 PRECAUTIONS:

1. Make sure that the beam and load are placed at proper position.
2. The cross section of beam should be large.
3. Note down the readings of the vernier scale carefully.



EXPERIMENT NO: 8

EXPERIMENT 8: To perform Shear Test on different materials and determine ultimate shear strength.

1.0 OBJECT:

To perform Shear Test on different materials and determine ultimate shear strength.

2.0 MATERIAL AND EQUIPMENT:

1. Universal testing machine (UTM)
2. Shear test attachment
3. Given specimens

3.0 OBSERVATION:

Diameter of pin, d = mm

Cross sectional area of pin (double shear) = 2 x 3.141/4 x d^2= mm^2

Load taken by specimen at time of failure, W = (N)

Strength of pin against shearing = 0 x 2 x 3.141/4 x d^2 where 0 is shear strength

W = 0 x 2x 3.141/4 x d^2 ,

0 = W/ 2 X 3.141 x d^2

4.0 PROCEDURE:

1. Insert the specimen in position and grip one end of the attachment in the upper portion and one end in the lower portion
2. Switch on the main switch of universal testing machine.
3. Bring the drag indicator in contact with main indicator.
4. Select the suitable range of loads and place the corresponding weight in the pendulum and balance it if necessary, with the help of small balancing weights.
5. Operate (push) the buttons for driving the motor to drive the pump.
6. Gradually move the head control lever in left hand direction till the specimen shears.
7. Note down the load at which the specimen shears.
8. Stop the machine and remove the specimen.

Repeat the experiment with other specimens.

5.0 PRECAUTIONS :

1. The measuring range should not be changed at any stage during test.
2. The inner diameter of hole in the shear stress attachment should be slightly greater than that of specimen.
3. Measure the diameter of specimen accurately.

6.0 RESULS :

Shear strength of specimen = N / mm^2