INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

Lab Manual:Strength of Materials Laboratory

LABORATORY NAME(ACE13)

Prepared by

MS.. SURBHI THAREWAL (IARE10909)

DEPARTMENT OF CIVIL ENGINEERING
INSTITUTE OF AERONAUTICAL ENGINEERING

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Contents

INTRODUCTION

1.1 Introduction

Strength of materils laboratory is intended to enhance the learning experience of the student to test variety of structural elements made up of different materials subjected to different loading and measure the behavior using sophisticated equipment. How the student performs in the lab dependsonhis/herpreparation,participation,andteamwork.Each team member must participate in all aspects of the lab to insure a thorough understanding of the equipment and concepts. The student, lab teaching assistant, and faculty coordinator all have certain responsibilities toward successful completion of the lab's goals and objectives.

1.1.1 Student Responsibilities

The student is expected to be prepared for each lab.Lab preparation includes reading the lab experiment from the lab manual.If you have questions or problems with the preparation,contact yourLabAssistant and faculty incharge but in a timely manner.Do not wait until an hour or two before the lab and then expect the Lab Assistant and faculty in charge to be immediately available.

Active participation by each student in lab activities is expected. The student is expected to askthe Lab Assistant and faculty incharge any questions they may have.

A large portion of the student's grade is determined in the comprehensive final exam, resulting in a requirement of understanding the concepts and procedure of each lab experiment for the successfulcompletion of the lab session. The student should remain alert and use common sense while performinga lab experiment. They are also responsible for keeping a professional and accurate record of the labexperiments in the lab manual wherever tables are provided. Students should report any errors in the lab manual to the Faculty incharge or course coordinator.

1.1.2 Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each labprior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

1.1.3 Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

1.1.4 Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

1.2 Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the samesemester as AAEC01, but receives a separate grade.

1.3 Course Goals and Objectives

The Mechanics of solids laboratory is designed to provide the student with the knowledge of material properties and its measuring equipments. In addition, the student should learn how to record experimental results effectively and present these results in a written report. More explicitly, the class objectives are:

1. Examine the mechanical properties of different solid engineering materials
2. Identify the behavior of various material samples under different loads and equilibrium conditions.
3. Experiment with materials subjected to tension, compression, shear, torsion, bending and impact.
4. Extract and analyze material testing data and its interpretation.

1.4 Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment andtechniques for conducting experiments. Some understanding of the lab instruments is necessaryto avoid personal or equipment damage.By understanding the device's purpose and following a fewsimple rules, costly mistakes can be avoided.

The following rules provide a guideline for instrument protection.

1.5 Data Recording and Reports

1.5.1 The Laboratory Worksheets

Students must record their experimental values in the provided tables in this laboratory manual and reproduce the min the lab reports. Reports are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory work sheets serve as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report.

1.5.2 The Laboratory Files/Reports

Record is the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab report to inform your faculty incharge about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your faculty incharge to prepare a lab report on a few lab experiments during the semester.

Your laboratory record should be clear and concise. The lab record shall be typed on a word processor. As a guide, use the format on the next page. Use tables, diagrams , as necessary o show what you did, what was observed, and what conclusions you can draw from this.

Order of Lab Report Components

COVERPAGE- Cover page must include lab name and number, your name, your lab partner's name, and the date the lab was performed.
OBJECTIVE - Clearly state the experiment objective in your own words.
EQUIPMENT USED- Indicate which equipment was used in performing the experiment.
For each part of lab

- Write the lab's part number and title in bold font. Firstly, describe the problem that you studied in this part, give an introduction of the theory, and explain why you did this experiment. Do not lift the text from the lab manual; use your own words.

- Secondly, describe the experimental setup and procedures. Do not follow the lab manual in listing out individual pieces of equipment and assembly instructions. That is not relevant information in a lab report! Instead, describe the circuit as a whole and explain how it works. Your description should take the form of a narrative, and include information not present in the manual, such as descriptions of what happened during intermediate steps of the experiment.

- Thirdly, explain your findings. This is the most important part of your report, because here, you show that you understand the experiment beyond the simple level of completing it. Explain (compare expected results with those obtained). Analyze (analyze experimental error).

- Finally, provide a summary of what was learned from this part of the laboratory experiment. If the results seem unexpected or unreliable, discuss the mand give possible explanation

1.6 Conclusions

The conclusion section should provide a take home message summing up what has been learned from the experiment:

- Briefly restate the purpose of the experiment(the question it was seeking to answer)
- Identify the main findings (answer to the research question)
- Note the main limitations that are relevant to the interpretation of the results
- Summarise what the experiment has contributed to your understanding of the problem.

Further Probing Experiments- Advance experiments pertaining to this lab must be probed in further coming weeks

Lab1–DIRECT TENSION TEST

2.1 Introduction

A tensile test, also known as a tension test, is one of the most fundamental and common types of mechanical testing. A tensile test applies tensile (pulling) force to a material and measures the specimen's response to the stress.

2.1.1 Objectives

By the end of this lab, the student should able to apply the concepts of stresses, strains and its relations to materials which are tested practically.

2.2 Equipment

1. Mild steel rod
2. Steel rule
3. Vernier calipers
4. 2 ft Steel rule
5. Extensometer

2.3 Background

DESCRIPTION OF APPARATUS: The machine serves the purpose of conducting tension, compression and bending test. The testing machine is operated hydraulically. Driving is performed by the help of electric motor. The machine is equipped with pendulum dynamometer. A recording device is used for registering load deformation diagram.

CONTROL PANNEL: The control panel consists of a complete power pack with drive motor, oil tank, control valves, a pendulum dynamometer, a load indicator system and an autographic recorder.

POWER PACK: The power pack generates the maximum pressure of 200kgf/cm^2. The hydraulic pump provides continuously non-pulsating oil flow. Hence the load application is very smooth.

LOAD INDICATOR SYSTEM: This system consists of a large dial and a pointer. A dummy pointer is provided to register the maximum load reached during the test. Different measuring ranges can be selected by operating the range selecting knob. An overload trip switch is incorporated, which automatically cuts out the pump motor when the load range is exceeded.

The load ranges has 4 positions.
i.e., 0 to 40 KN
0 to 100 KN
0 to 200 KN
0 to 400 KN

PENDULUM DYNAMOMETER: This unit permits selection of favorable hydraulic ratios producing relatively small directional forces. Pressurized oil in the loading cylinder pushes up the measuring piston proportionately and actuates the special dynamometer system. The piston is constantly rotated to eliminate friction. The dynamometer system is also provided with an integral damper and ensures high reliability of operation. The load transmitted to the dynamometer is transferred through a pendulum to the load indicator.

AUTOGRAPHIC CONTINUOUS ROLL LOAD –ELONGATION RECORDER: This unit is of the open and drums type and is supplied as standard.

GRAPH PAPER: The graph paper which is there in the UTM machine is used to draw the stress-strain diagram for the given material.

GRAPH DRUM: Graph drums on which the graph paper is rolled. It is used to draw the stress Vs strain diagram for the given material

ELONGATION SCALE: On this scale we measure the elongation or compression of the specimen. This is marked from 0 to 20 cm.

PEN HOLDER: This is placed above the graph drum, which is to be used for holding the pen. While the needle of the pendulum dynamometer is rotating, this is to be moved. By using this pen holder we can draw the stress-strain diagram.

LOADING PLATFORM: Loading platform is one on which we keep the specimen for doing the compression test. This loading platform is to be moved in to upward direction by switching on the upward switch of the driving motor. And it is moved downwards by pressing the down switch of the driving motor.

ELECTRIC MOTOR: The electric motor gives the power supply to the system by which we can operate the driving motor properly. This power supply is given to the threading device of the UTM.

2.4 Procedure

1. Measure the length and diameter of given specimen

2. Fix the load range by placing counter weights on the balancing pendulum at the back of the machine.

3. Grip the specimen vertically and firmly between the jaws of the UTM and adjust the machine to read zero.
4. Before operating the UTM ensure that the oil delivery valve (left) is open and the pressure release valve (right) is closed.
5. After switching on the UTM open the pressure release valve and close the oil delivery valve.
6. Now, push the 'ON' button on the control panel and there will be tension acting on the specimen due to fluid pressure.
7. Before applying the pressure adjust the pencil to the graph roll.
8. The yield point is observed when the line needle is suddenly stops for a second and continues to move.
9. At one stage the line needle begins to return, leaving the dummy needle there itself. At this point the ultimate strength of the specimen is observed.
10. After some time the specimen breaks making a huge sound.
11. As the specimen breaks the graph is metallically plotted according to the behaviour of specimen under tension due to applied load.
12. Note and record the required reading and the graph plotted.
13. Remove the broken pieces of the specimen from the machine and safely switch off the machine.
14. Measure the gauge length of the test specimen and diameter of the neck.

S.No.	Load	Deflection	Stress	Strain	Modulus of elasticity
1					
2					
3					
4					
5					

2.4.1 SAMPLE CALCULATIONS:

Diameter of the specimen, d =

Length of the specimen, L=

Yield point found at =

Ultimate strength found at =

Break point found at =

Stress: The resistance offered by a body against the deformation is called stress.

Stress (f) = Load (p)/area of cross section (A)

= P/A N / mm^2

Strain: The ratio of change in length to the original length is called strain

Strain (e) = Change in length / Original length (l)

Young's modulus: The ratio of stress to strain within the elastic limit is called modulus of elasticity (or) young's modulus.

E = Stress (f)/ Strain (e)

Tensile Strength: The tensile strength or ultimate tensile strength is the maximum load obtained in a tensile test divided by the original area of the cross-section of the specimen. It is used for the quality control of the product. It can be co-related to other properties such as hardness and fatigue strength.

Pu= Pmax/A0

Where Pu = ultimate tensile strength in kg/mm2

Pmax= Maximum load obtained in tensile test in Kgs

A0 = original cross-sectional area of load specimen in mm2.

Yield Strength: It is defined as the stress which will produce a small amount of permanent deformation.

Yield strength Py = Pe/ A0

Pe= load obtained at yield point

A0 = original area of cross-section in mm2.

Percentage Elongation: %E = (L-L_0)/ L_0 ×100

E = percentage elongation

L = Increased length or gauge length at fracture.

L_0 = original length.

Total % elongation up to fracture point is an indication of ductility (ability of a material to with stand plastic deformation).

Reduction of Area:It is the ratio of decrease in cross-sectional area to the original area expressed in percentage.

% RA = (A0-A)/ A0×100

RA = percentage reduction in area.

A0 = original cross-sectional area

A = final cross-sectional area after fracture

2.4.2 RESULT-

MODULUS OF ELASTICITY OF MILD STELL BAR—

Lab2–BENDING TEST ON CANTILEVER BEAM

3.1 Introduction

A beam is generally considered to be any member subjected to principally to transverse gravity or vertical loading. The term transverse loading is taken to include end moments. There are many types of beams that are classified according to their size, manner in which there are supported and their location in any given structural system.

3.2 Objective

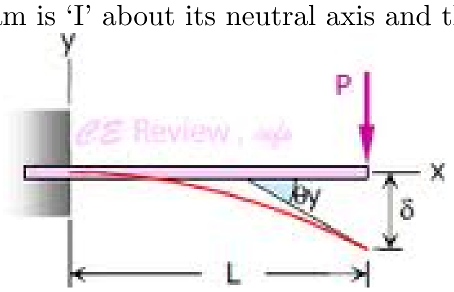
By the end of this lab, the student should understand the behavior of beam under application of load.

3.3 Equipment

1. Beam
2. Dial gauge
3. Weights
4. Weight hanger

3.4 Background:

A cantilever is a beam one end of which is clamped and other end is free. A cantilever beam with a length Lis fixed at one end and the other end is free. Let the moment of inertia of the beam is 'I' about its neutral axis and the young's modulus be 'E'



Cantilever Beam Subjected to Point Load at Free End

Moment of inertia about the neutral axis I= bd^3 / 12,

Deflection at the centre (Max deflection) δ related to the load 'W'. Span 'L' moment of Inertia 'I', and Young's modulus 'E' through the equation.

$$\delta = \frac{WL^3}{3\,EI}$$

From the theory we can observe that, if the load is doubled, the deflection also will be doubled.

EXPERIMENTAL SET-UP

The set up contains the following:

1. One rigid clamping support for fixing one end of the beam.
2. Rectangular cross sectional beam.
3. Loading arrangement along with different weights.
4. Dial gauge with magnetic stand.
5. Measuring tape.

3.5 Procedure:

1. Clamp the beam horizontally and the clamped supported at one end.
2. Hang the loading pan at the free end of cantilever beam.
3. Fix the dial gauge at the point of loading and set the dial gauge reading to zero position.
4. Load the beam with different loads and note the corresponding dial gauge readings

3.6 THEORETICAL DEFLECTIONS

Sl No:	LOAD (W)	Deflection(δ_{th})
1		
2		

1. **EXPERIMENTAL DEFLECTIONS:**

Sl No:	LOAD (W)	Deflection (δ_{ex})
1		
2		

Further Probing Experiments:

Q1. Reinforced concrete beams

Q2. Concrete beam

3.6.1 RESULT-

DEFLECTION OF CANTILEVER BEAM—

Lab3–BENDING TEST ON SIMPLY SUPPORTED BEAM

4.1 Introduction

A beam is generally considered to be any member subjected to principally to transverse gravity or vertical loading. The term transverse loading is taken to include end moments. There are many types of beams that are classified according to their size, manner in which there are supported and their location in any given structural system.

4.2 Objective

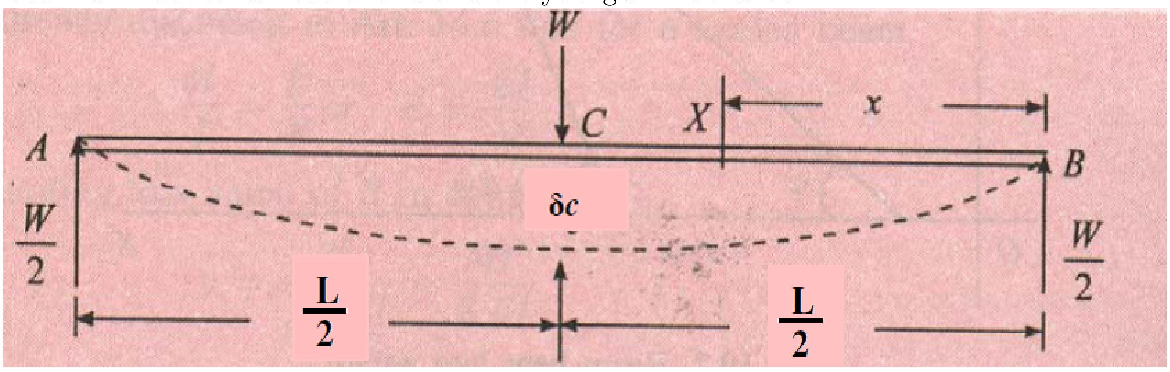
By the end of this lab, the student should understand the behavior of beam under application of load.

4.3 Equipment

1. Beam
2. Dial gauge
3. Weights
4. Weight hanger

4.4 Background:

A beam with a span L & is supported at both ends knife edges. Let the moment of inertia of the beam is 'I' about its neutral axis and the young's modulus be 'E'.



Moment of inertia about the neutral axis I= bd^3 / 12,

Deflection at the centre (Max deflection) δ related to the load 'W'. Span 'L' moment of Inertia 'I', and Young's modulus 'E' through the equation.

$$\delta = \frac{WL^3}{48\,EI}$$

From the theory we can observe that, if the load is doubled, the deflection also will be doubled

EXPERIMENTAL SET-UP:

The set up contains the following:

1. Two knife edges & supported stands for beam.
2. Rectangular cross sectional beam.
3. Loading arrangement along with different weights.
4. Dial gauge with magnetic stand.
5. Measuring tape.

4.5 Procedure:

1. Set the beam horizontally on the two knife edges.
2. Measure the span of the beam L.
3. Hang the loading pan at the mid-point of span.
4. Fix the dial gauge at the point of loading and set the dial gauge reading to zero position.
5. Load the beam with different loads and note the corresponding dial gauge readings.

Further Probing Experiments:

Q1. Reinforced concrete beams
Q2. Concrete beam

4.5.1 RESULT-

DEFLECTION OF SIMPLY SUPPORTED BEAM—

Lab 4– TORSION TEST

5.1 Introduction

Torsion testing is a type of mechanical testing that evaluates the properties of materials or devices while under stress from angular displacement. Torsion testing can be split into two distinct categories: testing raw materials like metal wires or plastic tubing to determine properties such as shear strength and modulus, or functional testing of finished products subjected to torsion, such as screws, pharmaceutical bottles, and sheathed cables. The most common mechanical properties measured by torsion testing are modulus of elasticity in shear, yield shear strength, ultimate shear strength, modulus of rupture in shear, and ductility.

5.2 Objectives

By the end of this lab, the student should be able to apply shear concepts and its application to materials.

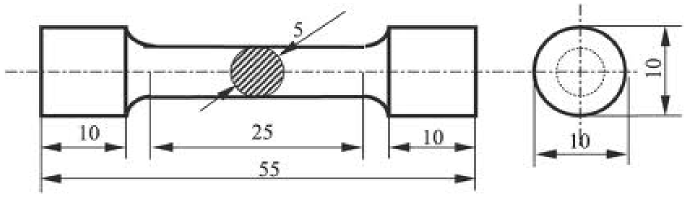
5.3 Equipment

1. A torsion testing apparatus
2. Standard specimen of mild steel or cast iron.
3. A steel rule
4. Vernier caliper.

5.4 Background

A torsion test is quite instrumental in determining the value of rigidity (ratio of shear stress to shear strain) of a metallic specimen. The value of modulus of rigidity can be found out through observations made during the experiment by using the torsion equation:

$$\frac{T}{I_p} = \frac{C\theta}{l} \quad \text{or} \quad C = \frac{T\,l}{I_p\,\theta}$$

Torsion Testing Machine Test Specimen

Where,
T=torque applied,
I_p= polar moment of inertia,
C=modulus of rigidity,
θ= Angle of twist (radians), and
l= gauge length.

In the torque equipment, one end of the specimen is held by a fixed support and the other end to a pulley. The pulley provides the necessary torque to twist the rod by addition of weights (w). The twist meter attached to the rod gives the angle of twist.

5.5 Procedure

1. Prepare the testing machine by fixing the two twist meters at some constant lengths from fixed support.
2. Measure the diameter of the pulley and the diameter of the rod.
3. Choose the appropriate loading range depending upon specimen.
4. Set the maximum\m load pointer to zero.
5. Load the member in suitable increments, observe and record strain readings.
6. Continue till failure of the specimen.
7. Calculate the modulus of rigidity C by using formulae within the elastic limit.
8. Plot the graph between C and θ.

5.6 OBSERVATIONS

Gauge length (L) = ...mm
Diameter of the specimen (D) = ...mm.
Polar moment of inertia (Ip) = ...mm^4.
Maximum angle of twist (θ max) =..........rads.
Modulus of rigidity (C) = ...N/mm^2

5.7 Table:

Sl No.	L (mm)	D (mm)	T (N-mm)	θ		Ip mm^4	C (N/mm^2)
1							
2							

5.8 Further Probing Experiments

Q1.Torsion testing of metallic wire
Q2. Torsion testing of bone screws.

5.8.1 RESULT-

MODULUS OF RIGIDITY OF SPECIMEN—

Lab 5–HARDNESS TEST

6.1 Introduction

Hardness is defined as the resistance of a metal to plastic deformation against Indentation, scratching, abrasion of cutting. In this session the equipment associated for finding hardness number is presented.

6.2 Objective

To familiarize the students with the hardness test equipment used for measuring the hardness number made of different materials subjected to load.

6.3 Equipment

1. Rockwell hardness testing machine.
2. Black diamond cone indenter,
3. Hard steel specimen.
4. 2 ft Steel rule

6.4 Background

Hardness: It is defined as the resistance of a metal to plastic deformation again indentation, scratching, abrasion of cutting. Rockwell test is developed by the Wilson instrument co U.S.A in 1920. This test is an indentation test used for smaller specimens and harder materials. The test is subject of IS: 1586. The hardness of a material by this Rockwell hardness test method is measured by the depth of penetration of the hardness. Both ball or diamond cone types of indenters are used in this test. There are three scales in the machine for taking hardness readings. Scale 'A' with load 60kgf or 588.4 N and diamond indenter is used for performing tests on thin steel and shallow case harnessed steel. Scale 'B' with load 100kgf or 980.7N and 1.588mm dial ball indenter is used for performing tests on soft steel, malleable iron, copper and aluminum alloys. First minor load is applied to overcome the film on the metal surface. Minor load also eliminates errors in the depth of measurements due to spring of the machine frame or setting down of the specimen and table attachments.

The Rockwell hardness is derived from the measurement of the depth of the impression

E_p = Depth of penetration due to minor load of 98.07N.

E_a = Increase in the depth of penetration due to major load.

E = Permanent increase of the depth of indentation under minor load at 98.07N even after removal of major load.

This method of test is suitable for finished or machine parts of simple shapes.

6.5 Procedure

1. Select the load by rotating the knob and fix the suitable indenter.
2. Clean the test-piece on the special anvil or work table of the machine.
3. Turn the capstan wheel to elevate the test specimen into contact with the indenter point.
4. Further turn the wheel for three rotations forcing the test specimen against the indenter. This will ensure that the minor load of 98.07N has been applied.
5. Set the pointer on the scale dial at the appropriate position.
6. Push the lever to apply the major load. A dash pot provided in the loading mechanism to ensure that the load is applied gradually.
7. As soon as the pointer comes to rest pull the handle in the reverse direction slowly. This releases the major, but not minor load. The pointer will now rotate in the reverse direction.
8. The Rockwell hardness can be read off the scale dial, on the appropriate scale, after the pointer comes to rest.

6.6 OBSERVATIONS:

Material of test piece =
Thickness of the piece =
Hardness scale used =

6.7 Further Probing Experiments

Q1. Testing of titanium
Q2. Testing of certain plastics

6.7.1 RESULT-

HARDNESS OF MATERIAL BY ROCKWELL HARDNEESS NO—

Lab 6–SPRING TEST

7.1 Introduction

Spring is a deformable member and it can support both tensile and compressive forces. Special springs are designed to support bending or torsional loads. Knowledge of force deformation characteristic of a spring is essential to design springs for an application.

7.2 Objective

By the end of this lab, the student should learn the characteristics of a spring under tensile or compressive force.

7.3 Equipment

1. Spring testing machine
2. Springs for testing
3. Micrometer
4. Vernier caliper.

7.3.1 Background

Springs are elastic members which distort under load and regain their original shape when load is removed. They are used in railway carriages, Motor cars, Scooters, Motor cycles, Rickshaws, Governors etc.

Types of springs:

1. Close-coiled helical springs & Tension helical springs with circular cross-section
2. Open-coiled springs & compression helical springs with square cross-section
3. Full-elliptical leaf springs.
4. Semi-elliptical laminated springs.
5. Cantilever lever springs.
6. Circular springs.

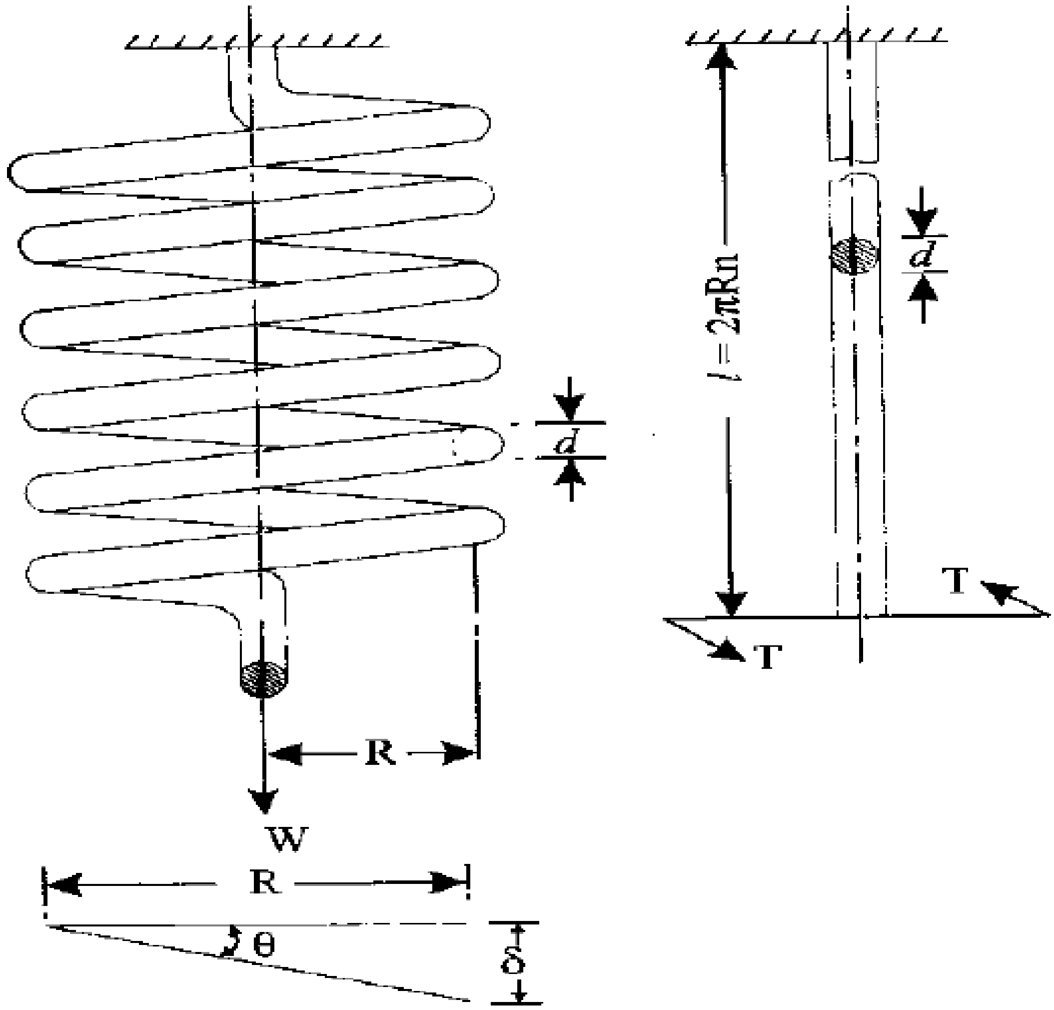
According to their uses, the springs perform the following function:

1. To absorb shock or impact loading as in carriage springs.
2. To store energy as in clock springs.

3. To supply forces to and to controls motions as in brakes and clutches.
4. To measure forces as in spring balances.
5. To absorb the vibrations, characteristic of a member as in flexible mounting of motors.
6. The springs are usually made of either high carbon steel (0.7% to 1.0%) or medium carbon alloy steels. Phosphor bronze, Brass and 18/8 stainless steel. Other metal alloys are used for corrosion resistance.

Analysis of close-coiled helical springs: (circular section wire)
W Axial load applied(N)
R_m Mean radius of the coil (mm)
D_o Outer diameter of coil (mm)
D_m (D_o -d) Mean diameter of the coil (mm)
D Diameter of the wire of the coil (mm)
δ Deflection of coil (m) under the load 'W'
C Modulus of rigidity (N/mm^2)
n Number of coils or turns.
L Length of wire = $2\pi R_m n$ (mm)
t shear stress(N/mm^2)
T Torque (N-mm)
I_p Polar Moment of Inertia of wire = $\pi d^4/32$ (mm^4)
Spring index = D_m/d

Modulus of rigidity **C** = $\frac{8WD_m{}^3 n}{\delta d^4}$



Closed coil helical spring

7.4 Procedure

1. Measure the diameter of the wire of the spring by using the micrometer.
2. Measure the diameter of spring coils by using the Vernier caliper.
3. Count the number of turns.
4. Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in tension or compression.
5. Increase the load and take the corresponding axial deflection readings.
6. Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring.

OBSERVATIONS:

Sl No.	Load W, (N)	Deflection, δ, (mm)	Stiffness W/δ, (N/mm)
1			
2			

Further Probing Experiments:

Q1. Metal spring of aerospace applications

Lab 7–COMPRESSION TEST

8.1 Introduction

A copmression test,is one of the most fundamental and common types of mechanical testing. A copmression test applies tcopmressive (pushing) force to a material and measures the specimen's response to the stress.

8.2 Objectives

By the end of this lab, the student should able to apply the concepts of copressive sthrenth of concrete , strains and will identify the grade of concrete.

8.3 Equipment

1. UTM or A compression testing m/c
2. Cylindrical or cube shaped specimen,
3. Vernier caliper,
4. Liner scale

8.4 Background

concrete are used in construction of either load bearing walls or in portion walls in case of frame structure. In bad bearing walls total weight from slab and upper floor comes directly through concrete and then it is transversed to the foundation. the concrete are loaded with compressive nature of force

the concrete in actual practice they have to be tested in laboratory for their compressive strength.

DIAGRAM:

8.5 Procedure

1. 1. Select some Concrete with uniform shape and size
2. Measure diamesions of cube as L, B, H.
3. Place the concrete on the lower platform of compression testing machine and lower the spindle till the upper motion of ram is offered by a specimen the oil pressure start increasing the pointer start returning to zero leavingthe drug pointer that is maximum reading which can be noted down.

TABULAR COLUMN:
When one end is hinged and other end is fixed before loading.

Sl. No	**L x B x H, Cm3**	**Area, L x B, Cm2**	**Load (P), N**	**Diameter (mm)**	**Compressive Strength (P/A), KPa**
1)	Stainless steel				

8.6 Calculation

Max. Load at failure
Compressive Strength =—- KPa

8.7 Result

The average compressive strength of new brick sample is found to be — KPa

Lab 8– IMPACT TEST

9.1 Introduction

Impact is a very important phenomenon in governing the life of a structure. For example, in the case of an aircraft, impact can take place by a bird hitting a plane while it is cruising, or during takeoff and landing the aircraft may be struck by debris that is present on the runway, and as well as other causes. It must also be calculated for roads if speed breakers are present, in bridge construction where vehicles punch an impact load, etc. Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation they can endure

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9.2 Objectives

By the end of this lab, the student should learn how to calculate the impact strength of different materials by using Izod impact test.

9.3 Equipment

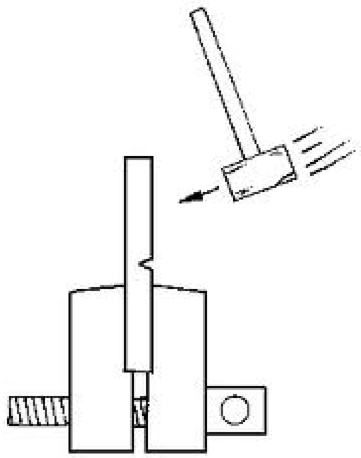
1. Izod abd charpy impact testing machine
2. Test specimen
3. Vernier caliper
4. Steel rule

9.4 Background

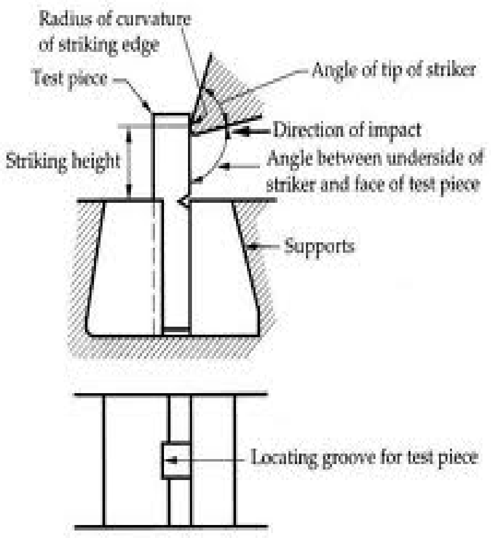
In a impact test a specially prepared notched specimen is fractured by a single blow from a heavy hammer and energy required being a measure of resistance to impact. Impact load is produced by a swinging of an impact weight W (hammer) from a height h. Release of the weight from the height h swings the weight through the roof of a circle, which strikes the specimen to fracture at the notch. Kinetic energy of the hammer at the time of impact is $mv^2/2$, which is equal to the relative potential energy of the hammer before its release.ie., P.E = mgh, where m is mass of the hammer and $v = \sqrt{2gh}$ is its tangential velocity at impact, g is gravitational acceleration (9.806 m/s^2) and h is the height through which hammer falls. Impact velocity will be 5.126 m/s or slightly less. Here it is interesting to note that height through which hammer drops determines the velocity and height and mass of a hammer combined determine the energy. Energy used can be measured from the scale given. The difference between potential energies is the fracture energy. In test machine this value indicated by the pointer on the scale. If the scale is calibrated in energy units, marks on the scale should be drawn keeping in view angle of fall and angle of rise.

Height h_1 and h_2 equals, $h_1 = R\ (1 - \cos\theta)$ and $h_2 = (1 - \cos\theta)$.

With the increase or decrease in values, gap between marks on scale showing energy also increase or decrease. This can be seen from the attached scale with any impact machine. Energy used in fracturing the specimen can be obtained approximately as Wh_1-Wh_2. This energy value called impact toughness or impact value, which will be measured, per unit area at the notch.



Izod Impact Testing Machine Direction of Impact



Impact on the Specimen

9.5 Procedure

1. Measure the dimensions of a specimen. Also, measure the dimensions of the notch.
2. Raise the hammer to 90 degrees position, fix it to the hook and note down initial reading from the dial, which will be energy to be used to fracture the specimen.
3. Place the specimen for test and see that it is placed center with respect to hammer. Check the position of notch.
4. Release the hammer and note the final reading. Difference between the initial and final reading will give the actual energy required to fracture the Specimen.
5. Compute the energy of rupture of the specimen.

OBSERVATIONS

Sl No.	A Area of cross-section of specimen	K Impact energy absorbed	I impact strength

9.6 Further Probing Experiments

Q1. Natural fibre composites
Q2. Rubbers and plastics

9.6.1 RESULT-

impact strength of steel specimen by (a)Izod test— (b) Charpy Test —

Lab 9-SHEAR TEST

10.1 Introduction

shear strength is the strength of a material or component against the type of yield or structural failure when the material or component fails in shear. A shear load is a force that tends to produce a sliding failure on a material along a plane that is parallel to the direction of the force..

10.2 Objective

By the end of this lab, the student will find the shear strength of given specimen.

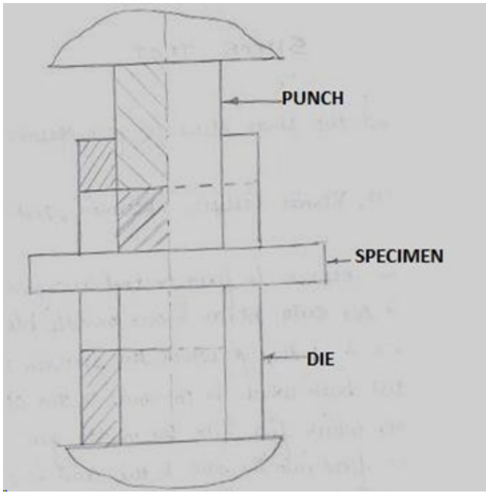
10.3 Equipment

1. Universal testing machine
2. Shear test attachment.
3. Specimens.

10.3.1 Background

Place the shear test attachment on the lower table, this attachment consists of cutter. The specimen is inserted in shear test attachment and lift the lower table so that the zero is adjusted, then apply the load such that the specimen breaks in two or three pieces. If the specimen breaks in two pieces then it will be in single shear and if it breaks in three pieces then it will be in double shear.

10.4 Diagram



10.5 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 machine
3. The drag indicator in contact with the main indicator
4. Select the suitable range of loads and space the corresponding weight in the pendulum and balance it if necessary with the help of small balancing weights.
5. Operate (push) buttons for driving the motor to drive the pump
6. Gradually move the head control level in left-hand direction till the specimen shears
7. Down the load at which the specimen shears
8. Stop the machine and remove the specimen

OBSERVATIONS:
Diameter of the Rod, D = ….. mm
Cross-section area of the Rod in double shear =
Load taken by the Specimen at the time of failure , W = N

10.6 Result

Shear strength of mild steel specimen is found to be = N/mm2

Lab 10–VERIFICATION OF MAXWELL'SRECIPROCAL THEOREM ON BEAMS

11.1 Introduction

A beam is generally considered to be any member subjected to principally to transverse gravity or vertical loading. The term transverse loading is taken to include end moments. There are many types of beams that are classified according to their size, manner in which there are supported and their location in any given structural system.

11.2 Objective

To find young's modulus of the material of the given beam by conducting bending test on simply supported beam using Maxwell's law of reciprocal deflections.

11.3 Equipment

1. Beam supports
2. Loading yoke,
3. Slotted weight hange
4. Dial gauge stand
5. Scale
6. Vernier callipers

11.4 FORMULA:

$$\delta = \frac{11\ WL^3}{768\ EI}$$

11.5 Procedure:

1. The breadth and depth of the beam along the span is measured and average values are taken. The load is applied in increments and the corresponding deflections with the help of dial gauge are measured.
2. Precautions are to be taken to keep the dial gauge in correct position to measure the desired deflection. The deflections corresponding to various loads for each case are tabulated.

3. The beam is placed horizontally and in the first case, the loads are acted in the middle and dial gauge is placed at 1/4th of the beam and loads are added slowly and according to the load, the readings are noted. Similarly note down the deflections while unloading.
4. In the second case load is placed at 1/4th of the beam and dial gauge at the center and the readings are noted similar to the first case.

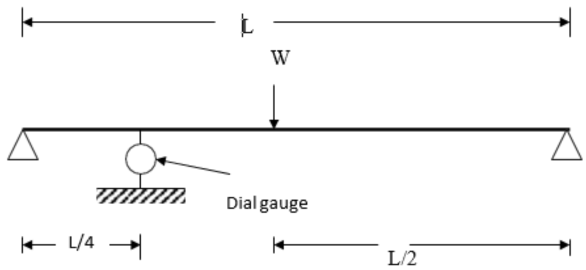
11.6 Parameters of set-up

Sl No:	Parameters of set-up	Value(δ_{th})
1	Width of the beam (rectangle) cross-section, b mm	
2	Depth of the beam (rectangle) cross-section, d mm	
3	Moment of inertia , bd3/12	

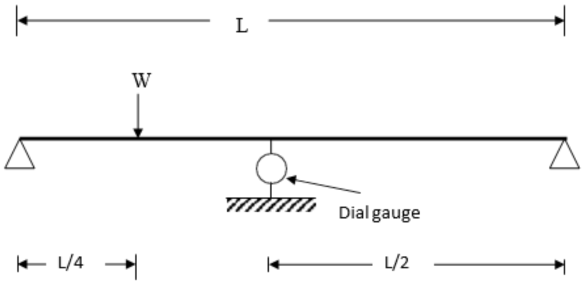
1. **EXPERIMENTAL DEFLECTIONS:**

Sl No:	Load(W) N (W)	Young's Modulus
1		
2		

Case (i):



Case (ii):



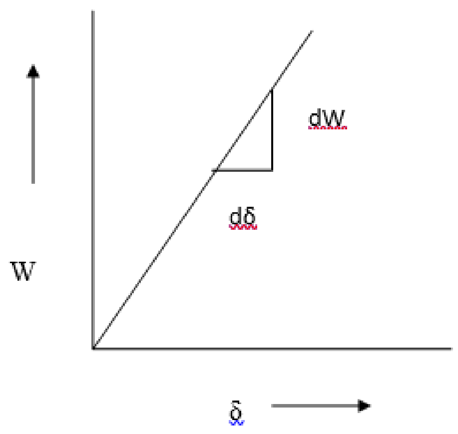
11.7 Calculations

Moment of inertia I =—
young's Modulus E=—

11.8 Result

The Young's modulus of steel by Maxwell's reciprocal theorem is:–
The percentage error is:—

11.8.1 GRAPHS TO BE DRAWN



Lab 11– STRAIN MEASUREMENT

12.1 Introduction

The stress analysis with strain gauge is used to determine the stress in a single component. In the stress analysis with strain gauges usually bridge circuits are used with only one active measurement grid. In a uniaxial stress condition, it is sufficient to detect the strain with a single measuring grid.

12.2 Objective

To measure the stress and strain using strain gauges mounted on cantilever beam.

12.3 Equipment

1. 1 Strain gauge Kit,
2. cantilever beam weights, .
3. Multimeter

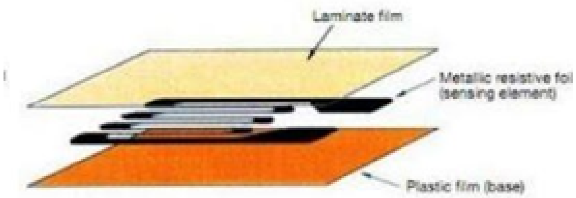


Fig: Strain Gauge

12.4 Procedure:

1. Arrange the cantilever beam, ammeter and voltmeter as shown in figure. After this, put the weight on the rod of cantilever beam.
2. Measure the digital display reading for a particular weight. Measure the value of ammeter (along) and voltmeter reading (micro-volt)
3. Increase the strength of weight. Repeat the steps for increased weight.
4. Measure all dimensions of scale of cantilever. Plot a graph
5. Find Gauge Factor (GF) by finding the inverse of the slope i.e. =

$$\frac{\varepsilon}{\Delta R / R_0}$$

Mark on the graph and use Gauge Factor to find strain.

12.5 Observations:

S.No	Loads (gms)	Resistance			$\frac{\Delta R}{R_o}$	Strain Ɛ
		R_o	R_f	$\Delta R = Rf - R_o$		
1.						
2.						
3.						
4.						
5.						
6.						
7.						

12.6 Calculations:

Strain Ɛ (Theoretical) = $\frac{\Delta l}{l} = \frac{6PL}{Ebt^2}$ for cantilever type elastic member

Ɛ (Experimental) = $\frac{\frac{\Delta R}{R_o}}{Guage\ Factor\ (GF)}$

Modulus of Elasticity E = Stress/Strain

Strain = E x strain = E x e

Lab12–DEFLECTION OF CONTINUOUS BEAM

13.1 Introduction

when there is the vertical displacement at any point on the loaded beam, it is said to be deflection of beams. The maximum deflection of beams occurs where slope is zero. Slope of the beam is defined as the angle between the deflected beam to the actual beam at the same point

13.1.1 Objectives

To find the young's modulus of the given structural material mild steel or wood by measuring deflection of Continuous beam.

13.2 Equipment

1. Beam supports
2. loading yoke
3. Slotted weight hanger
4. Dial gauge and Dial gauge stand
5. Scale and Vernier callipers.

13.3 Background

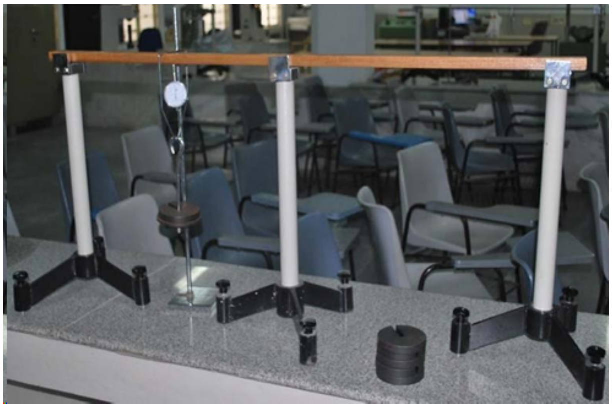
Consider the following loading case as a two span continuos beam of Uniform flexural rigidity EI. It is loaded at half of each span from end supports and deflection is measured at 1/4th of span from right end support.

W= Load. L= span E= Young's Modulus I = Moment of inertia of the beam = 1/12/bd3

13.4 Procedure

1. A beam of known cross-section rectangular shape with width "b" and depth "d" and length "L" is simply supported at two ends and at the center at A,C and B. Equal loads W are applied at half of each span at D and E as shown in the figure
2. In six increments The deflection at F is correlated graphically to the load applied and the Young's Modulus is determined

13.4.1 CONTINUOUS BEAM SETUP



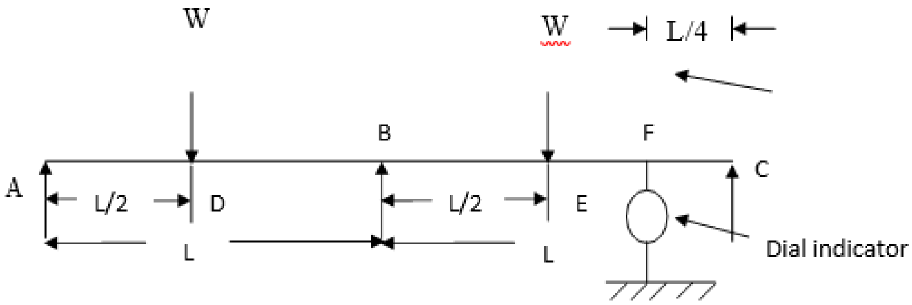


Figure.1: Continuous Beam Deflection.

13.4.2 obseravation and tabukar coloum

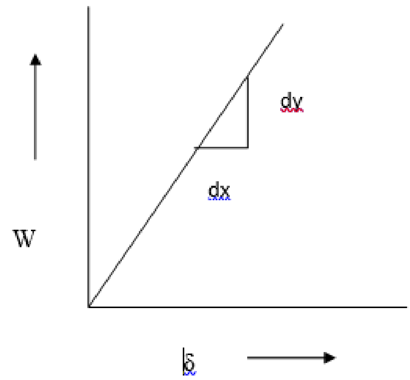
S.No.	Load applied	Deflection in mm	Average	Deflection LC x Avg	Modulus of elasticity
1					
2					
3					
4					
5					

13.4.3 SAMPLE CALCULATIONS:

Diameter of the specimen, d =
Length of the specimen, L=
Moment of inertia (I) =
Young's Modulus (E) =

13.4.4 GRAPHS TO BE DRAWN:

Deflection (δ) vs. Load (W)



13.5 RESULT

RESULT:

Young's Modulus of steelL from the deflections on a two span continuous beam is:—– N/mm2

Lab 12 – Final Exam

14.1 Introduction

This has been your fourth engineering laboratory. Although you have been provided with a (this manual), hopefully you have not just blindly followed instructions in order to get a good grade. If you have, you have cheated only yourself. The theory which you have learned from your textbook and lectures is a way of looking at reality and thinking about how to organize experience, i.e., dealing with real, physical things. It is only through combining practical experience with theory that you can begin to develop the necessary analytical skills to aid you in “taking things apart and putting them together in new ways” that is the essence of the practice of real engineering.

14.2 Objective

This examination is designed to help you and your lab to determine how much you have developed your knowledge, skills and self-confidence.

14.3 Equipment

1. Writing Pad & Scale and Pencils
2. Eraser & Lab record

14.4 Procedure

The final exam will consist of a written exam and a practical exam. The practical exam involves performing a lab procedure to obtain a desired result. The written exam will cover the application of theory to understand circuit behavior, based upon your laboratory experiences in this course.

14.4.1 Further Probing Experiments

Q1. What have you done to develop your expertise and skills?
Q2. What will you do differently in the next course?
Q3. What have you learned from your experience?