TABLE OF CONTENT

Exp. No.1	Preparation of dove-tail joint from given wooden piece to required shape

AIM: To prepare a dovetail joint from the given wooden piece and achieve the required shape by following accurate measurements, marking, and cutting processes.

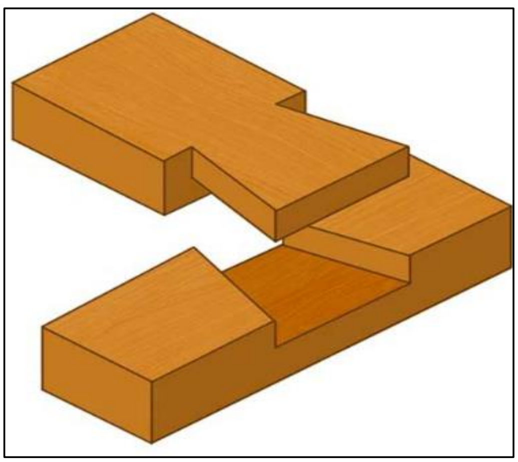
REQUIREMENTS FOR EXPERIMENT EXECUTION

1. Wooden pieces of size 300 mm x 40 mm x 40mm
2. Measuring tape or ruler
3. Pencil/marking gauge
4. Try square
5. Jack Plane
6. Chisels (various sizes)
7. Mallet
8. Tenon saw or dovetail saw
9. Sandpaper (various grits)
10. Wood glue (optional for assembly)
11. Workbench with clamps

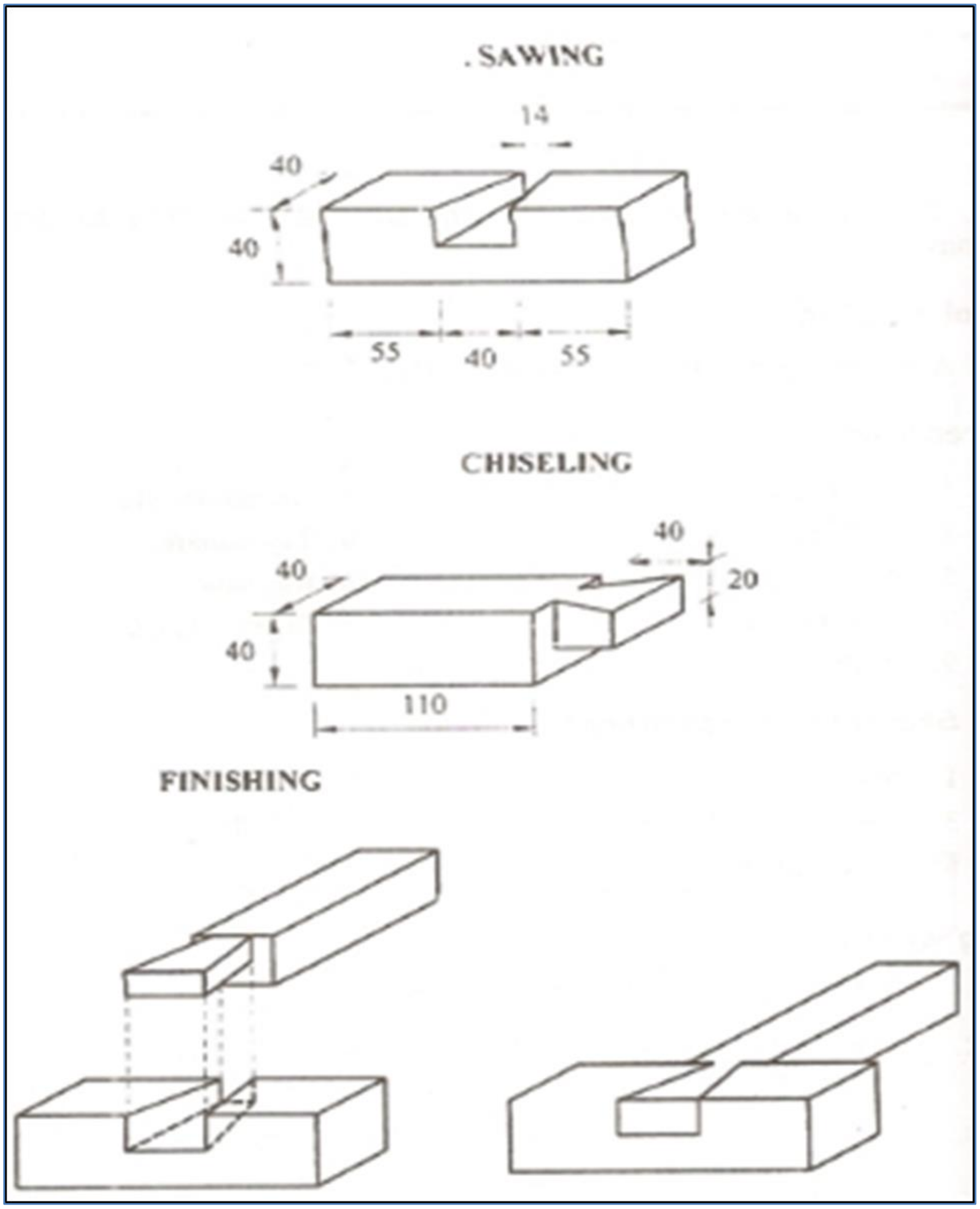
Sequence operation:

- Rough planning.
- Marking.
- Cutting (or) Sawing.
- Finished planning.

Diagram:



Dove-tail lap joint



Dove-tail lap joint to be prepared for the given dimension (All dimensions are in mm).

Procedure:

1. The given job is checked to ensure its correct size.
2. The job is firmly clamed in the carpentry vice and any two surfaces are planned by jack plane to get right angle.
3. Using try square, the right angle of the work piece is checked.
4. Now all the four sides of the wooden piece are planned to get the smooth finish surface.
5. Now the job is cut into two halves using rip saw then proper marking is do for Cross lap joint on the pieces using steel rule and marking gauge.
6. The required dimensions are marked on the work piece using steel rule and marking

gauge.

7. By means of jack plane, the job is planned such that it should have accurate dimensions.
8. The size, shape and angle of the planned piece have been checked using try square to ensure right angle.
9. Finally, the length of the job is marked in the planned wood and the excess portion is removed from the job using tenon saw.
10. One half is taken. Using tenon saw and firmer chisel and unwanted portion has been removed as per the drawing.
11. The above procedure is repeated for the other half of the work piece.
12. Jack plane is used to plane the other faces up to the marked portion.
13. Now the two pieces are assembled to check proper fitting.
14. The finishing job is again checked for its accurate shape and size using try square and steel rule.

Practical Application of Dovetail Joint

OBSERVATIONS

- Note the accuracy of the fit and finish of the joint.
- Record any issues encountered during the process and their solutions.

CONCLUSION

The dovetail joint is a strong and precise wood joint commonly used in wood working projects. Successful completion of this exercise demonstrates the ability to measure, mark, cut, and assemble wooden joints accurately.

VIVA QUESTIONS

1. What is the purpose of carpentry exercises in a training program?
2. Describe the basic tools used in carpentry exercises and their functions.
3. Explain the process of measuring and marking materials accurately in carpentry exercises.
4. How do you safely operate hand tools in carpentry exercises? Discuss some common hand tools and their proper usage.
5. Describe the process of cutting and shaping materials in carpentry exercises. Discuss different saw types and their uses.
6. What safety precautions should be followed during carpentry exercises? Explain the measures to prevent accidents and injuries.

Exp. No.2	Modelling wax engineering component creation.

AIM: To create a engineering component using modelling wax, demonstrating fine motor skills, creativity, and an understanding of basic shapes and structures.

REQUIREMENTS FOR EXPERIMENT EXECUTION

S NO.	ITEM DESCRIPTION WITH SPECIFICATION	QUANTITY
1	Modeling wax	1
2	Wax sculpting tools (spatulas, knives, carving tools)	1
3	Wax heater or warm water	1
4	Base or platform for the model	1
5	Power Supply (9V battery)	1

BACKGROUND THEORY :

- Modeling wax is a versatile material used in engineering applications for prototyping, pattern making, and precision casting.
- It is favored for its ease of manipulation, ability to hold fine details, and smooth surface finish. In lost-wax casting (investment casting), modeling wax is shaped into a prototype of the desired part, then coated with a refractory material to form a mold.
- After the wax is melted and drained away, molten metal is poured into the mold to create a precise metal replica.
- This method is essential for creating complex and high-precision components in industries such as aerospace, automotive, and jewelry.

PROCEDURE:

- Gather modeling wax, sculpting tools, and a wax heater or warm water bath.
- Heat the wax until it reaches a pliable consistency suitable for molding.
- Form the wax into a rough shape of the desired part using hands and basic sculpting tools.
- Use finer sculpting tools to add intricate details and refine the shape of the wax model.
- Create separate components if the part is complex, then join them using heated connection points.
- Smooth the surface and add any final textures or patterns to the wax model.
- Coat the wax model with a refractory material to form a mold around it.
- Heat the mold to melt and remove the wax, leaving a hollow cavity that matches the wax model.
- Pour molten metal or other material into the mold to create the final part.
- Once cooled, remove the mold to reveal the cast part and perform any necessary finishing operations.

DATA AND OBSERVATIONS

Record your observations and notes in the given table:

Step	Observations
Initial Shaping	
Detailing	
Assembly	
Finishing Touches	
Mold Creation	
Wax Removal	
Casting	
Mold Removal	

Cast Components

CONCLUSION

The modeling wax experiment successfully demonstrated the process of creating a detailed prototype and casting it into a final metal part. The wax model accurately represented the intended design, and the casting process produced a precise and high-quality final product. This exercise highlighted the importance of precision in each step, from shaping the wax to finishing the cast part, underscoring the effectiveness of modeling wax in engineering applications.

VIVA QUESTIONS

1. What are the primary characteristics of modeling wax that make it suitable for creating engineering components?
2. Describe the steps involved in the lost-wax casting process using a wax model.
3. What considerations must be taken into account when designing a wax model for engineering purposes?
4. How do you ensure the accuracy and detail of a wax model?
5. What are the common challenges encountered in the modeling wax process, and how can they be mitigated?
6. Reflecting on your experience, what improvements would you suggest for the modeling wax process in future projects?

Exp. No.3	Preparation of Lap joint from given metal piece to the required shape.

AIM: To make the lap joint using the two given metal strips by Arc welding.

TOOLS REQUIRED

1. Flat file
2. Chipping hammer
3. Steel rule
4. Hand shield
5. Try-square
6. Tongs

MATERIALS REQUIRED

- A Two Mild steel (MS) strips of size 100 x 25 mm and thickness 6 mm.

SEQUENCE of OPERATION:

1. Filing of the workpiece
2. Connection of wires
3. Jointly keep the pieces
4. Weld the piece using electrode

DIAGRAM

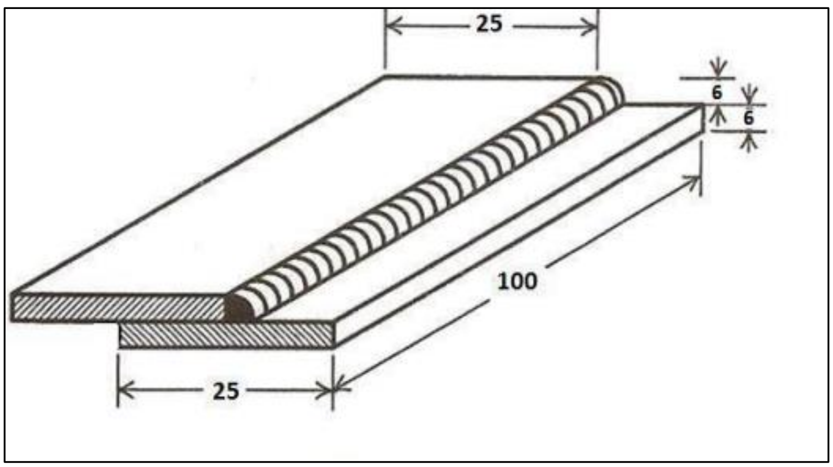


Fig. 7. Lap joint. (All dimensions are in mm)

SAFETY PRECAUTIONS

1. Inspect cable, connections and the amp setting before starting the welding operation.
2. Wear shoes and stand on a dry surface when welding
3. In order to prevent electrical shock, radiation exposure and burns when welding, wear a shield with filter lens, leather gloves, leather apron, cotton long pants and long-sleeved shirts or blouses
4. Always guard your face and eyes when chipping slag.

5. Weld in well-ventilated areas to avoid toxic fumes.
6. Before welding, make sure that the welding area is free of flammable materials such as gasoline, paint and grease.
7. Handle hot metal with pliers or tong.

PROCEDURE

1. First of all, the work pieces must be thoroughly cleaned to remove rust, scale and other foreign materials.
2. Then the given work pieces are placed on the table in such a way that work pieces are brought close to each other.
3. Appropriate power supply should be given to the electrode and the work pieces.
4. Now the welding current output may be adjusted.
5. When current is passed, arc is provided between the electrode and work pieces.
6. Now set the two pieces in correct position and maintain the gap 3mm and tag at both ends of the work pieces.
7. Then the welding is carried out throughout the length.
8. As soon as the welding process is finished, switch off the current supply
9. Slag is removed by chipping process with the help of chipping hammer.
10. Finally using wire brush welded portions are cleaned

Practical Application

CONCLUSION

The Lap - welding process successfully joined the metal pieces, forming a strong Lap-joint with a consistent weld appearance. Minor adjustments were made to ensure proper penetration and a clean finish. The final weld was inspected and found to meet quality standards.

VIVA QUESTIONS

1. What is the purpose of welding exercises?
2. Describe the different types of welding processes commonly used in welding exercises.
3. What safety precautions should be followed during welding exercises? Discuss the measures to prevent accidents and protect against hazards.
4. Explain the role of personal protective equipment (PPE) in welding exercises. List some examples of PPE used by welders.
5. How do you prepare metal surfaces for welding in welding exercises? Discuss the importance of cleaning and removing contaminants.

Exp. No.4	Facing and turning of a workpice in a normal lathe

AIM: To understand the basic operation, safety, and use of a normal lathe for machining processes.

REQUIREMENTS FOR EXPERIMENT EXECUTION

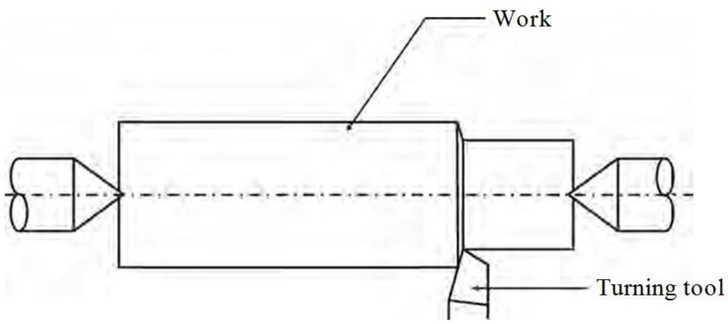
S NO.	ITEM DESCRIPTION WITH SPECIFICATION	QUANTITY
1	Lathe machine	1
2	Metal pieces (MS)	1
3	Cutting tools (e.g., carbide inserts, HSS tools)	1
4	Calipers or micrometer (for measurements)	1
5	Measuring tools (vernier caliper)	1
6	Chuck key	1

BACKGROUND THEORY :

- A lathe is a machine tool used to shape workpieces by rotating them against cutting tools.
- Key operations include turning, facing, and threading, which allow for the creation of cylindrical parts, flat surfaces, and screw threads.
- Understanding the lathe's components and controls, such as the headstock, tailstock, carriage, and tool post, is essential for safe and effective use.

PROCEDURE:

- Check the lathe for any damage, ensure all parts are secure, and confirm that it is clean and properly lubricated.
- Measure and cut the workpiece to the desired length. Secure it in the lathe's chuck, tightening it with the chuck key and removing the key immediately after use.
- Select the appropriate cutting tool for the operation and install it in the tool post. Tighten it securely with the tool post wrench.
- Adjust the tool so it is aligned with the center height of the workpiece. Check alignment with a dial indicator or similar tool if available.
- Set the spindle speed and feed rate according to the material and desired operation. Adjust these settings based on the material type and cutting requirements.
- Start the lathe and perform the machining operation (e.g., turning, facing). Maintain a steady feed rate and monitor the cut for quality.
- Stop the lathe and measure the workpiece using calipers or a micrometer. Check dimensions and surface finish for accuracy and quality.
- Remove the finished workpiece, clean the lathe and work area, and properly store all tools and equipment.



Straight turning

OBSERVATION TABLE:

Parameter	Observed Value	Comments
Workpiece Material		e.g., steel, aluminum, plastic
Spindle Speed		e.g., 1000 RPM
Feed Rate		e.g., 0.1 mm/rev
Tool Type		e.g., carbide insert, HSS tool
Operation Performed		e.g., turning, facing, threading
Surface Finish		e.g., smooth, rough
Dimensions		e.g., diameter, length

CONCLUSION

The lathe operations were successfully completed, producing a workpiece with the desired dimensions and surface finish. The machining process demonstrated the correct use of the lathe, appropriate tool selection, and effective safety practices.

VIVA QUESTIONS

1. What are the primary functions and capabilities of a normal lathe, and how do they apply to various machining tasks?
2. Can you explain the setup process for a lathe operation, including how to mount the workpiece and set up cutting tools?
3. What factors do you consider when selecting cutting speeds, feeds, and depths of cut for different materials on a lathe?
4. How do you ensure the accuracy and precision of your lathe work, and what measurements or adjustments are commonly made?
5. What are the common safety practices and procedures you follow while operating a lathe to prevent accidents and ensure safe machining?

Exp. No.5	V profile fitting using acrylic (3 or 6 mm thickness)/ plywood

AIM: To study and perform the fabrication of a V-profile fitting using acrylic sheets/plywood and to understand the steps involved in precision fitting.

REQUIREMENTS FOR EXPERIMENT EXECUTION

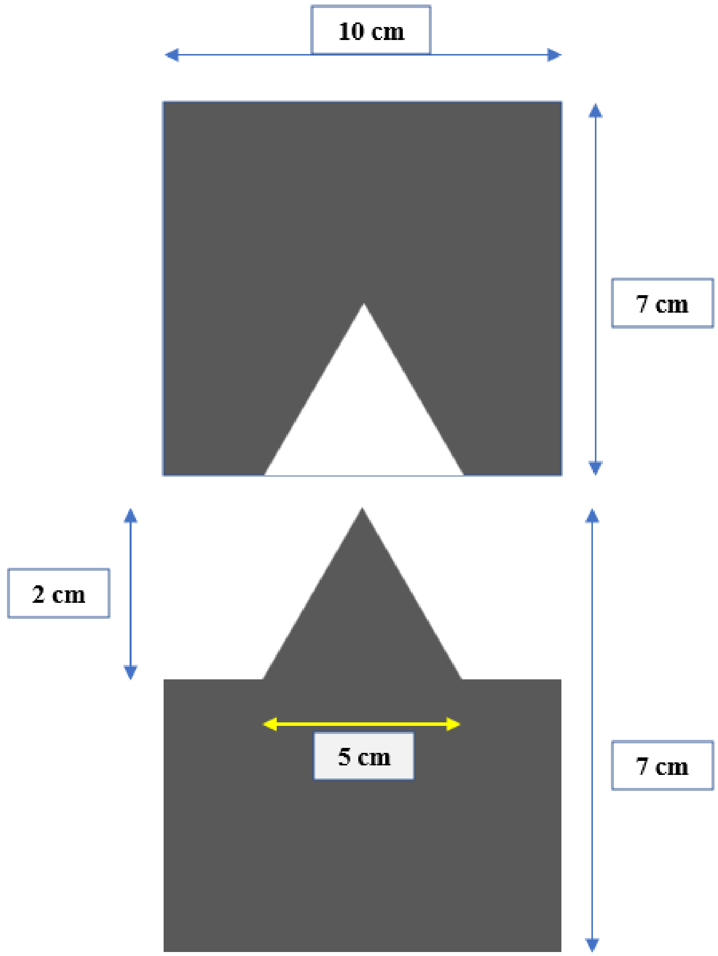
S NO.	ITEM DESCRIPTION WITH SPECIFICATION	QUANTITY
1	Acrylic sheets (3 mm or 6 mm thickness) or Plywood (pre-cut to required dimensions)	1
2	Files (flat, round, and triangular)	1
3	Sandpaper (various grits)	1
4	Adhesive for acrylic (such as acrylic cement or epoxy resin)	1
5	Measuring tools (vernier caliper, ruler, protractor)	1
6	Clamps	1
7	Personal protective equipment (PPE): safety glasses, gloves, apron	1

BACKGROUND THEORY :

- Manual cutting uses hand tools to cut materials like acrylic or plywood into desired shapes.
- Tools such as utility knives, saws, files and rulers are employed based on material thickness and type.
- Precision is crucial; for acrylic, scoring and snapping methods are used, while cardboard requires serrated knives.
- This method allows for customization and is ideal for small-scale projects but demands careful measurement and safety practices to ensure accurate and clean cuts.

PROCEDURE:

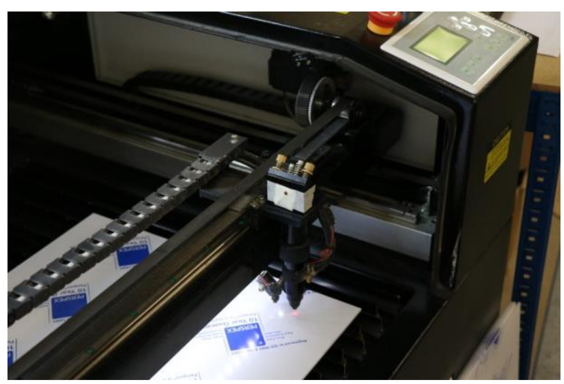
- Draw the 2D profile of the “V” on the material using a ruler and pencil.
- Choose appropriate cutting tools (utility knife for acrylic, hacksaw for plywood).
- Secure the material on a cutting surface using clamps or weights.
- Use a straightedge to mark precise cutting lines on the material.
- Carefully cut along the marked lines, following the design.
- Test-fit the cut pieces to ensure they align correctly.
- Make any necessary adjustments for a snug fit or clean edges.
- Use a file or sandpaper to smooth rough edges, especially for acrylic.
- Fit the pieces together, aligning tabs and slots for a press-fit assembly.
- Ensure the final assembly is secure and correctly assembled.



V profile fitting

PROFILE FIT BOX

LASER CUTTTING MACHINE



OBSERVATION TABLE:

Parameter	Observed Value	Comments
Material Type		e.g., Acrylic, Plywood
Material Thickness		e.g., 3 mm or 6 mm
Cutting Tool Used		e.g., utility knife, Hacksaw
Accuracy of Cutting		e.g., precise, needs adjustment
Edge Quality		e.g., smooth, rough
Fit of Pieces		e.g., snug, loose
Assembly Quality		e.g., secure, requires adjustment
Time Taken		e.g., 1 hour

CONCLUSION

The experiment demonstrates the steps involved in fabricating a precise V-profile fitting using acrylic sheets/Polywood. Proper execution of the procedure ensures a strong, aesthetically pleasing joint suitable for various applications.

VIVA QUESTIONS

1. What are the properties of acrylic/plywood that make it suitable for this experiment?
2. How do you ensure precision while forming the V-profile?
3. What are the common applications of V-profile fittings?
4. Why is it important to use fine-grit sandpaper for finishing?
5. What precautions should be taken while working with adhesives?
6. Reflecting on the process, what improvements would you recommend for future projects involving 2D profile cutting of similar materials?

Exp. No.6	Simple LED Blinker Circuit using 555 Timer IC

AIM: To design and simulate a simple LED blinking circuit using a 555 Timer IC in astable mode on EasyEDA.

MATERIALS REQUIRED:

S NO.	ITEM/SOFTWARETOOLS DESCRIPTION WITH SPECIFICATION	QUANTITY
	Components available in EasyEDA libraries:	
1	555 Timer IC	1
2	Resistors (1 kΩ and 470 kΩ)	1
3	Capacitors (0.01 µF)	1
4	LED	1
5	Power source (9V DC)	1
6	Breadboard (optional for reference)	1

BACKGROUND THEORY :

- This is a simple circuit designed to explain the working and use of a 555 timer IC. This circuit is designed using a low power consumption output device, a red LED.
- There are many applications of 555 timers, generally used in Lamp Dimmer, Wiper Speed control, Timer Switch, Variable duty cycle fixed frequency oscillator, PWM Modulation etc.
- The 555 Timer IC, used in astable mode, generates a continuous square wave to blink an LED.
- In this mode, it oscillates without external triggers, with frequency and duty cycle set by resistors (R1, R2) and a capacitor (C1).
- The frequency is calculated as $f=1.44/(R1+2R2)\times C1$.
- The capacitor charges and discharges between 1/3 and 2/3 of the supply voltage, controlled by the 555 Timer.
- The output (Pin 3) alternates between high and low states, causing the LED to blink.
- Resistors limit current flow, while the capacitor controls timing intervals.
- The power supply provides the necessary voltage for the circuit.
- This simple configuration demonstrates basic electronics and timing principles.

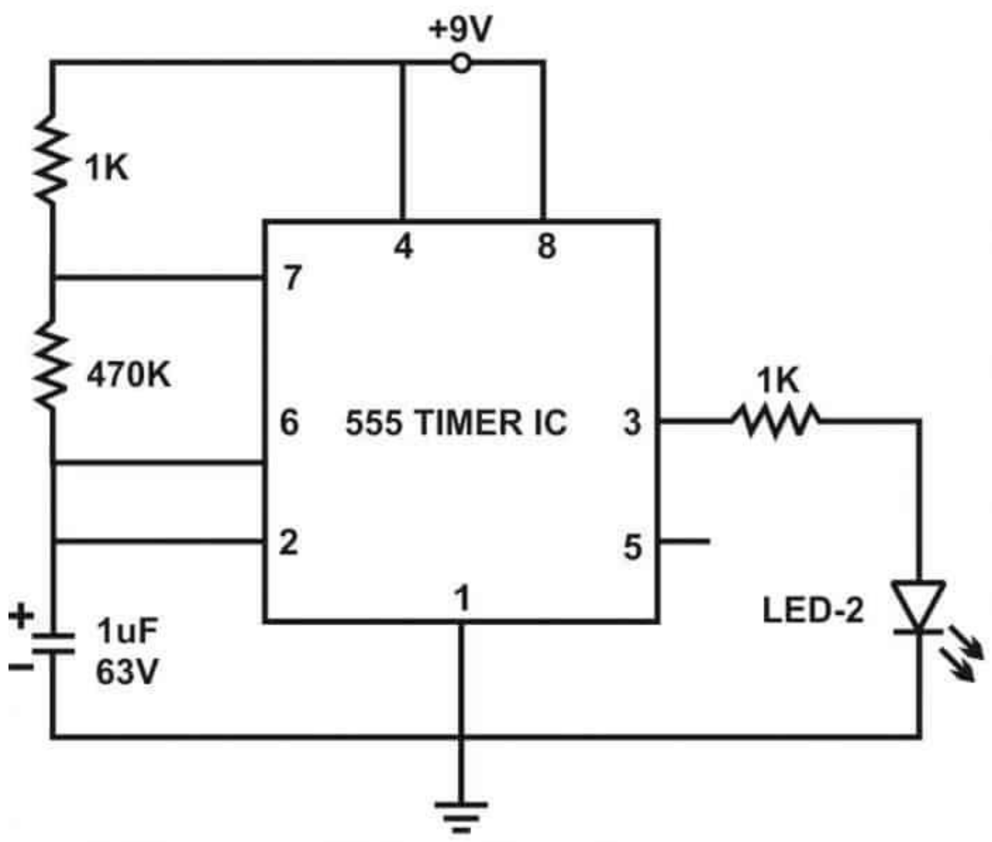
PROCEDURE

1. **Open EasyEDA**:
   - Log in to EasyEDA.
   - Start a new project.
2. **Place the 555 Timer IC**:
   - Search for "555 Timer" in the component library.
   - Drag and drop it onto the schematic canvas.
3. **Add Resistors (R1 and R2)**:
   - Place two resistors from the library.

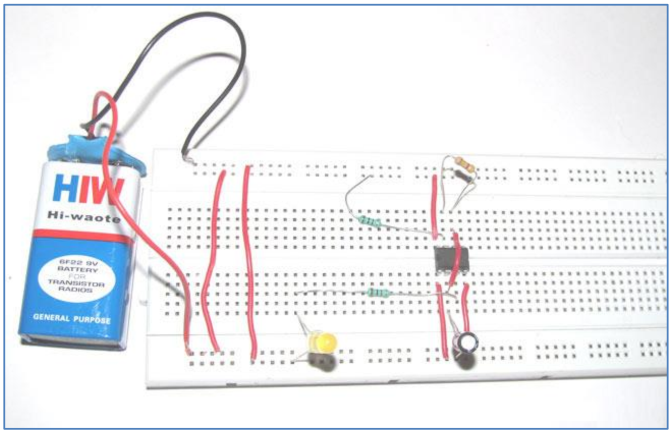
- Connect R1 between pin 8 (VCC) and pin 7 (DISCHARGE).
- Connect R2 between pin 7 (DISCHARGE) and pin 6 (THRESHOLD).

4. **Add a Small Decoupling Capacitor (C1)**:
   - Place a 0.01 µF capacitor across pin 2 (TRIGGER)) and pin 1 (GND).
5. **Connect LED**:
   - Place an LED in series with a 1 kΩ resistor.
   - Connect the cathode of the LED to pin 3 (OUTPUT).
   - Connect the anode to the ground through the resistor.
6. **Power Connections**:
   - Connect pin 8 (VCC) to the 9V power source.
   - Connect pin 1 (GND) to ground.
7. **Complete the Circuit**:
   - Verify that all connections match the schematic diagram for a 555 Timer in astable mode.
8. **Set Component Values**:
   - R1: 470 kΩ
   - R2: 1 kΩ
   - C1: 0.01 µF
9. **Simulate the Circuit**:
   - Click on the "Simulation" tab.
   - Run the simulation to observe the LED blinking. Adjust component values if necessary to modify the blinking frequency.

SCHEMATIC DIAGRAM



PHYSICAL DIAGRAM



OBSERVATIONS

- Observe the LED blinking frequency in the simulation.
- Vary R1, R2, or C1 values to see changes in the blinking speed.

CONCLUSION

The LED blinker circuit using a 555 Timer IC was successfully designed and simulated in EasyEDA. Component values influence the blinking frequency and duty cycle, demonstrating the operation of the 555 Timer in astable mode.

VIVA QUESTIONS

1. What happens when you increase the value of C1?
2. How does changing R1 or R2 affect the frequency?
3. Explain the role of the 555 Timer IC in this circuit.

Exp. No.7	Embedded programming using Arduino

AIM: To introduce the basics of embedded programming using Arduino, enabling students to write and upload simple programs to control traffic light system Iin Tinkercad, controlling three LEDs (red, yellow, green) to mimic a real-world traffic signal.

.REQUIREMENTS FOR EXPERIMENT EXECUTION

1 Arduino Uno R3
2. Red LED
3. Yellow LED
4. Green LED
5. Resistors (220Ω) - 3
6. Breadboard
7. Jumper Wires

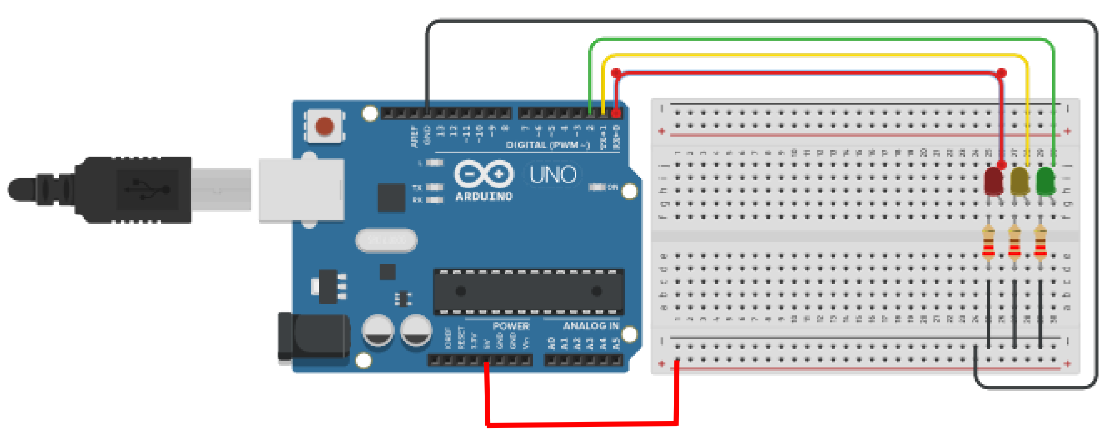
BACKGROUND THEORY :

Embedded programming involves writing software that directly interacts with hardware components. Arduino is a popular platform for embedded programming due to its simplicity and versatility. The Arduino board includes a microcontroller that can be programmed using the Arduino IDE, which uses a simplified version of C++.

Key Concepts

- **Microcontroller**: The brain of the Arduino board, capable of executing programmed instructions to control connected devices.
- **Digital and Analog Pins**: Used to interface with various sensors and actuators. Digital pins can be either HIGH or LOW, while analog pins read a range of values.
- **Sketch**: A program written in the Arduino IDE, consisting of two main functions: setup() and loop().

CIRCUIT DIAGRAM



- Connect the Red LED anode to digital pin 0 of the Arduino through a 220Ω resistor.
- Connect the Yellow LED anode to digital pin 1 of the Arduino through a 220Ω resistor.
- Connect the Green LED anode to digital pin 2 of the Arduino through a 220Ω resistor.

- Connect the cathodes of all LEDs to the GND rail on the breadboard.
- Connect the GND rail of the breadboard to the GND pin of the Arduino.

PROCEDURE

1. Open Tinkercad and create a new circuit.
2. Add an Arduino Uno and three LEDs to the workspace.
3. Make the connections as described above.
4. Write the following code to control the traffic light sequence.

CODE

```
void setup() {
  pinMode(0, OUTPUT); // Red LED
  pinMode(1, OUTPUT); // Yellow LED
  pinMode(2, OUTPUT); // Green LED
}

void loop() {
  // Red Light
  digitalWrite(0, HIGH);
  digitalWrite(1, LOW);
  digitalWrite(2, LOW);
  delay(5000); // Red for 5 seconds

  // Yellow Light
  digitalWrite(0, LOW);
  digitalWrite(1, HIGH);
  digitalWrite(2, LOW);
  delay(2000); // Yellow for 2 seconds

  // Green Light
  digitalWrite(0, LOW);
  digitalWrite(1, LOW);
  digitalWrite(2, HIGH);
  delay(5000); // Green for 5 seconds
}
```

EXPECTED OUTPUT

- The traffic light sequence is simulated:
    1. Red → Yellow → Green → Red (repeats).
- LEDs light up in the specified durations and order.

APPLICATIONS

1. Real-world traffic signal control systems.
2. Learning timing and sequential control using Arduino.
3. Basis for more complex traffic systems with sensors for vehicles and pedestrians.

Traffic light control with Arduino

CONCLUSION

This experiment demonstrates how to use Arduino to control LEDs in a specific timing sequence to mimic real-world systems. It builds a foundation for more advanced projects, such as smart traffic management using sensors.

Pre-Viva Questions:

1. What is the role of the pinMode() function in the Arduino code?
2. How does the digitalWrite() function control the LEDs in this experiment?
3. Why is the traffic light sequence important in real-world applications?
4. How can this system be modified to include a pedestrian crossing?
5. What are the advantages of using Arduino for traffic light control systems?.

Exp. No.8	3D printing of a geometry using FDM printer

AIM: To successfully print a predefined geometry using the principles of 3D printing technology with a Fused Deposition Modeling (FDM) printer

REQUIREMENTS FOR EXPERIMENT EXECUTION

S NO.	ITEM DESCRIPTION WITH SPECIFICATION	QUANTITY
1	FDM 3D Printer	1
2	Filament (PLA, ABS, or other suitable material)	1
3	Computer with slicing software (e.g., Cura, PrusaSlicer)	1
4	Isopropyl alcohol and lint-free cloth (for bed cleaning)	1
5	Calipers (for measuring and calibration)	1

BACKGROUND THEORY :

- 3D printing, or additive manufacturing, creates objects layer by layer from a digital file.
- Fused Deposition Modeling (FDM) is a common method, using a heated nozzle to extrude thermoplastic filament onto a build platform.
- Key components include the extruder (melts and deposits filament), build platform (supports the print), and stepper motors (control movement).
- FDM is known for its accessibility, affordability, and ability to print complex geometries. Understanding these principles is crucial for effective 3D printing.

PROCEDURE:

- Import the STL file into slicing software and configure print settings.
- Slice the model to generate the G-code file.
- Load the G-code onto an SD card or transfer via USB.
- Turn on the 3D printer and heat the extruder.
- Load the filament into the extruder.
- Level the print bed and clean it with isopropyl alcohol.
- Insert the SD card or select the G-code file.
- Start the print and monitor the first few layers.
- Wait for the print to complete and cool down.
- Carefully remove the model and inspect for defects.

OBSERVATION TABLE:

Parameter	**Observed Value**	**Comments**
Filament Type		e.g., PLA, ABS
Extruder Temperature		e.g., 200°C for PLA
Bed Temperature		e.g., 60°C for PLA
Layer Height		e.g., 0.2 mm

Print Speed		e.g., 50 mm/s
Infill Density		e.g., 20%
Adhesion Quality		e.g., good, poor
Print Time		e.g., 3 hours
Print Quality		e.g., smooth, rough
Any Defects (Warping, etc.)		e.g., minor warping

CONCLUSION

The predefined geometry was successfully 3D printed using the FDM printer with PLA filament. The final model exhibited good adhesion and smooth surface quality. Minor warping was observed at the corners but did not affect the overall integrity. The print time was approximately ____ hours.

VIVA QUESTIONS

1. What are the main components of an FDM (Fused Deposition Modeling) 3D printer, and how do they function together?
2. Can you explain the process of preparing a 3D model for printing with an FDM printer?
3. What are the common materials used in FDM 3D printing, and what are their properties?
4. How do you ensure adhesion of the first layer to the print bed, and why is it important?
5. What factors influence the print quality in FDM 3D printing, and how can they be optimized?
6. Reflecting on the entire process, what improvements would you suggest for future 3D printing projects using FDM technology?

Exp. No.9	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure

AIM: To design, implement, and test a capstone project that integrates embedded hardware, software, and a custom enclosure fabricated using machining or 3D printing techniques.

REQUIREMENTS FOR EXPERIMENT EXECUTION

1. Embedded Hardware

Microcontroller/Microprocessor:

- **Model**: Arduino Uno or Raspberry Pi
- **Microcontroller**: ATmega328P (Arduino) or Broadcom BCM2837 (Raspberry Pi)
- **Operating Voltage**: 5V (Arduino), 3.3V (Raspberry Pi)
- **Digital I/O Pins**: 14 (Arduino), 40 GPIO pins (Raspberry Pi)
- **Analog Input Pins**: 6 (Arduino)
- **Flash Memory**: 32 KB (Arduino)
- **Clock Speed**: 16 MHz (Arduino), 1.2 GHz (Raspberry Pi)

Sensors and Actuators:

- **Temperature Sensor**: DHT22
- **Light Sensor**: LDR (Light Dependent Resistor)
- **Motors**: Servo Motor SG90, DC Motor
- **LEDs**: 5mm Red, Green, Blue LEDs
- **Buttons**: Tactile push buttons (6mm x 6mm)

Electronic Components:

- **Resistors**: 220Ω, 10kΩ
- **Capacitors**: 10μF, 100μF
- **Transistors**: 2N2222
- **Breadboard**: 400 tie-points
- **Jumper Wires**: Male-to-male, male-to-female, female-to-female (assorted lengths)

Power Supply:

- **Batteries**: 9V battery with connector
- **AC Adapter**: 12V, 1A for Arduino; 5V, 2.5A for Raspberry Pi

2. Software Tools

Development Environment:

- **Arduino IDE**: For programming Arduino
- **Libraries**: Adafruit sensor libraries

3. Enclosure Design

3D Printing:

- **Material**: PLA or ABS
- **3D Printer Model**: Prusa i3 MK3, Creality Ender 3
- **Layer Height**: 0.2mm
- **Infill Density**: 20%

Machining:

- **Material**: Acrylic or plywood
- **Thickness**: 3mm to 6mm
- **Tools**: Laser cutter, CNC machine
- **Finish**: Sanding and painting as required

Design Software:

- **CAD Software**: Tinkercad, Fusion 360
- **File Format**: STL for 3D printing, DXF for laser cutting

4. Testing Equipment

Measurement Tools:

- **Multimeter**: For measuring voltage, current, and resistance
- **Oscilloscope**: For analyzing signal waveforms
- **Calipers**: For precise measurements of components and enclosures

Prototyping Tools:

- **Soldering Iron**: For assembling PCBs
- **Solder**: Lead-free solder wire
- **Heat Shrink Tubing**: For insulating exposed wires

PROCEDURE:

- Define objectives, requirements, and constraints. Create a block diagram outlining the main components and their interactions.
- Choose appropriate sensors, actuators, microcontroller (Arduino or Raspberry Pi), and other electronic components.
- Design the circuit schematic using software tools like Fritzing or Eagle.
- Assemble the circuit on a breadboard and test for functionality.
- Write and debug code using Arduino IDE or Python, starting with simple tests and incrementally adding functionality.
- Design the enclosure using CAD software (e.g., Tinkercad, Fusion 360) ensuring it fits all components and allows necessary openings.
- Create the enclosure using a 3D printer or machining tools. Post-process if needed.
- Place hardware components into the enclosure, making all necessary electrical

connections securely.

- Combine hardware and software, ensuring all components work together as expected.
- Perform functional and performance tests, document results, prepare a project report, and create a user manual.

SOME EXAMPLES OF THE PROJECT

1. Smart Home Energy Management System
2. Autonomous Delivery Robot
3. Health Monitoring Wearable
4. Automated Plant Irrigation System
5. Portable Air Quality Monitor
6. Home Security Surveillance System
7. Automated Parking System
8. Smart Irrigation System
9. Basic Line Follower Robot
10. Proportional Line Follower
11. Camera-Based Line Follower
12. IoT-Enabled Greenhouse
13. Smart Water Quality Monitoring System
14. Gesture-Controlled Robotic Arm
15. Color-Based Line Follower

PROJECT PHOTO WITH TITLE AND TEAM MEMBERS DETAIL

CONCLUSION

The capstone project successfully integrates embedded hardware, software, and a custom-designed enclosure. The final product meets the defined objectives and performs the intended functions reliably.