CONTENTS

Faculty In charge

COURSE OBJECTIVES:

At the end of the Workshop Practice Lab course, the students must be able to:

1. Carry out sheet metal and plumbing work
2. Describe the construction & working of machine tools and automotive systems
3. Demonstrate electrical and wiring principles.
4. Conduct basic testing of electronic components and measurement.
5. Describe the process of material testing and surveying practices.

Mechanical and Manufacturing Engineering Department

List of Experiments

MME 1061: WORKSHOP PRACTICE [0 0 3 1]

Mechanical Division:

Module 1	Sheet Metal Practice	**1 week**
Module 2	Plumbing Practice	**1 week**
Module 3	Study of Automotive Systems	**1 week**
Module 4	Study of Machine tools & Measuring Instruments	**1 week**

References:

1. Laboratory manual
2. Hajra Choudhury S. K. and Bose S. K., Elements of Workshop Technology, Vol I, Media
   Promoters & Publishing Pvt. Ltd., Mumbai, 2012.
3. Raghuvanshi S.S, Workshop Technology, Dhanpat Rai and Sons, Delhi, 2002.

1. SHEET METAL PRACTICE

Soldering:

Soldering is one method of joining two pieces of metal with an alloy that melts at a lower temperature than the metals to be joined. For a good job, the metals to be joined should be free from dirt, grease and oxide. Solder is made of tin and lead, usually in equal proportions. It comes either in the form of wire or bar.

Capillary action between the solder and base metal will not take place unless the base metal is clean. A flux is used with the solder to remove oxides and thus permit good soldering.

Classification of soldering:

Soldering is classified into Soft soldering and hard soldering.

Soft soldering is used extensively in sheet metal work for joining parts that are not exposed to the action of high temperatures and are not subjected to excessive loads and forces. Soft soldering also employed for joining wires and small parts. The solder, which is mostly composed of lead and tin, has a melting range of 150˚C to 350˚C. A suitable flux is always used in soft soldering. Its function is to prevent oxidations of the surface to be soldered or to dissolve oxides that settles on the metal surfaces during the heating process. Although corrosive, zinc chloride is the most common soldering flux. Rosin is non-corrosive, but it does not have the cleaning properties of zinc chloride. Soldering iron constitutes the equipment for heating the base metals and melting the solder and the flux.

Hard soldering employs the solder which melts at higher temperature and stronger than those used in soft soldering. Silver soldering is hard soldering method and silver alloyed with tin is used as a solder. The temperatures of the various hard solders vary from about 600˚C to 900˚C

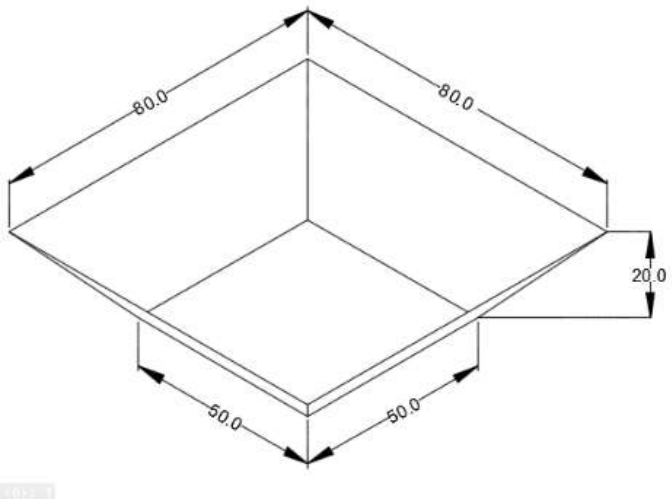
The different compositions of solder for different purposes are as

1. Soft solder- lead 37%,tin 63%
2. Medium solder- lead 50%,tin 50%
3. Plumber’s solder- lead 70%,tin 30%
4. Electrician’s solder- lead 58%,tin 42%

Use of soldering: Soldering is used for joining the following,

- Electrical components in television, radio, transistor and tape recorders.
- Electronic components like printed circuit boards
- Automobile parts like radiators
- Sheet metal works
- Utensil repairs

Sheet Metal Model: Tray



Objective: To prepare a sheet metal tray as per the dimension.

Material to be joined: Galvanized iron sheet 33 SWG

Tools used: Solder iron, snip or tin cutter, flux, nose pliers, engg. steel scale, prick punch, stakes, mallet, etc.

Operations involved: Surface development, marking, punching, cutting, cleaning, tinning, soldering, inspection, etc.

Procedure:

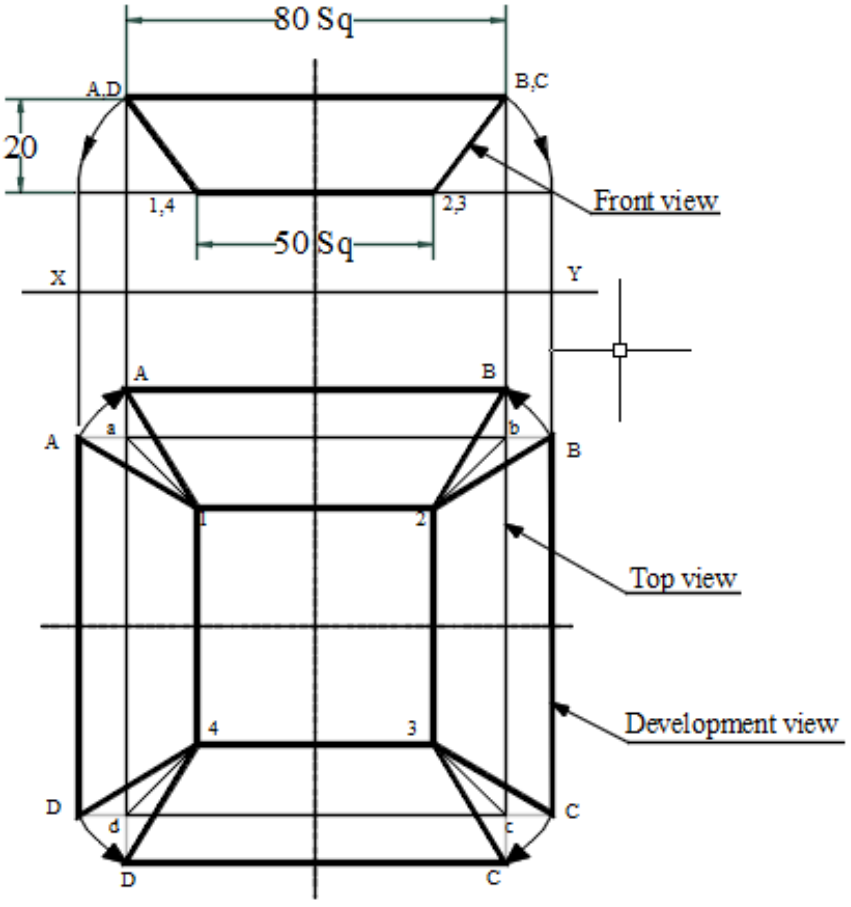
- Mark the dimensions (by punching operation using prick punch) according to the surface development and cut the sheet metal using tin cutter.
- Tinning is to be done on the joining parts.
- Flatten the work piece as per requirement.

- Bend all the four sides of the tray using proper stakes.
- Join the corners by soldering.
- Finishing the process - by cleaning the joined area, using cotton waste.

Precautions:

- Use right tools for right operation.
- Care should be taken while bending, cutting and, cleaning.
- Be careful while handling hot soldering iron.
- Avoid loose clothing, wear shoes while working
- Keep the place clean while working.

Development of Surface: Tray



Steps in drawing the development of Surface:

1. Draw front elevation and Top View (Plan) of the tray to actual size (1:1 scale) and name the corners.
2. From front elevation, draw arcs to get the true length of slant edge as shown in the figure.
3. Locate corresponding top and bottom points as shown in the figure.

2. PLUMBING PRACTICE

Introduction:

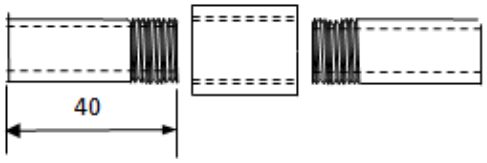
Plumbing deals with the laying of pipe lines. Pipe line provides the means of transporting the fluid/gas. It is obvious that, laying out the pipe line, requires a number of joints to be made and a number of valves to be incorporated, while connecting different lengths of pipes. Plumbing work requires tools like pipe wrenches, hack saw, pipe cutter, threading equipment and a pipe vice.

Different types of pipe fittings:

The size of the pipe is designated by its inside diameter. The size of thea pipe fitting is designated by the size of the pipe on which it fits. There are different types of pipe fitting available in market. They should be selected, keeping in mind the desired piping layout. The most common pipe fittings are coupling, union, elbow, nipple,tee, plug, cap, flange, gate valve, globe valve, non-return(check) valve, common tap etc.

PLUMBING PRACTICE : 1

Objective: To make pipe joint using a coupler.



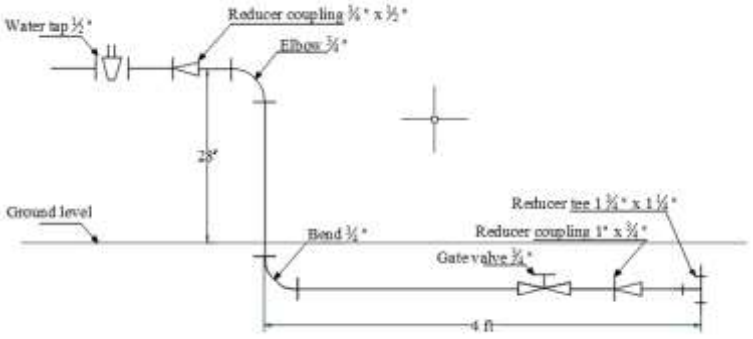
Material: PVC pipe (blue) ½ " size, ½" coupler

Tools Used: Pipe Wrench, Die Block and ½" die set

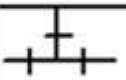
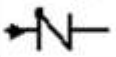
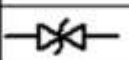
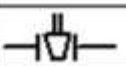
Operation : External thread cutting on pipe ends and fixing into the coupler.

PLUMBING PRACTICE : 2

Plumbing circuit: To fix a water tap of 12 mm as shown in the sketch.



Types of Pipe fittings:

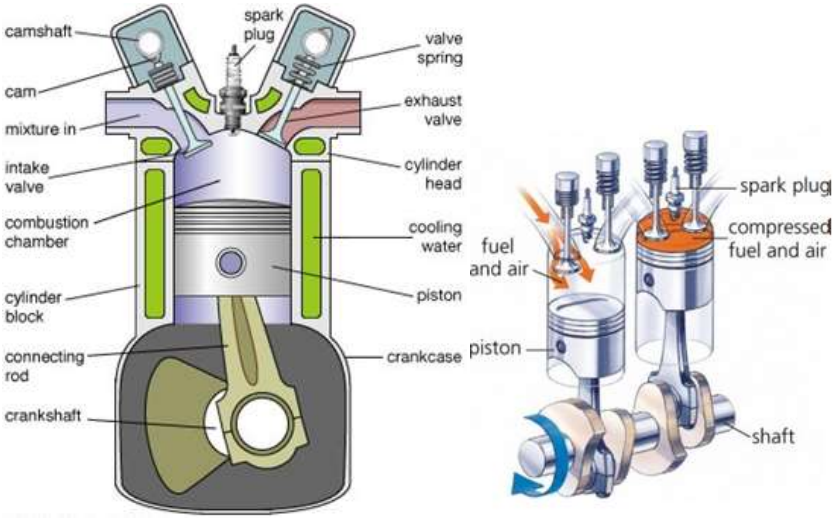
Purpose	Fittings used	Classification	Graphical symbol of Threaded Fittings
1. Extension	a) Coupling	i) Equal coupling	
		ii) Reducer coupling	
	b) Union	----	
	c) Nipple	i) Hex Nipple	---
		ii) Barrel Nipple	---
	d) Flanged pipe Coupling	----	
2.Change of direction	a) Elbow	i) Equal Elbow	
		ii) Reducer Elbow	
	b) Bend	i) Conventional Bend	
		ii) Female Bend	---
3.Junction	a) Tee	i) Equal Tee	
		ii) Reducer Tee	---
	b) Cross	---	
4.Sealing off	a) Plug	---	---
	b) Cap	---	---
5.Regulation	Valves	i) Gate Valve	
		ii) Wheel (Globe) Valve	
		iii) Non- Return (Check)Valve	
		iv)Float Valve	
		v) Safety Valve	
		vi)Stop Cock (Bib cock)	

Courtesy:http://draftingmanuals.tpub.com/

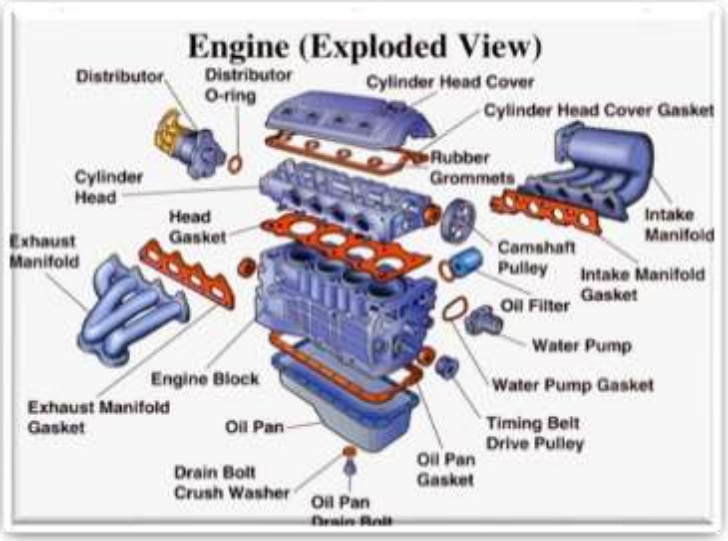
3. AUTOMOTIVE SYSTEMS

3.1 I.C. ENGINE PARTS: The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine the expansion of the high-temperature and -pressure gases produced by combustion applies direct force to some component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy. The various parts of an internal combustion engine are shown below.

Courtesy: www.autoevolution.com



Courtesy: http://www.studyvilla.com



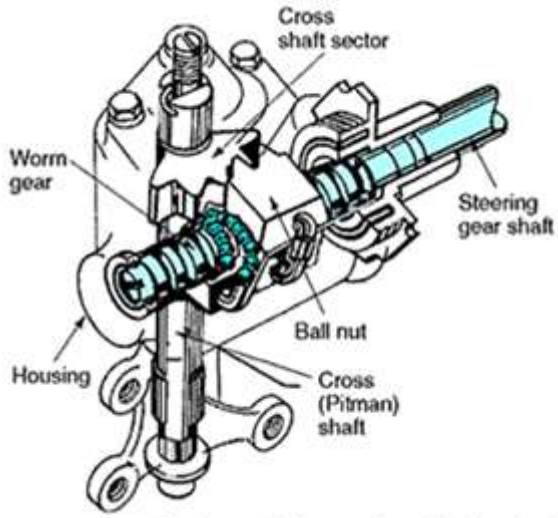
Courtesy: http://hdabob.com

3.2 Steering mechanisms:

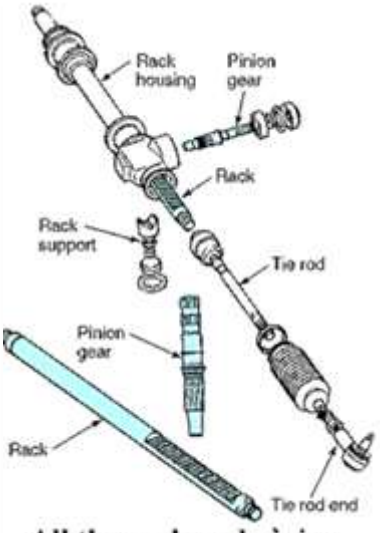
The most conventional steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints (which may also be part of the collapsible steering column design), to allow it to deviate somewhat from a straight line. Tracked vehicles such as bulldozers usually employ differential steering

In a rack and pinion steering mechanism, the steering wheel turns the pinion gear and the pinion moves the rack, which is a linear gear that meshes with the pinion, converting circular motion into linear motion along the transverse axis of the car.

Another mechanism which is normally used in the trucks is the recirculating ball mechanism. This is a variation of the older worm and sector design. The steering column turns a large screw (the "worm gear") which meshes with a sector of a gear, causing it to rotate about its axis as the worm gear is turned an arm attached to the axis of the sector moves the Pitman arm, which is connected to the steering linkage and thus steers the wheels. The recirculating ball version of this mechanism reduces considerable friction with the presence of the steel balls between the thread of the worm and that of the screw. The balls are recirculated from one end of the nut to the other end of the nut.

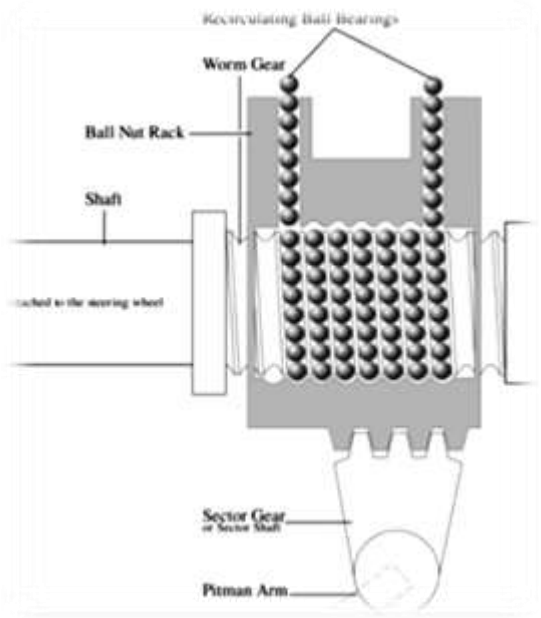


Cross- sectional view of the recirculating ball gear

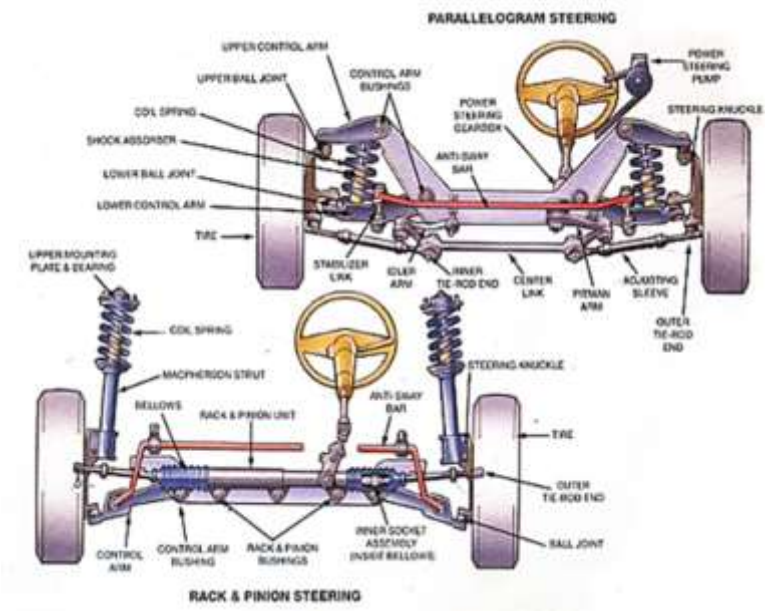


All the rack and pinion components

Courtesy:www.imperialclub.com



Recirculating ball worm mechanism in the steering system
Courtesy: www.auto.hoestuffworks.com



Different types of steering and suspension systems
Courtesy: https://www.sunautoservice.com/

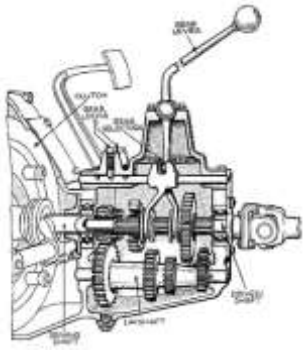
3.3 Transmission system:

A machine consists of a power source and a power transmission system, which provides controlled application of the power. Transmission system is an assembly of parts including the speed-changing gears and the propeller shaft by which the power is transmitted from an engine to a live axle. The term *transmission* refers to the whole drivetrain, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts

Gearbox:

Often transmission refers simply to the gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device. In most vehicles with manual transmission, gears are selected by manipulating a lever called a gear shift lever, gear selector, or shifter connected to the transmission via linkage or cables and mounted on the floor, dashboard, or steering column. Moving the lever forward, backward, left, and right into specific positions selects particular gears.

A sample layout of a four-speed transmission is shown below. N marks *neutral*, the position wherein no gears are engaged and the engine is decoupled from the vehicle's drive wheels. The entire horizontal line is a neutral position, though the shifter is usually spring-loaded so it will return to the center of the N position if not moved to another gear. The R marks reverse, the gear position used for moving the vehicle backward. When the gear shift lever is positioned in a lower numbered position, for example 1, the output speed will decrease and the torque available will be more and vice versa. Lower numbered position of gear shift lever is normally recommended when the vehicle is moving in a upward sloping road. When the vehicle is moving in a plain road and speed is to increased, the gear shift lever should be in the higher numbered position.



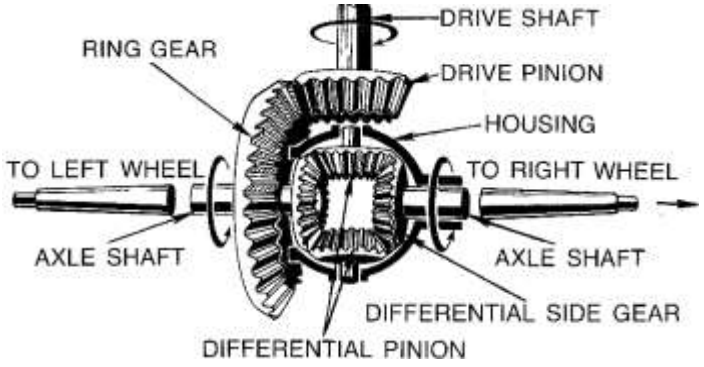
Gear Box of a four wheeler

Layout of 4 speeds on the gear shift lever

Courtesy: http://en.wikipedia.org

Differential unit: In automobiles and other wheeled vehicles, a differential couples the drive shaft to half-shafts that connect to the rear driving wheels. The differential gearing allows the outer drive wheel to rotate faster than the inner drive wheel during a turn. This is necessary when the vehicle turns, making the wheel that is travelling around the outside of the turning curve roll farther faster than the other. Average of the rotational speed of the two driving wheel equals the input rotational speed of the drive shaft. An increase in the speed of one wheel is balanced by a decrease in the speed of the other.

A differential consists of one input, the drive shaft, and two outputs which are the two drive wheels, however the rotation of the drive wheels are coupled by their connection to the roadway. Under normal conditions, with small tyre slip, the ratio of the speeds of the two driving wheels is defined by the ratio of the radii of the paths around which the two wheels are rolling, which in turn is determined by the track-width of the vehicle (the distance between the driving wheels) and the radius of the turn.



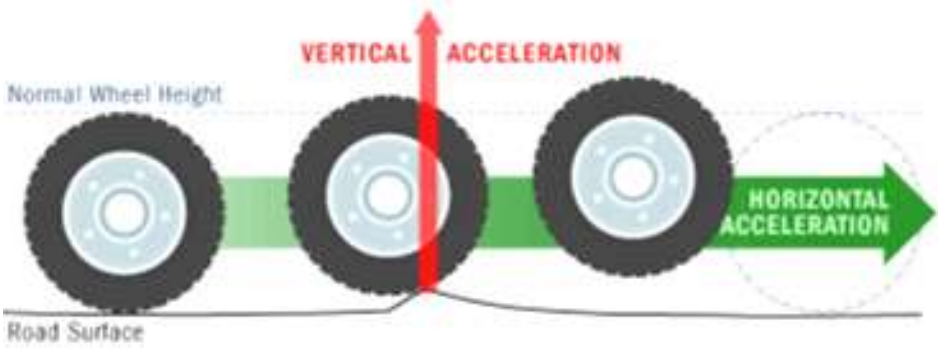
Courtesy: http://andreacollo.wordpress.com

3.4 Suspension System:

The function of a car suspension is to maximize the friction between the tires and the road surface, to provide steering stability with good handling and to ensure the comfort of the passengers. If a road is perfectly flat, with no irregularities, suspensions wouldn't be necessary. But roads are far from flat. Even freshly paved highways have subtle imperfections that can interact with the wheels of a car. It's these imperfections that apply forces to the wheels. According to Newton's laws of motion, all forces have both magnitude **and** direction**.** A bump in the road causes the wheel to move up and down

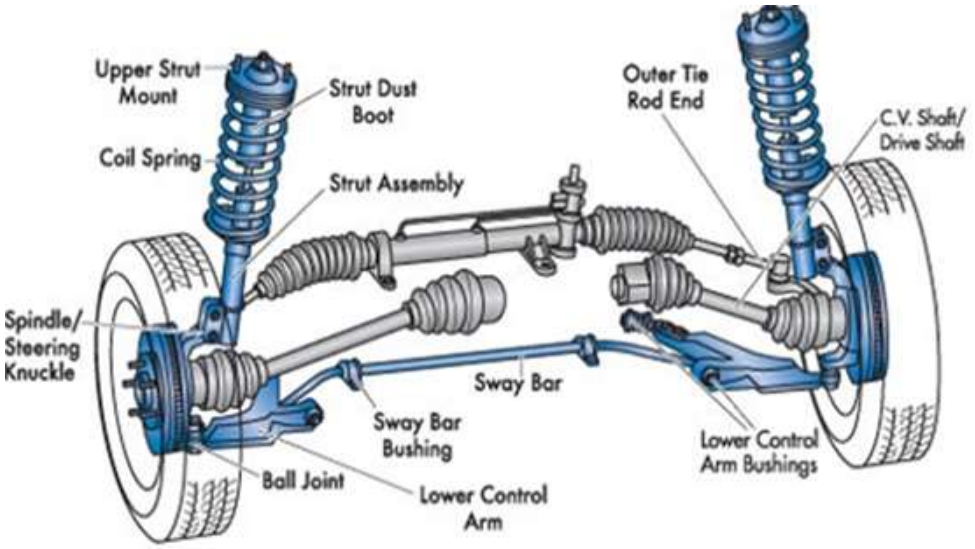
perpendicular to the road surface. The magnitude depends on whether the wheel is striking a giant bump or a tiny speck. Either way, the car wheel experiences a vertical acceleration as it passes over an imperfection.

Without an intervening structure, all of wheel's vertical energy is transferred to the frame, which moves in the same direction. In such a situation, the wheels can lose contact with the road completely. Then, under the downward force of gravity, the wheels can slam back into the road surface. What you need is a system that will absorb the energy of the vertically accelerated wheel, allowing the frame and body to ride undisturbed while the wheels follow bumps in the road.

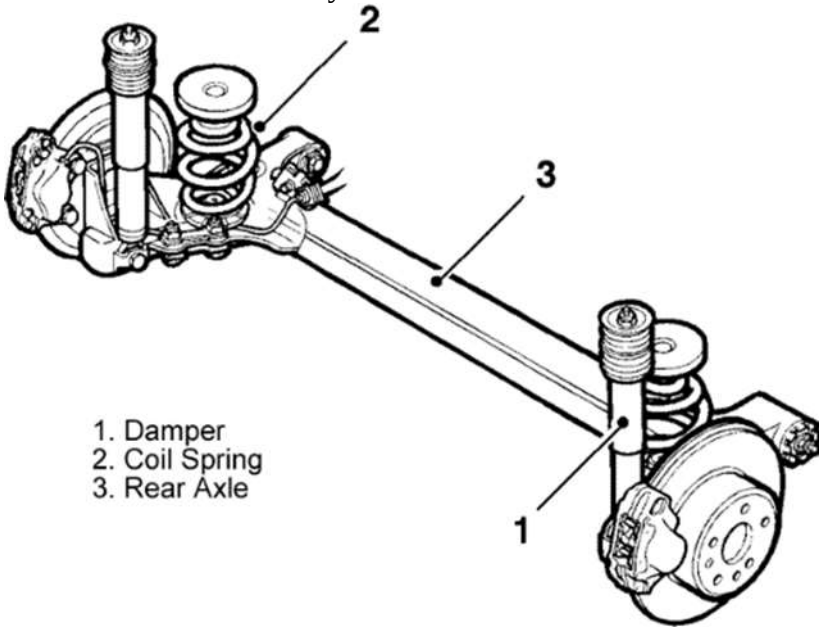


How suspension works-Vertical / horizontal acceleration

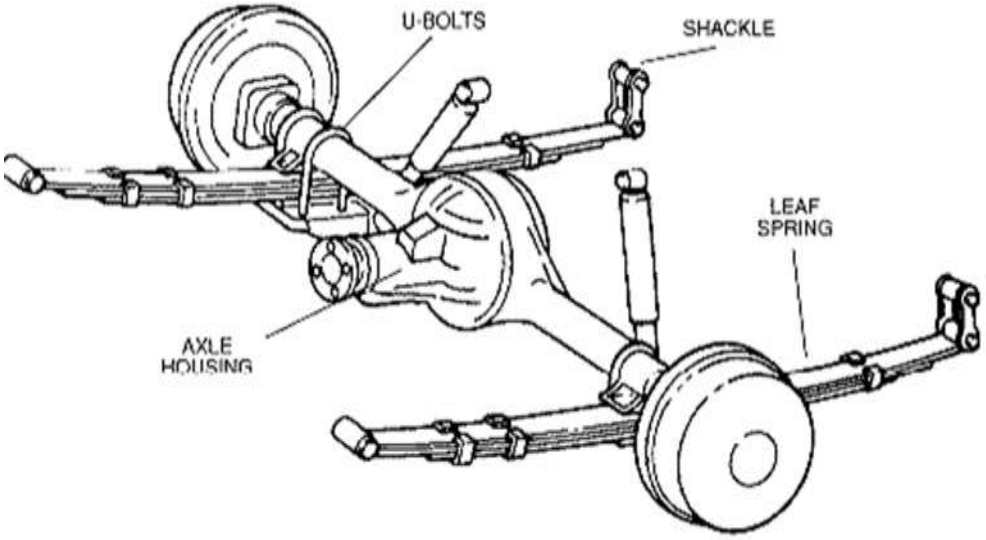
Courtesy: http://auto.howstuffworks.com



Front wheel drive suspension system.
Courtesy: www.flmidas.com



Rear Axle suspension for front wheel drive vehicle without differential
Courtesy: http://images.1233.tw/



Rear wheel drive suspension system with differential
Courtesy:www.thinglink.com

FOUR WHEELER VEHICLE CHECK LIST

ENGINE:

Sl. No.	Particulars	Check	Tick Mark √ **or X**
1	Water pump drive belt Belt deflection	Tension, Wear 6-8mm	
2	Engine coolant	Level and Leakage	
3	Engine oil and oil filter	Level and Leakage	
4	Cooling system hoses & connection	Leakage, Damage	
5	Exhaust system	Noise, Leakage	
6	Positive crankcase ventilation system	Hoses connection &Valve	
7	Temperature gauge check	Instrument cluster	

IGNITION:

8	Ignition wiring	Damage, Deterioration	
9	Distributor cap	Crack	
10	Plug chords	Inspection	
11	Ignition light	Instrumental panel	

FUEL:

12	Air cleaner	Clean	
13	Accelerator cable and Throttle shafts	Inspect & Lubricate	
14	Fuel tank cap, fuel lines &connection	Leakage, Damage	

CLUTCH & TRANSMISSION:

15	Clutch pedal	Play	
16	Manual Transmission/Transfer & differential oil, clutch fluid checkup	Level, Leakage	
17	Gear Shifter linkages	Operation	
18	Propeller shaft play	Inspect	
19	Universal joints slack	Inspect	
20	Drive shaft boots	Damage	

BRAKE:

21	Brake fluid	Level, Leakage	
22	Brake pedal	Pedal to wall clearance	
23	Parking brake lever &cable	Play, Damage	
24	Master cylinder &wheel cylinder or caliper	Oil leakage, Boot kit	
25	Brake hoses &pipes	Leakage, Damage	

WHEEL:

26	Tyres	Air pressure, Abnormal wear, Crack, Rotation	
27	Wheel	Damage	
28	Front/Rear wheel bearings	Loose, Damage/ Slack	

FRONT & REAR SUSPENTION:

29	Suspension strut	Oil leakage, Damage	
30	Suspension arms & knuckle supports	Loose, Damage	
31	Rear spring	Damage	
32	Shock absorbers	Oil leakage, Damage	
33	Suspension arms& tension rods	Bush & linkage & bend	

STEERING :

34	Steering wheel	Play, Loose	
35	Steering linkages	All connections	
36	Power steering	Operation, Oil level, Leakage	
37	Steering gear box	Oil leakage	

ELECRICAL:

38	Battery electrolyte	Level, leakage, Specific gravity	
39	Wiring harness connections	Looseness, Damage	
40	Lighting system/Horn	Operation	
41	Horn	Operation	
42	Wiper operation	Wiper motor, pipe & wiper blade	

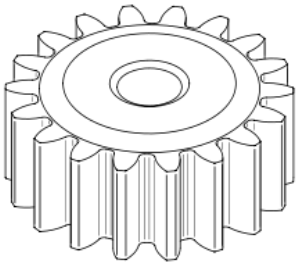
BODY:

43	All latches, hinges & locks	Operation/Lubrication	
44	Seat belt	Operation	
45	Seat latch, lever & knob	Operation	

4. STUDY OF MACHINE PARTS, MACHINE TOOLS & MEASURING INSTRUMENTS

MACHINE PARTS:

Spur gear:



Gears whose axes are parallel and whose teeth are parallel to the center line of the gears are called spur gear. They are used to transmit power from one shaft or element to another in cases where the shafts have their axes parallel. Spur gear is used over a wide range of articles –from small watches, precision measuring instruments, machine tools to gearboxes fitted in motor cars and aero engines etc.

Courtesy: http://en.wikipedia.org

Helical gear:

In helical gears, the teeth are cut in the form of helix around the gear .Helical gear is used to connect parallel shafts as well as non-parallel, non-intersecting shafts. The pitch surface are cylindrical as in spur gearing, but the teeth, instead of being parallel to the axes, wind around the cylinders helically like screw threads. The advantage of helical gears, when compared to spur gears is that helical gears run more smoothly and more quietly at high speeds.

Courtesy: http://precision-gear .en.made-in-china.com

Bevel gear:

When two shafts, the axes of which intersect, are to be connected by gearing, bevel gears are used. In a bevel gear, the teeth are cut on a conical surface, which is represented by a truncated cone. In most of the bevel gear drives, the shafts are at right angles, but the angle between the shafts may be either greater or less than 90°. In such cases the gears are called angular bevel gears. When the angle between the shafts is 90° and two gears of a pair are

equal, the gears are called mitre gears. When the pitch angle of a bevel gear is 90°, it is called crown gear.
Courtesy: http://science.howstuffworks.com

Belt drives:

Belt drive is one of the device for transmitting motion and power from one shaft to the other, by means of a thin inextensible band running over two pulleys. They are used for general purpose application in mills and factories, especially when the distance between the shafts is more. In a belt drive arrangement, one of the pulleys called driver is mounted on the driving shaft while the other, which is mounted on the shaft to which power is to be transmitted is called driven pulley or follower. When the belt moves over the pulleys, there is always the possibility of some slip between the belt and the surface of the pulleys, and hence the motion transmitted is not positive and there will be loss of power. Where positive action is required, gears or chains must be used.

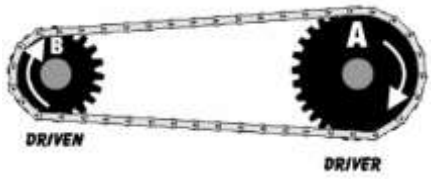
Flat type belt is used when the power is to be transmitted over relatively longer distance, however power loss due to slip is more. Vee type belts are used for power transmission over smaller distance, but power loss due to slip is less.

Flat Belt drive

Vee Belt drive

Courtesy: http://en.wikipedia.org Courtesy: www.hitekbalancing.com

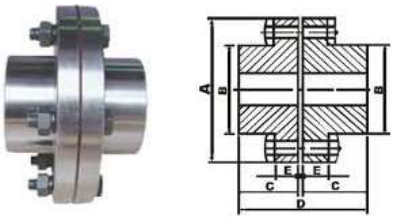
Chain drive:



Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. In a chain drive, slip is less when compared to belt drives.

Courtesy:www.technologystudent.com

Couplings:



Flanged coupling

Two shafts are joined together by means of couplings. The coupling should always be placed as close to a bearing as possible and should support and align the two ends of the shaft rigidly, so as to give an effect of a continuous shaft. The two principal types of couplings are Rigid Coupling and Non- rigid or flexible Coupling. Flexible coupling is a type of non rigid coupling and can take care of small misalignment in the shafts being connected.

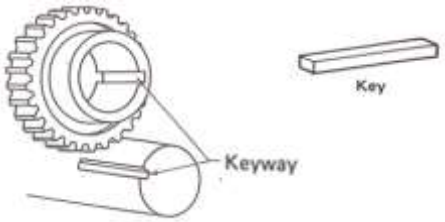
Courtesy: www.conveyourchains.in/pin_bush_couplings.htm

Keys:

Keys are used to secure flywheels, pulleys, gears, cranks, couplings, and similar items to shaft, in such a way that there can be no relative rotary motion between the two parts. The key may not permit longitudinal movement of the wheel or other machine parts along the shaft.

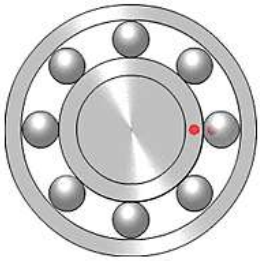
All keys are made of steel and are usually of rectangular section of uniform width. But when the key is required to prevent longitudinal movement along the shaft it must be made slightly tapered in thickness, and the taper recommended is 1 in 100 or 10mm per meter.

The groove, cut in the shaft as well as in hub of the part to accommodate the key, is called keyway.



Courtesy: http://its.foxvalleytech.com

Bearings:



The main function of a rotating shaft is to transmit power from one end of the line to the other.

The shaft needs a good support to ensure stability and frictionless rotation. The support for the shaft is given by **"**bearing**"**. The shaft has a "interference fit" in a ball bearing. All bearings are provided lubrication in the form of grease or oil, to reduced friction between rotating elements.

Courtesy:http://en.wikipedia.org

Fasteners:

In most of the assemblies, the various parts are held together by fasteners and the process is known as fastening. There are two type of Fastening used in engineering construction (i) permanent, and (ii) temporary. In the Permanent fastenings, either the fastener or members joined together must be destroyed in dismantling the members. In Temporary fastenings, repeated assembly or disassembly is possible without the damage to the fastener or the part.

Permanent fastening may be done by riveting or welding. Temporary fastening is done by bolts, nuts, screws, pins, keys, etc.

Courtesy: www.abbott-interfast.com

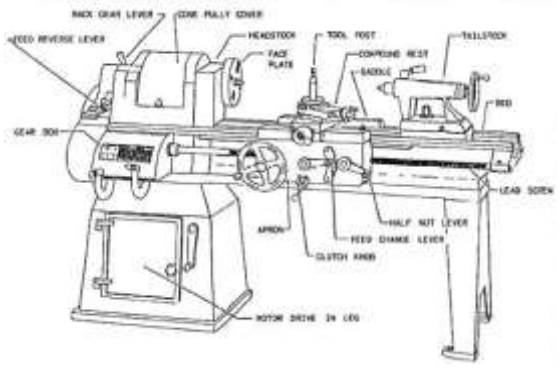
MACHINE TOOLS:

Lathe:

Lathe is also known as the "mother of the entire machine tool family". A lathe operates on the principle of rotating work piece and a fixed cutting tool. The final shape of the machined work piece is obtained by removing material in the form of chips. The work piece to be machined is held in the chuck, which is mounted on the front of the spindle. The back end of the spindle is driven by an electric motor. As the motor runs, the work piece also rotates. (the rpm of the work piece and its diameter defines the "cutting speed". First, the cutting tool is fed into the rotating work piece across its axis (by an amount called "depth of cut" which decides the thickness of the chip) and then moved along the work piece with a certain velocity (called as "feed rate"). The final shape of the work piece is obtained by removing chips progressively, by manipulating the tool motion.

Operations performed in a lathe:

Facing: to produce a flat surface at the end of the part or for making face grooves.
Centering: to make a conical groove at the end of long work piece, for supporting by tailstock
Turning: to produce cylindrical, conical, curved, or grooved work pieces
Threading: to produce external or internal threads
Knurling: to produce a regularly shaped roughness on cylindrical surfaces
Drilling: to produce a hole by fixing a drill in the tailstock
Boring: to enlarge a hole or cylindrical cavity made by a previous process



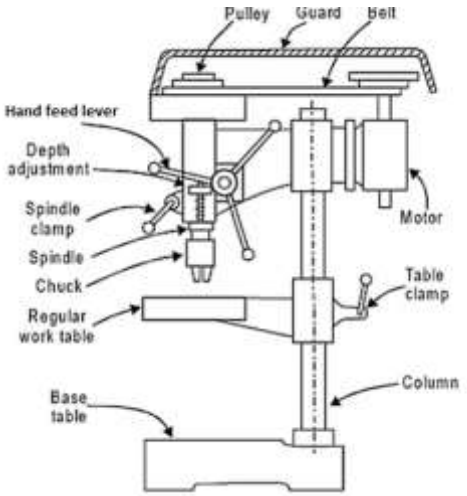
Lathe

Courtesy: http://enginemechanics.tpub.com

Drilling machine:

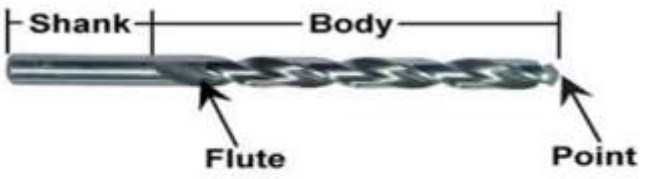
A drilling machine is used to make accurate holes with the help of drill bits. The drill bit is held in the chuck fixed to the end of the spindle. The spindle is driven by an electric motor. Initially the work piece is fixed on a vise fitted on the work table. As the motor is started, the drill bit starts rotating. The rotating drill bit is fed into the work piece by moving the hand feed lever. As the drill bit moves into the work piece, hole is made by removing material in the form of "chips"

For joining the machine parts, holes are made in them, for inserting the fasteners. The holes in the machine parts are made by a drilling machine.



Drilling Machine

Courtesy: http://4mechtech.blogspot.com



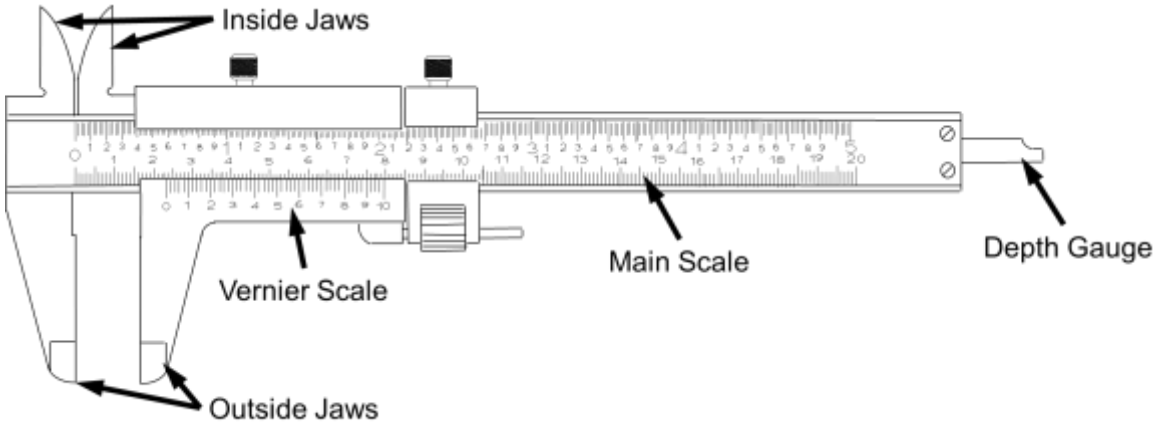
Drill Bit

Courtesy: www.acefixings.com

MEASURING INSTRUMENTS

VERNIER CALIPER

Vernier Caliper is used to measure inside & outside diameter of cylindrical parts and thickness of cubical parts.



Least count: The least count of a measuring instrument is the smallest change in the measured quantity that can be resolved on the instrument's scale.

Least count of = Least count of Main Scale /Number of divisions on Vernier Scale
Vernier Caliper

On the Main Scale,1cm is divided into 10 divisions of 1mm each.
Vernier Scale has 50 divisions.
The Least count of Vernier Caliper =1/50 = 0.02mm.

Procedure for Reading:

To read the Vernier, first note down the main scale reading, up to the zero mark of the Vernier
Then count the number of division on the Vernier scale from the zero line to the line which coincides with a line on the main scale.

TR = MSR + CVD x LC
where TR = Total Reading,
MSR = Main Scale Reading,
CVD = Coinciding Vernier Scale Division,
LC = Least Count of vernier

Example:

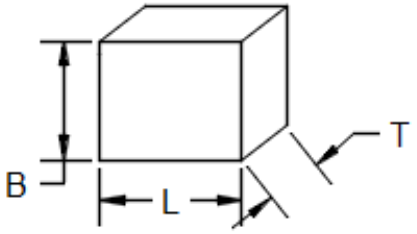
In the fig. shown above, Main scale divisions is 23 and 5th division on the Vernier scale is coinciding with one of the division on the main scale.

23 Main Scale Division (23x1mm) = 23.00 mm
5th Vernier Scale Division (5x0.02 mm) = 00.10 mm

= 23.10 mm

Hence, the reading will be 23.10 mm

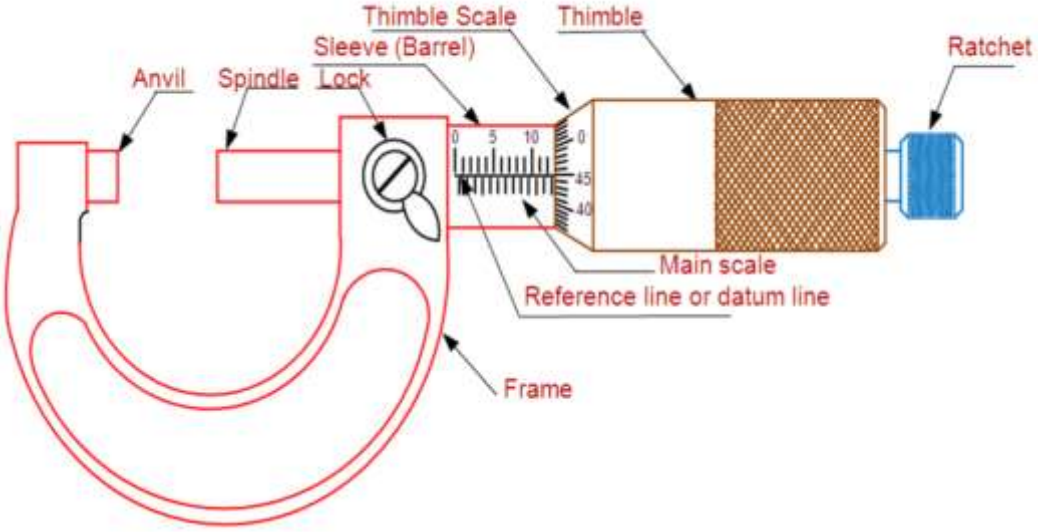
Exercise: To measure the dimensions of the given cubical work piece.



Reading Trial	**Dimension**		
	Length (L)	**Breadth (B)**	**Thickness (T)**
1			
2			
3			
Average			

MICROMETER

Micrometer is used to measure outside diameter of cylindrical parts and thickness of cubical parts.



Least count:

It is the value of one division on the thimble scale and least measurement that can be read.

The micrometer screw has a pitch of 0.5mm, while the thimble has a scale with 50 divisions around its circumference. Upon one rotation, the thimble will move by one thread pitch (0.5 mm).

Therefore,

Least count of = Least count of Main Scale / Number of divisions on Thimble Scale

Micrometer

= 0.5 mm /50

= 0.01 mm

Procedure for Reading:

Read the number of main scale divisions above the reference line in mm.

Read the sub-division below the reference line, after the last visible graduation on main scale.

Read the number of divisions on thimble scale coinciding with the datum line on sleeve.

Example:

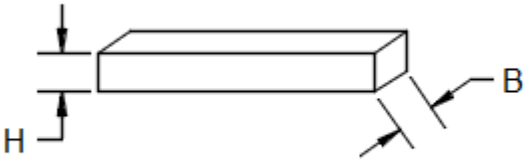
In the figure, on main scale 12 divisions are visible. One 0.5 mm division crossed and the 45th division of the thimble coincides with the datum line.

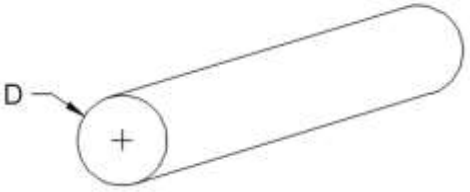
12 main division (12x1mm)	= 12.00 mm
1 sub division (1x0.5 mm)	= 00.50 mm
45 thimble scale divisions (45x0.01 mm)	= 00.45 mm

	12.95 mm

Hence, the reading will be 12.95 mm

Exercise: To measure the dimensions of the given cubical and cylindrical work piece.





Reading Trial	Dimension		
	Cubical work piece		Cylindrical work piece
	Breadth (B)	Height (H)	Diameter (D)
1			
2			
3			
Average			

Department of Electrical and Electronics Engineering

List of Experiments

MME 1061: WORKSHOP PRACTICE [0 0 3 1]

Module 1	1. Electrical Wiring Practice-I 2a. Electrical Wiring Practice-II 2b. Introduction to Electrical Lighting Sources	**2 weeks**
Module 2	3. Electronic Circuit Assembly - I 4. Electronic Circuit Assembly - II	**2 weeks**

Evaluation Plan – Continuous

Parameters: Regularity, Preparation, Performance, Documentation.

References:

1. Laboratory manual
2. Uppal S.L. and Garg G.C., Electrical Wiring, Estimating and Costing, Khanna Publishers, 2014.
3. Bishop Owen, Electronics – A First Course, 2nd Edition, NEWNES – An Imprint of Elsevier, 2006.

SAFETY PRECAUTIONS FOR E&E MODULES

- Wearing a pair of shoes is MANDATORY.
- All the wiring connections should be firm & tight. No loose connections in circuits. No joints to be made between cables in open.
- Students are required to get their wiring connections checked by the Staff on duty before powering the mains supply ON.
- NEVER touch the electrically energized ("LIVE") portions of the circuits when the experimental conduction is ongoing.
- At the end of every conduction, mains MCB must be turned off. Any additions / modifications in the electrical circuits should be done only after this is ensured.
- Keep away from the rotating shaft of the motor.
- Do not touch a soldering iron (after powering it on) to avoid burns injury. When it is not in use, place it always in its stand.
- Avoid accidental burning of the insulation of the soldering iron's power cord by plugging it to a power socket away from its stand.

NOTE:

- It is necessary to have a general understanding of the experiment.
- All observations & calculations must be completed in the laboratory & the signature of the Faculty should be obtained before leaving the Lab.
- If you are *absent* for your regular lab, *it is your responsibility to complete the pending experiment*, *at the earliest*, by joining any subsequent batch, within a week or two. Ensure that this is done before the E&E modules end for your group.
- Attending a viva session is MANDATORY.

1. ELECTRICAL WIRING PRACTICE-I

Objective:

1. To familiarize with the components and wiring of single-phase domestic appliances.
2. To estimate electrical energy charges.

Components Required:

1 Way Switches, Holder for Incandescent Lamp, Incandescent Lamp, Fan, Regulator, 3-pin Socket, 2-Way Switches, Cables.

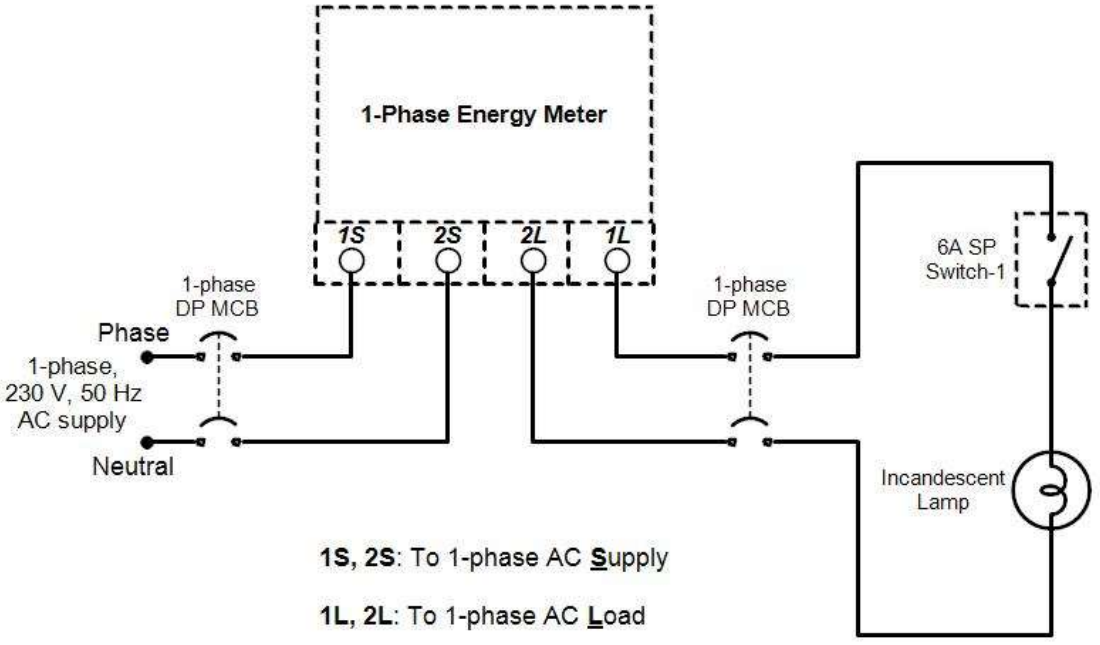
Precautions:

1) Power to the Experimental table must be OFF before making connections.
2) Ensure that the cables are terminated properly.
3) Do not to touch the terminals when the power is ON.

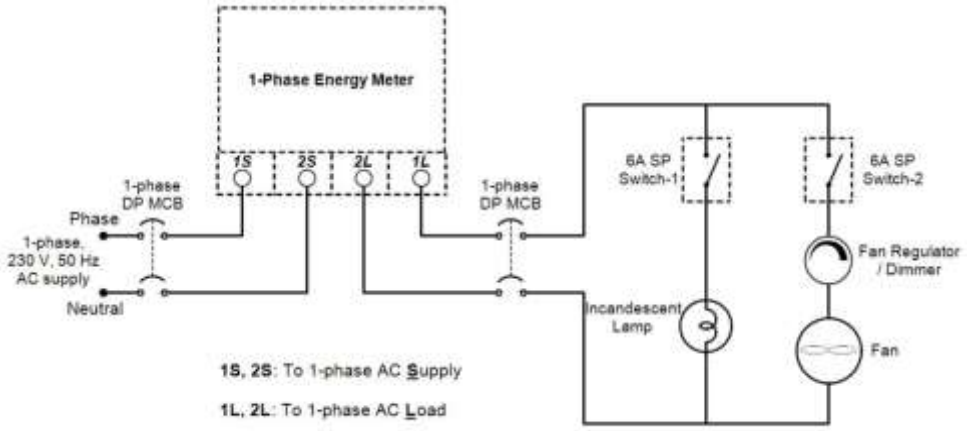
1.1 Problem Statement:

To develop a single-phase wiring scheme to power loads consisting of an incandescent lamp, a Fan and a 3-pin Socket.

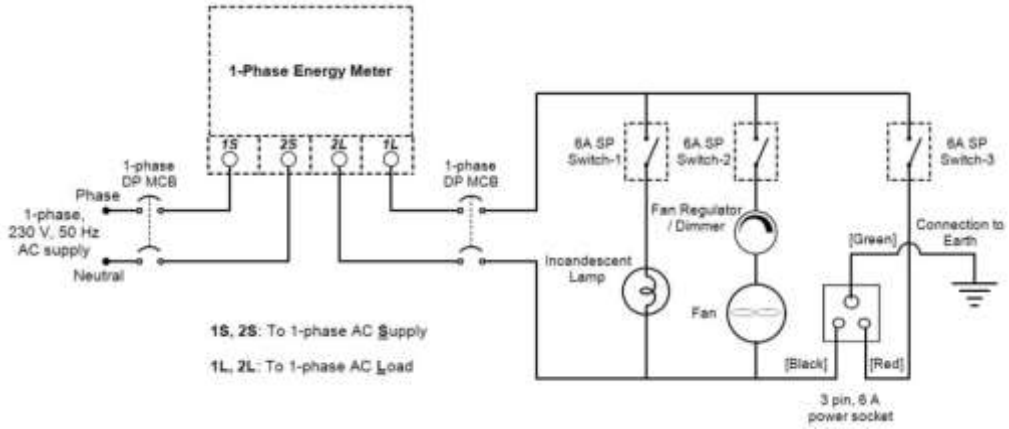
Step-1: Wiring of the Lamp Circuit:



Step-2: Connecting the Fan with the Regulator:



Step-3: Connecting the 3-pin Socket:



1.2 Procedure:

1) Develop the connections step-by-step as shown above.
2) Get the circuit checked by the Instructor.
3) Power ON the supply and verify the functionality of the wiring scheme.
4) Switch OFF the supply.
5) Estimate the energy consumption for 30 minutes with the above loads.

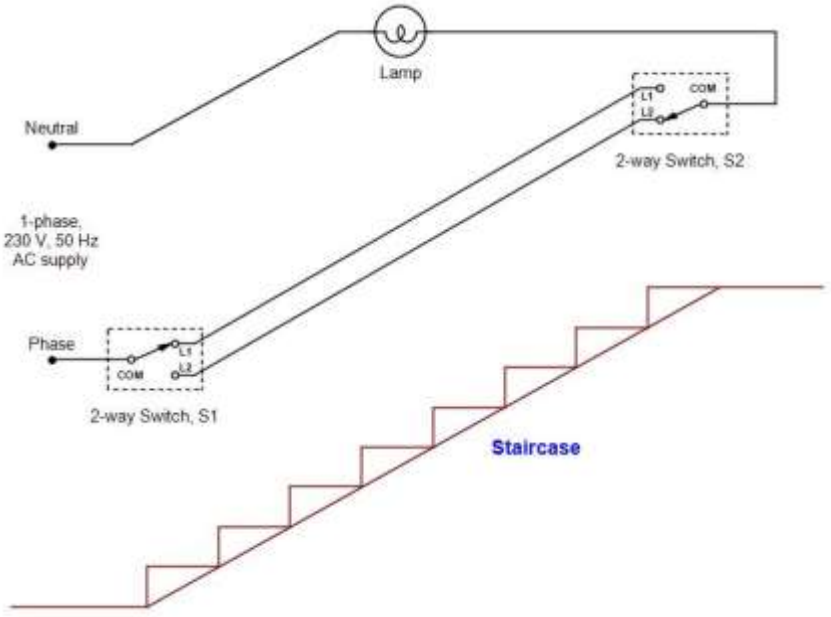
1.3 Observations:

Estimated energy consumption for 30 minutes = kWh

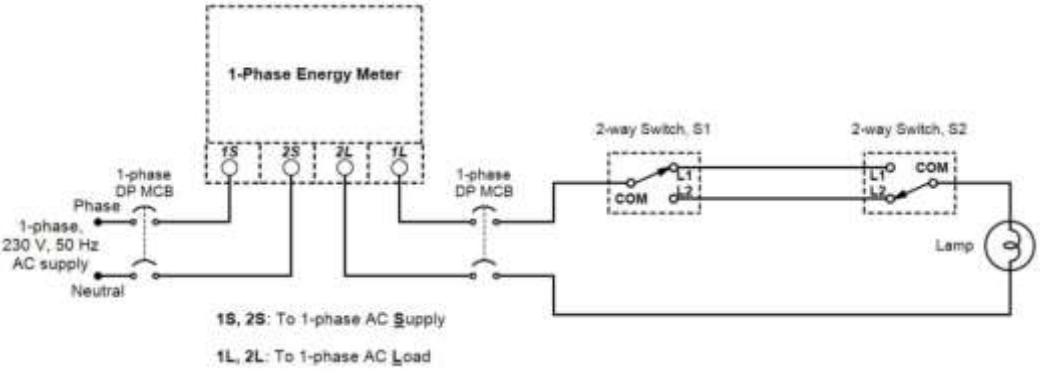
1.4 Problem Statement:

To develop a single-phase wiring scheme to control a Lamp by 2 two-way Switches (***Staircase wiring***).

1.5 Wiring of *2-way control of a lamp*: Layout Diagram:



1.6 Wiring of *2-way control of a Lamp*: Circuit Diagram:



1.7 Procedure: Make the connections as shown above and verify the functionality.

1.8 Case study on estimation of cost of energy:

A bath attached room is fitted with two Fluorescent lamps (36 W each), LED Lamp (9 W), Fan (70 W), Electric Iron (1 kW), Geyser (2 kW), Air Conditioning unit (1.6 kW). Determine the ***monthly energy charges*** for the following daily load pattern.

Fluorescent lamps are switched ON from 5 AM to 7:30 AM & 6 PM to 10:30 PM; LED lamp from 6 PM to 8 AM; AC from 6 PM to 7 AM (Assume a duty cycle of 60 % for AC). Fan is used for 4 hours; Electric Iron and Geyser are used for one hour each.

Refer to Electricity Tariff, LT 2(a)(i) given in Annexure-1 and determine the *energy charges* for the electricity consumed.

Calculations:

2(a) ELECTRICAL WIRING PRACTICE-II

Objective:

1. To familiarize with the components and wiring of three-phase circuits.
2. To estimate the electrical energy charges for three-phase loads.

Components Required:

1-way Switches, Holders for Incandescent Lamps, Incandescent Lamps, Three-phase Fractional HP (0.25 HP/0.18 kW) Induction motor, DOL Starter, Cables.

Precautions:

a) Power to the Experimental table must be OFF before making connections.

b) Ensure that the cables are terminated properly.

c) Do not to touch the terminals when the power is ON.

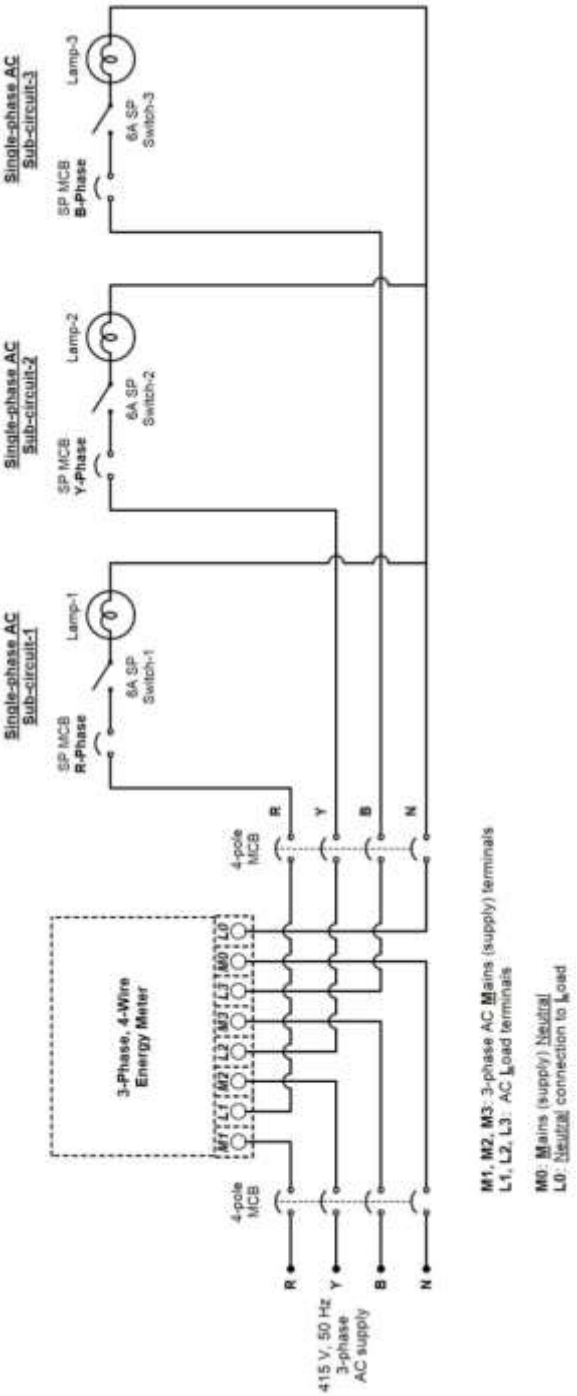
2.1 Problem Statement:

To develop a three-phase wiring scheme to power single-phase loads consisting of incandescent lamps in three phases and a three-phase load (i.e., a 3-phase Induction Motor).

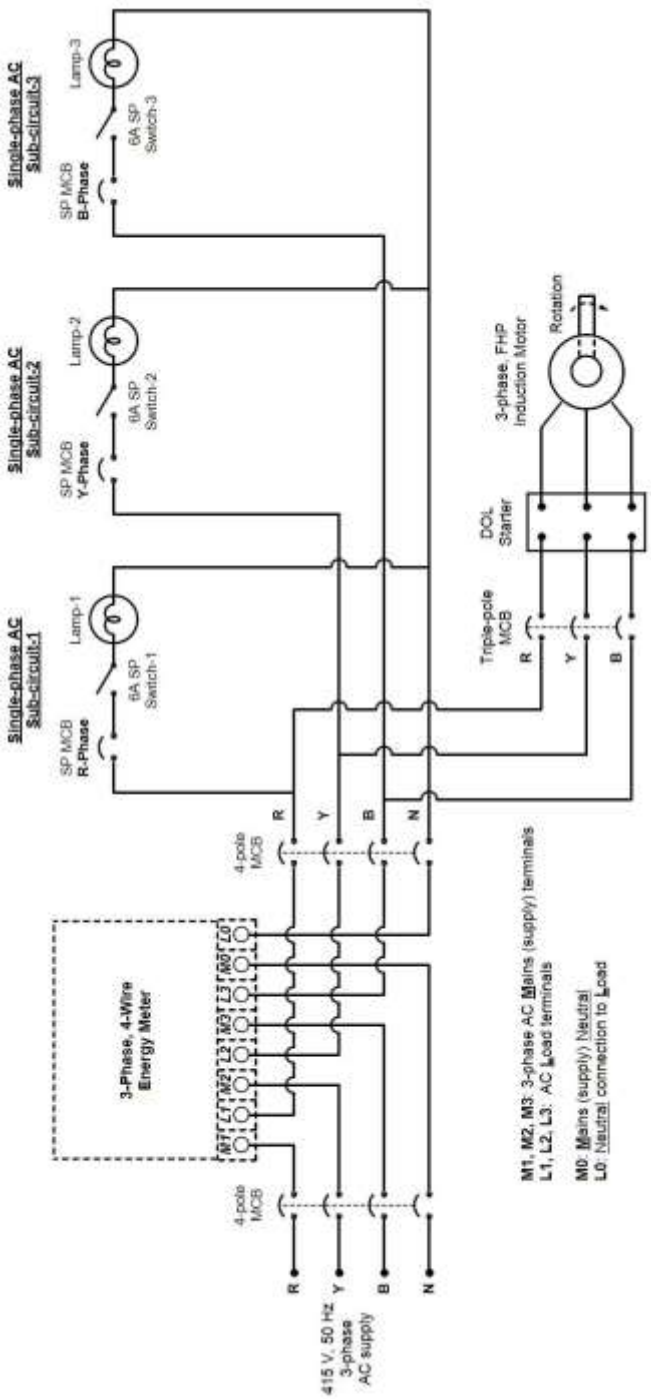
2.2 Procedure:

1) Develop the connections step-by-step; first for 'R' phase and then for 'Y' and 'B' phases as shown in the circuit diagram overleaf.
2) Get the circuit checked by the Instructor.
3) Power ON the supply and verify the functionality of the wiring scheme.
4) Switch OFF the supply.

Step-1: Wiring of Lamp Loads in three phases:



Step-2: Connecting the Three-Phase Induction Motor:



Write down the name-plate details (Ratings) of the 3-phase induction motor below.

2.3 Procedure:

1) Make the 3-phase Induction Motor connections *additionally* as shown overleaf.
2) Get the circuit checked by the Instructor.
3) Power ON the supply to the circuit.
4) Press the START (Green) button on the Direct On-Line (DOL) starter.
5) Measure the no-load speed by using a tachometer.
6) Observe the *direction of rotation*.
7) Also, switch ON all the lamps.
8) STOP the three-phase induction motor by pressing STOP (Red) button on DOL starter.
9) Switch OFF the power supply.
10) Interchange *any two* supply line cables (out of the three) in the motor circuit.
11) Follow steps 3 – 6. Observe that the direction of rotation of the motor is *reversed*.
12) STOP the motor and switch OFF the supply.
13) Estimate the energy consumption of the circuit for 30 minutes.

2.4 Observations:

RMS value of 3 ***line*** voltages (Line to Line values):

$\mathbf{V_{RY}}$ = $\mathbf{V_{YB}}$ = $\mathbf{V_{BR}}$ =

RMS value of 3 ***Phase*** voltages (Line to Neutral values):

$\mathbf{V_{RN}}$ = $\mathbf{V_{YN}}$ = $\mathbf{V_{BN}}$ =

Frequency (Hz): f =

Measured *no-load speed* (rpm): N =

Estimated energy consumption for 30 minutes = kWh

2(b) INTRODUCTION TO ELECTRICAL LIGHTING SOURCES

Objective:

To compare Natural Lighting with Artificial Lighting and also to familiarize with various electrical lighting sources.

Natural Lighting:

Daylight is the light received from Sun. However, the illuminance (i.e., the amount of light reaching earth's surface, measured in terms of lux) can vary from 1,00,000 lux for direct sunlight at noon in summer, to less than 5 lux for thick storm clouds with the sun at the horizon. At night, we receive up to 0.25 lux on a Full moon with clear sky. During Sunrise and Sunset illuminance level will be 400 lux under clear sky. In order to reduce energy consumption, daylight harvesting systems are introduced which use daylight to reduce the amount of electric lighting needed to illuminate a space.

Artificial Lighting:

Artificial Lighting is illuminating the facility or environment using electrical light sources. An illuminance level of 300 lux to 500 lux is expected for office lighting and classroom lighting. An international standard football and cricket stadium needs a lighting level of 500 lux and 750 lux respectively. Depending on the type of the road, roads are lit in the range of 4 lux to 30 lux. Hence different facilities require different lighting conditions.

Electrical light sources work under two operational principles - Incandescence and Luminescence. Incandescent Bulb (Tungsten Halogen lamp) works on the principle that certain materials emit light when heated to higher temperature (principle of incandescence). Fluorescent Tubular Lamp (FTL), Compact Fluorescent Lamp (CFL), Low Pressure Sodium Vapour (LPSV) lamp, High Pressure Sodium Vapour (HPSV) lamp, High Pressure Mercury Vapour (HPMV) lamp and Metal Halide (MH) lamp operate on Gas discharge principle i.e. Luminescence. LED works on Electroluminescence Principle. Table-1 shows the Performance Characteristics of different light sources to be considered while designing various lighting schemes.

CHARACTERISTICS	GLS	FTL	CFL	HPMV	MH	LPSV	HPSV	LED
Abbreviated as	General Lighting Service Lamp (GLS) or Incandescent Lamp 	Fluorescent Tube Light 	Compact Fluorescent Lamp 	High Pressure Mercury Vapour Lamp 	Metal Halide Lamp 	Low Pressure Sodium Vapour Lamp 	High Pressure Sodium Vapour Lamp 	Light Emitting Diode 
Rating (watt)	25 to 2,000	14 to 65	4 to 56	50 to 2,000	250 to 2,000	18 to 180	50 to 1,000	1 to 200
Working principle	Incandescence	Low pressure gas discharge	Low pressure gas discharge	High Pressure gas discharge	High Pressure gas discharge	Low Pressure gas discharge	High Pressure gas discharge	Electroluminescence
Luminous Flux (lm)	250 to 40,000	750 to 5,300	200 to 2,800	2,000 to 1,25,000	19,000 to 1,87,000	1,800 to 33,000	3,300 to 1,30,000	60 to 20,000
Luminous Efficacy (lm/W)	10 to 20	40 to 90	50 to 70	35 to 65	75 to 95	100 to 200	80 to 120	40 to 100
Light color	Warm white	Warm white, neutral white and cool white	Warm white, neutral white and cool white	Neutral white	Neutral white and cool white	yellowish	Warm white (golden Yellow)	Warm white, neutral white & cool white
Color Temperature (K)	2,800	3,500, 4,500 & 6,500	3,500, 4,500 & 6,500	3,850	3,200 to 5,200	1,700	2,500	2,700 to 6,500 (smoothly variable)

Color Rendering Index	>95	65 to 95	65 to 90	50	65 to 90	~44 (non-existing)	23 to 60, 80 – White SON	50 to 90
Ballast	None	Choke, electronic	Electronic (in-built)	Choke	Choke	Hybrid	Choke	Driver Circuit
Starter/Ignitor	None	None (Electronic Ballast)	None	None	Ignitor	Separate or built into ballast	Separate or built into lamp	None
Run-Up time (min)	Zero	Zero	Zero	3	3	10	5	Zero
Restrike time (min)	Zero	Zero	Zero	5	10	2	<1	Zero
Lamplife (Hours)	1,000	10,000	10,000	12,000	30,000	15,000	20,000	50,000
Applications	General, domestic, Photographic, theatre, Studio etc.	General Lighting – House, office, retail shops, educational facility etc.	House lighting decorative, recreational, office, corridor lighting etc.	Industrial, Street, Road, flood lighting etc.	Industrial, Sports, Flood lighting etc.	Road lighting and street lighting	Industrial, Street, Road, flood lighting etc.	General, Automotive, street, architectural, industrial, signals, electronic gadget etc.

Table1: Performance characteristics of different electrical light sources.

Definitions:

1. **Luminous Flux**: It is the electromagnetic radiant energy which is human eye sensible, radiated per second in all possible directions by a luminous body. Its unit is lumen (lm). *Example*: Luminous flux output of an incandescent lamp of 100 W is 1,200 lm to 1,300 lm

2. **Luminous Efficacy:** Energy efficiency of a light source is measured in terms of luminous efficacy. It is the ratio of lumen output per watt of input electrical power; of a light source. Its unit is lumen/watt.
3. **Average illuminance:** It is the amount of light reaching the unit surface area. Its unit is lm/m^2 (Lux).

4. **Colour Temperature:** Colour temperature of a source is a temperature at which a Black Body Radiator must be operated in order to emit radiation evoking colour sensation exactly the same as that produced by radiant energy from the source in question. Unit is kelvin (K).

5. **Colour Rendering Index (Ra):** Colour appearance of a source depends on spectral energy distribution of the light emitted by it. It is a measure of light source capability of faithful surface colour reproduction. True colour recognition is possible on by black body sources. Ideal Light Source is the Sun or an Incandescent lamp. CRI requirements differ by lighting application.
   - ✓ CRI 90 - 100: Retail (merchandise, artwork) and work spaces (design) where faithful colour rendering is critical.
   - ✓ CRI 70 - 90: Most office, retail, school, educational, medical, and other work and residential spaces.
   - ✓ CRI as low as 50: Industrial, security and storage lighting where colour fidelity is not important.

6. **Incandescence:** Certain bodies when heated to high temperature start producing light in visible range in continuous spectrum. The phenomenon of emitting radiation is called incandescence. Examples: Red hot coal stove – red colour radiation - 800K, Burning candle – 2,000K, Tungsten filament bulb – 2,800K, Halogen bulb – whitish yellow – 3,000K, Sun at noon with clear sky - white light – 5,500K

7. **Luminescence:** This is opposite of incandescence. The emission of light as a result of the excitation of atoms by energy other than heat. The emission of light that does not derive energy from the temperature of the emitting body. They are caused by chemical reactions, electrical energy, sub-atomic motions or stress on a crystal.

8. **Gas Discharge:** A gas discharge lamp is a light source that generates light by creating an electrical discharge through an ionized gas. These lamps use gases such as argon, neon, krypton and xenon, or a mixture of these. Many lamps are also filled with additional gases like sodium and mercury, while some others have metal halide additives. Gaseous discharges may be classified on the basis of gas pressure as

   - ✓ Low pressure discharge
   - ✓ High pressure discharge

   Discharge lamps are operated in conjunction with ballasts. Primary function of the ballast is to limit the current flowing in the lamp to a prescribed value, which if left unchecked, would destroy the lamp. The ballast is normally a combination of chokes and capacitors. A starter or an ignitor is employed to initiate the discharge. Alone or together with the ballast, it delivers voltage pulses which ionize the discharge path and bring about ignition.

Ignition is followed by lamp run-up, during which the gas or vapour stabilizes. This can last for up to several minutes, according to lamp type. During this time, the luminous flux increases with rise in power consumption until the lamp reaches its nominal value. Tubular fluorescent lamps have a shorter run-up period, while for high-pressure discharge lamps, this period is longer.

The discharge creates a multi-line spectrum whose composition is determined by the gas or vapour filling and the pressure within the discharge tube. Low-pressure discharge lamps exhibit a clear, line spectrum. The low-pressure sodium vapour lamp, with virtually only a single resonance line, is an extreme example of a so called monochromatic light source. An example of the opposite extreme is the high-pressure mercury lamp with halide additives of various metals and rare earths, whose multi-line spectrum covers the entire visible range.

3. ELECTRONIC CIRCUIT ASSEMBLY-I

Objectives:

1. To familiarize with the discrete electronic components and solderless breadboard.
2. To familiarize with the Digital Multimeter.
3. To test the electronic components.
4. To experiment with the demonstration circuit boards.

Components Required:

Resistors, Potentiometers, Light Dependent Resistor (LDR), Rectifier diodes, Zener diodes, LED, Transistors, Capacitors, Integrated Circuits (ICs), Solderless breadboard, General purpose PCB, Hook-up wires.

3.1 Electronic components and solderless breadboard:

Resistors:

In most electronic circuits, the most basic role of resistors is current limiting i.e. precisely controlling the quantity of electrical current that is going to flow through a device. The photo shows typical fixed resistors. These are sold in a range of different resistances, from less than 1 Ω and up to 10 MΩ.

Resistor 4-Band Colour Code:

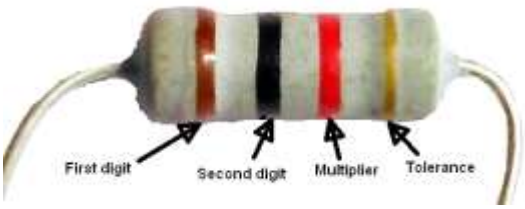
Reading from the end, the meaning of the 4 bands is:

First band: First digit of resistance

Second band: Second digit of resistance

Third band: Multiplier – a power of 10

Fourth band: Tolerance



Tolerance band is located at the end opposite to the three bands. This band tells us how far the actual resistance may differ from its nominal value.

The table shows the meanings of the colours.

Colour	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Colour	Tolerance
Red	± 2%
Gold	± 5%
Silver	± 10%
No band	± 20%

Example-1:
For a carbon resistor, the bands are Brown, Black, Black and Golden. The nominal value of this resistor is: 10×10^0 Ω = 10 Ω with a ± 5% tolerance. Thus, the actual resistance may be somewhere between 10±0.5 Ω. That is, between 9.5 Ω and 10.5 Ω.

Example-2:
For a carbon resistor, the bands are Green, Blue, Red and Silver. The value of this resistor is: 56×10^2 Ω = 5.6 kΩ with a ± 10% tolerance.

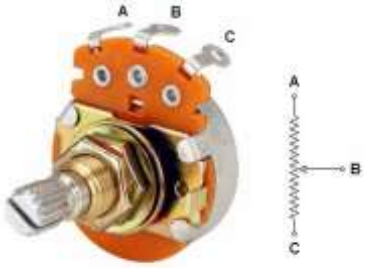
Example-3:
For a carbon resistor, the four bands are Yellow, Violet, Gold and Gold. Find its value.
Note: This is a special case. Multiplier of Gold is 0.1 and that of Silver is 0.01.
Colour Code: Yellow, Violet, Gold, Gold
Multiplier: Gold, 0.1
Tolerance: Gold, ± 5%
Therefore, its value=4.7 Ω with a ± 5% tolerance.

Exercise-1:
A 220 kΩ resistor has no tolerance band. Find the range of values where the actual resistance may lie.

Potentiometer:

If we want to vary the resistance of part of a circuit, we use a type of variable resistor called a ***potentiometer***. It is a three-terminal resistor with a sliding contact or wiper (B) that forms an adjustable voltage divider. If only two terminals are used [any one end (A or C) and the wiper (B)], it acts as a variable resistor.

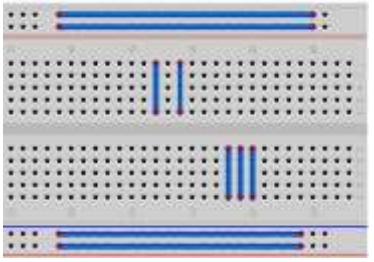
Pots are often used as volume controls in audio equipment (e.g.: music player, guitar, etc.).



Breadboard:

A breadboard makes it easy and quick to build circuits. It is a plastic block with rows of sockets. The sockets in each row are connected *electrically*, as indicated in the figure.

If you plug two or more component wires into the same row, current can flow from one to the other.



Digital Multimeter:

A multimeter is indeed a multiple meter. It can measure DC and AC voltages, currents, and in addition, resistances. A digital multimeter (DMM) indicates the measured parameter on a numeric display. Recent DMMs can additionally measure frequency, capacitance, etc.

Two long probes are used to connect the DMM to a circuit during a measurement. The meter has sockets for probes:

- Positive, marked '+', and usually 'red', and
- Common (negative), marked COM or '—' and usually 'black'.

The central dial has a knob to choose the parameter to be measured.

The auto-ranging DMM automatically selects the correct range when a measurement is made and often has autopolarity.

Note: When the DMM is not in use, keep the knob in OFF position.

Exercise-2:

Components Required:

Fixed carbon resistors of different values, a breadboard, and a DMM

To do:

1. Find out the value of one of the resistors by reading its colour code.
2. Set the DMM to read the resistance.
3. Plug the wire leads of the resistor into different rows on the breadboard. Touch the probes of DMM to the resistor leads.
4. Read the resistance indicated on the meter. Does it agree with the colour code?
5. Repeat with the other resistors.

Resistor	Colour Code	Value (as per Colour code)	Value (as measured by DMM)
1.			
2.			
3.			
4.			
5.			

Capacitors:

Capacitors store electric charge. The ability to do this is called its capacitance. It is expressed in farad. Most electronic circuits need much smaller capacitances. Typical units are: pico farad, nano farad, and micro farad.

There are many types of capacitor. Those used most often are Ceramic Disc, Polyester, Polystyrene, Electrolytic and Variable capacitors.

Ceramic Disc Capacitor:

Ceramic disc capacitors are printed with a code that indicates the value of capacitance. If the code has a 3 digit number printed on it, the first two digits give us the first part of the value and the third digit indicates the multiplier (a power of 10). The resulting value is expressed in pico farad (pF).

Note: If the code has only 2 digits (say 10), then the value is 10 pF.

Examples:
Capacitor-1 has the code of 472. So, its value is 47×10^2 pF = 4.7 kpF or 4.7 nF
Capacitor-2 has the code of 101. So, its value is 10×10^1 pF = 100pF

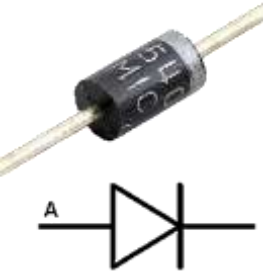
Exercise-3:
Sample ceramic disc capacitors have the codes: 102, 103, 202, 223 and 104. What are their capacitances?

Electrolytic capacitors:
These are used to store large amounts of charge. Their capacity is usually 1 μF or more.

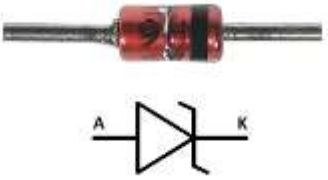
Precautions to be taken:

- Electrolytic capacitors are polarized. This means that they have positive and negative terminals. They ***must*** be connected the right way round. A reversed polarity can cause an explosion!
- These can store charge for hours. When building or testing circuits, there is a danger from electric shock if you touch its terminals without giving it, time to discharge fully.

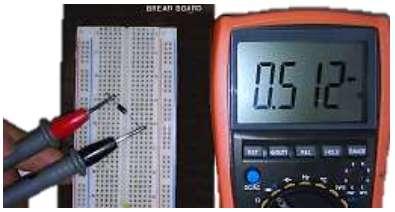
Diode:
A diode is made of semiconductor. It is contained in a small capsule made of glass or plastic. It has two terminals, namely, anode and cathode. **A band marked on the diode indicates the cathode terminal (symbol 'K').** A forward biased diode (with its anode held positive relative to its cathode) conducts. However, it blocks the applied voltage when reverse biased (i.e., cathode held positive relative to anode).
This property is used in rectifiers for AC to DC conversion.



Zener diode:
Unlike a normal diode, a zener diode is used in 'reverse-bias' in the avalanche breakdown region. Voltage across it will then remain almost constant at the breakdown voltage (called the zener voltage); while the current through it can change. The diode is safe as long as its maximum current rating is not exceeded. This characteristic enables it to function as a voltage regulator. Forward characteristic of the zener diode is similar to a normal diode.



Exercise-4:



Components Required:

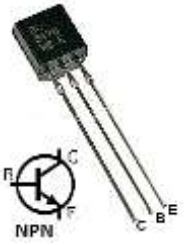
Diode 1N4007, Zener diode, LED, a breadboard, and a DMM

To do:

1. Set the DMM's knob to test diode.
2. Plug the leads of the 1N4007 diode into different rows on the breadboard. Touch 'red' probe of DMM to anode of the diode and the 'black' probe (connected to 'COM' socket on DMM) to the cathode.
3. DMM should display the forward voltage drop of the conducting diode.
4. Swap the probes. DMM should indicate over-range (high resistance).
5. Repeat steps 2 – 4 with the DMM set to measure resistance. What are your observations?
6. Repeat steps 2 – 5 with a Zener diode.

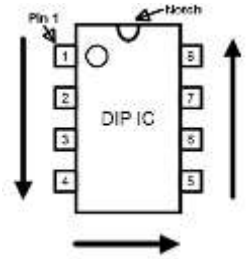
Transistors:

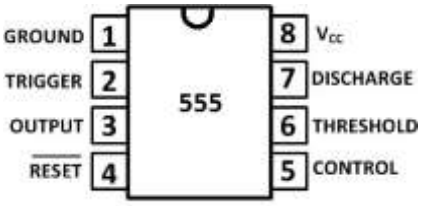
All transistors have three terminal connections. Low power transistors are enclosed in a plastic package or a metal case. The plastic case has a flat surface and the metal case has a tag on its rim. The terminals are labelled with letters, C, B and E, to identify the terminals as Collector, Base and Emitter.



Integrated Circuits (ICs):

Integrated Circuit is a name given to a package which can hold millions of electronic components. They can give various functions like: (i) the function of a full microprocessor circuit (e.g. 8085), (ii) a memory chip, (iii) a voltage regulator (7805) or (iv) can contain just digital logic gates (e.g. LS7400). They come in a black bench like casing with a notch on one side and with legs for electrical connections, which are called pins. Datasheets provided by the IC manufacturers can be referred to, to know the details of pin configurations. A typical IC package called a DIP (Dual Inline Package) has a rectangular housing and two parallel rows of pins. The pins are usually read starting from left of notch and going anticlockwise as shown in picture.

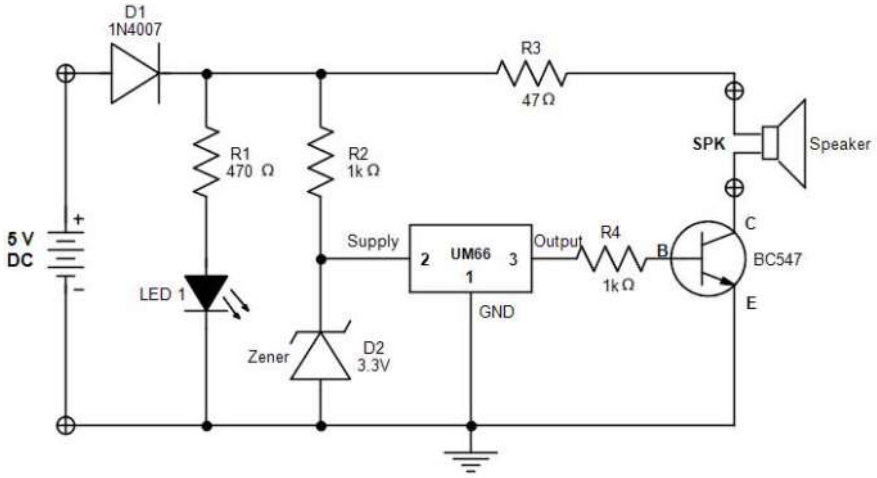




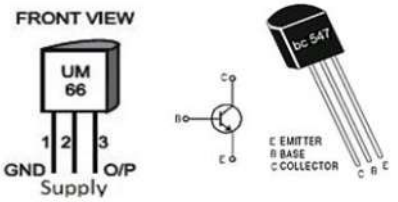
3.2 Demonstration Circuit Boards:

Doorbell using Melody IC UM66/BT66:

UM66 is a melody IC designed for door bell, telephone and toy applications. It is an on-chip ROM programmed for musical performance. It operates with a 1.5V to 4.5V DC supply and has low power consumption. In this circuit, the external speaker is driven by an NPN transistor, BC547.



Pin diagrams [TO-92 packages]

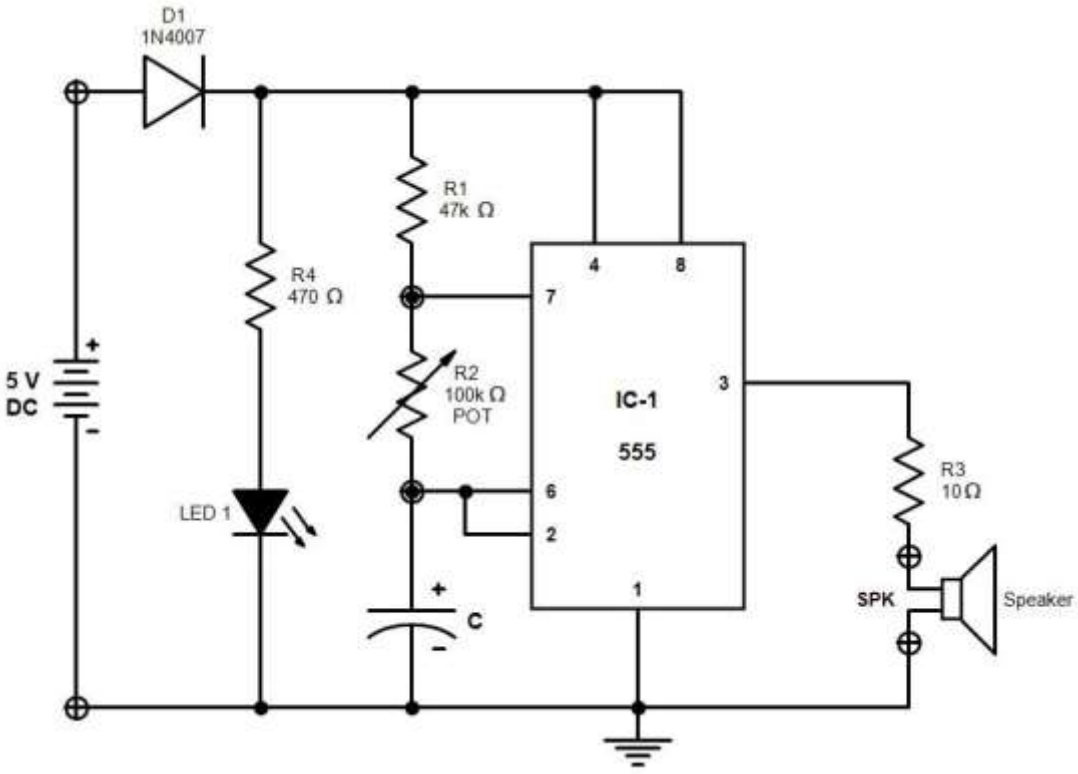


Procedure:

1. Connect the speaker to the demonstration board using the screw-type connector [CON2].
2. Connect the output cord of the 5V DC power adaptor to the corresponding terminals [CON1] on the demo board.
3. Plug-in adaptor to the AC socket and switch it ON.
4. Observe the LED-1 glow; indicating that the circuit is powered.
5. Listen to the melody played out of the speaker.
6. Switch OFF the supply.

3.2 555 Timer IC based Audio Buzzer

The 555 timer IC is a highly stable device for generating accurate time delays or oscillation. The following circuit operates in astable mode as an oscillator. Its free running frequency and duty cycle are accurately controlled with two external resistors (R1 and R2) and one capacitor (C).



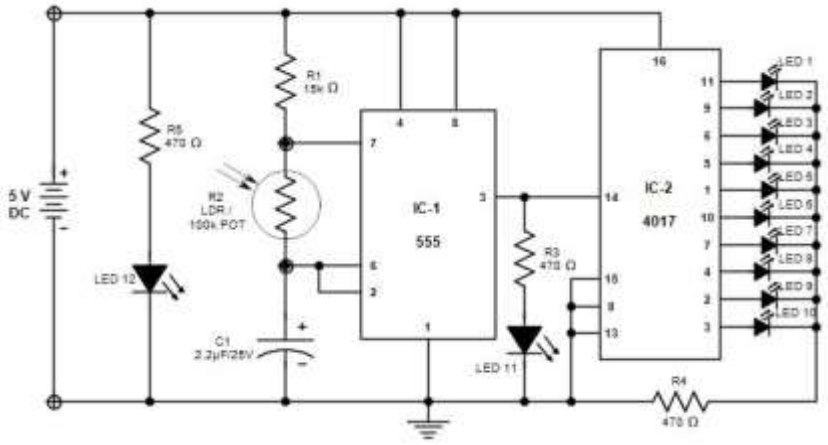
Procedure:

1. Connect the speaker and the POT to the demonstration board using the screw-type terminals [CON2 and CON3] respectively.
2. Connect the output cord of the 5V DC power adaptor to the corresponding terminals [CON1] on the demo board.
3. Plug-in adaptor to the AC socket and switch it ON.
4. Observe the LED-1 glow; indicating that the circuit is powered.
5. Listen to the audio played out of the speaker.
6. Change the frequency of the tone by turning the POT.
7. Switch OFF the supply.

3.3 LED Chaser

CD4017B is a decade counter IC from Texas Instruments. It produces 10 decoded outputs. Each decoded output remains high for one full clock cycle. These outputs are used to drive 10 LEDs (LED 1 through LED 10) sequentially in the following circuit. The IC used has a 16-lead DIP package.

The clock signal is generated by 555 timer IC-1 running in astable mode. Its output frequency (and hence the flashing rate of LED 1 – LED 10) can be changed by changing the value of R_2.

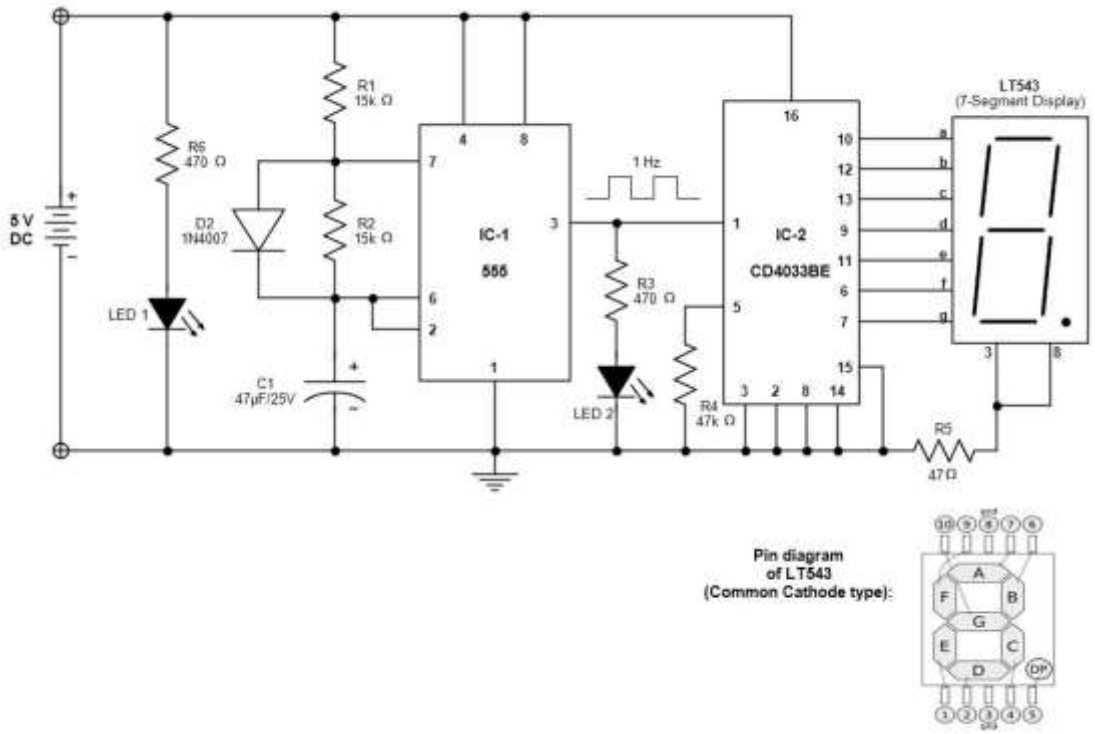


Procedure:

1. Connect the LDR to the screw-type terminals on the demonstration board [CON2].
2. Connect the output cord of the 5V DC power adaptor to the corresponding terminals [CON1] on the demo board.
3. Plug-in adaptor to the AC socket and switch it ON.
4. Observe the LED-12 glow; indicating that the circuit is powered.
5. With LDR exposed to the ambient light, observe the flashing sequence of LED-1 through LED-10 and also, its rate.
6. Observe that the LED-11 is indicating the CLOCK frequency of IC 4017.
7. Cover the LDR by palm. Observe the change in the flashing rate.
8. Illuminate the LDR by a bright light source. Observe the new flashing rate.
9. Switch OFF the supply.
10. Replace the LDR by a 100 kΩ potentiometer.
11. Observe the variable flashing rate by turning the POT's knob.
12. Switch OFF the supply.

3.4 Seven-segment display based Digital Counter

CD4033 is a decade counter IC commonly used to drive 7-segment decimal displays. IC 555 is wired in astable mode to produce a fixed 1 Hz square wave for triggering the CD4033. For each output of 555, the output of CD4033 advances by one count and this is displayed by the 7-segment display, LT543.



Procedure:

1. Connect the output cord of the 5V DC power adaptor to the corresponding terminals [CON1] on the demo board.
2. Plug-in adaptor to the AC socket and switch it ON.
3. Observe the LED-1 glow; indicating that the demo board is powered.
4. Observe the flashing of LED-2 at 1 Hz frequency.
5. Observe the 7-segment display count up to 9.
6. Switch OFF the supply.

4. ELECTRONIC CIRCUIT ASSEMBLY-II

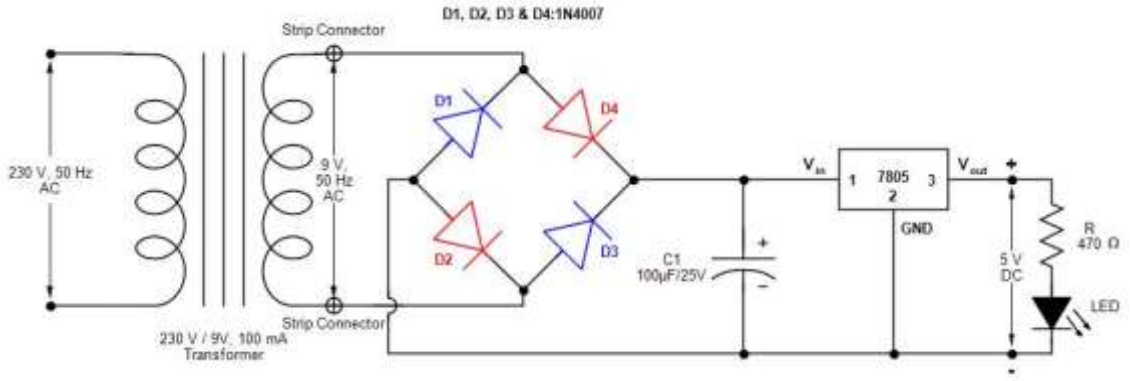
Objectives:

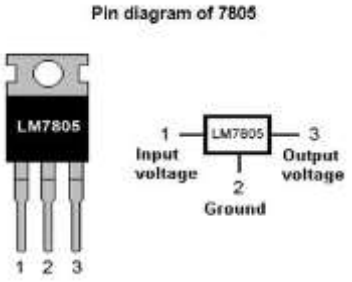
1. To familiarize with the tools used for soldering.
2. To build a simple +5V DC power supply circuit.

Components Required:

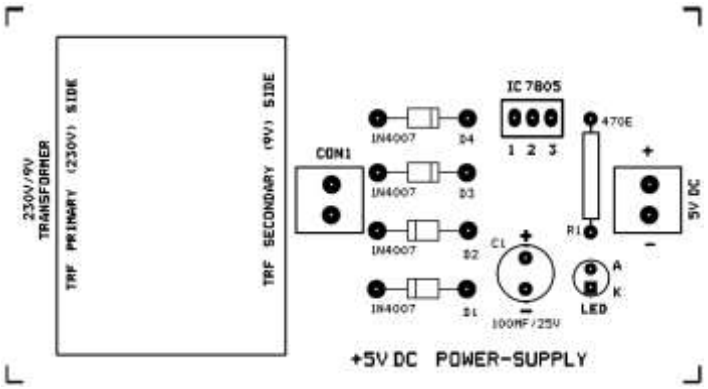
230V/9V, 100mA transformer, 1N4007 diodes, Carbon resistor 470Ω, LED, Capacitor: 100µF/25V Electrolytic, 7805 Voltage Regulator IC, DMM, PCB, Soldering equipment, small nuts and bolts.

Circuit Diagram:

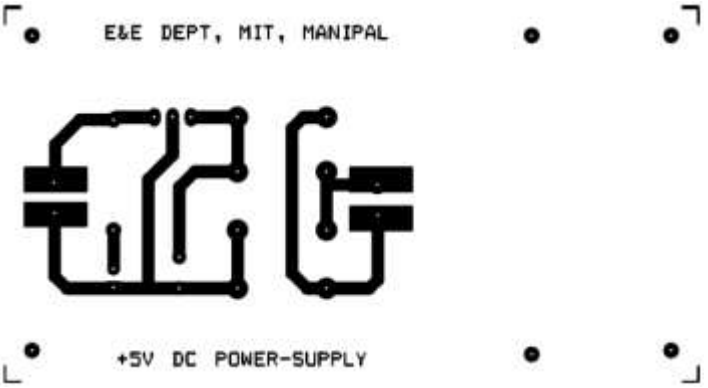




PCB Layout – *Component Side*:



PCB Layout – *Solder Side*:



4.1 Precautions:

General:

1. Check all the components as per parts' list and confirm that no part is missing.
2. *Test the components individually.*
3. Identify anode and cathode of rectifier diodes and LED; before soldering.
4. Pay attention to the polarity of the electrolytic capacitor.
5. Identify the legs of the voltage regulator IC.
6. Ensure that the power switch is in OFF position before plugging in the power cord on the transformer primary side (230V AC side).
7. If you find any faulty condition, it is not wise to leave the power on for a long time. The components may burn out.

Soldering specific:

1. The soldering iron will take a few minutes to reach its operating temperature, after switching it ON. Do not touch it to avoid burn injury. When it is not in use, place it always in its stand.
2. While soldering, make sure that the soldering iron is hot and clean.
3. Make sure that the solder flows evenly over the whole joint. Do not use too much of solder.
4. Solder all components properly.
5. After completing the soldering exercise, switch the soldering iron OFF.

4.2 Procedure:

Preparing the soldering iron:

1. Place the soldering iron in its stand and plug it into the AC socket. Switch it ON.
2. Wait for a few minutes for the soldering iron to warm up. You can check if it is ready; by trying to melt a little solder on the tip.
3. Wipe the tip of the iron on the damp sponge. This will clean the tip. Melt a little solder on the tip of the iron.

Soldering the components:

1. Use the component overlay indicated on the PCB to insert the component.
2. Apply some flux to the PCB track and the terminal of the component being soldered; if necessary.
3. Hold the soldering iron like a pen, near the base of the handle. Touch the soldering iron onto the joint to be made. Make sure it touches both the component lead and the track.
4. Hold the tip there for a few seconds and feed a little solder onto the joint. It should flow smoothly onto the lead and track to form a volcano shape. Apply the solder to the joint, not the iron.
5. Remove the solder, then the iron, while keeping the joint still.
6. After all the components have been soldered, check the soldering closely for any breaks. Inspect your work carefully.
7. The solder joints should have a ‘shiny’ look about them. Check that there are no solder bridges between adjacent tracks.
8. Use a nipper to cut the excess length of component leads.
9. Use a DMM to test for continuity in the circuit.

Mounting the transformer:

1. Place the transformer in its designated area on the PCB and mount it securely on to the PCB by using the nuts and bolts provided.
2. Connect the secondary winding (9V side) terminals of the transformer to the screw-terminals provided on the PCB [CON1]. This would provide AC supply to the diode bridge.

Testing the circuit:

1. Plug in the power cord on the primary side of the transformer to the AC power socket on the experimental table.
2. Switch on the AC supply to the circuit.
3. Observe the LED glow continuously.
4. Measure the output DC voltage of the circuit using the DMM.
5. Press 'DC/AC' button on the DMM to set it to measure AC voltage. Measure the input AC voltage to the diode bridge at connector-1 [CON1].
6. Switch OFF the AC supply.

4.3 Observations:

Input *RMS AC* Voltage to the diode bridge (V)	**Input *DC* voltage to the 7805 IC (V)**	**Output *DC* Voltage (V)**

4.4 Conclusions:

ANNEXURE-1

Electricity Tariff **LT 2(a)(i)** of **M**angalore **E**lectricity **S**upply **Com**pany Limited (MESCOM):

Rate Schedule of MESCOM's LT-2(a)(i) Retail Electricity Supply Tariff [as per the order of Karnataka Electricity Regulatory Commission (KERC)] effective from 30 May 2019 is as given below.

Fixed Charges per month:

For the first kW	Rs. 60/- per kW
For every additional kW	Rs. 70/- per kW

Energy Charges:

For 0 - 30 units (i.e., first 30 units)	Rs. 3.70/- per unit
31 to 100 units (for next 70 units)	Rs. 5.20/- per unit
101 to 200 units (for next 100 units)	Rs. 6.75/- per unit
Above 200 units	Rs. 7.80/- per unit

REFERENCES

1. Electric Power Tariff - 2019 of MESCOM. Ref: http://www.mesco.in/tariffs
2. Datasheets of ICs [namely; 555, UM66, 4017, CD4033, 7805]

Civil Engineering Department
List of Experiments

MME 1061: WORKSHOP PRACTICE [0 0 3 1]

Module 1	1. Testing the strength of materials 1a. Tension Test on Mild Steel 1b.Shear Test on Mild Steel 1c.Compression Test on Cast Iron	**1 week**
Module 2	Chain Surveying	**1 week**
Module 3	Compass Surveying	**1 week**
Module 4	Levelling	**1 week**

Evaluation Plan – Continuous

Parameters: Regularity, Preparation, Performance, Documentation.

Reference:

1. Laboratory manual
2 Punmia B.C, Ashok K. Jain, Arun K. jain, "Surveying", Vol.1, Laxmi Publications (P) Ltd, Bangalore, 2012
3 Bhavikatti S. S, "Strength of materials", Third edition, Vikas publishing house Pvt. Ltd., 2012

Important conversion factors:

Conversion factors for linear measurements					
Meters	**Yards**	**Feet**	**Kilometers**	**Nautical Miles**	**Miles**
1	1.0936	3.2808	1	0.53996	0.6214
0.9144	1	3	1.852	1	1.1508
0.3048	0.3333	1	1.6093	0.869	1

Conversion factors for areas					
Unit	**Sq. feet**	**Sq. meter**	**Cent**	**Acre**	**Hectare**
1 Sq. feet	1	0.093	1/435.6	1/43560	1/107639
1 Sq. meter	10.75	1	1/40.46	1/4046	1/10000
1 Cent	435.6	40.46	1	1/100	1/247.1
1 Acre	43560	4046	100	1	1/2.471
1 Hectare	107639	10000	247.1	2.471	1

1(a). TENSION TEST ON MILD STEEL

Objective:

1. To study the behavior of standard mild steel specimen, under the action of a gradually increasing axial tensile load, tested up to failure, as per IS: 1608 - 1972.
2. To determine tensile strength, true and nominal breaking stress.

Apparatus required:

Universal testing machine, Extensometer, Gripping device, Scale, Micrometer, Punch and Hammer.

Scope and Applicability:

The tension test is done on a standard test piece by applying a gradually increasing uniaxial load (static load). This is also called static tension test. It is one among the most commonly made simple mechanical tests to evaluate the fundamental mechanical properties viz., elasticity, ductility and tensile strength. These properties are important parameters in the design of structural components which are expected to undergo static tensile force during the loading period. Tension test is also made use of to study the stress-strain characteristics of mild steel in tension which is of greater interest in mechanics of materials. It helps to understand the yielding and necking phenomenon and the cup and cone type of fracture.

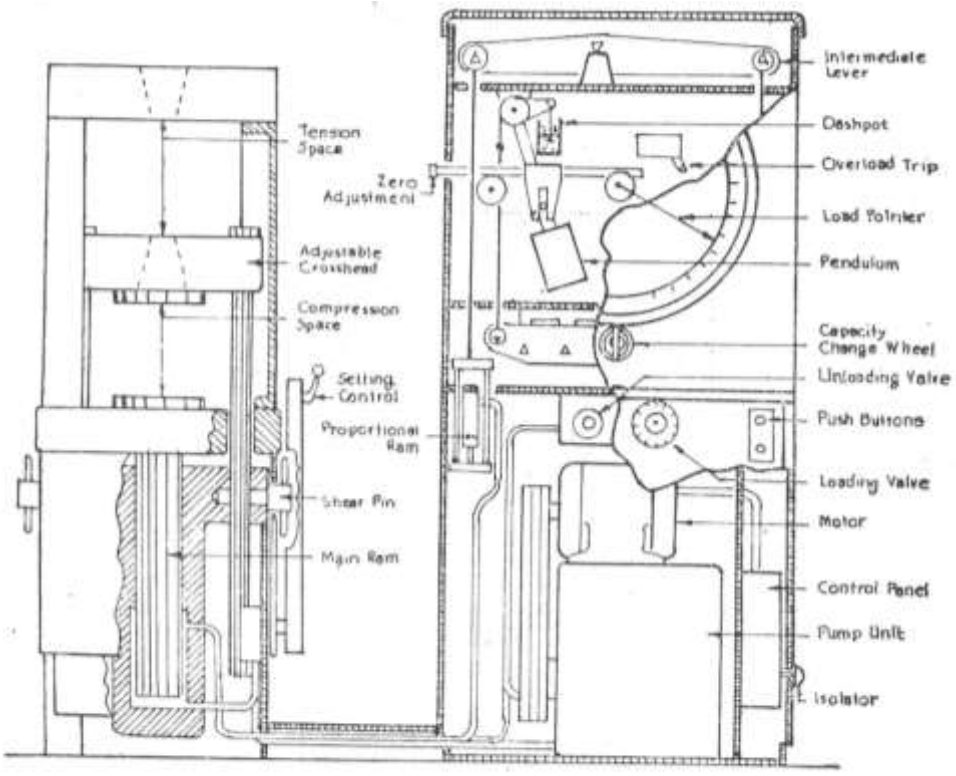
Important Terms and Definitions:

a) Gauge Length: It is the distance between two reference points on the prescribed part of the test piece on which deformations are measured during the test. As per BIS specification, the original gauge length before the test piece is strained is given by the following formula.

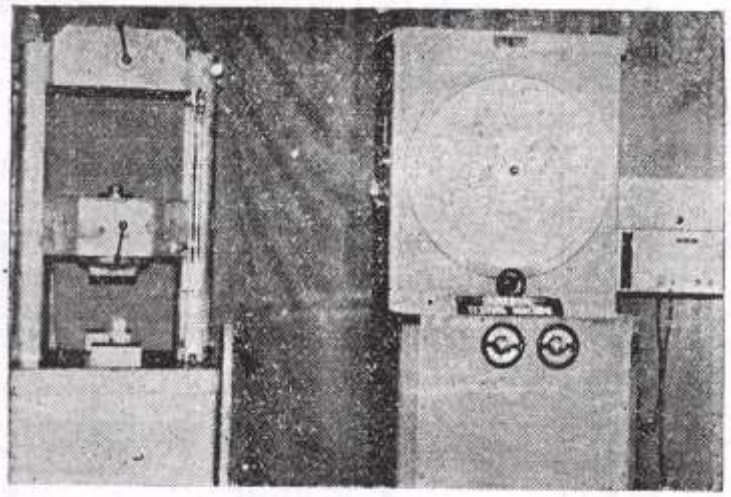
$$L_0 = 5.65\sqrt{S_0}$$

$$= 5d_0 \text{ for circular section}$$

where d_0 = Original diameter
S_0 = Original c/s area
L_0 = Original gauge length



UNIVERSAL TESTING MACHINE



UNIVERSAL TESTING MACHINE

b) Tensile Strength: The maximum load reached in the test divided by the original c/s area. This is also termed as maximum tensile stress or ultimate tensile stress for the material of the specimen.

c) Breaking Stress: Load at the time of breaking divided by the original c/s area is called nominal breaking stress.

Load at the time of breaking divided by the final c/s area is called true breaking stress. True breaking stress is always more than the nominal breaking stress.

d) Elastic limit: Elasticity is the property by which a material regains its shape fully when the load is removed. Elastic limit is the stress limit below which a material behaves as perfectly elastic. Practically this is close to proportional limit (limit up to which stress is proportional to strain) so both are approximately considered as same. (Actually elastic limit comes after proportional limit in stress-strain graph.)

e) Modulus of Elasticity: It is the ratio of axial stress to axial strain within the elastic limit. It is the slope of the initial straight line portion of the stress-strain graph, where stress is taken along Y-axis. It is a measure of elasticity. It is also known as Young's Modulus, 'E'. Standard value of 'E' for mild steel is 2.1×10^5 N/mm^2

Specimen:

Test should be conducted on a standard specimen as specified by IS: 1608-1972. As per BIS, c/s of the test piece may be circular, square or rectangular. Test on circular specimen

is done in the laboratory. Diameter of the specimen may be in between 3.99 mm to 22 .56mm. Form of a typical circular test piece is shown in Fig 1-1

Extensometer:

The extensometer is used for measuring extension precisely. It has aIeast count of 0.0025mm. It has two clamping points 50mm apart and a graduated drum which can be rotated using a screw head. It also has a light arrangement which enables the user to know whether the predefined extension has taken place or not

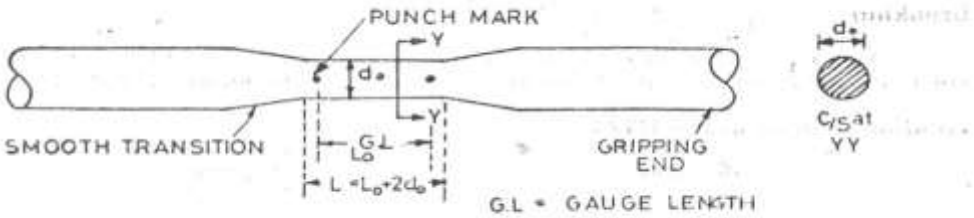


Fig. 1.

Procedure:

1. Diameter of the given specimen is measured using screw gauge at three different places and average diameter d_0 is calculated.
2. Centre point of the specimen is located and half the gauge length is set on either side of it by punch marks.
3. The ends of the specimen are then gripped in the cross heads of the UTM using gripping jaws.
4. Load pointer of UTM again moves forward up to a maximum point, leaving the dummy needle at the maximum load value and it moves backward as the 'necking'[1]starts.Note down the maximum load in kg. (Pu)
5. Finally the specimen fails at a lower load than the maximum load. Note down this breaking load (P_b) in kg when the specimen breaks.
6. The failed specimen is then removed. Keep the two pieces together and measure the final gauge length (L_u). The final diameter at the neck is measured (d_u).
7. The failure pattern is then studied.

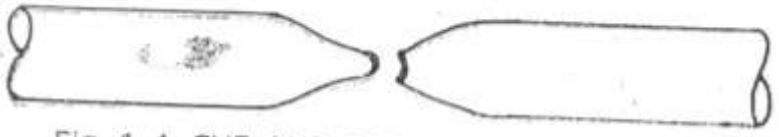


Fig. 1-4. CUP AND CONE TYPE OF FRACTURE

Observation:

Diameter d_1 = mm d_2= mm d_3= mm

Average Diameter d_0 = mm

Gauge Length L_0 = mm

Maximum load P_u = kg = N

Breaking load P_b = kg = N

Final gauge

Length after fracture L_u = mm

Diameter at neck d_u = mm

Calculations:

Initial Area, $A_0 = \pi d_0^2/4$ = = mm^2

Final Area, $A_u = \pi d_u^2/4$ = = mm^2

Ultimate stress, = P_u/A_0

=

= N/mm^2

Nominal breaking stress, = P_b/A_0

=

= N/mm^2

True breaking stress, = P_b/A_u

=

= N/mm^2

1(b). SHEAR TEST ON MILD STEEL

Objective:

To determine the ultimate shear strength in single shear and double shear of mild steel rod.

Apparatus required:

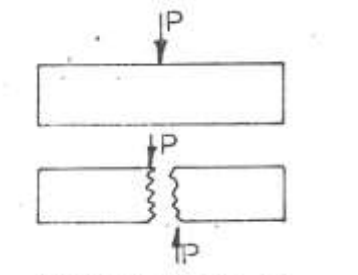
Universal Testing Machine, Shear Shackle, Micrometer screw gauge

Theory:

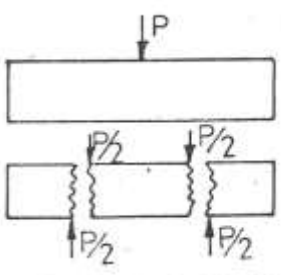
Shear stress is caused by forces which act parallel to an area of cross section and tend to produce sliding of one portion past another portion. If there is only one cross section which resists the failure, the material is said to be in single shear and the average ultimate shear strength will be equal to the failure load divided by the area of cross section. If two areas resist the failure then the material is said to be in double shear and the average ultimate shear strength will be equal to the failure load divided by twice the area of cross section.

The procedure for shear test is standardized by IS:5242-1969 "Method of Test for Determining Shear Strength of Mild Steel".

A special shear attachment called Shear Shackle is used to hold the specimen. The specimen can be placed either one end supported or two ends supported in the shackle. One end supported specimens fail under single shear and both ends supported specimens fail under double shear.



SINGLE SHEAR
(shear strength = P/A)



DOUBLE SHEAR
(shear strength = P/2A)

Scope and applicability of Direct Shear Test:

The result obtained from the direct shear test, that is the ultimate shear strength is used to arrive at a safe shear stress of the material after adopting a suitable factor of safety. This value of safe shear stress is used in design of rivets, crankpins, etc.

The result of the test depends to a considerable degree on the hardness and sharpness of the edges of the support bearing the specimen. Care should be taken to minimize the bending stress across the plane along which the shearing load is applied. This test has further limitation of being useless for the determination of modulus of elasticity or modulus of rigidity owing to the impossibility of measuring strains.

Procedure:

1) Note down the diameter of the specimen.
2) Place the specimen in the shear shackle with one end supported for single shear test
3) Place the shackle in the compression testing machine and load without any jerk till failure (load is to be applied in a uniform rate)
4) Note down the failure load P_u
5) Calculate the ultimate strength in shear.

Observations:

Initial diameter d_0 = mm

Load at failure P_u = kg = N

Area $(A_0) = \pi d_o^2/4$ = = mm^2

Shear Strength = P_u / A_o

=

= N/mm^2

1(C). COMPRESSION TEST ON CAST IRON

Objective:

To conduct compression test on a cast iron specimen and to determine the compressive strength

Apparatus required:

Universal testing machine, scale, calipers

Theory, scope and applicability:

'Compression test' usually refers to tests in which a standard specimen is subjected to a' gradually increasing (static) uniaxial compressive load until failure occurs.

Compression test is to be done with utmost care. Any lack of alignment of the specimen in a compression test causes increase in eccentricity of the load as load increases and lack of stability may cause collapse under a relatively lighter load. Length (height) of compression specimen is another important factor in this test. Since the specimen is expected to fail under pure compression, length (height) is to be limited to such a value that bending due to column action (buckling) should not take place. So shorter specimens are preferred for the test.

Specimen:

Short or medium specimens are generally used. If the length of the specimen is increased considerably with respect to diameter bending action takes place. When the height is very less compared to diameter, the diagonal planes along which failure would take place intersect the base. So generally ratio of length to diameter of 2 to 3 is commonly employed.

Description of Compression Testing Machine:

It is of self-contained type, consisting principally of one piece frame. The lower portion serving as an oil reservoir also supports the cylinder and ram which applies the load to the specimen through a platen attached to the top of the ram. The upper platen is spherically seated and is fitted to the adjusting screw which can be raised or lowered to

accommodate varying heights of specimens within the range of the machine. The load applied to the specimen is indicated on pressure gauges. Hydraulic pressure is applied to the ram by means of hand operated or electrically operated pump attached to the main frame.

Procedure:

1) Measure diameter and height of the specimen accurately.
2) Place the specimen centrally in the compression testing machine.
3) Keep the specimen tight in position by screwing down the upper platen.
4) Set a dial gauge to note the deformation and note down the least count of the dial gauge. The dial gauge has a range of 0-50 mm (1 div=0.01mm). Set the dial gauge to zero and note down the initial reading
5) Start pumping. Then note down the dial gauge reading for fixed load intervals.
6) Remove the dial gauge before the specimen fails.
7) Note down the failure load.
8) Remove the specimen, measure final diameter and height. Also study the fracture (Note: 1)

Observations:

Initial diameter, d_0 = mm

Load at failure, P_u = kg = N

Area, $(A_o) = \pi d_o^2/4$ = = mm^2

Compressive Strength = P_u / A_o

=

= N/mm^2

2. CHAIN SURVEYING

Objective:

To measure and plot of the given area/ plan using chain and tape.

Introduction:

Chain surveying is the method of land surveying in which only linear measurements are taken. No angular measurements are taken. Chain surveying is used for areas of small extent on open ground having simple details. This is the simplest type of surveying and consists of measuring the lengths of the lines marked out in the field. The process of measuring the horizontal distance between two terminal stations is known as chaining. For measuring the lengths of the lines it is important that the chain should follow as far as possible straight line between the terminal points. But if the line is long or the station at its distant end is not visible, it is necessary to place intermediate ranging rods to maintain the direction. The operation of establishing intermediate points on a straight line between the terminal points is known as ranging.

Instruments used for Chaining and their uses

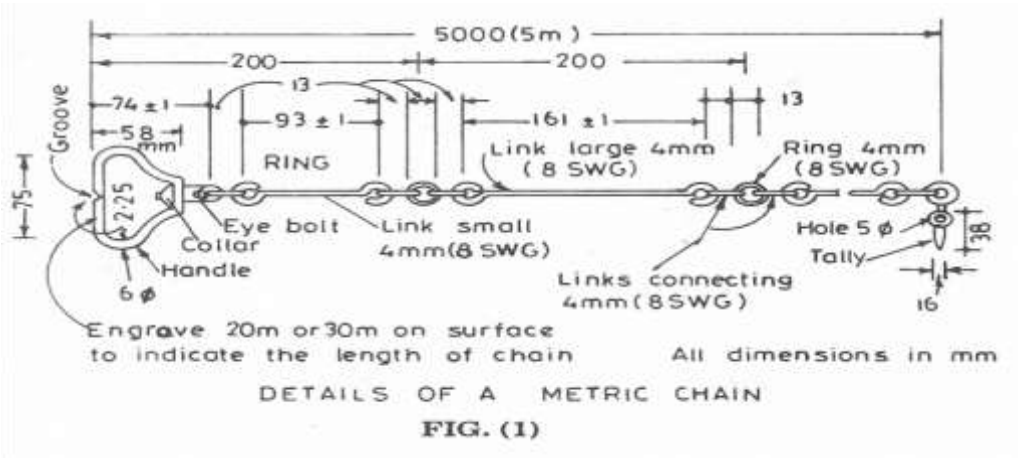
Chain or tape, arrows, peg, ranging rods, offset rod, plasterer's laths, whites, plumb bob

Chain:

The following different types of metric chains arc used for linear measurements.

1) 30 metre chain
2) 20 metre chain

The details of the metric chain are shown in the fig. 1. and details of particular 20m & 30 m chains are also shown in the fig. 2 & fig. 3.



DETAILS OF A METRIC CHAIN

FIG. (1)

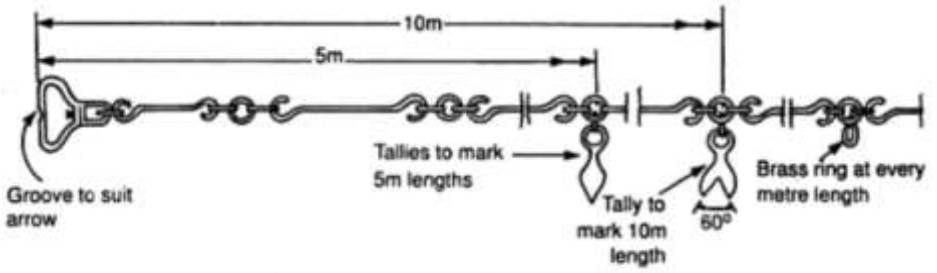


Fig 2 a) 20-metre chain (100 links)

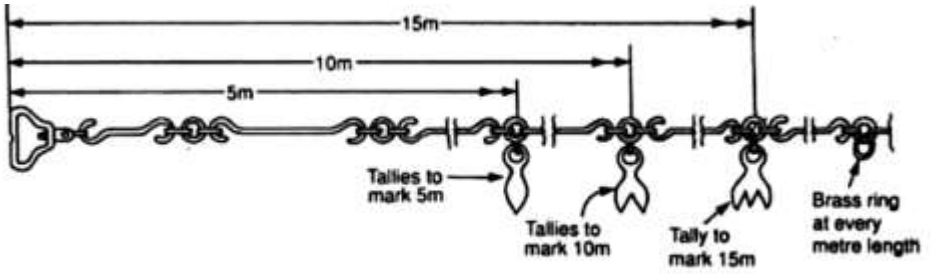
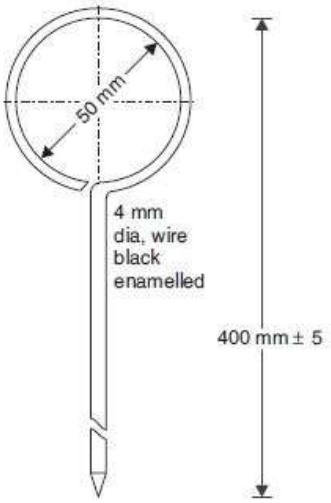


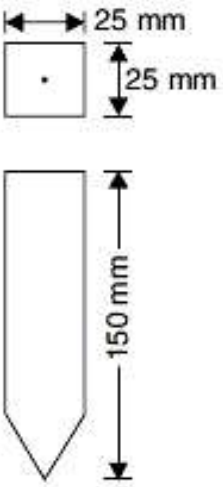
Fig 3 b) 30-metre chain (150 links)

Arrows:

To mark the end of the chain length, the arrow is inserted in to the ground, but when the ground is hard a scratch may be made with the pointed end.



Arrow-**Fig 4**



Wooden Peg-**Fig 5**

Pegs are made of hard timber and are tapered at one end. They are usually 2.5cm square and15cm long. It is used to mark the positions of the stations. Peg details have been shown in the fig. 5.

Ranging rods:

Used for ranging the line.

Fig. 6 shows the details.

Offset rods:

It has two short narrow vertical slots passing through the centre of the section at right angles to one another and set at about the eye level. Refer fig. 7

Fig 6 Ranging rod

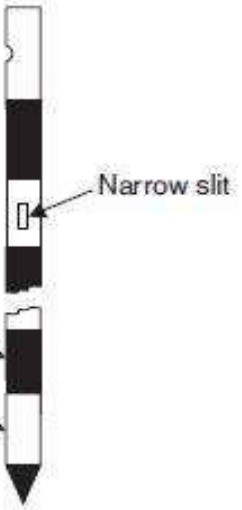


Fig 7 Offset rod

Plumb bob: Plumb bob is required when measuring distances along slopes in a hilly country in order to transfer the points to the ground as in the method of stepping and also for testing the verticality of the ranging poles.

Summary:

It can be summarized here that, chain surveying requires only simple instruments like chain, tape and few ranging rods, which can be used by a beginner in the field of surveying. This method of surveying is quite simple and has general applications. However chain surveying is not suitable for large areas having many details.

Procedure:

1. To begin with, the ranging rods should be erected vertically behind each end of line say at A & B.
2. To range a rod in line, surveyor stands about 2m behind the ranging rod at the beginning of the line, while the assistant holds the ranging rod vertically at arm's length at the point where it is desired to establish the intermediate station.
3. The ranging rod should be held tightly by the thumb and the forefinger and roughly in line.
4. The surveyor then directs the assistant to move the rod to right or left until the three ranging rods appear to be exactly in a straight line.
5. Surveyor finally checks by sighting over the lower ends of the rods in order to avoid errors due to non verticality of the rods.
6. Using cross staff line chainage BC on the ground will be perpendicular to BA.
7. Same procedure is adopted for the line BC, CD and DA. (FiG-1)
8. Sketch is plotted in the drawing sheet with a suitable scale.

3. COMPASS SURVEYING

Objective:

To measure and plot of the given area using prismatic compass

Introduction:

Chain surveying can be used when the area to be surveyed is comparatively small and is fairly flat. However when large areas are involved, methods of chain surveying are not sufficient and convenient. In such cases, it becomes essential to use some sort of instrument which enables angles or direction of the survey lines to be observed. In engineering practice, following are the instruments used for such measurements.

i) Surveyor's compass.
ii) Prismatic compass.

Bearings and Angles:

The direction of survey line can either be established (a) with relation to each other or (b) with relation to any meridian. The first will give the angle between the two lines while the second will give the bearing of the line.

Designation of Bearings:

Whole Circle Bearing System (W.C.B.) or Azimuthal System. In this system, the bearing of a line is measured from magnetic north (or south) in clockwise direction. The value of the bearing thus varies from 0° to 360°. Prismatic compass is graduated in this system.

Fore and Back Bearings:

If the bearing of line AB is measured from A towards B, it is known as forward bearing or fore bearing (FB).If the bearing of the line AB is measured from B towards A, it is known as backward bearing or back bearing (BB), since it is measured in backward direction.

Study of the Instrument

The Prismatic Compass: (fig. 8)

Prismatic compass is the most convenient and portable form of magnetic compass which can either be used as a hand instrument or can be fitted on a tripod. The main parts of the prismatic compass are:

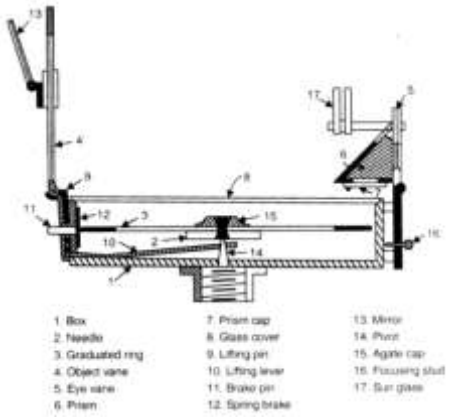


Fig. 8

1. **Magnetic needle:**
   Magnetic needle is attached to the circular ring or compass cord made up of aluminium, a non-magnetic substance. When the needle is on the pivot it will orient itself in the magnetic meridian and therefore the N and S ends of the rings will be in this direction.

2. **Sighting vane, eye slit and prism unit:**
   The line of sight is defined by the sighting vane and the eye slit both attached to compass box. The sighting vane consists of a vertical hair attached to a suitable frame. The eye slit consists of a vertical slit cut into the upper assembly of the prism unit, both, being hinged to the box. When an object is sighted, the sight vanes will rotate the N.S. end of ring through an angle which the line makes with the magnetic meridian.

   A triangular prism is fitted below the eye slit, having suitable arrangement for focusing to suit different eye sights. The prism has both horizontal and vertical faces convex, so that a magnified image of the ring graduation is formed.
   A metal cover fits over the circular box, when not in use. To sight the objects which are too high or too low directly, a hinged mirror capable of sliding over the sighting vane is provided and the object sighted by reflection. When bright objects are sighted, dark glasses may be interposed into the line of sight.

Temporary Adjustments:

i) Centering:

Centering is the process of keeping the instrument exactly over the station. The centering is invariably done by adjusting or manipulating the legs of the tripod. A plumb bob may be used to judge the centering and if it is not available it may be judged by dropping a pebble from the centre of the bottom of the instrument.

ii) Levelling:

A tripod is provided with ball and socket arrangement with the help of which the top of the box can be leveled.

Focusing the prism:

The prism attachment is slided up or down for focusing till the readings are seen to be sharp and clear.

Procedure:

1. Fix up the positions of stations A,B,C and D. by fixing ranging rods in such a way that adjacentstations are intervisible to each other.
2. Locate the position A by taking measurements and bearing to at least three prominent objects like tree, electric pole etc.
3. Centre the compass on the station A and level it.
4. Take fore bearing of AB and measure the length using chain or tape.
5. Shift the compass to B and take back bearing of AB.
6. Take fore bearing of BC and measure the length BC.
7. Procedure is continued until the last point is reached.
8. Knowing the bearing and length, boundary is plotted in a drawing sheet to some suitable scale

Table-1 Details of any **THREE** prominent points

Permanent object number	Distance in m	Bearing	Remarks

Table-2 Details of instrument station points

Instrument Station No.	Sighted to point	Line	Distance in m	Fore Bearing	Back Bearing	Remarks

4. LEVELLING

Objective:
To plot the profile of a ground using dumpy-level and leveling staff.

Introduction:
Levelling is defined as the art of determining the relative heights or elevations of points or objects on the earth's surface. It deals with the measurements in the vertical plane.

Definition of terms used in leveling:
Datum:
It is the surface with respect to which elevations of different points are expressed. Mean sea level is adopted as datum.

Bench Mark:
It is a fixed reference point whose elevation with respect to datum is known. It is required for starting the levelling work and also for checking the accuracy at the end of the work.

Reduced Level:
It is the vertical distance of a given point above or below the datum. It is also known as elevation.

Line of collimation:
It is the line passing through the intersection of the horizontal and vertical cross hairs and the optical centre of the object glass and its continuation.

Height of instrument or height of plane of collimation: (H.I)
It is the elevation of plane of collimation (Le. plane of sight) when the instrument is leveled correctly.

Back Sight: (B.S.)
It is the staff reading taken on a point of known elevation or change point. It is the first staff reading to be taken after the level is set-up and levelled properly

Fore Sight: (F.S.)
It is the last staff reading taken before shifting the instrument so that R.L. of change point =H.I - Fore sight.

Intermediate Sight: (I.S.) It is the staff reading taken on a point other than F.S. and B.S. points, from the same set up of the instrument. R.L of point =H.I.- I.S.

Change Point:

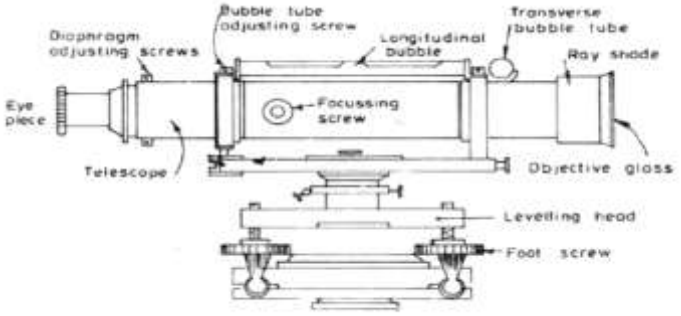
When the staff readings are not visible from the same set-up of the instrument, we have to shift the instrument. The point which denotes this shifting is known as the change point or turning point. On this change point both F.S. and B.S. are to be taken, F.S is taken before shifting the instrument and B.S is taken after shifting the instrument to determine the new H.I.

Level Instruments:

The instruments commonly used in direct leveling are 1)Level and 2) Levelling staff

1) Level:

The purpose of a level is to provide a horizontal line of sight. The dumpy level is a commonly used level



DUMPY LEVEL

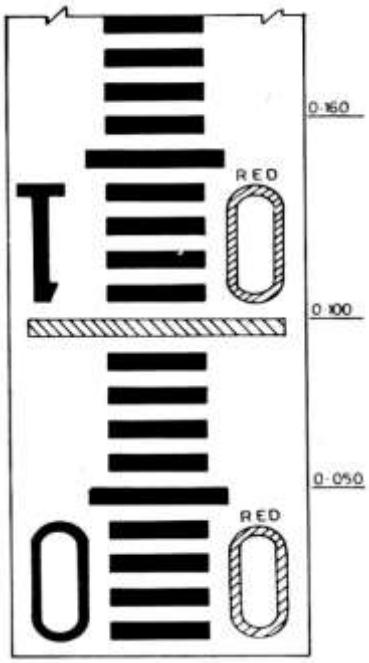
2) Levelling Staff: (rod)

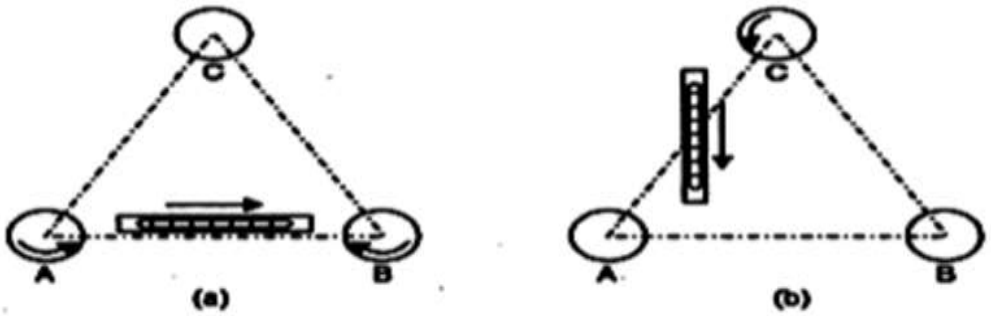
This is required to determine the vertical distance of the given point above or below the horizontal line of sight.

Levelling Staff: The purpose of levelling staff is to determine the amount by which the station is above or below the line of sight.

Folding Staff:

The folding type is of 4 m. length made up of well seasoned timber. It consists of two 2m wooden pieces with a joint in between. Each meter is divided in to 200 divisions, the thickness of the graduations being 5 mm. Each decimetre length IS figured with a corresponding numeral in black and marked to the left. Each meter numeral is in red and marked to the right. The graduations are inverted so that through the telescope they appear correct. When not in use, the staff can be folded about the hinge so that it becomes convenient to carry.





LEVELLING-UP WITH THREE FOOT SCREWS.

a) Elimination of parallax:

Parallax is the condition arising because of improper focusing where in the image formed by the objective is not lying in the plane of cross hairs. It can be eliminated using following steps.

(i) Focusing the eye-piece:

Turn the telescope towards sky or towards a clear white background such as paper sheet and move the eye-piece in or out until the cross-hairs are seen sharp and distinct.

(ii) Focusing the telescope:

Turn the telescope towards staff and turn the focusing screw until the image appears clear and sharp.

Procedure:

1) Let AB be the centre line.
2) Set up the level either to left or right of centre line. and temporary adjustment are done properly.
3) A back sight is taken on BM to determine H.
4) Having stretched the chain from A in line with AB, staff reading are taken at A and entered in intermediate column.
5) The staff held along the centre line at every 15m chain.
6) The last reading taken before shifting the instrument is termed as fore sight and entered in F.S column. All other readings taken after B.S and before F.S. are termed as Intermediate sights and are noted in I.S, column.

Plotting the Profile:

A horizontal line is first drawn as a datum and the chainages of staff points taken along section or centre lines are marked to convenient scale. Perpendicular line are then drawn at each plotted chainage and on these lines, the respective levels are set off.

The elevation of the datum line should be so assumed that the lengths of ordinates would be between 40mm to 150mm. Suppose if the R.L's of the different points varies between 104m and 112m, the elevation (RL) of the datum line can be assumed as 100m.

Vertical scale used in plotting is exaggerated i.e., larger than horizontal; usually ten times.

Sl. No.	B.S	I.S	F.S	H.I	R.L	Chainage in m(Centre)	Remarks
	ΣB.S		ΣF.S				

P.T.O for Arithmetical Check:

Arithmetical Check: ΣB.S - ΣF.S = Last RL – First RL