DAV UNIVERSITY

(Empowering Students with 21st Century Skills)

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

FOR

DESIGN THINKING AND IDEA LAB (MED-103)

Vision of the Department

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

Mission of the Department

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

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

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

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

Programme Educational Outcomes (PEOs)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Department of Mechanical Engineering

L	T	P	Credits
0	0	2	1

Course Code	MED103								
Course Title	**Design Thinking and Idea Lab**								
Course Outcomes	On the completion of the course the student will be able to: **CO1**: To learn all the skills associated with the tools and inventory associated with the IDEA Lab. **CO2:** Learn useful mechanical and electronic fabrication processes. **CO3**: Learn necessary skills to build useful and standalone system/ project with enclosures. **CO4**: Perceive individual differences and its impact on everyday decisions and further Create a better customer experience.								
Examination Mode	Practical								
Assessment Tools	Continuous Assessment (CA)				MSE	MSP	ESE	ESP	Total
	Quiz	Assignment/ Project Work	Attendance	Lab Performance					
Weightage	-	-	-	20%	-	30%	-	50%	100

S. No.	LIST OF EXPERIEMENTS	CO Mapping
1.	To study the working principles and operation of normal lathe machine.	CO1
2.	To study the, working and operation of different welding equipment's.	CO1
3.	To study the working principles and operation of wood lathe machine.	CO1
4.	To Study the machining of 3D geometry on soft material such as soft wood or modelling wax.	CO2
5.	To Study the 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.	CO2
6.	To Study the 3D 2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.	CO2
7.	Scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.	CO2
8.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.	CO3
9.	Embedded programming using Arduino and/or Raspberry Pi.	CO3
10.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.	CO4

	Reference content for theory Syllabus	CO Mapping
Unit 1	***An Insight to Learning, Remembering Memory and Emotions: Experience & Expression***	
	Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting. Understanding the Memory process, Problems in retention, Memory enhancement techniques. Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers	CO1
Unit 2	***Basics of Design Thinking***	

	Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test. Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving. Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design	CO2
Unit 3	***Prototyping & Testing***	
	What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing. Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences	CO3
Unit 4	***Design Thinking & Customer Centricity***	
	Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design. Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".	CO4
Text Books	1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company. 2. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), ISBN: 978-9391505332 3 Amrinder Singh, Manufacturing Practice. Mahalakshmi Publication, New Delhi.	
Reference Books	1. All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi. 2. 3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi 3. The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.	

Mapping of COs with PO(s)

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

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

Mapping of COs with PSO(s)

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

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

DESIGN THINKING AND IDEA LAB
(MACHINE SHOP)

EXPERIMENT NO: 1

Experiment 1: To study the working principles and operation of normal lathe machine.

Apparatus:

Single point tool, MS rod, Brush,

Theory:

Lathe is one of the most versatile and widely used machine tools all over the world. It is commonly known as the mother of all other machine tool. The main function of a lathe is to remove metal from a job to give it the required shape and size. The job is securely and rigidly held in the chuck or in between centers on the lathe machine and then turn it against a single point cutting tool which will remove metal from the job in the form of chips. Fig. 1 shows the working principle of lathe. An engine lathe is the most basic and simplest form of the lathe. It derives its name from the early lathes, which obtained their power from engines. Besides the simple turning operation as described above, lathe can be used to carry out other operations also, such as drilling, reaming, boring, taper turning, knurling, screw thread cutting, grinding etc.

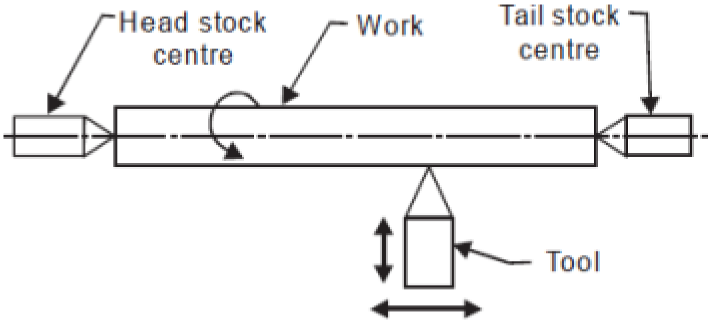


Fig.1. Working principal of lathe machine

Construction of Lathe Machine:

A simple lathe comprises of a bed made of grey cast iron on which headstock, tailstock, carriage and other components of lathe are mounted. Fig. 2 shows the different parts of engine lathe or central lathe.

The major parts of lathe machine are given as under:

1. Bed
2. Head stock
3. Tailstock
4. Carriage
5. Feed mechanism
6. Thread cutting mechanism

Bed:

The bed of a lathe machine is the base on which all other parts of lathe are mounted. It is massive and rigid single piece casting made to support other active parts of lathe. On left end of the bed, headstock of lathe machine is located while on right side tailstock is located. The carriage of the machine rests over the bed and slides on it. On the top of the bed there are two sets of guideways-innerways and outer ways. The inner ways provide sliding surfaces for the tailstock and the outer ways for the carriage. The guideways of the lathe bed may be flat and inverted V shape. Generally, cast iron alloyed with nickel and chromium material is used for manufacturing of the lathe bed.

Head Stock:

The main function of headstock is to transmit power to the different parts of a lathe. It comprises of the headstock casting to accommodate all the parts within it including gear train arrangement. The main spindle is adjusted in it, which possesses live centre to which the work can be attached. It supports the work and revolves with the work, fitted into the main spindle of the headstock. The cone pulley is also attached with this arrangement, which is used to get various spindle speed through electric motor. The back-gear arrangement is used for obtaining a wide range of slower speeds. Some gears called change wheels are used to produce different velocity ratio required for thread cutting.

Tail Stock:

Fig. 3 shows the tail stock of central lathe, which is commonly used for the objective of primarily giving an outer bearing and support the circular job being turned on centers. Tail stock can be easily set or adjusted for alignment or non-alignment with respect to the spindle centre and carries a centre called dead centre for supporting one end of the work. Both live and dead centers have 60° conical points to fit centre holes in the circular job, the other end tapering to allow for good fitting into the spindles. The dead centre can be mounted in ball bearing so that it rotates with the job avoiding friction of the job with dead centre as it important to hold heavy jobs.

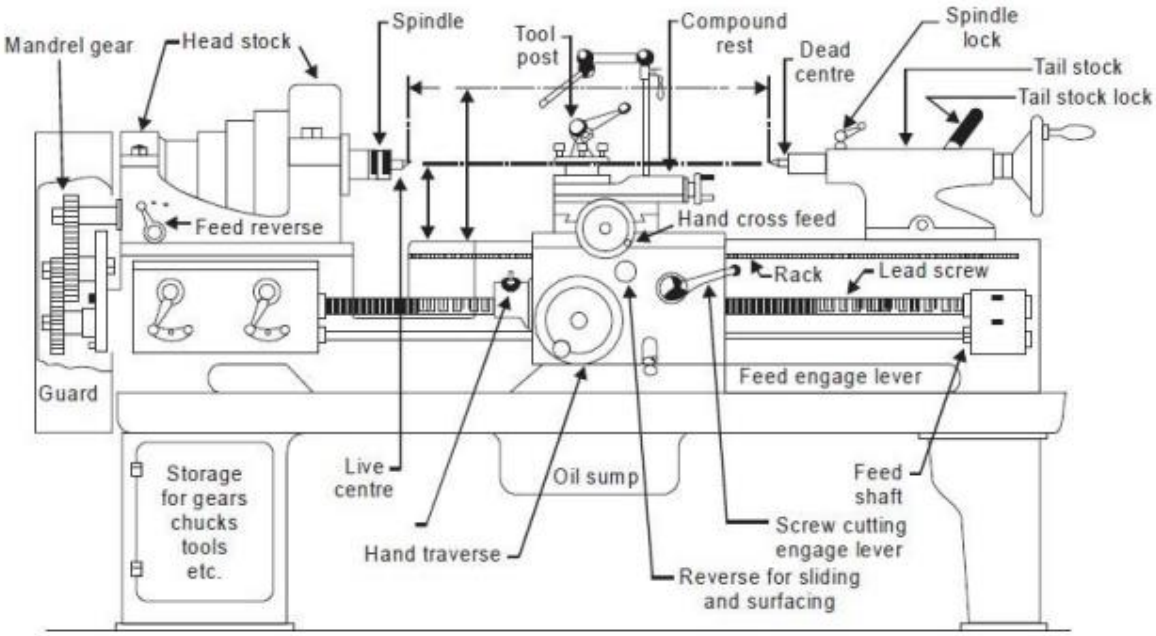


Fig.2 Different parts of engine lathe or central lathe

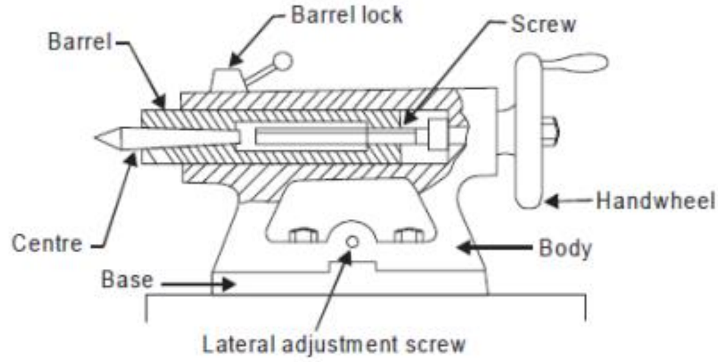


Fig.3 Tail stock of central lathe

Carriage:

Carriage is mounted on the outer guide ways of lathe bed and it can move in a direction parallel to the spindle axis. It comprises of important parts such as apron, cross-slide, saddle, compound rest, and tool post. The lower part of the carriage is termed the apron in which there are gears to constitute apron mechanism for adjusting the direction of the feed using clutch mechanism and the split half nut for automatic feed. The cross-slide is basically mounted on the carriage, which generally travels at right angles to the spindle axis. On the cross-slide, a saddle is mounted in which the compound rest is adjusted which can rotate and fix to any desired angle. The compound rest slide is actuated by a screw, which rotates in a nut fixed to the saddle. The tool post is an important part of carriage, which fits in a tee-slot in the compound rest and holds the tool holder in place by the tool post screw. Fig. 4 shows the tool post of centre lathe.

Feed Mechanism:

Feed mechanism is the combination of different units through which motion of headstock spindle is transmitted to the carriage of lathe machine. Following units play role in feed mechanism of a lathe machine

1. End of bed gearing
2. Feed gear box
3. Lead screw and feed rod
4. Apron mechanism

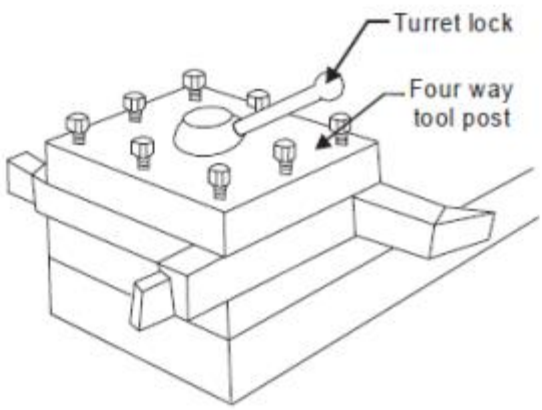


Fig.4 Tool post of centre lathe

The gearing at the end of bed transmits the rotary motion of headstock spindle to the feed gear box. Through the feed gear box, the motion is further transmitted either to the feed shaft or lead screw, depending on whether the lathe machine is being used for plain turning or screw cutting. The feed gear box contains a number of different sizes of gears. The feed gear box provides a means to alter the rate of feed, and the ration between revolutions of the headstock spindle and the movement of carriage for thread cutting by changing the speed of rotation of the feed rod or lead screw. The apron is fitted to the saddle. It contains gears and clutches to transmit motion from the feed rod to the carriage, and the half nut which engages with the lead screw during cutting threads. Thread Cutting Mechanism The half nut or split nut is used for thread cutting in a lathe. It engages or disengages the carriage with the lead screw so that the rotation of the leadscrew is used to traverse the tool along the workpiece to cut screw threads. The direction in which the carriage moves depends upon the position of the feed reverse lever on the headstock.

Specification of Lathe:

The size of a lathe is generally specified by the following means:

(a) Swing or maximum diameter that can be rotated over the bed ways

(b) Maximum length of the job that can be held between head stock and tail stock centres

(c) Bed length, which may include head stock length also

(d) Maximum diameter of the bar that can pass through spindle or collect chuck of capstan lathe.

Fig. 5 illustrates the elements involved in specifications of a lathe. The following data also contributes to specify a common lathe machine.

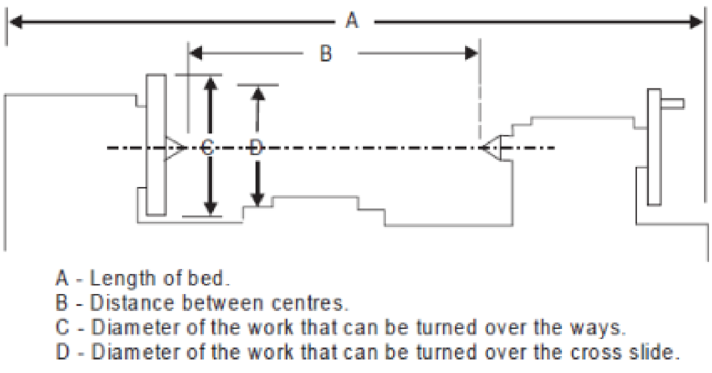


Fig 5: Specifications of lathe machine

Pre-viva questions:

1. What is a lathe?
2. What are the various operations can be performed on a lathe?
3. What are principle parts of the lathe?
4. State the various parts mounted on the carriage.
5. List any four types of lathe.
6. State the various feed mechanisms used for obtaining automatic feed.
7. List any four holding devices.
8. What are the different operations performed on the lathe?
9. State any two specification of lathe.
10. What are the types of headstock?

EXPERIMENT NO: 2

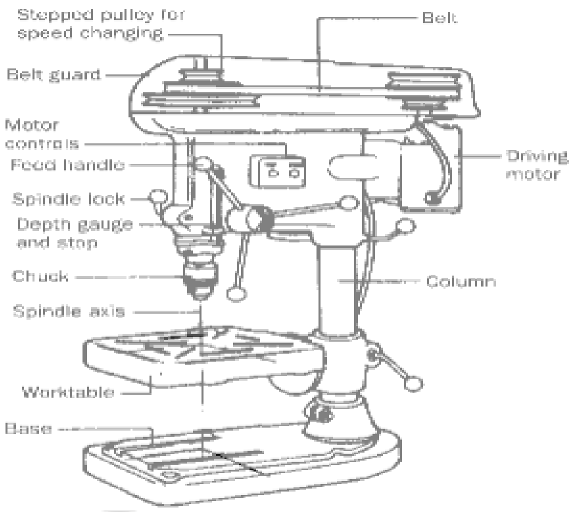
Experiment 2 To study the working of drill machine for drilling different holes for different dia.

Apparatus:

Drilling machine, drill tool, coolant, metal piece, brush.

Theory:

When drilling a hole using a hand or power drill, it can be tricky to drill the hole at a right angle to the work. Drills often have a level incorporated into the drill housing, but usually this requires good vision to read. There are, however, several techniques that persons with low vision or no vision use which can make drilling quite accurate. These techniques include: Drill guides in a range of diameters are available from hardware stores or building supply centers. Placing the guide on the surface of the work to be drilled and inserting the bit through the guide makes it possible to drill a hole straight into the work. If you have access to a drill press, you can make a set of drill guides yourself by drilling holes of different diameters into small blocks of wood. These works just like the drill guides described above. If you don't have access to a drill press, you might ask a sighted friend to make drill guides using a portable drill with a built-in level.

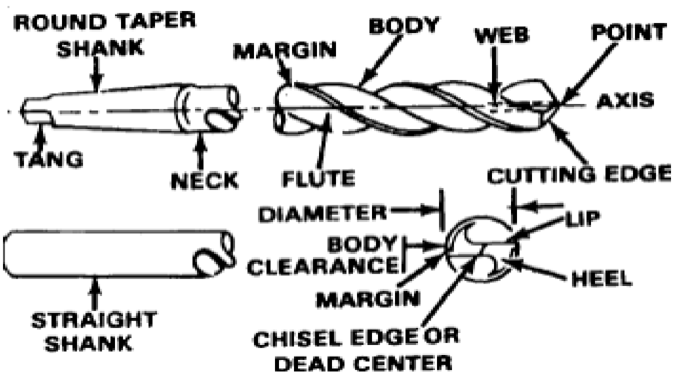


Tip:

Over time, the guide hole in the wooden guide may become slightly enlarged, which may make it a bit more difficult to position the drill at exactly a 90-degree angle. Remove a square or rectangle of wood from a board, creating a right angle; then place the bit into the corner to help align the bit. Place a large-headed nail with the head down on the surface of the board, and align the bit with the nail by touch. Use an empty spool of thread or sewing machine bobbin (pictured below). Mark the spot by making a "start hole" with an awl, nail, or ice pick. Place the drill bit through the spool or bobbin and align the point of the bit with the start hole you have created. With the drill in the "off" position, place the flat end of the spool or bobbin firmly against the surface and hold it in place with pliers. Please note: Do not use your hands to hold the spool in place. With the drill and spool in this position, start the drill – and your hole will be straight/perpendicular with the surface.

Twist Drill:

Twist drills are rotary cutting tools normally having two cutting edges and two flutes which are grooves formed in the body to provide cutting lips, to permit the removal of chips and to allow coolant or cutting fluid to reach the cutting action. They are identified by the shank style, straight or taper, then by length, screw machine, jobber or taper length, by the material they are made from and finally by the helix or spiral of the flutes.



DESIGN THINKING AND IDEA LAB
(WELDING SHOP)

EXPERIMENT NO: 3

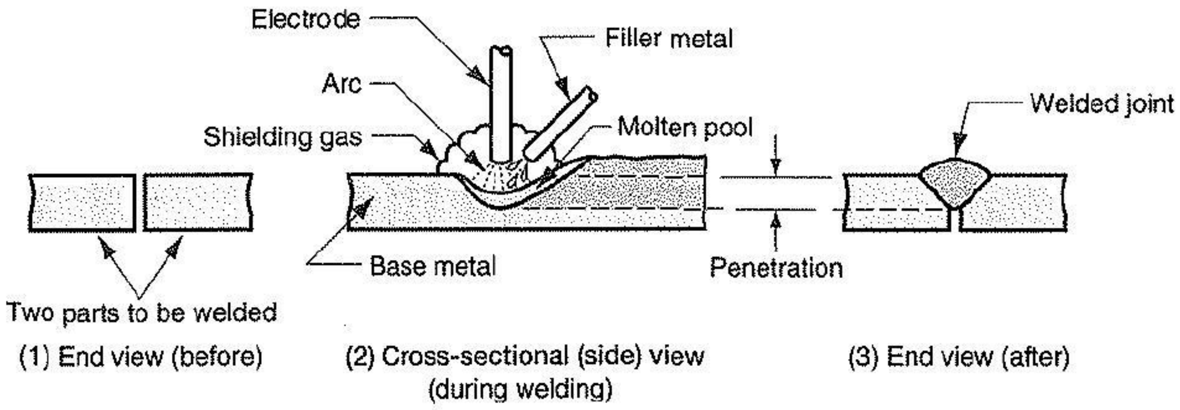
Experiment 3: To study the, working and operation of different welding equipment's (Arc Welding).

Equipment and Material Required:

D.C Welding machine, Bench vice, Tensile testing machine, M.S. Plates of 100x50x5(2), Metallurgical microscope.

Tools Required:

Hack saw, chipping hammer, wire brush, safety goggles, Hand gloves, Face shield, Files.



Welding Terminology:

1) Backing: It is the material support provided at the root side of the weld to aid in the control of the penetration.
2) Base Metal: The metal to be joined or cut.
3) Bead or Weld bead: It is the metal added during a single pass of welding. The bead appears as strikers.
4) Crater: In arc welding, a crater is the depression in the weld metal pool at the where the arc strikers.
5) Deposition Rate: Rate at which weld metal is deposited per unit time and expressed in kg/hr.
6) Fillet Weld: The metal fused into the corner of a joint made of two pieces placed at approximately 90 degrees to each other.
7) Penetration: Depth up to which the weld metal combines with the base metal as measured from the top surface.
8) Puddle: Portion that is melted by the heat of welding.
9) Root: The point at which the 2 pieces to joined are nearest.
10) Tach weld: A small weld used to temporarily hold the two pieces together during actual welding.
11) Weld face: Exposed surface of the weld.
12) Weld pass: A single movement of the welding torch or electrode along the length of the joint, which results in beats, is weld pass.

Description:

Principle of Arc welding:

An arc is generated below 2 conductor cathode and anode. When they are touched to establish flow of current. An arc is sustained electric discharge through ionized gas column called plasma b/w 2 electrodes. Electrons liberated from cathode move towards anode at high-speed large amount of heat is generated. To produce are potential diff b/w 2 electrodes should be sufficient.

Straight and Reverse Polarity:

The positive terminal of DC supply is connected to work piece and the negative terminal to electrode and known as DCSP.

The positive terminal of DC supply is connected to electrode and negative to work piece and is known as DCRP.

Heat Affected Zone (HAZ):

A HAZ of a weld is the part of welded joint, which has been heated to temperature up to solidify temperature resulting in various degree of microstructure as

Tensile Test: This test is carried out to determine the ultimate tensile strength under static loading of the base metal weld metal on welded joint.

Procedure:

1. Given 2 M.S. plates are filled at an angle of 450 at 2 surfaces to be joined (V groove is formed) 2. Electrode is fixed to electrode holder.
3. Connections to be given such that electrode- negative and work piece positive.
4. Welding is to be done carefully for the half-length of the plates.
5. The work piece is to be cut into two halves by power hacksaw.

6. The beads are polished, etched with two percent natal solution and studied under the microscope whose magnification factors 10X for the heat effected zone.

7. By gripping the beads b/w the jaws pf Tensile testing machine and load is applied until the work piece breaks and the readings is to be noted.

8. The same procedure is repeated for the remaining half which is welded by reverse polarity and the results are to be compared

Precautions:

1. Edge preparation should be done very carefully.
2. Before welding ensure that the surfaces are extremely clean.
3. While welding always use face shields or goggles.

Result:

The effect of polarity on weld strength and heat effected zone in arc welding was studied.

EXPERIMENT NO: 4

Experiment 4: To prepare a Single Strap Butt Joint on the given work pieces using spot welding

Material Required:

GI Sheet of 50 x 50 mm--- 1 No's

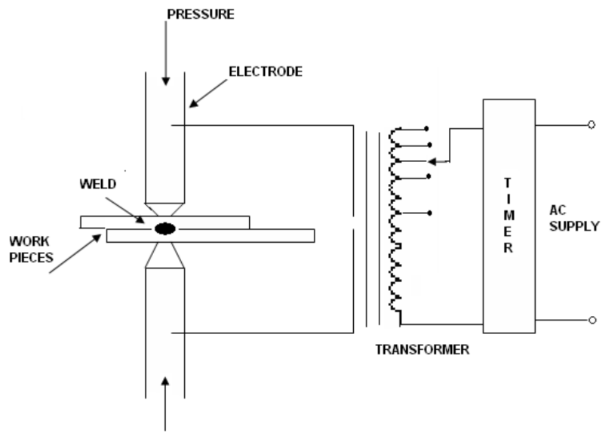
GI Sheet of 50 x 50 mm---- 1 No.

Apparatus Required:

Spot Welding Equipment, Snips and Gloves

Theory:

Spot welding is a resistance welding process in which overlapping sheets are joined by local fusion at one or more spots by the heat generated by resistance to the flow of electric current through work pieces that are held together under force by two electrodes, one above and the other below the two overlapping sheets as shown in Fig.



PRINCIPLE OF RESISTANCE SPOT WELDING

In resistance welding (RW) a low voltage (typically IV) and very high current (typically 15,000 A) is passed through the joint for a very short time (typically 0.25 s). This high amperage heats the joint, due to the contact resistance of the joint and melts it. The pressure on the joint is continuously maintained and the metal fuses together under this pressure. The heat generated in resistance welding can be expressed as

$$H = k I^2 R t$$

Where H = the total heat generated in the work, J

l = electric current, A

t = time for which the electric current is passing through the joint, s

r = the resistance of the joint, ohms

and k = a constant to account for the heat losses from the welded joint.

The resistance of the joint, R is a complex factor to know because it is composed of

1. The resistance of the electrodes,
2. The contact resistance between the electrode and the work piece,
3. The contact resistance between the two work piece plates,
4. The resistance of the work piece plates.

The amount of heat released is directly proportional to the resistance. It is likely to be released at all the above-mentioned points, but the only place where a large amount of heat is to be generated to have an effective fusion is at the interface between the two work piece plates. Therefore, the rest of the component resistances should be made as small as possible, since the heat released at those places would not aid in the welding. Because of the squaring in the above, equation, the current, i needs to be precisely controlled for any proper joint. The main requirement of the process is the low voltage and high current power supply. This is obtained by means of a step-down transformer with a provision to have different tappings on the primary side, as required for different materials. The secondary windings are connected to the electrodes which are made of copper to reduce their electrical resistance. The time of the electric supply needs to be closely controlled so that the heat released is just enough to melt the joint and the subsequent fusion takes place due to the force (forge welding) on the joint. The force required can be provided either mechanically, hydraulically, or pneumatically. To precisely control the time, sophisticated electronic timers are available. The critical variable in a resistance welding process is the contact resistance between the two work piece plates and their resistances themselves. The contact resistance is affected by the surface finish on the plates, since the rougher surfaces have higher contact resistance. The contact resistance also will be affected by the cleanliness of the surface. Oxides or other contaminants if present should be removed before attempting resistance welding.

Steps Involved In Spot Welding:

The job is clean, i.e. free from grease, dirt, scale, oxide etc. Electrode tip surface is clean, since it has to conduct the current into the work with as little loss as possible. Very fine emery cloth may be used for routine cleaning. Proper welding current has been set on the current selector switch.

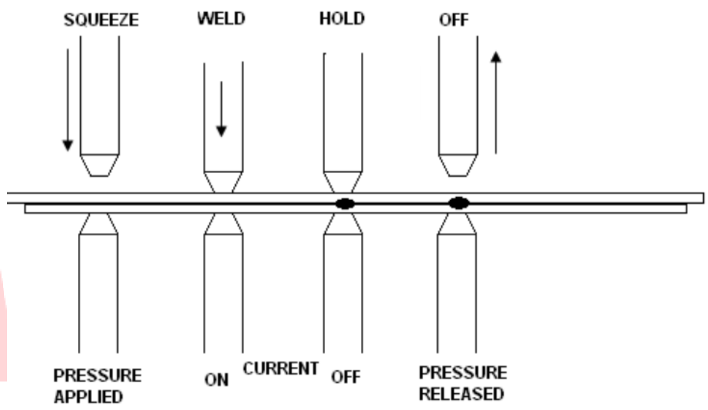
Proper time has been set on the weld-timer.

Step I: Electrodes are brought together against the overlapping work pieces and pressure applied so that the surfaces of the two work pieces under the electrodes come in physical contact after breaking any unwanted film existing on the work pieces.

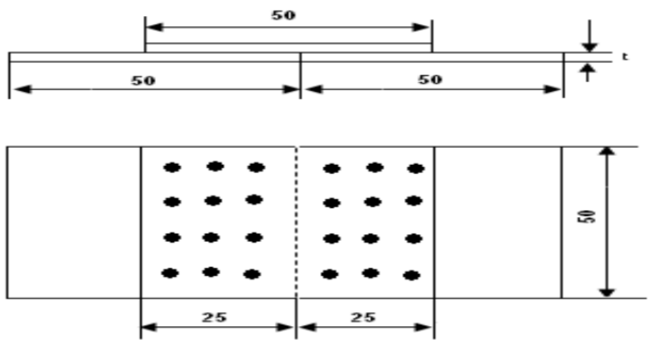
Step II: welding current is switched on for a definite period of time. The current may be of the order of 3000 to 100.000 A for a fraction of seconds depending upon the nature of material and its thickness. As the current passes through one electrode and the work pieces to the other electrode, a small area where the work pieces are in contact is heated. The temperature of this weld zone is approximately 8150C to 9300C. To achieve a satisfactory spot weld the nugget of coalesced metal should form with no meeting of the material between the faying surfaces.

Step III: at this stage, the welding current is cut off. Extra electrode force is then applied or the original force is prolonged. This electrode force forges the weld and holds it together while the metal cools down and gains strength.

Step IV: The electrode force is released to remove the spot-welded work pieces.



STAGES IN MAKING SPOT WELD



Single Strap Butt Joint

Procedure:

1. The two pieces to be joined by spot welding are placed between the two electrodes in the required position.
2. Set the timer for which the current flows through the electrodes with reference to the thickness of the plates
3. Press the foot lever, so that the movable electrode moves towards the fixed electrode.
4. This causes to develop a pressure of about 200-1000 Kg / cm2 on the sheets.
5. A low voltage and very high current is passed through the joint for a very short time. The duration of the current flow is for about 2 sec (This high amperage heats the joint, due to contact resistance at the joint and melts it).
6. Then the metal under electrodes pressure is squeezed and welded
7. The pressure is then released and the process is repeated until the job is completed.

Precautions:

1. Proper pressure should be applied on the electrodes.
2. Correct electrode diameter needs to be chosen depending on the material thickness to be joined.
3. Proper weld time should be selected for welding.
4. Use Gloves while doing operation.

DESIGN THINKING AND IDEA LAB
(AUTOMATION AND CONTROL-ECE LAB)

EXPERIMENT NO: 5

Experiment 5: To study the schematic and PCB layout design of a suitable circuit for fabrication, and testing.

Apparatus:

PCB art work film maker NV 180, Artwork table NV181, PCB sharing machine NV182, Photo resist dip coating machine NV183, UV exposure unit NV184, Dye tank NV185, Development tank NV186, PCB etching machineNV187, Drill Machine NV188.

Accessories:

Tray, Brush, PCB laminate, Spray, hand Gloves.

Theory

The development of the PCB involves following steps.

1) PCB printing using screen printing

2) Etching of the PCB.

3) Drilling of PCB

4) Coating of etched PCB to protect it from oxidation,

PCB printing using screen printing:

Sereen printing technique, the process that patterns the metal conductor to form the circuit. This PCB fabrication process involves a multistep integration of imaging materials, imaging equipment, and processing conditions with the metallization process to reduce the master pattern on a substrate. Screen printing is considered as the most versatile of all printing screen printing process is simple, and a wide variety of inks and dyes are available for use in screen printing than for use in any other printing process.

Etching of the PCB:

The final copper pattern is formed by selective removal of the unwanted copper which is not protected by an electric resist FeCl, solution is popularly used etching solution. FeCl, powder will remove the copper from the unprotected part of the PCB. After removing the PCB it is dried for some time.

Drilling of PCB:

After etching of the PCB the next step is to drill the PCB for the interconnection of the various components on the PCB. The drill hole is having a diameter of generally one nins but the resistance sometimes require 15mm diameter. The drilling of the PCB is very important in terms of the working of the PCB hence the drilling is done by drilling machine of large precision and accuracy

Coating of etched PCB to protect it from oxidation:

Since the upper layer of the PCB is a copper clad material which gets oxidised when comes in contact with the environment that affects the performance of the PCB. Hence the copper layer is coated with the laminates that are basically an insulator, to protect the Etched PCB to get oxidized.

Procedure:

1. Take 50 ml water in a beaker and add 3 gm of sensitizer powder to it.
2. Add 50 ml water to sensitizer solution to make 100 ml solution.
3. Take 10 ml screen coating solution and add 10 drops of sensitizer solution to it. 3. Cut the Light Sensitive film as per the size of PCB layout. Arrange the film and on PCB screen Printing Unit.
4. Coat the Light Sensitive film on the screen with the Squeeze and dry the screen in the curing machine for 5 minutes. Remove the plastic paper from film and dry it again for 5 minutes.
5. Take the print of PCB layout on the plotting paper and place it on UV exposure such that solder sude is in contact with glass.
6. Place screen then Rubber sheet and then weight.
7. Develop the screen by spraying water from 1 feet and dry the screen for 15 minutes in the open air.
8. Mount the Screen with the help of clamp on PCB Screen Printing Unit and cut it with the help of shearing machine.

9 Place PCB Laminate to print and pour the ink inside the screen

10. Pour 7 ltr water in the tank and add 2kg Ferric Chloride and stir it.
11. Mount the PCB on the clamp of Dipping Arrangement and dip the PCB on clamp from the opening of cover plate
12. Drill the PCB with appropriate size of drill bit.

Conclusion:

Thus PCB have been developed.

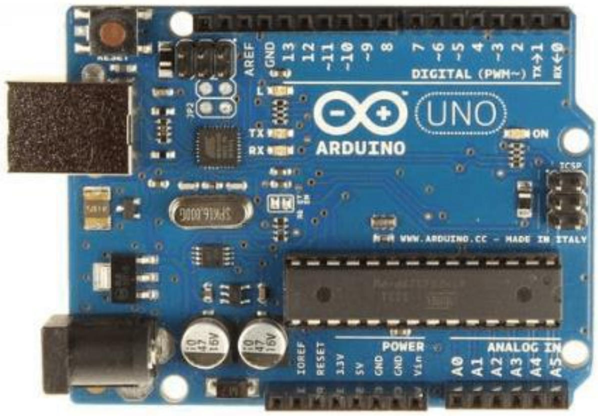
Experiment 6: To study the control of LEDs using Arduino Uno board.

Apparatus:

Universal Board, Arduino board, Led, 12V Adaptor, Power jack, USB Cable, Jumper Wires.

Theory:

Arduino The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software.

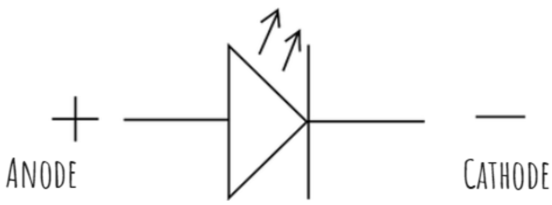


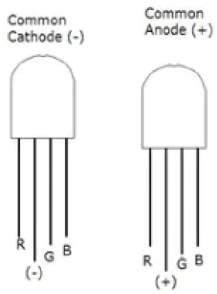
Features of the Arduino

1. Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
2. The board functions can be controlled by sending a set of instructions to the microcontroller on the board via Arduino IDE.
3. Arduino IDE uses a simplified version of C++, making it easier to learn to program.
4. Arduino provides a standard form factor that breaks the functions of the microcontroller into a more accessible package.

Light Emitting Diodes:

LEDs (Light Emitting Diodes) are becoming increasingly popular among a wide range of people. When a voltage is given to a PN Junction Diode, electrons, and holes recombine in the PN Junction and release energy in the form of light (Photons). An LED's electrical sign is comparable to that of a PN Junction Diode. When free electrons in the conduction band recombine with holes in the valence band in forward bias, energy is released in the form of light.



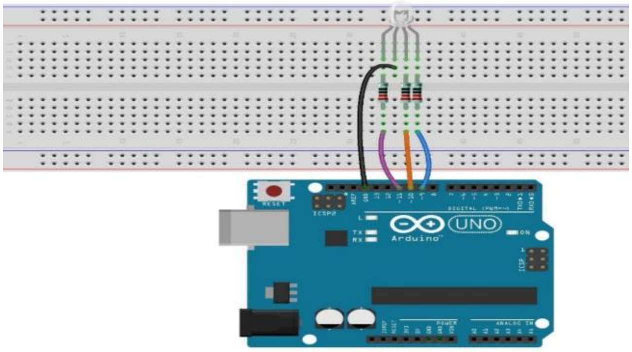


There are two types of RGB LEDs the common cathode one and the common anode one. In the common cathode RGB led, the cathode of all the LEDs is common and we give PWM signals to the anode of LEDs while in the common anode RGB led, the anode of all the LEDs is common and we give PWM signals to the cathode of LEDs. Inside the RGB led, there are three more LEDs. So, by changing the brightness of these LEDs, we can obtain many other colours. To change brightness of RGB led, we can use the PWM pins of Arduino. The PWM pins will give signal different duty cycles to the RGB led to obtain different colours.

Hardware Required:

S No	Component Name	Quantity
1	Arduino UNO	1
2	RGB LED	1
3	220Ω/330 Ω resister	3
4	USB Cable	1
5	Breadboard	1
6	Jumper wires	several

Connection Diagram:



Steps of working:

1. Insert the RGB LED into your breadboard and connect its cathode pin to the GND of the Arduino.
2. Insert the LED into the breadboard. Attach Red pin to pin 8, Green pin to pin 9 and Blue pin to pin 10 of the Arduino via the 220-ohm resistor, and the negative leg to GND.
3. Upload the code as given below.
4. Observe the changes in the color of the RGB LED.

The Sketch:

This sketch works by setting pinsD8, D9, D10 as for the different legs of RGB LED. After that the run a loop that continually reads the value from the pins and sends that value as voltage to the LED. The voltage value is between 0-5 volts, and the blinking of the LED will vary accordingly.

```
/************RGB LED Blink*******/
void setup() {
// put your setup code here, to run once:
pinMode(8,OUTPUT);
pinMode(9,OUTPUT);
pinMode(10,OUTPUT);
    }
void loop() {
   // put your main code here, to run repeatedly:
    digitalWrite (8,HIGH);
    digitalWrite (10,LOW);
    delay(1000);
digitalWrite (9,HIGH);
     digitalWrite (8,LOW);
    delay(1000);
    digitalWrite (10,HIGH);
    digitalWrite (9,LOW);
    delay(1000);
  }
```

Observation:

S No	Time (ms)	Color of LED
1		
2		
3		
4		

DESIGN THINKING AND IDEA LAB
(DESIGN AND FABRICATION LAB)

EXPERIMENT NO: 7

Experiment 7: To study and practice basic draw commands exist in the Auto CAD.

Apparatus:

Auto CAD Software, Computer Hardware

Commands:

Line, Poly line, Construction line, Polygon, Rectangle, Arc, Circle, Ellipse

Theory:

Line: The LINE command is used to draw a line between two specified points. First enter the LINE command or shortcut L in the command area. Mouse Cross hair displays to specify the first point of the line and next point of the line or enter the distance of the line. Press ESC key at the end of the line.

Polyline: POLYLINE command is used to draw a series of lines continuously at a time. PL or PLINE is the keyboard shortcut for polyline.

Rectangle: RECTANGLE command is used to draw a rectangular geometry in the drawings. REC is the keyboard shortcut for rectangle. First enter the REC command in the command area. A cross hair will be displays to specify the first corner point of the rectangle and input the dimensions of the rectangle as other corner point.

Circle: Circles are created with the CIRCLE command. There are several different ways you can define a circle. Those are defining center point and radius or diameter of the circle. In the 2Point method Define the circle with points on either end of the circle diameter. In the 3Point method Define the circle with 3 noncollinear points. In the Tangent, Tangent and Radius method define the circle by specifying two other objects that are tangent to the circle and the radius of the circle.

Arc: ARC command is used draw partial circles in the Auto CAD drawings.

There are seven methods available to draw an arc in the Auto CAD.

Those are

1. Specifying 3 points on the arc
2. Specifying starting point, center and end point
3. Specifying starting point, center and included angle
4. Specifying starting point, center and length of the cord
5. Specifying starting point, end point and radius
6. Specifying starting point, end point and included angle and
7. Specifying starting point, end point and direction of start

Polygon: The POLYGONE command is used to draw a polygon with 3 to 1024 sides by specifying a circle inscribed or circumscribed with definite radius or by entering side length of the polygon.

Ellipse: This ELLIPSE command is used to draw ellipses by giving starting and ending angles.

Result:

Studying and practicing of all basic draw commands is done in the Auto CAD.

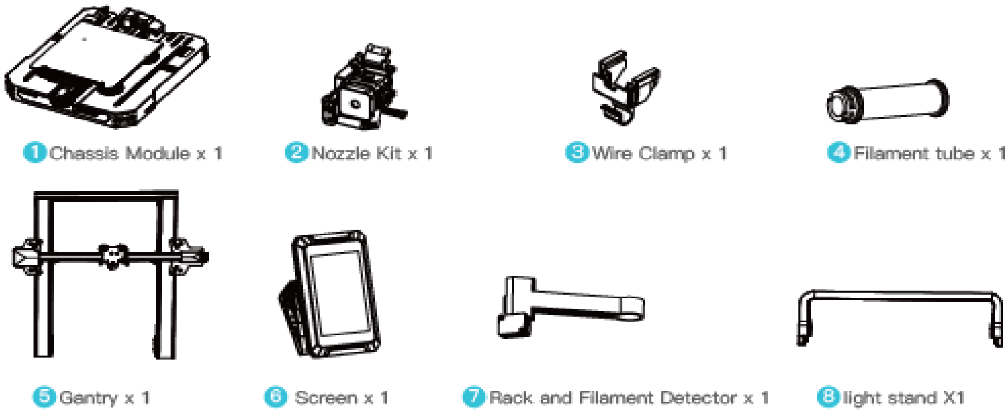
EXPERIMENT NO: 8

Experiment 8: 3D printing of scanned/designed geometry using FDM printer.

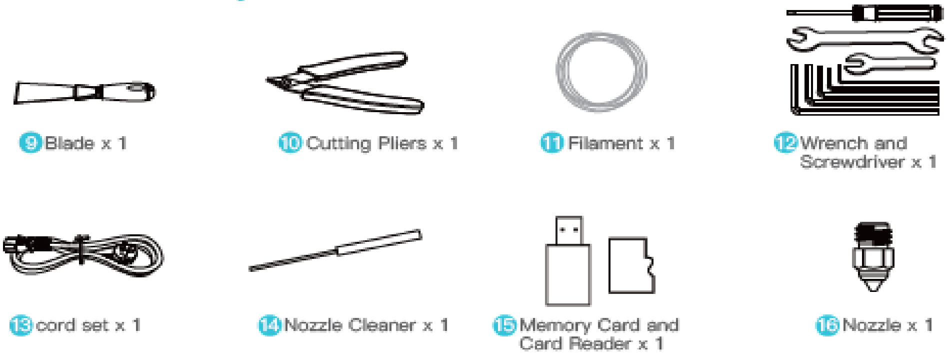
Apparatus:

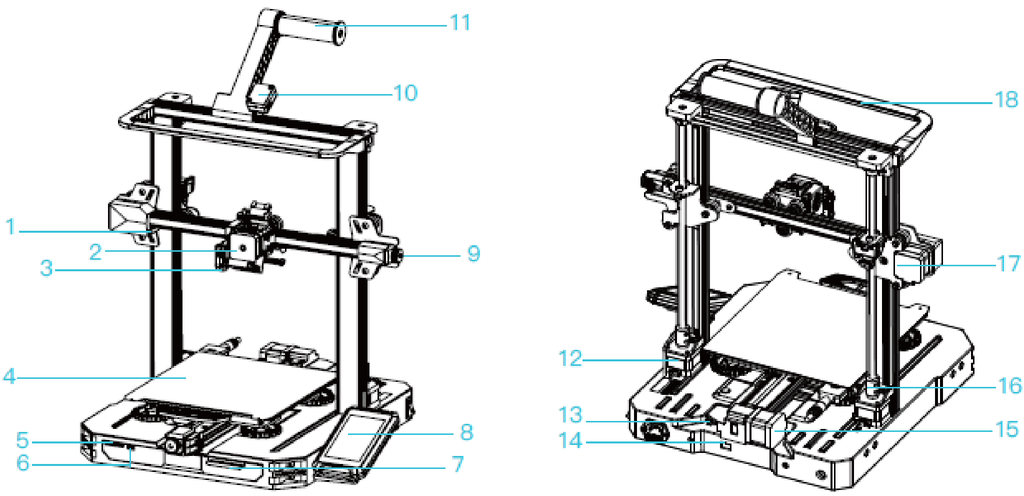
Cutting Pilers, Blade, memory card, filament PLA.

List of Main Parts



List of Accessory Kit Items





1	X-Axis Limit Switch	7	Tool Kit	13	Y-Axis Limit Switch
2	Nozzle Module	8	Display Screen	14	Voltage Toggle Switch
3	Auto Leveling Module	9	X-Axis Belt Adjustment Device	15	Y-Axis Motor
4	Printing Platform	10	Filament Detector	16	Coupling
5	Memory Card Slot	11	Rack	17	X-Axis Motor
6	Type-C Port	12	Z-Axis Motor	18	LED Light

Components of 3D Printer:

Axes Fixed Rods The three axes that the 3D printer utilizes are on the Cartesian coordinate system. The linear fixed rods are maintained at right angles to each other and each represents a coordinate axis. Movement: The timing belts and pulleys allow the movement of the hot end (or the print bed, depending on the type of 3D printe along each axes according to the g-code (generated by slicing software). The stepper motors power this movement.

Extruder Extrusion is the feeding of filament into the hot end of the 3D printer. This movement is also powered by a stepper motor Retraction This mechanism is the pulling of the melted filament from the hot end. This movement is primarily programmed through the g-code to prevent the formation of unwanted filament creating a bridge between two areas. The bridging of unwanted filament is referred to as stringing or the formation of cobwebs.

Dual Extrusion Some models of 3D printers are equipped with dual extrusion capabilities. This allows for mixed material objects to be printed. Dual extrusion can be used to print out complex objects with a different collour material as the support, making it easy to differentiate between the object and the support.

Hot End The hot end is heated to temperatures ranging from 160 C to 250 C, depending on the type of filament to be used. The hot end melts the filament and pushes the melted filament through the nozzle. The hot end needs to be thermally insulated from the other components of the 3D printer to prevent any damage.

Print Bed Heated Print beds that are heated improve print quality of 3D printed objects. The heated bed is heated to the glass transition temperature of the filament being used. This allows the model layers to slightly melt and stick to the heated bed. Non-Heated Print beds that are not heated require adhesion in the form of glue, tape, hairspray, etc. In the innovation lab, painters' tape is frequently used for adhesion.

Filament Filament is a consumable used by the 3D printer to print layers. Filament comes in a variety of materials and colors. Filament can be composed of metal, wood, clay, biomaterials, carbon fiber, etc. ABS: ABS is a thermoplastic that needs to be heated to temperatures from 210C to 250C. ABS can only be printed on a 3D printer with a heated bed, which prevents the cracking of the object. When ABS is heated, it emits a strong unpleasant odor. ABS requires a complete enclosure while printing PLA-PLA is a thermoplastic that needs to be heated to temperatures from 160C to 220C. PLA is also biodegradable and emits slight odors. PLA is most frequently used in the Innovation Lab on all 3D printers.

Preparing your 3D Model in CAD Software:

CAD software is used to create 3D models and designs. This software is available on our computers and the level of difficulty varies. With the exception of Sketch up Pro and the industry standard software mentioned, all of these programs are available on the innovation lab computers. Solid works main idea is user to create drawing directly in 3D or solid form. From this solid user can assemble it directly on their workstation checking clashes and functionality of it. Creating drawing is pretty easy just drag and drop the solid to drawing block.

Preparing your 3D Model for print in Idea maker software

These are following step for 3D printing of model

1. Install the 3D print software ideu maker
2. Check repair option in this software
3. Set the nozzle parameter and build tack temperature according to the printer guide.

Step:-1 Prepare the design Model using Designing Software(Solids Work, Autocad etc.)

Step:-2 Convert the designed Model file in Stl obj format.

Step:-3 Prepare the design model for printing Using Software Idea Maker and Ultimaker. Then set all parameter (nozzle temp., buildtak temp and support) and also repair your design using software option. Then after generate the file in geode format

Step:-4 ON the 3D Printer and load the filament in nozzle and give the command print by using 3D Printing Machine.

Precaution of 3D Printer machine:

These are some following precautions when you print the design in 3D Printer

1. Mechanical: Do not place limbs inside the build area while the nozzle is in motion. The printer nozzle moves to create the object.
2. High Temperature: Do not touch the printer nozzle it is heated to a high temperature to melt the build material.
3. Always buy, replacement parts from the manufacturer for safety related to equipment.
4. Choose an area that has adequate ventilation and exhaust capability.

Safety Equipment: Safety Glasses, Gloves (recommended for postprocessing)

Application of 3D Printer: Automotive, Marine, Aerospace

Advantages: Medical., Engineering, Architecture, Complex shapes, Freedom for design, Customize parts Less waste, Fewer unsold products, Less transport.

Limitations: Time, Cost, Skill, Materials.

General Specifications	
Model	Ender-3 S1 Pro
Modeling Dimensions	220 mm x 220 mm x 270 mm
Modeling Technology	FDM
Number of Nozzles	1
Slice Layer Height	0.1 to 0.35 mm
Nozzle Diameter	0.4 mm (standard)
Accuracy	±0.1mm
Printing Material	PLA/TPU/PETG/ABS
Supported Formats	STL/OBJ/AMF
Printing Method	Memory card offline printing or online printing
Supported Slicing Software	3D Creator Slicer, Repetier-Host, Cura, Simplify3D
Input voltage	100-120V~/ 200-240V~, 50/60Hz
Total Power	350W
Hotbed Temperature	≤100°C
Nozzle Temperature	≤300°C
Resume Printing Function	Yes
Filament Detection	Yes
Auto Leveling	Yes
PC Operating Systems	Windows XP/Vista/7/10/MAC/Linux
Printing Speed	Up to 150 mm/s, recommended 50 mm/s