Fundamentals of Additive Manufacturing Technologies

OpenSCAD Tutorial-1

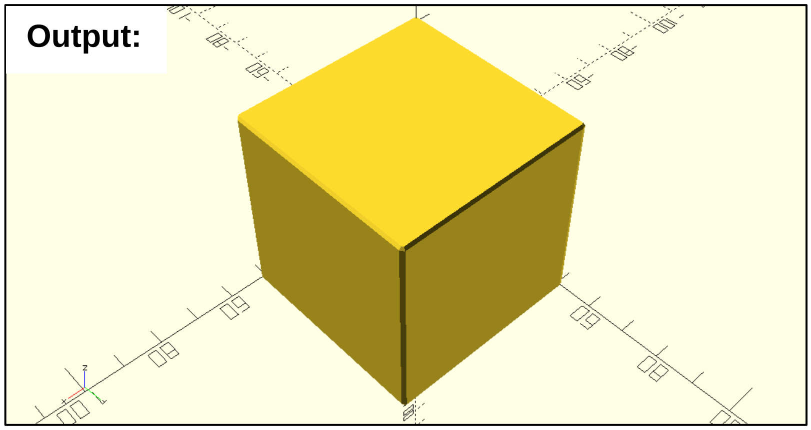
Name of the student: Atharva Lotankar Date: 26/03/2025

Aim: To create a hollow cube with side of 50 mm, wall thickness 5 mm and fillet radius 1 mm. using minkowski operation.

Code:

```
length = 50;

thickness = 5;

fillet_radius = 1;


difference() {

        minkowski() {

        cube(length);

        sphere(fillet_radius);

    }

    translate([thickness,thickness,thickness])

    minkowski() {

        cube(length - 2 * thickness);

        sphere(fillet_radius);

    }

}
```

Output:



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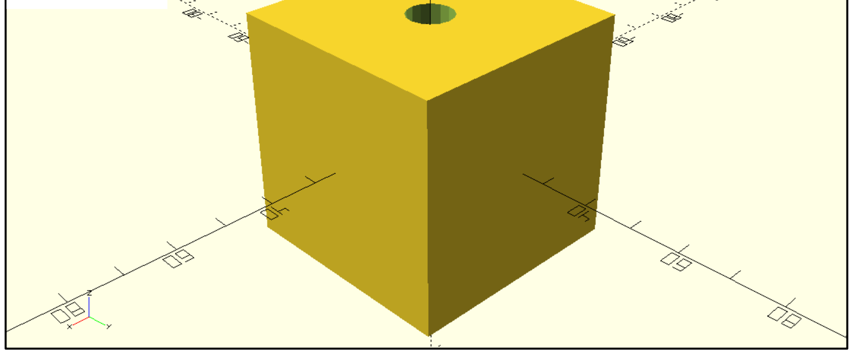
OpenSCAD Tutorial-2

Name of the student: Atharva Lotankar Date: 26/03/2025

Aim: To create a cube of side 50 mm with 10 mm diameter holes at the centre of opposite faces.

Output:



Code:

```
cube_size = 50;

hole_diameter = 10;

hole_radius = hole_diameter / 2;

hole_offset = cube_size / 2;


difference() {

    cube([cube_size, cube_size, cube_size], center = true);

    rotate([0, 0, 0])

    translate([0, 0, hole_offset])

    cylinder(h = cube_size + 2, r = hole_radius, center = true);

    rotate([180, 0, 0])

    translate([0, 0, hole_offset])

    cylinder(h = cube_size + 2, r = hole_radius, center = true);

}
```

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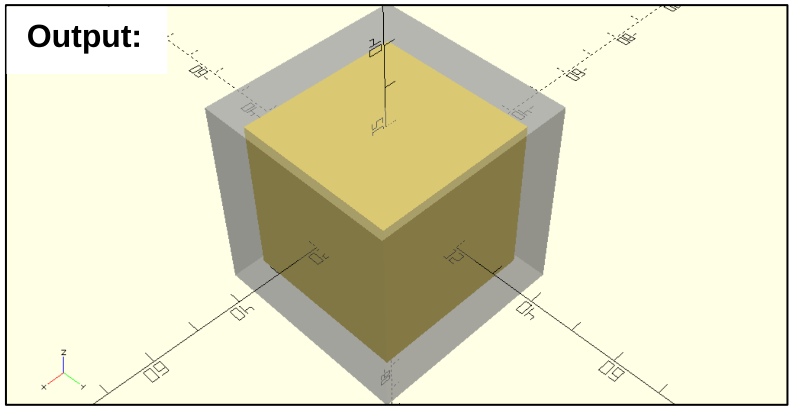
OpenSCAD Tutorial-3

Name of the student: Atharva Lotankar Date: 28/03/2025

Aim: A hollow cube with side of 50 mm, wall thickness 5 mm and fillet radius 1 mm WITHOUT using minkowski operation.

Output:



Code:

```
cube_size = 50;

wall_thickness = 5;

fillet_radius = 1;


difference() {

    %cube(cube_size, center = true);


    cube(cube_size - 2 * wall_thickness, center = true);


    for (x = [-1, 1])

    for (y = [-1, 1])

    for (z = [-1, 1]) {

        translate([x * (cube_size / 2 - fillet_radius), y *
(cube_size / 2 - fillet_radius), z *

(cube_size / 2 - fillet_radius)])

            sphere(fillet_radius);

    }

}
```

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OpenSCAD Tutorial-4

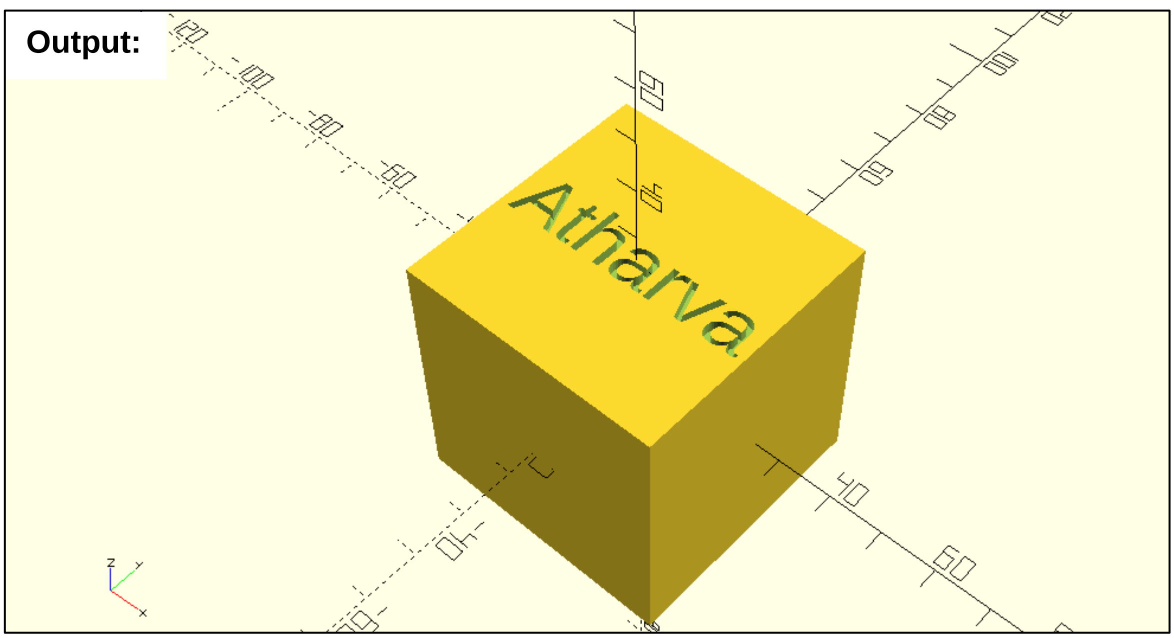
Name of the student: Atharva Lotankar Date: 28/03/2025

Aim: To create a cube of 50 mm with your name engraved at the center of the top face.

Code:

```
cube_size = 50;

text_depth = 2;

difference() {

cube(cube_size, center = true);

translate([0, 0, cube_size / 2 - text_depth])

linear_extrude(height = text_depth + 0.1)

text("Atharva", size = 10, halign = "center", valign = "center");

}
```

Output:



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OpenSCAD Tutorial-5

Name of the student: Atharva Lotankar Date: 02/04/2025

Aim: To generate a cylinder of 50 mm diameter and 80 mm height with a sphere of 40 mm diameter based on the top surface of the cylinder using modules. Also scale the model to 0.5

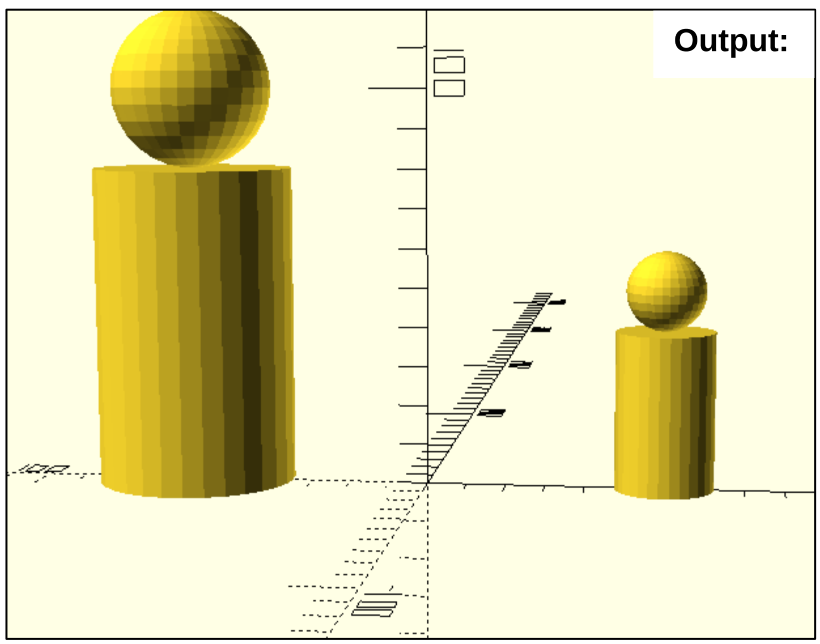
(Display actual model and scaled model side by side)

Code:

```
module shape() {
    cylinder(h = 80, d = 50, center = false);
    translate([0, 0, 100])
        sphere(d = 40);
}

translate([-60, 0, 0])
    shape();

translate([60, 0, 0]) {
    scale([0.5, 0.5, 0.5])
        shape();
}
```



Fundamentals of Additive Manufacturing Technologies

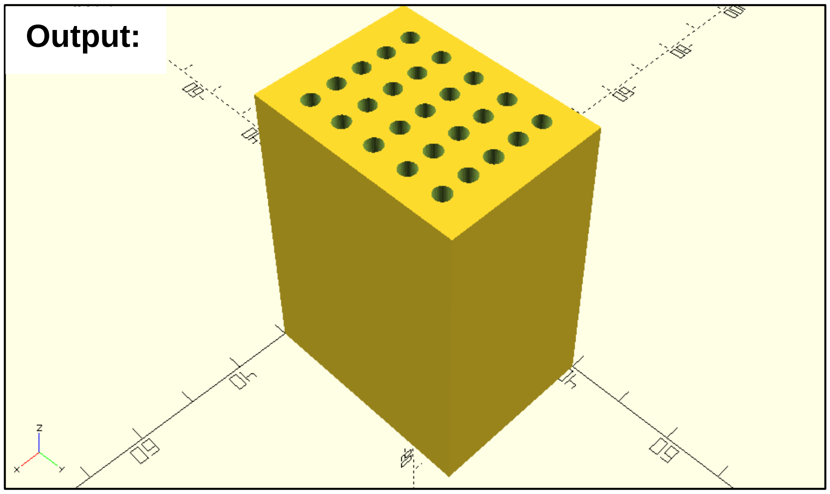
OpenSCAD Tutorial-6

Name of the student: Atharva Lotankar Date: 02/04/2025

Aim: To create a 30×40×50 mm^3 cuboid with a 5×5 grid of 5 mm diameter holes evenly spaced across the top surface.

Code:

Output:



```
cuboid_length = 30;

cuboid_width = 40;

cuboid_height = 50;

hole_diameter = 3;

hole_radius = hole_diameter / 2;

grid_rows = 5;

grid_cols = 5;

x_spacing = cuboid_length / (grid_cols + 1);

y_spacing = cuboid_width / (grid_rows + 1);

difference() {

    cube([cuboid_length, cuboid_width, cuboid_height]);

    for (i = [1:grid_cols]) {

        for (j = [1:grid_rows]) {

            translate([

                i * x_spacing,

                j * y_spacing,

                0

            ])

            cylinder(h = cuboid_height + 1, r = hole_radius, $fn = 30);

        }

    }
}
```

Fundamentals of Additive Manufacturing Technologies

OpenSCAD Tutorial-7

Name of the student: Atharva Lotankar Date: 11/04/2025

Aim: 1. To generate a cuboid of height 10 mm by extruding a rectangle of 50*30 mm^2

2. To generate a triangular prism by extruding an equilateral triangle of side 50 mm

Code:

7.1.

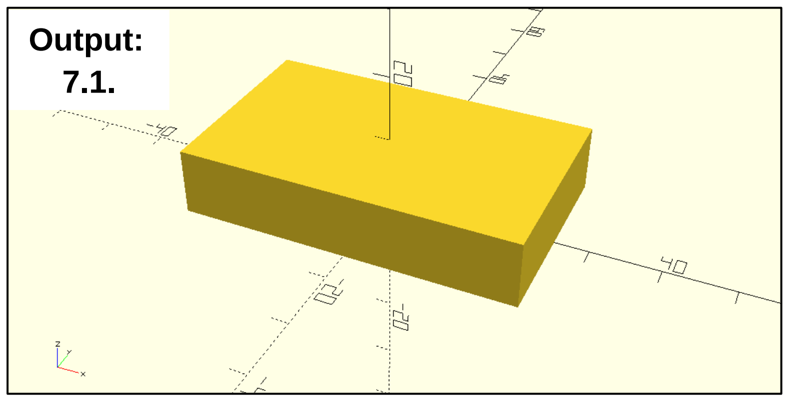
```
Linear_extrude(height = 10)
    square([50, 30], center = true);
```

7.2.

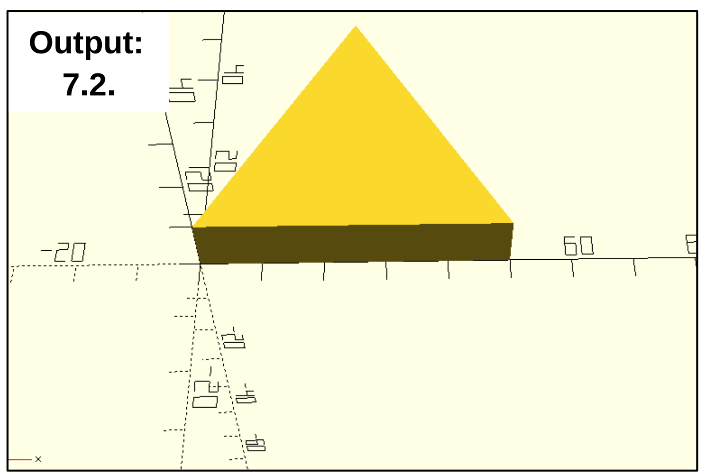
```
side = 50;
height = 10;

module equilateral_triangle(s) {
    polygon(points = [
        [0, 0],
        [s, 0],
        [s/2, s * sqrt(3)/2]
    ]);
}

linear_extrude(height = height)
    equilateral_triangle(side);
```



Output: 7.1.



Output: 7.2.

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OpenSCAD Tutorial-8

Name of the student: Atharva Lotankar Date: 11/04/2025

Aim: 1. To perform Addition, Subtraction, Multiplication, and Division on any two given variables

2. To calculate the area of a rectangle for given dimensions using functions.

Code:

```
8.1.

a = 20;

b = 5;

echo("Addition: ", a + b);

echo("Subtraction: ", a - b);

echo("Multiplication: ", a * b);

echo("Division: ", a / b);
```

Output:

8.1.

```
Compiling design (CSG Tree generation)...
ECHO: "Addition: ", 25
ECHO: "Subtraction: ", 15
ECHO: "Multiplication: ", 100
ECHO: "Division: ", 4
```

```
8.2.

function rectangle_area(length, width) = length * width;

length = 50;
width = 30;

area = rectangle_area(length, width);
echo("Area of rectangle: ", area, " mm^2");
```

Output:

8.2.

```
Compiling design (CSG Tree generation)...
ECHO: "Area of rectangle: ", 1500, " mm^2"
```

OpenSCAD Tutorial-9

Name of the student: Atharva Lotankar   Date:16/04/2025

Aim: To slice a 3D model using 3D printer software (slicer)

Theory: Slicing is a critical step in the 3D printing workflow where a 3D model (typically in STL or OBJ format) is converted into instructions that a 3D printer can understand. This is done using slicing software. The slicer software divides the digital 3D model into horizontal layers (slices) and generates G-code, which is a set of instructions that control the movement, temperature and other functions of the 3D printer.

Key concepts in slicing include:

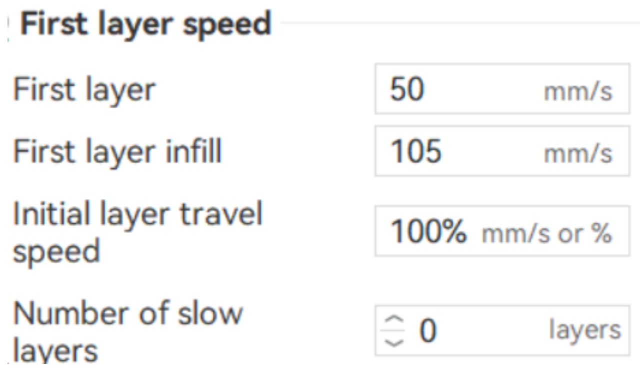
- Layer height: Determines the resolution and surface finish of the print.
- Infill density and pattern: Affects strength, weight, and material usage.
- Shells/perimeters: The number of outer walls of the printed object.
- Print speed and temperature: Affect print quality and material behavior.
- Supports: Structures added automatically to support overhanging parts.
- Bed adhesion settings: Such as rafts, skirts, or brims to ensure the print sticks to the build plate.

Understanding these settings helps optimize the 3D printing process for prototyping, testing, or manufacturing components with functional or mechanical requirements.

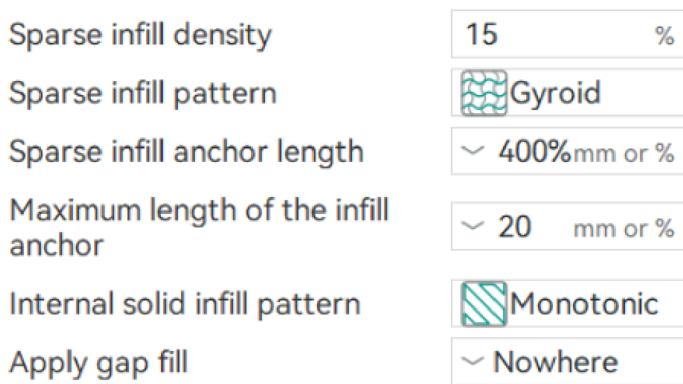
Procedure:

- Create a 3D model using CAD software or download an existing model in STL or OBJ format.
- Launch the slicing software
- Import the Model by loading the STL or OBJ file into the slicer.
- Set the Printer Specifications
- Check or configure build volume, nozzle diameter, and bed size.

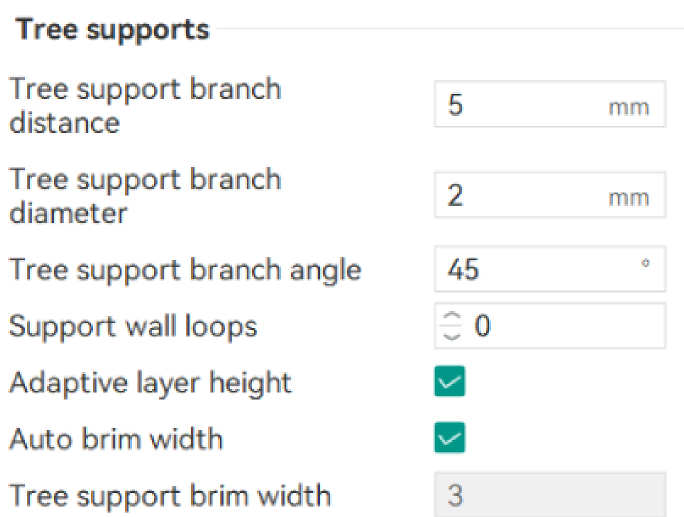
- Adjust quality settings like layer infill speed, layer travel speed, etc.



- Adjust strength settings like Infill Density and Pattern, wall Thickness etc.



  - Adjust support settings like support distance, diameter, support angle, etc.



- Slice the model. Preview it layer-by-layer and inspect each layer to ensure proper support and structure.

OpenSCAD Tutorial-10

Name of the student: Atharva Lotankar Date:16/04/2025

Aim: To configure and calibrate a 3D printer for optimal performance.

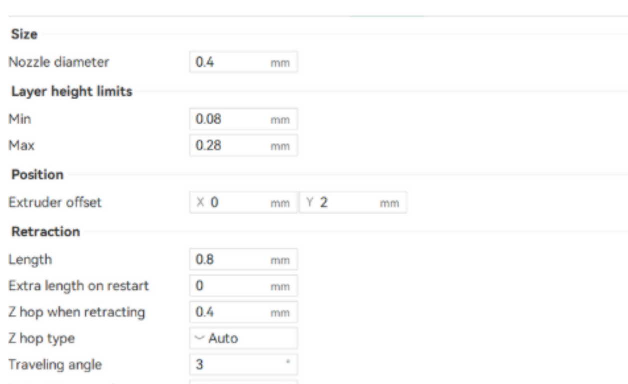
Theory:

Before a 3D printer can be used effectively, it must be properly configured and calibrated. Configuration ensures that the printer's hardware and software settings match the intended parameters for successful operation. This includes:

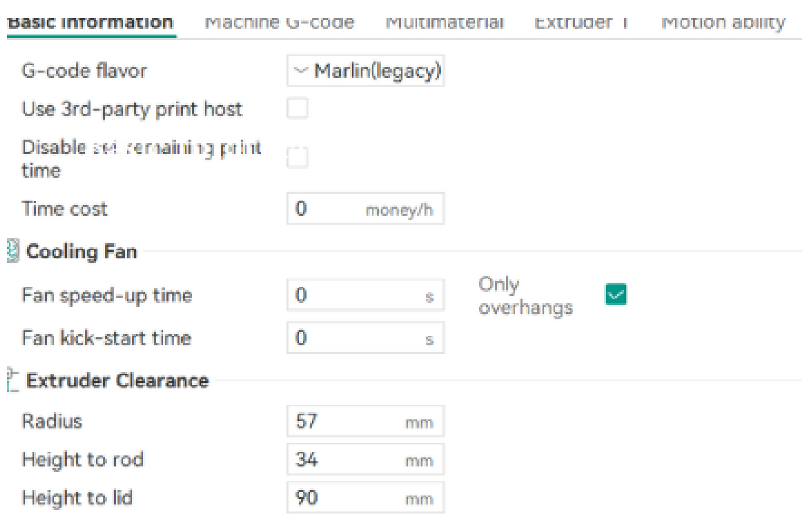
- Leveling the build plate, setting correct Z-offset, checking belt tension, and ensuring smooth motion.
- Ensuring correct printer dimensions, temperature limits, and motion constraints are set.
- Proper loading and unloading of filament through the extruder.
- Setting appropriate extruder and bed temperatures for the specific filament material being used.
- Establishing a connection between the printer and the computer (via USB or SD card) and verifying communication.

Procedure:

- Turn on the 3D printer and ensure it is functioning properly.
- Ensure the printer's settings are updated and set to the correct printer profile (dimensions, nozzle size, etc.).



- Use the printer's auto or manual bed leveling function to level the build plate
- Adjust the bed height using screws or knobs until a piece of paper can slide with slight resistance between the nozzle and bed at all corners.
- Adjust the Z-offset to ensure the first layer adheres properly but isn't too squished or too far from the bed.
- Preheat the nozzle to the filament's melting temperature. Insert filament into the extruder until it extrudes smoothly from the nozzle.
- Manually or automatically move the print head along X, Y, and Z axes to check for smooth, accurate motion.



- Ensure belts are tight and pulleys are secure.
- Load a basic G-code file and start a test print.
- Observe the first layer and overall print quality.
- Adjust print speed, temperatures, and leveling if needed based on the test print outcome.