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# Tribe D Documentation

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ELP305

DESIGN AND SYSTEM LABORATORY  
PROJECT 1

Requirements, Specifications, Milestones and Design Submission

*Submitted to:*  
PROF. SUBRAT KAR

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TRIBE D (DEMANATORS)

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<https://github.com/naunidhsingh03/ELP305-Tribe-D>



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## Abstract

In this project, we want to conceptualize and develop an innovative fabric-cleaning apparatus that specifically targets and effectively eliminates oil stains, particularly those situated near the edges of manufactured cloth.

The unique selling proposition (USP) of our designed fabric-cleaning machine lies in its remarkable capability to selectively target and clean only the areas of the cloth that are stained, leaving the already pristine portions untouched. This distinct feature not only contributes to maintaining the fabric's quality and durability but also streamlines the cleaning process, by doing this we reduce the time and resources required for subsequent drying processes.

Furthermore, a significant aspect of our project involves the systematic testing of various solvents which effectively remove oil and grease stains commonly encountered during the cloth manufacturing process. Our research and experimentation have led us to focus our model on the thorough cleaning of the edges of the cloth since there is a higher probability of deterioration in the peripheral regions of the cloth. It is necessary to note that the clean cloth which will be obtained after undergoing all the processes is not completely dry.

The initial phase of our design focuses on the development of a prototype model for the fabric-washing machine. In subsequent iterations, we will further incorporate more advanced features. The said Iterations will be done after extensive surveys and research conducted throughout the project's duration, aimed at aligning with the evolving needs of contemporary users. Through this entire process, we aspire to create a fabric-cleaning solution that not only addresses specific manufacturing challenges but also anticipates and adapts to the dynamic requirements of the industry.



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## Motivation

The textile industry owned by the client produces fabric of fixed width that is delivered in batches that get stained on the edges with grease and oil due to the industry equipment.

This cloth must be cleaned before it can be shipped to the market. Since this type of staining is localised, our team is developing a machine that only focuses on the area of the cloth that is expected to be dirty and cleans it in two stages: scrubbing/washing and drying. The end product is a cloth with clean and dry edges, with the rest of the material left untouched to preserve quality and lifespan. The relevance of this model lies in the fact that it speeds up the cleaning process without having to spend extra resources on cleaning the cloth as it utilises the localised nature of the stain to its full advantage. The cloth is folded to a vertical configuration with the help of rollers and then the cleaning is performed only on the bottom areas, where the edges lie. This separates the clean part of the cloth from the dirty part and makes it easier to clean while also making it easier to dry. The scope of this type of machine is in industrial applications where the stain is only towards the edges, which may be due to faulty rollers in the assembly line, and the rest of the cloth is clean. This machine cannot be used for general-purpose cleaning where the stain is outside the target region on which the machine operates.



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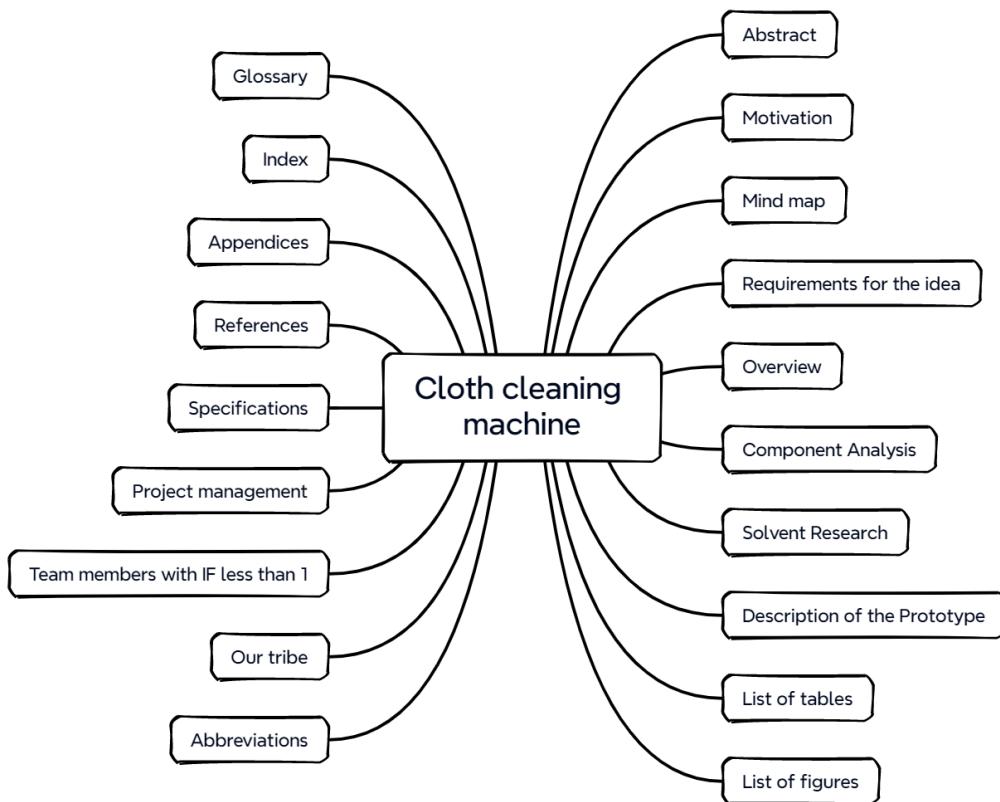
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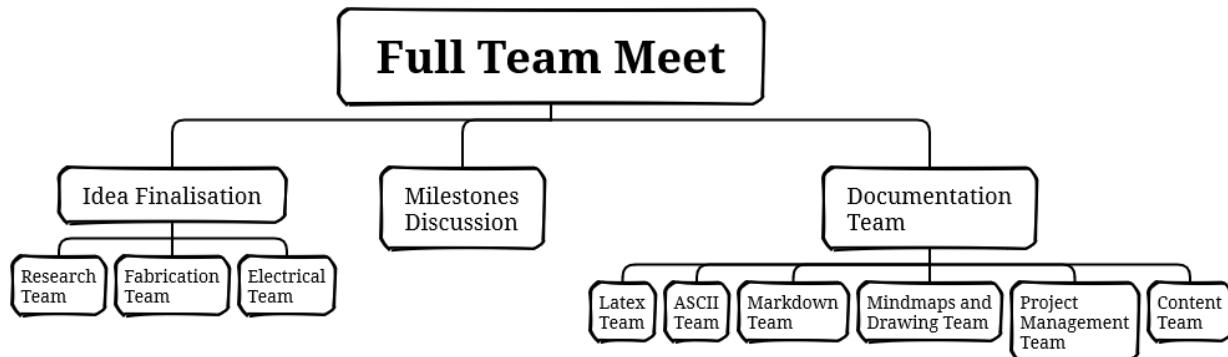
## Mind Map

**Note:** Mindmaps provided here are abbreviated versions to ensure visibility. For detailed mindmaps, refer to the Xmind files provided in the .zip file.



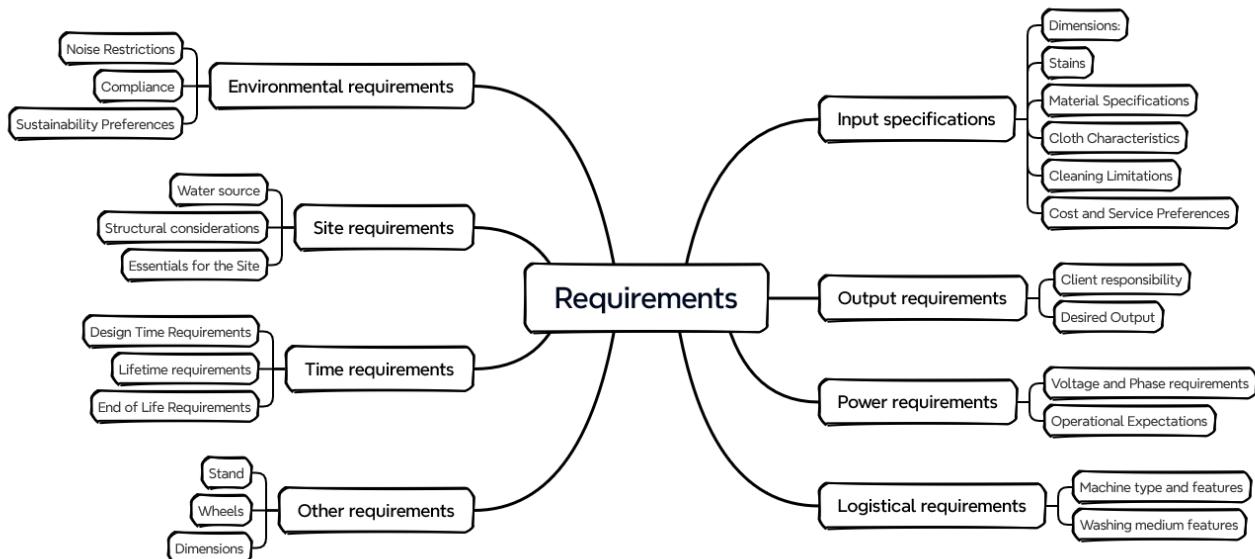
Presented with xmind

Figure 1: Outline Mindmap



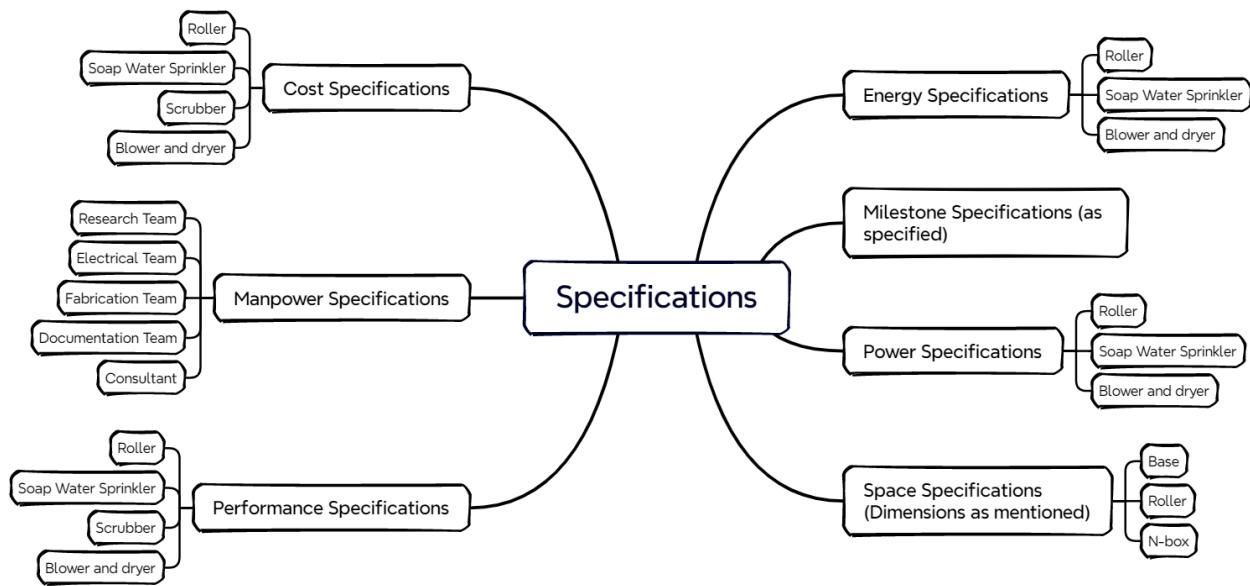
Presented with xmind AI

Figure 2: Task Structure



Presented with xmind AI

Figure 3: Requirements MindMap



Presented with xmind

Figure 4: Specifications Mind Map

# 1 Requirements for the idea

## 1.1 Input Requirements

### 1.1.1 Material Requirements

- Newly manufactured white unbleached cotton with single-ply, Denier 60, and a threadcount of 400.

### 1.1.2 Stains

- Only oil and grease stains present on the edges of the cloth need to be removed.

### 1.1.3 Dimensions

- Cloth is either available on rollers ( $2m \times 10m$ ) or it can be assumed as an infinite sheet supply of width 2 m.

### 1.1.4 Cloth Characteristics

- Free from foul odour, slightly damp, and without buttons, zippers, or attachments.



### 1.1.5 Cleaning Limitations

- Maximum weight for cleaning is set at 11 kg dry, with stains limited to those occurring during manufacturing.

## 1.2 Outputs Requirement

### 1.2.1 Desired Output

- A cleaned and dry cloth wound on rollers.

### 1.2.2 Client Responsibilities

- Treating discharged greywater, managing lint, and ensuring the returned cloth is wrinkle-free and bone-dry.

## 1.3 Power Requirements

### 1.3.1 Voltage and Phase Requirements:

- The washing machine should operate on 220VAC 15A, with the option for 440VAC 3-phase available at an additional cost.

### 1.3.2 Operational Expectations

- They are expected to run continuously, 24/7, with an emergency shutdown initiated using a 1-button process.

## 1.4 Logistical Requirements

### 1.4.1 Machine Type and Features

- An automatic washing machine with minimal water usage and no need for portability or a programmable timer.

### 1.4.2 Washing Medium Features

- There are no restrictions on the washing medium, but costs may be incurred for using rare solvents, focusing on overall cost-effectiveness.

## 1.5 Environmental Requirements

### 1.5.1 Noise and Compliance

- Noise levels should not exceed 75 dB.



- Must comply with local regulations, including those set by the Central Pollution Control Board (CPCB).

### 1.5.2 Sustainability Preferences

- Preference for cold water washing, sustainable components, and optimization of energy consumption, robustness, and durability.

## 1.6 Site Requirements

### 1.6.1 Essentials for the Site

- Adequate power supply, suitable drainage, and specific design parameters.

### 1.6.2 Water Source and Structural Considerations

- The water source was specified as having 60 mg CaCO<sub>3</sub>/l hardness, with an overhead tank and a 50,000-liter refillable capacity at 35 meters.
- Structural considerations include material selection and the ability to withstand the maximum cloth weight.

## 1.7 Time Requirements

### 1.7.1 Cleaning and Setup Time

- Cleaning and drying time is set at 45 minutes.
- Setup time should be at most 1 day.

### 1.7.2 Design Time Requirements

- Cleaning and Drying time: At most 45 minutes.
- Usage time: 24 hrs a day.
- Setup Time: As little time as possible, no more than 1 day.

### 1.7.3 Life-Time Requirements

- Expected Lifetime: The machine is expected to last at least 6 years.
- Service Hours and Cost: No more than 6 hours per year and there isn't an explicit cost constraint for the servicing years.



#### 1.7.4 End-of-Life Requirements

- Replacement for Old Machine: Client could be interested in replacing the old machine with a new one at a discounted price.
- Parts Availability: Parts of the machine should be available for 10 years to enable servicing.

### 1.8 Other Non-Functional Requirements

#### 1.8.1 Miscellaneous Considerations

- Dimensions and the inclusion of a stand or wheels are left to the designer's discretion.
- We need to clean only the edges of the cloth rather the whole cloth.
- Only oil stains and grease stains need to be removed.
- Cloth is either available on rollers ( $2m \times 10m$ ) or it can be assumed as an infinite sheet supply of width 2 m.



## 2 Overview

We propose the development of an innovative cloth cleaning machine that can be used to clean oil stains (which occur near the edges) off manufactured cloth after the manufacturing process. Our design consists of rollers, driving motors, a guiding frame (used to fold the cloth in half vertically), wiping and cleaning surface (Cleaning Foams/sponge), a soap water mixture compartment, a water compartment, and a drying chamber. This automated system aims to streamline the cloth manufacturing process, ensuring efficient cleaning and drying during the manufacturing process while minimising the impact on the fabric. The USP of our design is that the regions of the cloth that are guaranteed to come in clean are untouched in the process, which preserves the quality and durability of the cloth. This approach also ensures that drying requires less effort and resources in comparison to other approaches.

### 2.1 Key Components

#### 1. Rollers with Motor Control:

- Two rollers placed on either side of the machine.
- Motor-controlled to regulate the speed of the cloth movement.

#### 2. Cloth Attachment:

- Cloth is securely attached to the rollers upon loading in batches, ensuring uniform tension.

#### 3. Guiding Frame:

- Positioned between the rollers upon viewing from the side and placed parallel between the two vertical walls when viewed from the top.
- The frame when viewed from the side looks like a smoothed plateau with a long flat top and curved sides (coming from and going towards the input and output rollers respectively).
- Upon viewing from the top, it looks like the edge of a railing.
- The frame is slightly angled and is broader at the bottom than at the top.
- All edges on the frame are filleted and smoothed to ensure that the cloth doesn't rip or tear or get stuck while it slides over the frame due to the pull of the motor.
- It is shaped this way to guide the fabric to smoothly rise in height from the horizontal roller configuration at the input to the folded vertical configuration in the cleaning and drying chamber.



- This vertical folding ensures that the stained edges are hanging on the two sides of the frame symmetrically with the entire cloth folded along the midline and suspended vertically by the normal reaction from the sleek frame.
- The part of the fabric towards the centre in the horizontal configuration now slides at the top of the smooth frame as the rollers on the other end pull it at a constant speed and is unaffected by the cleaning and drying process.
- Once the cloth crosses the drying chamber, the guiding frame is shaped in such a way that it lowers the cloth from the raised frame back to its horizontal configuration onto the rollers.

#### 4. Cleaning Mechanism:

- Cleaning Foams along the edges of the frame at a fixed distance from the height (coincides with the stained edge of the cloth).
- The parallel wall also has Cleaning Foams at the same vertical height, and the two Cleaning Foams hold on to the edge of the cloth as it moves under the influence of the rollers and scrubs against the Cleaning Foams, hence getting cleaned.
- Solvent drizzled from the top onto the stained part of the cloth). The solvent mixture and water are dispensed in succession and recursively creating stages along the length of the frame. (first “x” cm → soap, next “y” cm → water, next “x” cm → soap, etc.).
- Cleaning Foams act as scrubbers to enhance cleaning effectiveness.

#### 5. Cleaning Fluid Compartment:

- Alternating compartments for soap water mixture and water.
- The soap compartments have Cleaning Foams along the wall, while the water compartment consists of high-pressure water nozzles to take out the soap from the cloth.
- Ensures proper cleaning of the cloth during the process.

#### 6. Drying Chamber:

- Located after the cleaning mechanism.
- Equipped with air blowers to blow hot air onto the cloth.
- Ensures quick and effective drying.

#### 7. Guiding Fixtures:

- Transfer the cloth from the input roller to the cleaning chamber of the frame and from the drying chamber of the frame to the rollers.

- Facilitates a smooth movement of the cloth.

#### 8. Waste Tub:

- A waste tub at the bottom to collect residual drippings and lint.

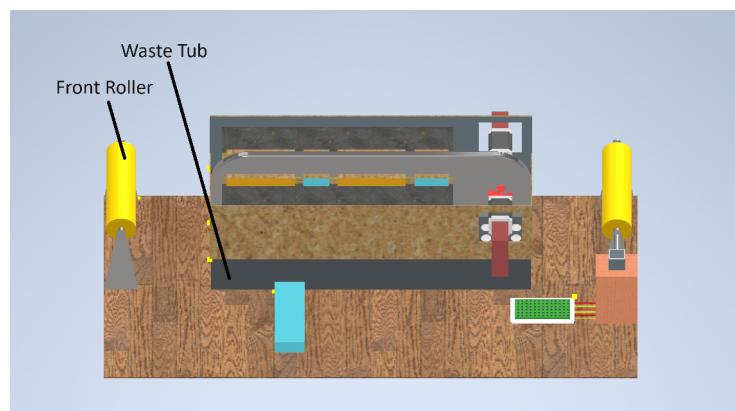


Figure 5: Side view of the final CAD model

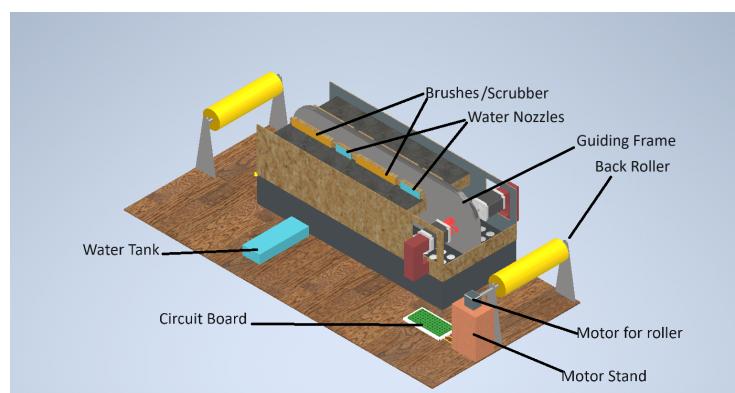


Figure 6: Slanted isometric view of the final CAD model

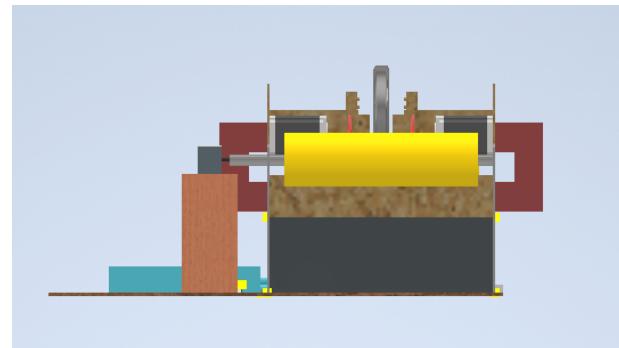


Figure 7: Back view of the final CAD model

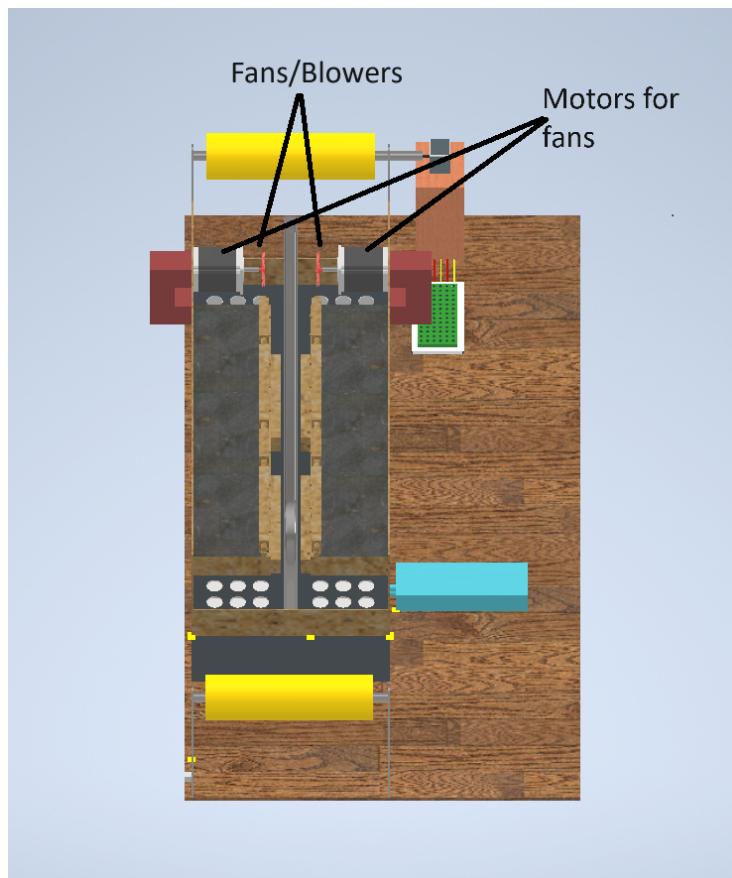


Figure 8: Slanted front view of the final CAD model



## 2.2 WorkFlow

- Cloth is loaded onto input rollers over the guiding frame, through the cleaning and drying chamber and onto the output roller. To prevent wastage of a significant initial length of the cloth roll, we can attach it to a clean dummy cloth of machine length, with the help of a speed punching system and later detach the dummy cloth and reuse it for the next batch. This is not relevant for demonstration but crucial during industrial scaling.
- Then a lever/switch is activated which brings the two walls closer to the guiding frame with the cloth attached to it and the horizontal line of Cleaning Foams lock onto each hanging edge of the cloth securing it in place.
- Motors are powered on, and the cloth starts sliding on the frame while being kept in place by the walls and guiding fixtures.
- The Solvent is drizzled from the top with targeted precision on the edges, and Cleaning Foams act as scrubbers for thorough cleaning as the cloth slides over them.
- The cloth passes through multiple alternating soap water mixture and water compartments and gets recursively cleaned for better results.
- The cloth then enters the drying chamber, where hot air is blown to expedite the drying process.
- After drying, the cleaned and dried cloth moves through guiding fixtures onto the rollers for subsequent manufacturing processes.

## 2.3 Benefits

- Improved cloth cleaning efficiency.
- Minimized impact on the fabric during the cleaning process.
- Streamlined manufacturing workflow.
- Enhanced drying capabilities for increased production speed.

### Calculation of order of magnitude of the length of chamber:

- Load in one batch = 11 kg.
- Breadth of cloth roll = 2 m.
- The Areal density of Single ply cotton cloth unbleached, denier 60, thread count 400 =  $0.180 \text{ kg/m}^2$ .
- Time provided for cleaning = 45 minutes.

- $l = \frac{90 \times 11}{0.18 \times 2 \times 45 \times 60}$  m=1 m approx=40 inches approx ( $l$  =cleaning and drying length).
- Varying soaps changes the time cloth needs to spend in the chamber which increases/decreases the length of the machine.

## 3 Component Analysis

### 3.1 Roller

1. The roller will roll the washed cloth, coming through the conveyor belt.
2. A controlled DC motor will be used to drive the roller.
3. Appropriately select the dimensions of the roller, like the diameter of the roller and its length, based on the conveyor width.
4. Choose a proper outer covering for the roller, which can provide a better grip and friction for the cloth.
5. The cloth will also be straightened using 1 or 2 uncontrolled rolling cylinders which can provide the requisite tension in the fabric and guide the fabric onto the roller.

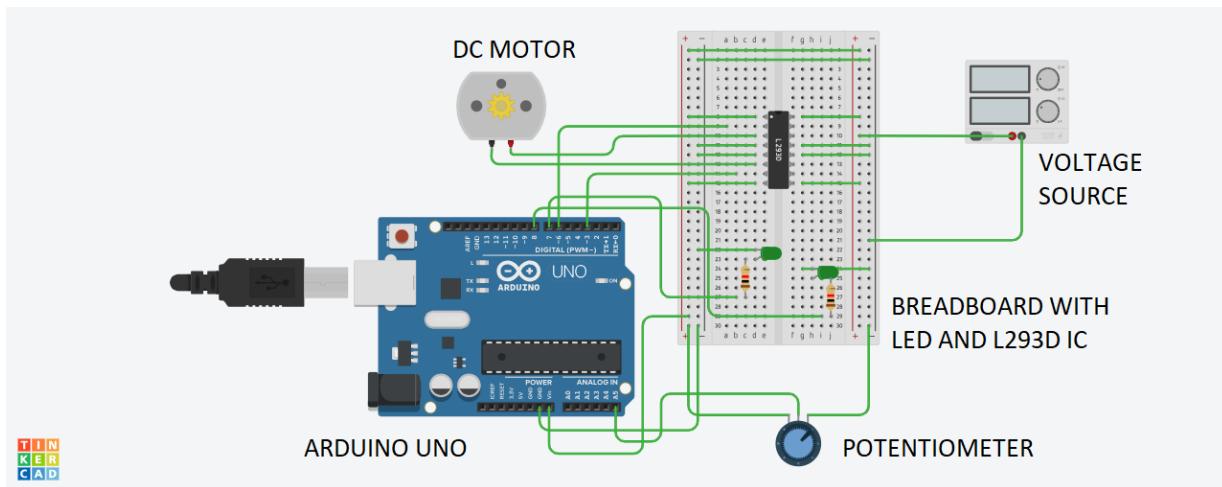


Figure 9: Circuit diagram for controlling roller's motor



### 3.1.1 Controlling DC Motor using Arduino

To control the speed of a DC motor using Arduino, we need to adjust the input voltage supplied to the motor. We can control the input voltage with a pulse-width modulated (PWM) signal. To change the speed of the DC motor we need to change the amplitude of the input voltage that is applied to the motor. A common technique to do that is PWM (Pulse Width Modulation). In PWM the applied voltage is adjusted by sending a series of pulses, so the output voltage is proportional pulse width generated by the microcontroller that is also known as duty cycle. The higher the duty cycle, the higher the average voltage

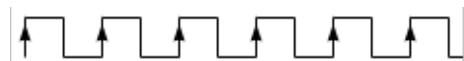


Figure 10: A square wave with 50% duty cycle

applied to the DC motor (resulting in higher speed) and the shorter the duty cycle, the lower the average voltage applied to the DC motor (resulting in lower speed).

### 3.1.2 Arduino and L293D Circuit Diagram

A common and cheap solution to drive motors and efficiently control them is to use a Motor Controller module along with Arduino. L293D Motor driver module is a readily available IC which can be easily interfaced with Arduino, to control the various aspects of DC motors like speed, direction and braking. It is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36V. Below is an example of a circuit diagram to drive multiple motors from a single module, and Arduino code to interface a motor with the module.

```
1 # Define constants for pin numbers
2 leftForward = 6
3 leftBackward = 3
4 pot = A5
5 onled = 8
6 offled = 7
7
8 # Initializing some variables
9 pwm
10 x
11
12 # Running the Setup function once at the beginning
13 setup()
14
15 # Set the leftForward and leftBackward as outputs and pot as
16     an input
17 pinMode(leftForward , OUTPUT)
18 pinMode(leftBackward , OUTPUT)
```

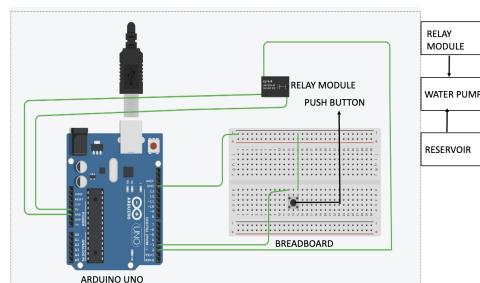


```
18 pinMode(pot, INPUT)
19 pinMode(offled, OUTPUT)
20 pinMode(onled, OUTPUT)
21
22 # Begin serial communication for debugging
23 Serial.begin(9600)
24
25 # Loop function to run repeatedly
26 loop()
27 # Reading the analog value from pot
28 pwm = analogRead(pot)
29 # mapping the value of pwm within appropriate bounds
30 x = map(pwm, 0, 1023, 0, 255);
31 # Defining the logic for the LEDs to indicate if the machine
   is running or not
32 if(x == 0)
33 {digitalWrite(offled, HIGH); digitalWrite(onled, LOW);}
34 else
35 {digitalWrite(onled, HIGH); digitalWrite(offled, LOW);}
36 # Assigning the value of pwm to x, and configuring the values
   to drive the motor in a particular direction
37 analogWrite(leftForward , x);
38 digitalWrite(leftBackward , LOW );
```

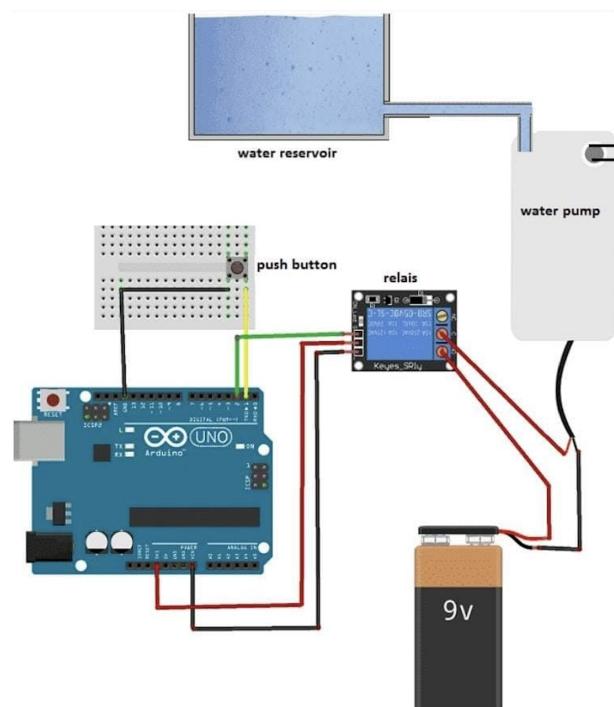
[Click here for the Arduino code reference](#)

## 3.2 Solvent Dispenser

### 3.2.1 Using relay module and pump



(a) Using Push Button



(b) Full circuit

Figure 11: Sprinkler

### Explanation

- A push button is employed to toggle the relay, managing the on/off state of the pump.
- The relay is cycled at regular intervals, simulating control over a device, such as a



solvent pump. To activate the relay, the relay pin (control pin) is set to HIGH. To deactivate the relay, the relay pin is set to LOW.

[Click here for code reference](#)

```
1 # Define constants for pin numbers
2 relayPin = 2
3 buttonPin = 3
4
5 # Setup function to run once at the beginning
6 setup():
7     # Set the relayPin as an output and buttonPin as an input
    # with pull-up resistor
8     pinMode(relayPin, OUTPUT)
9     pinMode(buttonPin, INPUT_PULLUP)
10
11    # Begin serial communication for debugging
12    Serial.begin(9600)
13
14    # Turn off the relay initially
15    digitalWrite(relayPin, LOW)
16
17 # Loop function to run repeatedly
18 loop():
19     # Read the state of the button (HIGH or LOW)
20     buttonState = digitalRead(buttonPin)
21
22     # Print the button state for debugging
23     Serial.println(buttonState)
24
25     # Check if the button is pressed (LOW state)
26     if buttonState is LOW:
27         # Turn on the relay
28         digitalWrite(relayPin, HIGH)
29     else:
30         # Turn off the relay
31         digitalWrite(relayPin, LOW)
```

### 3.3 Scrubber

- Static stationary Cleaning Foams scrubber is an industrial cleaning tool designed for efficient cloth cleaning. This device features stationary Cleaning Foams that remain fixed during operation, providing a stable cleaning surface. The static design allows for controlled and targeted cleaning of fabrics, ensuring uniform and effective

removal of dirt and contaminants. This type of scrubber is commonly employed in industrial settings where precision and consistency in cloth cleaning are essential for maintaining high standards of hygiene and product quality.

- Stationary Cleaning Foams would be used near the edges of the cloth.
- Static cleaning mechanism.

### 3.4 Dryer

We are planning to use the configuration of tunnel dryer to dry the clothes. The power and torque requirements of the motor used in blower and power requirements of the heater will depend on the time needed to dry the cloth, rate at which the cloth is being fed, width and height of the chamber, final moisture content and initial moisture content.

Also, cross-flow configuration will be used in our design. Tunnel dryer has been used for the inspiration for our design.

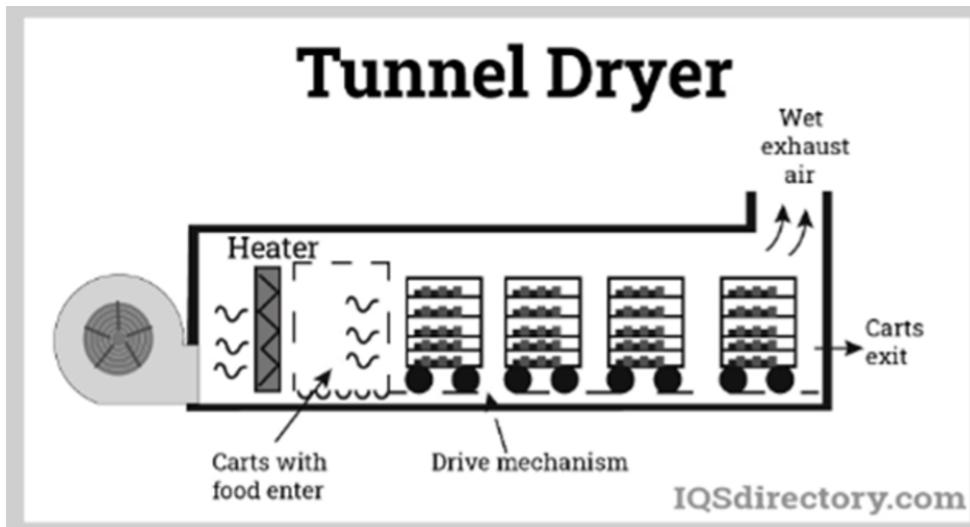


Figure 12: Idea for the design of drying mechanism

In our prototype/behavioral model, we will only have a fan driven by DC555 motor (depends on procurement of materials), which is controlled using Arduino to control the flow of air over the drying region. In the actual machine a heater can be used along with the fan to fasten up the process.

Arduino, a motor driver module, DC555 motor, battery and bunch of connecting wires are being used to design the circuit for the prototype.



### 3.4.1 Requirements for dryer (prototype)

- DC 555 motor (Qty. 1)
- Arduino UNO (Qty. 1)
- L298N Motor Driver IC (Qty. 1)
- DC Voltage Source (12V)
- Jumper Wires

One of the circuits which can be used is as follows:

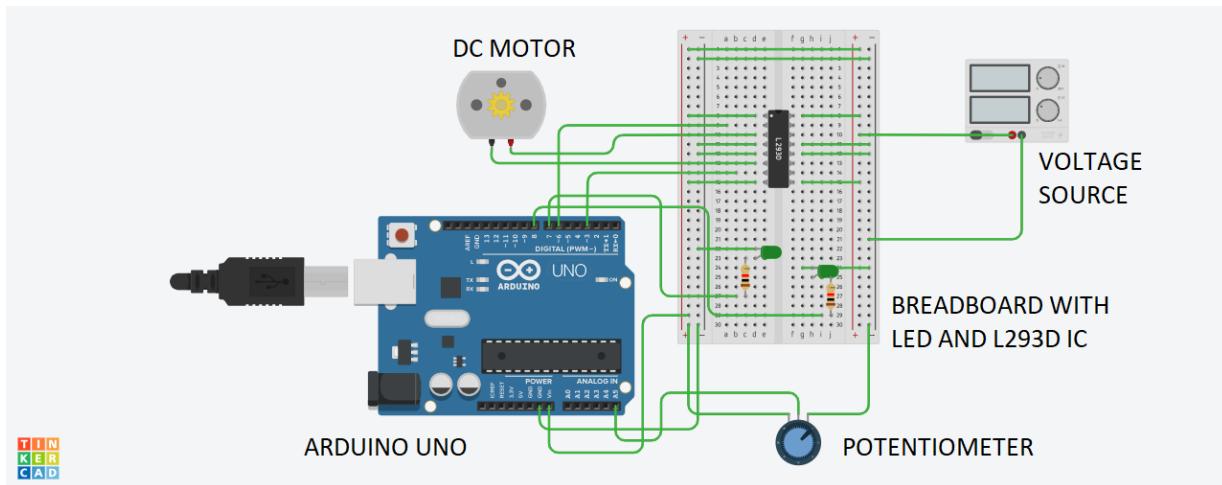


Figure 13: TinkerCad simulation of DC motor speed control

One can have LCD display to keep track of status of machine. In our case we will be using LEDs to show the working or idle state of machine. Due to unavailability of L298N IC on Tinker CAD, we used L293D for simulation purposes

### 3.4.2 Working of the design

The DC555 motor will be controlled using a L298N motor driver and an Arduino Uno Board. Currently Analog Output (works by generating PWM pulses) has been set to +5V and will be adjusted later on as per speed requirements.

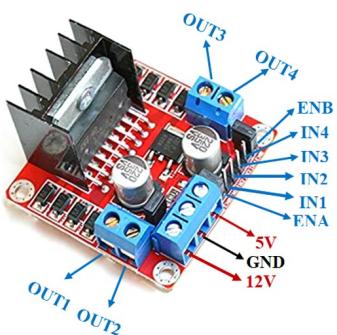


Code for the Arduino:

```
1 //Code for controlling the DC motor using PWM technique.
2 //Speed will be changed as per requirement
3 int in1 = 2;
4 int in2 = 3;
5 int en1 = 6;
6 //Parameter to tune the speed. Currently at maximum speed.
7 int speed = 255;
8
9 void setup()
10 {
11     pinMode(2,OUTPUT);
12     pinMode(3,OUTPUT);
13     pinMode(6,OUTPUT);
14 }
15
16 void loop()
17 {
18     digitalWrite(in2,HIGH);
19     digitalWrite(in1,LOW);
20     analogWrite(en1,speed);
21 }
```

[Click here for the file of the code](#)

#### 3.4.3 List of Components



(a) L298N motor driver



(b) DC RS-555 motor

PWM signal is used to control the motor. The waveform is:

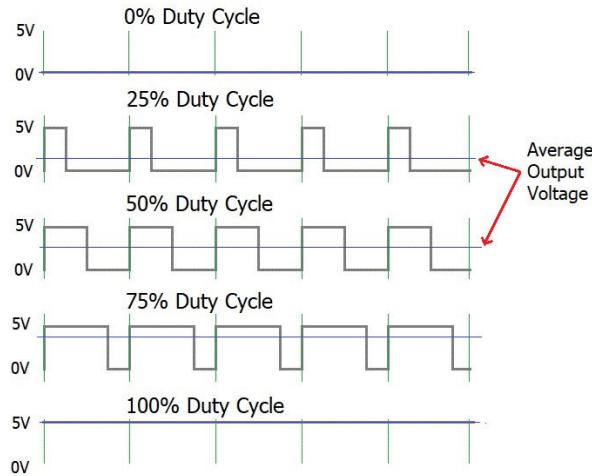


Figure 15: Pulse Width Modulation Waveform

We can directly make a purchase of dryer for actual machine from bluelink

- It costs around 100000 INR.
- Power Requirement – 4-6 kW depending on the speed of feeding the cloth and drying rate.
- Speed – upto  $120 \text{ m min}^{-1}$
- Voltage – 220V
- Infrared based heating

For the prototype:

- We will be using a motor driven fan to dry the clothes
- Voltage requirements - 220V (for adapter to give input to Arduino)
- Power requirement - 20 - 30 W
- Cost - 500 INR



## 4 Solvent Research

Some of the cleansing agents that were researched and tested for oil and grease stains:

### 1. Lipase Enzyme

- **Pros:** Lipase is an enzyme that breaks down oil, making it a potential solution for cleaning oil and grease stains.
- **Cons:** Requires slightly warm water ( $\sim 40\text{-}50^\circ\text{C}$ ) for optimal enzyme action, which may be challenging to maintain.

### 2. Spot Remover (e.g. Shout) and Hot Water

- **Pros:** Effective in removing both oil and grease stains. Hot water and Cleaning Foamsing enhance results.
- **Cons:** Increases energy requirements and costs due to hot water usage. Spot removers add to the overall cost.

### 3. Spot Lifter (e.g. K2R Spot Lifter) followed by Dry Cleaning Foamsing

- **Pros:** Overcomes the need for scrubbing in hot water. After application, a short waiting period lifts the stain, requiring only Cleaning Foamsing in the end.
- **Cons:** Costly ( $\sim 3300 \text{ Rs for } 150 \text{ ml}$ ) and availability may be an issue for large quantities due to US manufacturing.

### 4. Baby Powder/Cornstarch/Salt/Vinegar followed by Washing

- **Pros:** Effective in cleaning oil and grease stains significantly.
- **Cons:** Time-consuming, requiring soaking and multiple iterations to remove stains.

### 5. WD-40 or Lighter Fluid

- **Pros:** Effective in cleaning oil and grease stains significantly.
- **Cons:** Requires 20 minutes of soaking time, and hot water is needed for washing.

### 6. PCE (Perchloroethylene)

- **Pros:** Nonflammable liquid solvent widely used in dry cleaning, effective in removing oil and grease stains in small quantities.
- **Cons:** Extended exposure to large quantities may cause irritation to eyes, skin, throat, nose, and respiratory system.



## 7. Handwash (Dettol)

- **Pros:** Biodegradable, environmental friendly. Can be washed and reused multiple times. Soft and less abrasive.
- **Cons:** May be more prone to staining depending on material and color.

## 8. Dishwasher (Vim Drop)

- **Pros:** Effective in removing both oil and grease stains by scrubbing with Vim Drop and water with normal pressure.

## 9. Trichloroethylene (TCE)

- **Pros:** Stain remover and degreaser. Evaporates quickly, leaving behind a dry surface.
- **Cons:** Linked to various health risks, including respiratory, neurological, and reproductive effects. Considered a potential human carcinogen. Flammable and persistent in the environment.

## 10. Isopropyl (Rubbing Alcohol 68-72%)

- **Pros:** Natural degreasing agent.
- **Cons:** Ineffective in practical experiments on grease and oil-stained cotton cloth. May be effective after longer soaking, making it inefficient due to time constraints.

## 11. Detergent (Surf Excel)

- **Pros:** Effective on oil stains with slight scrubbing.
- **Cons:** The idea was rejected as it was not effective on grease stains, even after hard scrubbing.

## 12. Acetone

- **Pros:** As it is volatile, it would be quite convenient in the drying stage.
- **Cons:** We have experimentally seen that it does not work efficiently on grease stains

#### 4.1 Solvent Testing

- WD-40



(a) Before



(b) After

Figure 16: Application of WD-40

- Acetone



(a) Before



(b) After

Figure 17: Application of Acetone

- **Dishwasher (Vim Drop)**



(a) Before



(b) After

Figure 18: Application of Dishwasher (Vim Drop)

- **Some more applications**



(a) using Isopropyl



(b) using Detergent

Figure 19: Image of greased cloth after cleaning



Factor	Acetone	Stain Remover	Isopropyl Alcohol	Liquid Washing Soap
Suitability for oil-based stains	Excellent	Good	Good	Moderate
Amount of solvent	5-10 mL, test in inconspicuous area first	Follow product instructions (5-15 mL typical)	5-10 mL, test in inconspicuous area first	Apply directly to stain or dilute 5-10 mL in water for pre-treatment
Cleaning time	5-10 minutes	10-15 minutes	5-10 minutes	Depends on washing cycle time
Scrubbing intensity	Light scrubbing with soft cloth	Light to moderate scrubbing	Light scrubbing with soft cloth	Moderate scrubbing with Cleaning Foams or hands
Evaporation/drying time	Evaporates quickly (5-10 minutes)	Dries moderately fast (15-30 minutes)	Evaporates quickly (5-10 minutes)	Depends on fabric and drying method
Safety	Flammable, use with caution and good ventilation	May contain harsh chemicals, follow product instructions	Flammable, use with caution and good ventilation	Generally safe, but test on inconspicuous area first
Fabric suitability	Works well on most fabrics, but test first on delicate fabrics	Check product label for fabric compatibility	Works well on most fabrics, but test first on delicate fabrics	Suitable for washable fabrics

Table 1: Comparison of Different Solvents for Stain Removal



## 5 Specifications

### 5.1 Energy Specifications

<b>Roller</b>	Maximum Operating Voltage	36 V
	Maximum Current rating (per channel)	600 mA
<b>Sprinkler</b>	Relay Module Voltage	5 V
	Battery Voltage	9 V
	Water Pump Voltage	12 V
<b>Dryer</b>	Operating Voltage	220 V

Table 2: Energy specifications for the Model

### 5.2 Space Specifications

<b>Frame (3mm sheet)</b>	Height	20 cm
	Length	75 cm
	Width	2 cm
	Arc radius of the corners	9 cm
<b>Roller</b>	Height from ground	21 cm
	Length	30 cm
	Diameter	8 cm
<b>Box</b>	Length	75 cm
	Height	10 cm
	width	30 cm
<b>Wall</b>	Height	20 cm
	Length	75 cm
	Width	30 cm
<b>Scrubber</b>	Length	18 cm
	Width	3 cm
<b>Fan</b>	Diameter	3 inches

Table 3: Space specifications for the Model



### 5.3 Power Specifications

<b>Roller</b>	Power Rating	21.6 W
<b>Sprinkler</b>	Power Rating	18 W
<b>Dryer</b>	Actual machine requirement	4-6 KW
	For Prototype	20-30 W

Table 4: Power specifications for the Model

### 5.4 Cost Specifications

<b>Roller</b>	Prototype Average Cost	200 INR
<b>Sprinkler</b>	Arduino	2500 INR
	Resistors	1 - 2 INR
	Breadboard	90 INR
	Relay Module	50 INR
	Connecting Wires	15 INR
	Pipe (2-3 meters)	200 INR
	Solvent Pump	200 INR
<b>Scrubber</b>	Cost per meter	300-400 INR
	No of scrubbers	2 - 4
<b>Dryer</b>	Actual Machine Cost	1,00,000 INR
	Prototype cost	500 INR

Table 5: Cost specifications for the Model



## 5.5 Performance Specifications

### Roller

- Rolling Capacity:  $\sim$ 60-80 meters/min.
- Rewind Diameter: 1.8-2 meters.
- The driver module for the prototype can be used simultaneously by other motors in the system.
- The cost of the actual machine can be reduced significantly because it would be integrated with other components.
- If a small DC motor is used, a no-load speed of  $\sim$ 9000 rpm, and a loaded speed of  $\sim$ 5000 rpm can be achieved in the prototype.

### Solvent Sprinkler

- Arduino controls the operation of the water pump. It also controls the flow rate and directions of water.

### Scrubber

- Stationary scrubbers/Cleaning Foams remain fixed during operation, providing a stable cleaning surface.
- The static design allows for controlled and targeted cleaning of fabrics, ensuring uniform and effective removal of dirt and contaminants.

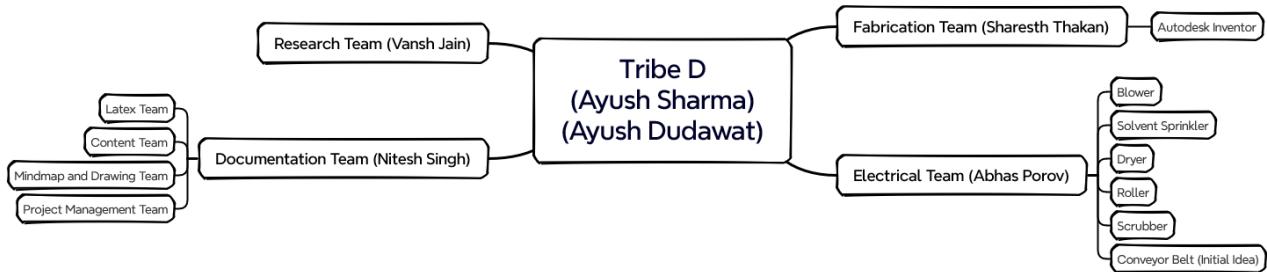
### Dryer

- Control Mechanism: DC 555 motor, Arduino UNO (Qty. 1), L298N Motor Driver IC (Qty. 1), DC Voltage Source (12V) and Jumper Wires will be used.
- We will be using cross flow configuration for the model.
- The power and torque requirements of the motor used in Dryer will depend on the time needed to dry the cloth, rate at which the cloth is being fed, width and height of the chamber, final moisture content and initial moisture content.

## 5.6 Manpower Specifications

Team	Man Hours
Research Team	82 Hours
Electrical Team	60 Hours
Fabrication Team	13.5 Hours
Documentation Team	127 Hours
Consultant	2 Hours

Table 6: Manpower specifications for the Machine



Presented with xmind AI

Figure 20: Work Distribution Mind Map

## 5.7 Milestone Specifications

### 5.7.1 Milestone 1 (25 marks) (25% completed)

1. Outline and ideation of the initial design based on the initial requirements of the client. Discussion of the initial design with the whole team, looking for solutions to the loopholes suggested by the team to make it feasible in the real world. (6 marks)
2. Empirical research on various solvents and cleaning agents like isopropyl alcohol, WD40, acetone, dishwashing liquid (vim drop), detergent, and vanish stain remover by application on the cloth, and finalizing the best solvent. (6 marks)
3. Scraping of the previous idea due to some last-minute changes and ideation of the new design based on the revised requirements of the client. (6 marks)
4. Validation of our idea with Fabrication and Electrical Teams and making on-site visits to find facilities to build our final product. (4 marks)



5. Discussion of the new idea with the consultant and incorporating the changes suggested by them to finalise the idea. (3 marks)

**TRL 2:** Outlining the proposed design, learning skills, and formation of a team indicates the initiation of the project. The use of AutoCAD for basic visualization enhances maturity by translating ideas into tangible forms, although it's still in the early stages of development involving ideation and conceptualization.

### 5.7.2 Milestone 2 (25 marks) (50% completed)

1. Realisation of the components required in the design by using a basic CAD model incorporating specifics such as dimensions and placement of every minor component within the model Incorporating information about the dimensions and positions of all the minor components within the model - (10 marks).

The frame is curved from corners with arc radius = 9cm for smooth flow of cloth over it.

<b>Frame</b> (3mm sheet)	Height	20 cm
	Length	75 cm
	Width	2 cm
	Arc radius of the corners	9 cm
<b>Roller</b>	Height from ground	21 cm
	Length	30 cm
	Diameter	8 cm
<b>Box</b>	Length	75 cm
	Height	10 cm
	width	30 cm
<b>Wall</b>	Height	20 cm
	Length	75 cm
	Width	30 cm
<b>Scrubber</b>	Length	18 cm
	Width	3 cm
<b>Fan</b>	Diameter	3 inches

Table 7: Dimensions of the Model



## 5 Specifications

2. Conducting trial and error checks on the code and activating the motors through iterative testing to ensure precise and effective control over the motorised components. (8 marks)
3. Finalising the items required for building the prototype model and sending the procurement list to the vendor. (7 marks)

**TRL 3:** Realizing components, conducting trial and error checks on the code, purchasing required materials, and finalizing the design using ‘FreeCAD’ signify a transition from the early stages to a more mature state. The culmination of these activities indicates a significant advancement in technological readiness, approaching the stage where it can be practically implemented.

### 5.7.3 Milestone 3 (25 marks) (75% completed)

1. Concluding the circuits and codes for the components. (5 marks)
2. Individual Component realisation. (20 marks)

Components	Specifications	Marks
Rollers (2 in number)	Both move clockwise (at the same speed to keep the cloth taut always) one to unroll the cloth towards the machine and the other to roll the cloth onto itself after the cleaning process	2
DC BO Motors operation (3 in number)	To control the rotation of rollers and the cloth at constant speed	3
Main frame	The cloth comes from the roller, hangs on it and falls on either side	3
Water sprinkler	Aquarium pipes ooze out water onto the edges of the cloth.	0.5
Soap sprinklers	Located just above the scrubbers, they are like water sprinklers but ooze out soap solution instead.	0.5
Solvent Dispenser and water pump operation	To control the dispensing of water and soap from sprinklers, it is essential to regulate the operation of the pumps using an Arduino controlled circuit.	3



Scrubber (4 in number, 2 on each side)	The scrubbers are placed close to the main frame with gaps between them. They are stationary and the moving cloth's edges rub past it (against the middle part), thus cleaning them.	1
Fans (2 in number, 1 on each side)	Constituting the final step, they are placed at a fair distance from the middle part, to not rip the cloth off, but dry the cloth to finally roll it back up.	1
DC 555 Motor operation (3 in number)	To regulate the operation of the dryer motors (fans), ensuring efficient flow of air onto the fabric for effective drying.	2
Tub	Placed under the machine in the section of water and soap sprinklers, to collect the water and drain it off.	1
Water and soap solution tanks(bucket)	The water and soap sprinklers take respective solution from this to sprinkle on the cloth.	1
Zero Board	Realisation of the circuits used in controlling the electrical components of the prototype by making the essential connections through soldering.	2

Table 8: Individual Component realisation for Phase 3

**TRL 4:** Demonstrating fully functional components to the client, finalizing circuits and codes, and providing detailed specifications to represent a high level of maturity. This milestone is marked by a readiness for deployment, with working components and comprehensive documentation that can lead to the assembly of a full prototype.

#### 5.7.4 Milestone 4 (25 marks) (100% completed)

1. Assembling all the different components to make a full working prototype. (9 marks)
2. The following things can be expected to be assured in the model:(8 marks)
  - a. For the CAD model- (4 marks)
    - i. A detailed CAD model on Autodesk Inventor showing positioning of the parts of the fabric-cleaning machine. (2 marks)
    - ii. Circuits showing a general idea of where and how the motors and other components are included. (2 marks)
  - b. Fabrication assurances - (4 marks)
    - i. Ensuring the seamless operation of all components, such as scrubber and rollers, in the prototype model designed for uninterrupted cloth processing.



3. Listing out electrical limitations -
  - a. As motors necessitate a direct current current (DC) power supply, we will employ a regulated power supply to demonstrate the functionality of our prototype.
  - b. Considering that the electrical connections are not very complicated and do not demand the use of a printed circuit board (PCB), we plan to implement the circuit using a zero board and establish the essential connections through soldering.
  - c. To achieve proper working of DC motors, a requisite power supply voltage not exceeding 12 volts is necessary, along with conductive wires having a current rating of 2 A.
4. Prototype Limitation- The expected cloth obtained after undergoing the process is not sufficiently dry due to the use of cold air blowers rather than hot air owing to the length/power constraints.
5. Conducting a live demonstration for the client using a sample cloth with edges stained with oil and grease to simulate a just-manufactured cotton cloth, followed by an assessment of the model's performance based on the quality of cleaning. (8 marks)

**TRL 5:** Assembling all components into a working prototype, conducting a live demonstration using a sample cloth, and assessing performance in real-world conditions with actual stains indicate a high level of readiness for practical application and deployment. Technology has progressed to the point where it can be reliably demonstrated and evaluated in real-world scenarios, signalling a mature state.

## 6 Design of the Prototype

### 6.1 Component Units

Units are considered those parts and sections in the model, which are first simulated on CAD software and then processed using the required materials. Till now, three different units have been prepared by manually working on acrylic sheets with the help of laser cutting machines. A 3mm acrylic sheet is being used for making the prototype model (A1 size) and a maximum of 3 units of these sheets will be used at the end of prototype modeling.

**Curved Frame:** For the unit upholding the cloth for proper cleaning of the edges of the same, a model of length 75 cm, height 20 cm, and width 2 cm is made (Figure shared below). A full acrylic sheet was used deliberately and the folding part, with a distance of 2 cm at right angles, between these two 20cm walls with the help of a hot gun at the grooves' cut programmed during the laser cutting functioning. This model is placed in the center of the prototype, with the name of the machine engraved as 'DEMANTORS'.

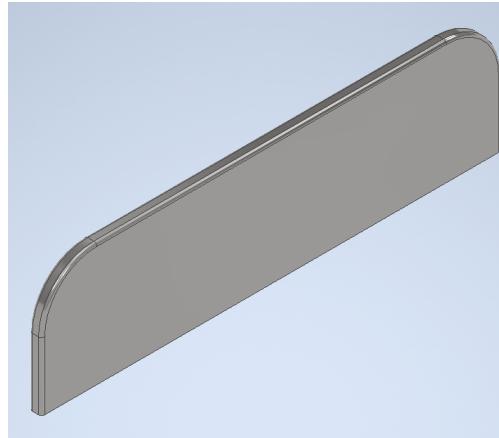


Figure 21: Guiding Frame

**Base:** This consists of the base part of the whole model, with a base of length 30 cm, having curved frame on its top and its walls containing other specifications concerning electrical and other applications.

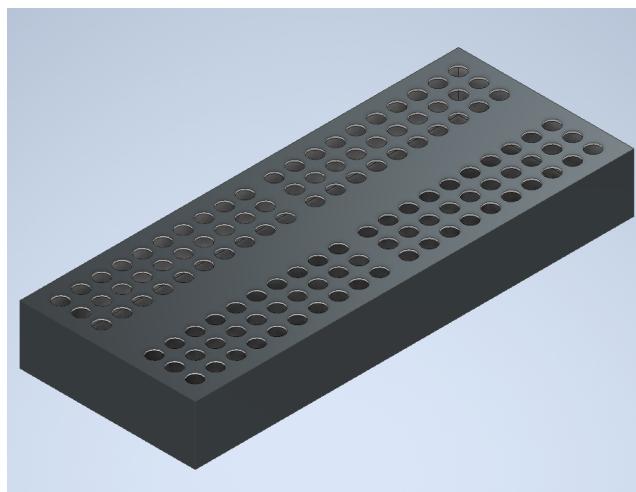


Figure 22: Base

**Roller:** This is the part where rollers are engaged with the main model for proper movement of the cloth during its cleaning. PVC pipes will be used for this purpose. The dimensions for the same are 2.5 inches in diameter and 30 cm in length.

Speed of laser cutter:

- For cutting: 15 RPM
- For grooving: 120 RPM
- Power: 75 - 77 W

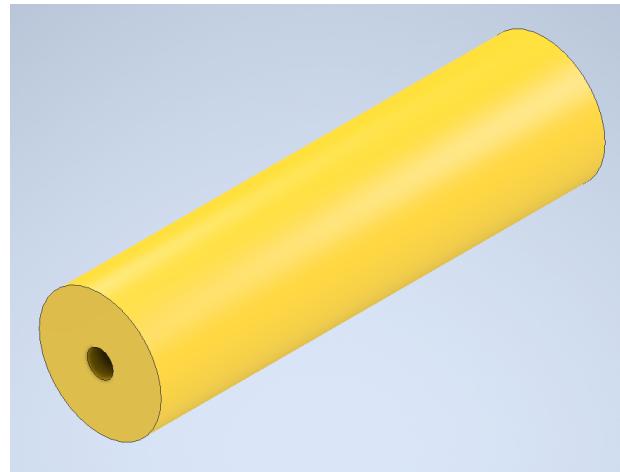


Figure 23: Roller

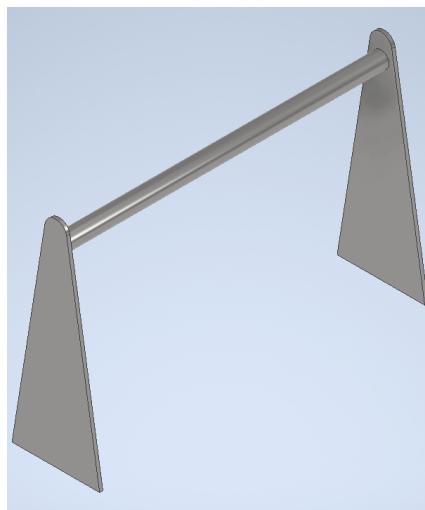


Figure 24: Roller Stand

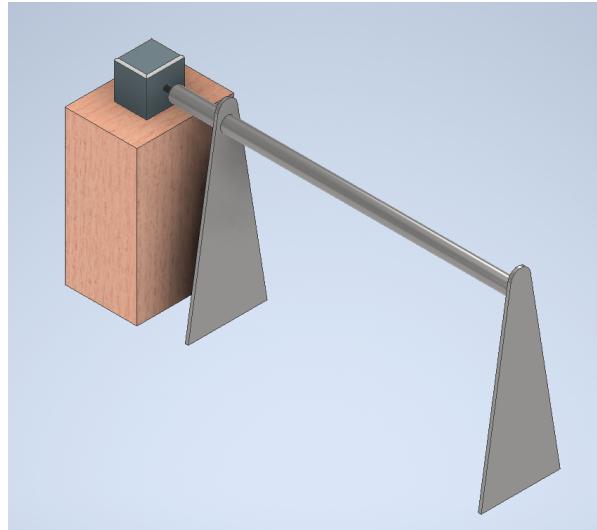


Figure 25: Stand with Motor

**Fan/Blower:** Our prototype uses the fan as a dryer to simulate the blowing or drying of the cloth for industry purposes. The diameter is designed to be of 3 inches and a simple motor of roughly 1.5 inches will be used for the same. Adequate holes in the frame would be cut for positioning of the fans for drying purposes.

- The fan will be directly mounted on the DC motor without any shaft in between the motor and fan blade.
- We will be providing 9V external supply to the motor using L298N motor driver module.
- The speed of fan is controlled using PWM technique with the help of Arduino.
- The fan will be running on a constant speed at a particular duty ratio according to our requirement.
- We have successfully tested the motor using an Arduino board, We observed that by changing the duty ratio of PWM ,the speed of motor is changing accordingly.



Figure 26: Dryer Components

**Sprinkler:** For pumping purposes and related to circulation of water in the machine, pipes will be used (those used in RO at homes) which will be mounted on the inner walls of the model, and aquarium pumps will be used with buckets for water. The components of this unit are as follows:

1. **Reservoir:** The system features a reservoir containing water mixed with vanish powder, designed to provide a steady supply of the sprinkling solution.
2. **Water Pump:** A water pump is integrated into the system to facilitate the circulation of the water-vanish mixture. This pump ensures a consistent flow of the solution throughout the system.
3. **Outlet Pipe:** Connected to the water pump, an outlet pipe is utilized to distribute the water vanish mixture onto the target surface. The outlet pipe is strategically perforated with holes to enable controlled dispersion of the solution.
4. **Distribution:** The outlet pipe is configured to cover both sides of the designated area, ensuring comprehensive coverage for effective sprinkling. Its length is optimized to accommodate the dimensions of the target surface adequately.
5. **Control Circuit:** Central to the system's functionality is the control circuit, which governs the operation of the water pump. Implementing this circuit allows the timing and duration of sprinkling sessions to be regulated precisely, optimizing efficiency and resource utilization.
6. **Relay Module:** The water pump is controlled using a relay module, which is an intermediary between the control circuit and the pump. The relay module ensures reliable and safe operation of the pump, allowing for seamless integration with the overall control system. A push button toggles the relay on and off, enabling manual control over the pump's activation.
7. **Relay Operation:** The relay is programmed to cycle on and off at regular intervals, simulating the control of a device (such as a solvent pump) through the relay. The

## 6 Design of the Prototype

relay pin (control pin) is set to HIGH to activate the relay and LOW to deactivate it, thereby regulating the flow of water through the system.



Figure 27: Water pump and pipe

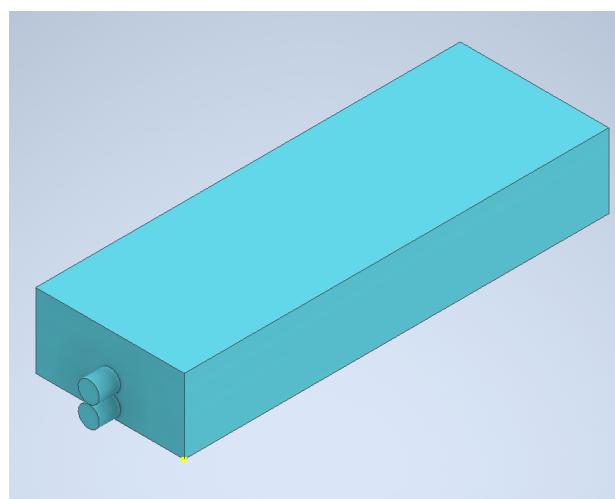


Figure 28: Water Tank



## 7 Materials used

### 7.1 Requirement of materials from fabrication team

S.No	Required for Part	Item Name	Quantity
1	Frame making[1]	Acrylic sheet (3mm thickness)	5 in number (A1 size)
2	Finishing purpose[2]	Sandpaper	200 grit (2), 400 grit (2), 600 grit (2)
3	Frame making[3]	Acrylic sheets (2mm thickness)	2 in number (A1 size)
4	Frame making[4]	Adhesive	250ml
5	Frame making[5]	Feviquick	40 ml
6	Rollers	PVC pipe	2.5inch diameter, 1.5m length
7	Rollers	PVC pipe cutter	1 in number
8	Motor Handling	Hinges	4 in number
9	Fitting purpose	Rubber washers	2 packs of 10 each
10	Fitting purpose	Screws	1 pack of 50 each
11	Fitting purpose	Nuts and bolts	1 pack of 40 each
12	Rollers	Plastic spokes (for support)	To be made by metal rods (20 in number)
13	Sticking parts	Silicon gluegun	1 gun,5 gluesticks

Table 9: Requirement of materials from fabrication team.



## 7.2 Items Required for Lab

Required for Part	Item Name	Quantity
Frame making	Acrylic sheet(3mm thickness, A1 size)	5
Finishing purpose	Sandpaper	200 grit (2), 400 grit (1) , 600 grit (1)
Frame making	Acrylic sheet (2mm thickness, A1 size)	2
Frame making	Adhesive	250 ml
Frame making	Feviquick	40 ml
Rollers	PVC pipe (2.5inch diameter, 1.5m length)	2
Rollers (for support)	Plastic/Metal spokes (whichever is available)	20
Frame making	Silicon glue gun	1 glue gun,5 glue sticks
Roller	DC BO Motor	3
Roller	Arduino UNO	5
Roller	L293D Motor Driver	3
Roller	DC Voltage Source( 6V)	2
Dryer	DC Voltage Source( 12V)	1
Scrubbing	Threaded shafts	4
Dryer	DC 555 motor	3
Dryer	L298D Motor Driver IC	1
Solvent Dispenser	Relay module (5V SRD-05DC)	1
Solvent Dispenser	Battery (9V)	1
Solvent Dispenser	4 pin push button	1
Soldering of connections	Zero Board	4

Table 10: Items Required for Lab

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# Abbreviations

Abbreviation	Stands For
IF	Involvement Factor
ID	Identification
CPCB	Central Pollution Control Board
mg	Milligram
AC	Alternating Current
dB	Decibels
Kg	Kilograms
ABS	Acrylonitrile Butadiene Styrene
PWM	Pulse Width Modulation
IC	Integrated Circuits
PCE	
TCE	
TRL	Technology Readiness Level
CAD	Computer Aided Design
NMOS	N-type Metal-Oxide-Semiconductor
LED	Light Emitting Diode
TCE	Tri-Chloro-Ethane
PCE	Power Conversion Efficiency

Table 11: Abbreviations

# Our Tribe

SNo	Name	Roll No.	Position	Email	IF
1	Ayush Dudawat	2021EE10694	Tribe Coordinator	ee1210694@ee.iitd.ac.in	1
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3	Nitesh Singh	2021MT10250	Documentation Coordinator	mt1210250@maths.iitd.ac.in	1
4	Vansh Jain	2021MT10234	Research Coordinator	mt1210234@maths.iitd.ac.in	1
5	Sharesth Thakan	2021EE30730	Fabrication and Testing Coordinator	ee3210730@ee.iitd.ac.in	1
6	Abhas Porov	2021EE10781	Electrical and Simulation Coordinator	ee1210781@ee.iitd.ac.in	1
7	Rishika Arya	2021MT10926	Research	mt1210926@maths.iitd.ac.in	1
8	Sarmistha	2021MT10261	Research	mt1210261@maths.iitd.ac.in	1
9	Anshika Prajapati	2021MT60961	Research	mt6210961@maths.iitd.ac.in	1
10	Rupam Kumawat	2021MT60267	Research	mt6210267@maths.iitd.ac.in	1
11	Sakshi Magarkar	2021MT60965	Research	mt6210965@maths.iitd.ac.in	1
12	Aniket Pandey	2021MT60266	Research	mt6210266@maths.iitd.ac.in	1
13	Nancy Kansal	2021MT10905	Research	mt1210905@maths.iitd.ac.in	1
14	Mukund Aggarwal	2021MT60939	Research	mt6210939@maths.iitd.ac.in	1
15	Keshvi Tomar	2021EE10682	Research	ee1210682@ee.iitd.ac.in	1
16	Aravind Udupa	2021MT60940	Research	mt6210940@maths.iitd.ac.in	1
17	Arpit Rathore	2021MT10920	Research	mt1210920@maths.iitd.ac.in	1
18	Vandit Srivastava	2021EE10640	Electrical	ee1210640@ee.iitd.ac.in	1
19	Ankita Meena	2021EE10173	Electrical	ee1210173@ee.iitd.ac.in	1
20	Aditya Gupta	2021EE30713	Electrical	ee3210713@ee.iitd.ac.in	1
21	Aditya Bhalotia	2021EE30698	Electrical	ee3210698@ee.iitd.ac.in	1
22	Ayush Shrivastava	2021EE10632	Electrical	ee1210632@ee.iitd.ac.in	1
23	Harshit Nagar	2021EE10155	Electrical	ee1210155@ee.iitd.ac.in	1

24	Shreyansh Jaiswal	2021EE10154	Electrical	ee1210154@ee.iitd.ac.in	1
25	Akshar Tripathi	2021EE10980	Electrical	ee1210980@ee.iitd.ac.in	1
26	Muskan Yadav	2021EE10686	Electrical	ee1210686@ee.iitd.ac.in	1
27	Pavan Bharadwaj	2021EE10630	Electrical	ee1210630@ee.iitd.ac.in	1
28	Aluka Mokshavi	2021MT10909	Electrical	mt1210909@maths.iitd.ac.in	1
29	Palle Sathvika	2021MT10928	Electrical	mt1210928@maths.iitd.ac.in	1
30	Shubham Anand	2021EE10674	Electrical	ee1210674@ee.iitd.ac.in	1
31	Kumar Sanu Singh	2021EE31213	Electrical	ee3211213@ee.iitd.ac.in	1
32	Diyvansh Agarwal	2021EE10035	Electrical	ee1210035@ee.iitd.ac.in	1
33	Rahul Kumar	2021MT10893	Fabrication	mt1210893@maths.iitd.ac.in	1
34	Manav Garg	2021EE30017	Fabrication	ee3210017@ee.iitd.ac.in	1
35	Kushagr Goyal	2021EE10634	Fabrication	ee1210634@ee.iitd.ac.in	1
36	Champak Swargiary	2021MT10263	Fabrication	mt1210263@maths.iitd.ac.in	1
37	Ajay Naik	2020MT60888	Fabrication	mt6200888@maths.iitd.ac.in	0
38	Aryan Sharma	2021EE10141	Fabrication	ee1210141@ee.iitd.ac.in	0
39	Tanisha	2021MT10927	Fabrication	mt1210927@maths.iitd.ac.in	1
40	Shreyansh Jain	2021MT10930	Fabrication	mt1210930@maths.iitd.ac.in	0.4
41	Akshansh Rajora	2021MT10933	Fabrication	mt1210933@maths.iitd.ac.in	1
42	Ayush Madhur	2021EE10161	Fabrication	ee1210161@ee.iitd.ac.in	1
43	Tanishk Singh	2021EE10167	Fabrication	ee1210167@ee.iitd.ac.in	1
44	Kanak Kumar Singh	2021EE10163	Fabrication	ee1210163@ee.iitd.ac.in	1
45	Vadlapudi Manoj	2021MT10245	Documentation	mt1210245@maths.iitd.ac.in	1
46	Bhavik Garg	2021EE10657	Documentation	ee1210657@ee.iitd.ac.in	1
47	Ishu	2021EE30735	Documentation	ee3210735@ee.iitd.ac.in	1
48	Alvakonda Sashidhar	2021EE30744	Documentation	ee3210744@ee.iitd.ac.in	1
49	Harshdeep Shakya	2021EE30745	Documentation	ee3210745@ee.iitd.ac.in	1
50	Abhinava Anwesha Mohanty	2021EE10136	Documentation	ee1210136@ee.iitd.ac.in	1

51	Atishay Aggarwal	2021MT60941	Documentation	mt6210941@maths.iitd.ac.in	1
52	Srinath K S	2021MT10912	Documentation	mt1210912@maths.iitd.ac.in	1
53	Kshitij K Gautam	2021MT60269	Documentation	mt6210269@maths.iitd.ac.in	1
54	Chandan Kumar	2021MT60268	Documentation	mt6210268@maths.iitd.ac.in	1
55	Naunidh Singh	2021MT60956	Documentation	mt6210956@maths.iitd.ac.in	1
56	Vipul	2021EE30731	Documentation	ee3210731@ee.iitd.ac.in	1
57	Amit Singh	2021MT10921	Documentation	mt1210921@maths.iitd.ac.in	1
58	Sumanth Mandala	2021EE10153	Documentation	ee1210153@ee.iitd.ac.in	1
59	Prabhat Babu	2021MT10255	Documentation	mt1210255@maths.iitd.ac.in	1

Table 12: Team Members list

## Tribe Members with IF less than 1

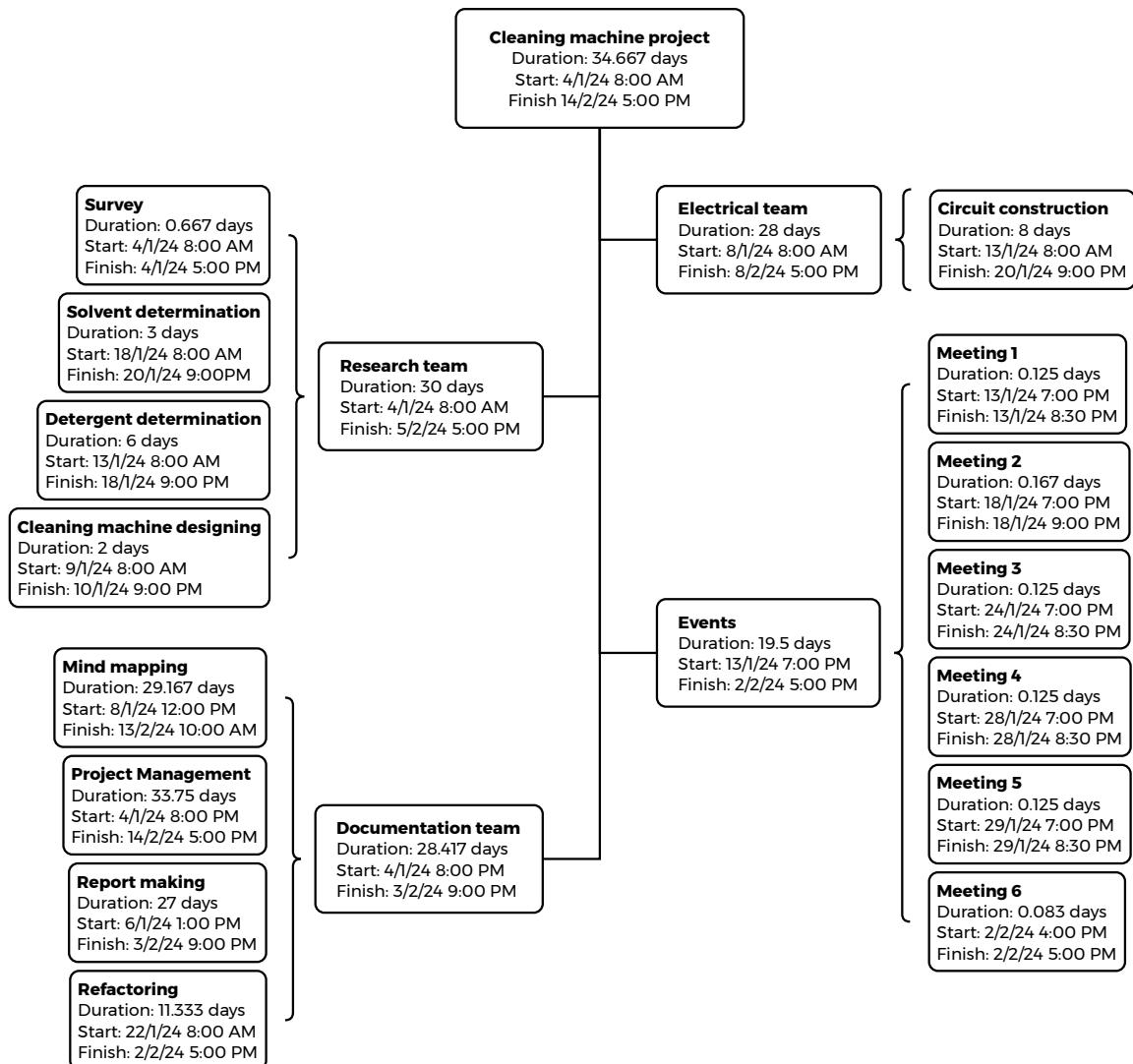
1	Shreyansh Jain	2021MT10930	Fabrication	mt1210930@maths.iitd.ac.in	0.4
2	Ajay Naik	2020MT60888	Fabrication	mt6200888@maths.iitd.ac.in	0
3	Aryan Sharma	2021EE10141	Fabrication	ee1210141@ee.iitd.ac.in	0

Table 13: Team Members with IF <1

**Reason:** Assigned tasks were not completed, Low participation in most of the meetings even after multiple reminders on the group. No inputs were given for the research stage. No role in CAD model designing.

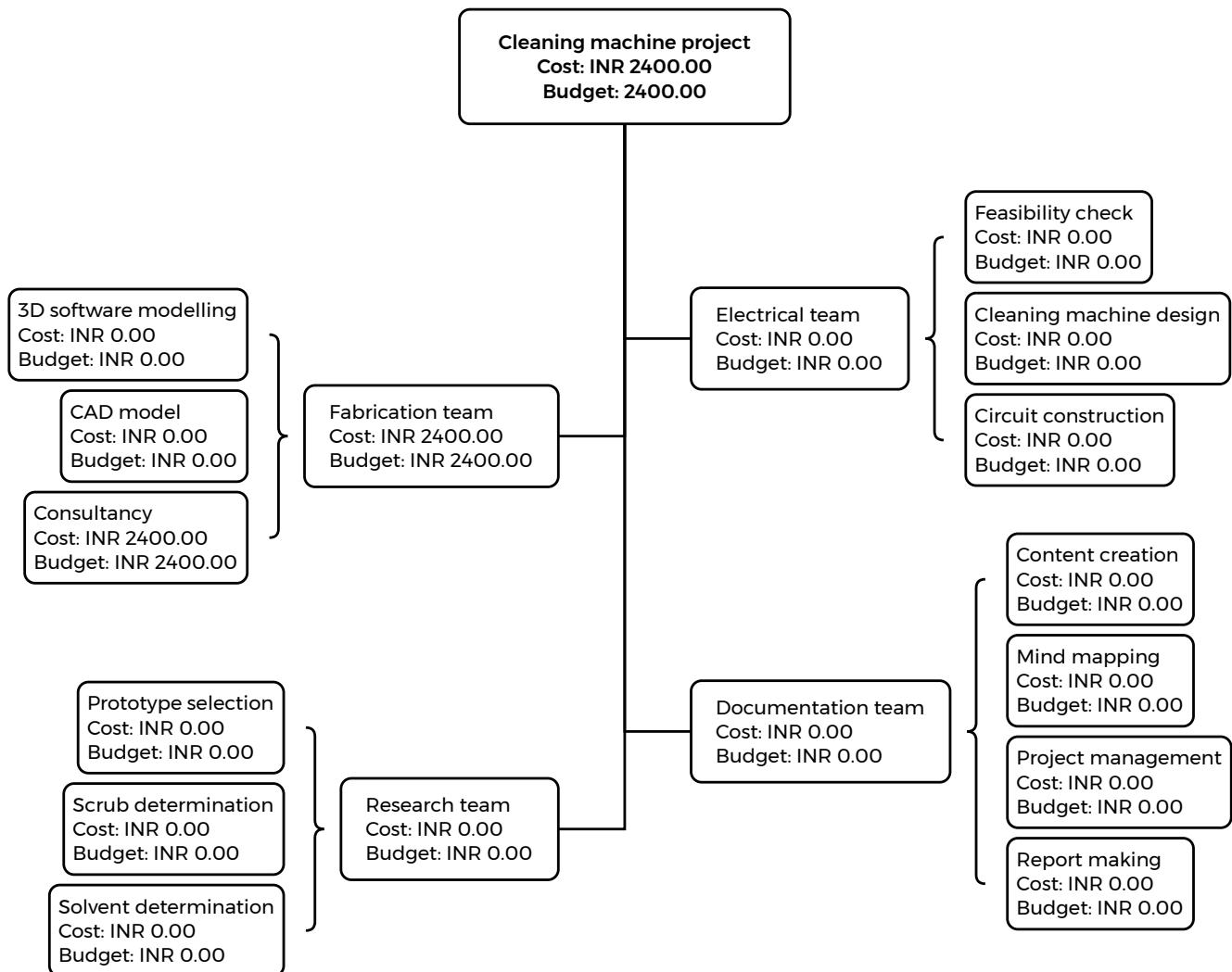
# Project Management

## Network Chart



Presented with **xmind AI**

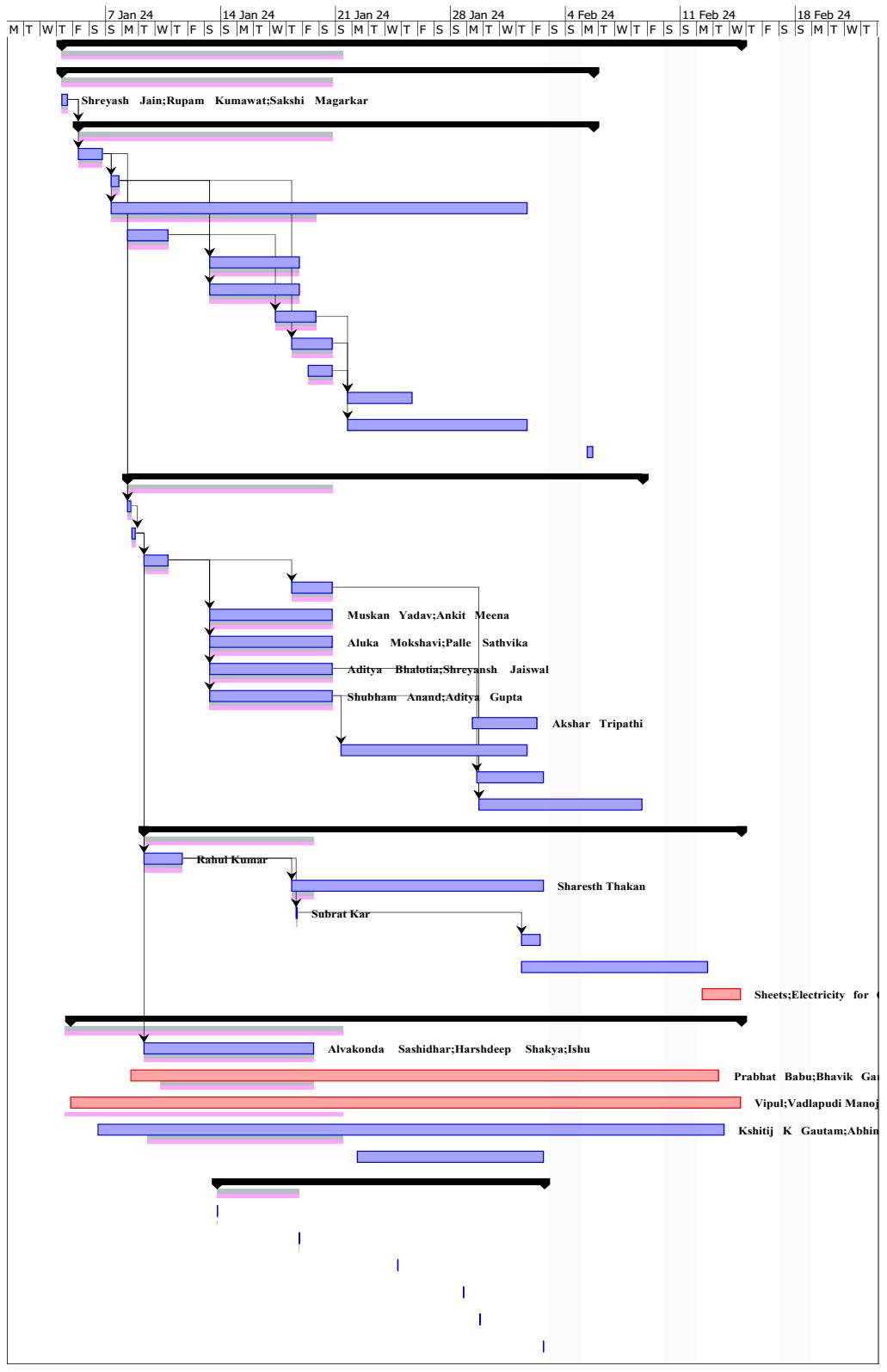
## WBS



## Gantt Chart

	Name	Duration	Start	Finish	Resource Names
1	■Cleaning Machine Project	34.667 days?	4/1/24 8:00 AM	14/2/24 5:00 PM	
2	■Research Team	30 days?	4/1/24 8:00 AM	5/2/24 5:00 PM	
3	Survey	0.667 days?	4/1/24 8:00 AM	4/1/24 5:00 PM	Shreyash Jain;Rupam Kuma...
4	■Research	29 days?	5/1/24 8:00 AM	5/2/24 5:00 PM	
5	Prototype Selection	2 days	5/1/24 8:00 AM	6/1/24 9:00 PM	
6	Prototype Finalization	1 day	7/1/24 8:00 AM	7/1/24 9:00 PM	
7	Information Exchange	25.667 days?	7/1/24 8:00 AM	1/2/24 5:00 PM	
8	Requirement Doc Creation	3 days	8/1/24 8:00 AM	10/1/24 9:00 PM	
9	Detergent Determination	6 days	13/1/24 8:00 AM	18/1/24 9:00 PM	
10	ScrubDetermination	6 days	13/1/24 8:00 AM	18/1/24 9:00 PM	
11	Glossary Prep	3 days	17/1/24 8:00 AM	19/1/24 9:00 PM	
12	SolventDetermination	3 days	18/1/24 8:00 AM	20/1/24 9:00 PM	
13	TimeDeterminationExperiment	2 days	19/1/24 8:00 AM	20/1/24 9:00 PM	
14	Finalization of Solvent	4 days	21/1/24 5:00 PM	25/1/24 5:00 PM	
15	DimensionFinalization	11 days	21/1/24 5:00 PM	1/2/24 5:00 PM	
16	Requirements Documentation	0.667 days?	2/2/24 5:00 PM	5/2/24 5:00 PM	
17	■Electrical Team	28 days?	8/1/24 8:00 AM	8/2/24 5:00 PM	
18	Feasability Check	0.5 days	8/1/24 8:00 AM	8/1/24 3:00 PM	
19	Modification	0.5 days	8/1/24 3:00 PM	8/1/24 9:00 PM	
20	Cleaning Machine Designing	2 days	9/1/24 8:00 AM	10/1/24 9:00 PM	
21	Moters Circuit Construction	3 days	18/1/24 8:00 AM	20/1/24 9:00 PM	
22	Blower Circuit Construction	8 days	13/1/24 8:00 AM	20/1/24 9:00 PM	Muskan Yadav;Ankit Meena
23	Sprinkler Circuit Construction	8 days	13/1/24 8:00 AM	20/1/24 9:00 PM	Aluka Mokshavi;Palle Sathvika
24	Dryer Circuit Construction	8 days	13/1/24 8:00 AM	20/1/24 9:00 PM	Aditya Bhalotia;Shreyansh J...
25	Roller Circuit Construction	8 days	13/1/24 8:00 AM	20/1/24 9:00 PM	Shubham Anand;Aditya Gupta
26	Static Scrubber Finalization	2.667 days	29/1/24 8:00 AM	2/2/24 8:00 AM	Akshar Tripathi
27	Rolling Scrubber Finalization	11.667 days?	21/1/24 8:00 AM	1/2/24 5:00 PM	
28	Dryer Finalization	3.833 days?	29/1/24 3:00 PM	2/2/24 5:00 PM	
29	Roller Finalization	6.333 days	29/1/24 5:00 PM	8/2/24 5:00 PM	
30	■Fabrication Team	29.667 days?	9/1/24 8:00 AM	14/2/24 5:00 PM	
31	3D Software Modelling	2 days	9/1/24 8:00 AM	11/1/24 5:00 PM	Rahul Kumar
32	CAD Model	8 days	18/1/24 8:00 AM	2/2/24 5:00 PM	Sharesh Thakan
33	Consultancy	0.167 days	18/1/24 3:00 PM	18/1/24 5:00 PM	Subrat Kar
34	Physical Modelling	1 day	1/2/24 8:00 AM	2/2/24 1:00 PM	
35	Material Gathering	5.333 days?	1/2/24 8:00 AM	12/2/24 5:00 PM	
36	Cleaning Machine Assembly	2 days?	12/2/24 8:00 AM	14/2/24 5:00 PM	Sheets;Electricity for CO2 la...
37	■Documentation Team	33.75 days	4/1/24 8:00 PM	14/2/24 5:00 PM	
38	Content Creation	10.667 days	9/1/24 8:00 AM	19/1/24 5:00 PM	Alvakonda Sashidhar;Harsh...
39	MindMapping	29.167 days	8/1/24 12:00 PM	13/2/24 10:00 AM	Prabhat Babu;Bhavik Garg
40	Project Management	33.75 days	4/1/24 8:00 PM	14/2/24 5:00 PM	Vipul;Vadlapudi Manoj
41	Report Making	31.667 days	6/1/24 1:00 PM	13/2/24 5:00 PM	Kshitij K Gautam;Abhinav An...
42	Refactoring of Previous Doc	11.333 days	22/1/24 8:00 AM	2/2/24 5:00 PM	
43	■Events	19.5 days	13/1/24 7:00 PM	2/2/24 5:00 PM	
44	Meeting 1	0.125 days	13/1/24 7:00 PM	13/1/24 8:30 PM	
45	Meeting 2	0.167 days	18/1/24 7:00 PM	18/1/24 9:00 PM	
46	Meeting 3	0.125 days	24/1/24 7:00 PM	24/1/24 8:30 PM	
47	Meeting 4	0.125 days	28/1/24 7:00 PM	28/1/24 8:30 PM	
48	Meeting 5	0.125 days	29/1/24 7:00 PM	29/1/24 8:30 PM	
49	Meeting 6	0.083 days	2/2/24 4:00 PM	2/2/24 5:00 PM	

## Gantt Chart - 2



## Resource Breakdown

	Name	RBS	Type	E-mail Address	Standard Rate	Cost Per Use
1	✉ Research Team		Work		Rs.0.00/hour	<b>Rs.0.00</b>
2	Vanish Jain		Work	mtt1210234@iitd.ac.in	Rs.0.00/hour	Rs.0.00
3	Shreyash Jain	koreascience.kr	Work	mtt1210231@iitd.ac.in	Rs.0.00/hour	Rs.0.00
4	RupamKumawat	textilelearner.net	Work	mtt6210267@iitd.ac.in	Rs.0.00/hour	Rs.0.00
5	Sakshi Magarkar	techjut.com	Work	mtt6210965@iitd.ac.in	Rs.0.00/hour	Rs.0.00
6	Tanisha		Work	mtt1210927@iitd.ac.in	Rs.0.00/hour	Rs.0.00
7	Rishika Arya		Work	mtt1210926@iitd.ac.in	Rs.0.00/hour	Rs.0.00
8	Sarmista Subhadharshini		Work	mtt1210261@iitd.ac.in	Rs.0.00/hour	Rs.0.00
9	Anshika Prajapati		Work	mtt6210961@iitd.ac.in	Rs.0.00/hour	Rs.0.00
10	Nancy Kansal		Work	mtt1210905@iitd.ac.in	Rs.0.00/hour	Rs.0.00
11	Divyansh Agarwal	tinkercad.com	Work	ee1210035@iitd.ac.in	Rs.0.00/hour	Rs.0.00
12	Mukund Aggarwal		Work	mtt6210939@iitd.ac.in	Rs.0.00/hour	Rs.0.00
13	Tanishk Singh		Work	ee1210167@iitd.ac.in	Rs.0.00/hour	Rs.0.00
14	Akshansh Rajora		Work	mtt1210933@iitd.ac.in	Rs.0.00/hour	Rs.0.00
15	Aniket Pandey		Work	mtt6210266@iitd.ac.in	Rs.0.00/hour	Rs.0.00
16	Ayush Madhur		Work	ee1210161@iitd.ac.in	Rs.0.00/hour	Rs.0.00
17	Keshvi Tomer		Work	ee1210682@iitd.ac.in	Rs.0.00/hour	Rs.0.00
18	Kanak Kumar Singh		Work	ee1210163@iitd.ac.in	Rs.0.00/hour	Rs.0.00
19	Aravind Udupa		Work	mtt6210940@iitd.ac.in	Rs.0.00/hour	Rs.0.00
20	Arpit Rathore		Work	mtt1210920@iitd.ac.in	Rs.0.00/hour	Rs.0.00
21	✉ Electrical Team		Work		Rs.0.00/hour	<b>Rs.0.00</b>
22	Abhas Porov		Work	ee1210781@iitd.ac.in	Rs.0.00/hour	Rs.0.00
23	Muskan Yadav	tinkercad.com	Work	ee1210686@iitd.ac.in	Rs.0.00/hour	Rs.0.00
24	Ankit Meena	tinkercad.com	Work	ee1210173@iitd.ac.in	Rs.0.00/hour	Rs.0.00
25	Aluka Mokshavi	circuitdigest.com	Work	mtt1210909@iitd.ac.in	Rs.0.00/hour	Rs.0.00
26	Palle Sathvika	www.instructables.com	Work	mtt1210928@iitd.ac.in	Rs.0.00/hour	Rs.0.00
27	Aditya Gupta	robocraze.com	Work	ee3210713@iitd.ac.in	Rs.0.00/hour	Rs.0.00
28	Shubham Anand	docs.arduino.cc	Work	ee1210674@iitd.ac.in	Rs.0.00/hour	Rs.0.00
29	Aditya Bhalotia	zotero.org	Work	ee3210698@iitd.ac.in	Rs.0.00/hour	Rs.0.00
30	Shreyansh Jaiswal	tanfonline.com	Work	ee1210154@iitd.ac.in	Rs.0.00/hour	Rs.0.00
31	Vandit Srivastava		Work	ee1210640@iitd.ac.in	Rs.0.00/hour	Rs.0.00
32	Ayush Srivastava		Work	ee1210632@iitd.ac.in	Rs.0.00/hour	Rs.0.00
33	Harshit Nagar		Work	ee1210155@iitd.ac.in	Rs.0.00/hour	Rs.0.00
34	Akshar Tripathi	polymagtek.com, portescap...	Work	ee1210980@iitd.ac.in	Rs.0.00/hour	Rs.0.00
35	Pavan Bharadwaj		Work	ee1210630@iitd.ac.in	Rs.0.00/hour	Rs.0.00
36	Kumar Sanu Singh		Work	ee3211213@iitd.ac.in	Rs.0.00/hour	Rs.0.00
37	✉ Fabrication Team		Work		Rs.0.00/hour	<b>Rs.0.00</b>
38	Shareesh Thakan	Autocad Inventor	Work	ee3210730@iitd.ac.in	Rs.0.00/hour	Rs.0.00
39	Rahul Kumar	Autodesk	Work	mtt1210893@iitd.ac.in	Rs.0.00/hour	Rs.0.00
40	Manav Garg	www.rdworxslab.com	Work	ee3210017@iitd.ac.in	Rs.0.00/hour	Rs.0.00
41	Kushagr Goyal	www.rdworxslab.com	Work	ee1210634@iitd.ac.in	Rs.0.00/hour	Rs.0.00
42	Champak Swargiary		Work	mtt1210263@iitd.ac.in	Rs.0.00/hour	Rs.0.00
43	Ajay Naiik		Work	mtt6200988@iitd.ac.in	Rs.0.00/hour	Rs.0.00
44	Aryan Sharma		Work	ee1210141@iitd.ac.in	Rs.0.00/hour	Rs.0.00
45	Subrat Kar		Work	subrat@iitd.ac.in	Rs.1200.00/...	Rs.0.00
46	✉ Documentation Team		Work		Rs.0.00/hour	<b>Rs.0.00</b>
47	Nitesh Singh	Github	Work	mtt1210250@iitd.ac.in	Rs.0.00/hour	Rs.0.00
48	Vipul	Project Libre	Work	ee3210731@iitd.ac.in	Rs.0.00/hour	Rs.0.00
49	Prabhat Babu	Xmind	Work	mtt1210255@iitd.ac.in	Rs.0.00/hour	Rs.0.00
50	Bhavik Garg	Xmind	Work	ee1210257@iitd.ac.in	Rs.0.00/hour	Rs.0.00
51	Kshitij Gautam	overleaf	Work	mtt6210269@iitd.ac.in	Rs.0.00/hour	Rs.0.00
52	Abhinav Anwesha Mohanty	overleaf	Work	ee1210136@iitd.ac.in	Rs.0.00/hour	Rs.0.00
53	Atishay Aggarwal	AsciIDoc	Work	mtt6210941@iitd.ac.in	Rs.0.00/hour	Rs.0.00
54	Naunidh Singh	AsciIDoc	Work	mtt6210956@iitd.ac.in	Rs.0.00/hour	Rs.0.00
55	Ishu	Vscode	Work	ee3210735@iitd.ac.in	Rs.0.00/hour	Rs.0.00
56	Alvankonda Sashidhar	Microsoft Word	Work	ee3210744@iitd.ac.in	Rs.0.00/hour	Rs.0.00
57	Harshdeep Shakya	Microsoft Word	Work	ee3210745@iitd.ac.in	Rs.0.00/hour	Rs.0.00
58	Vadilapudi Manoj		Work	mtt1210245@iitd.ac.in	Rs.0.00/hour	Rs.0.00
59	Amit Singh		Work	mtt1210921@iitd.ac.in	Rs.0.00/hour	Rs.0.00
60	Srinath K S		Work	mtt1210912@iitd.ac.in	Rs.0.00/hour	Rs.0.00
61	Chandan Kumar		Work	mtt6210268@iitd.ac.in	Rs.0.00/hour	Rs.0.00
62	Sumanth Mandala		Work	ee1210153@iitd.ac.in	Rs.0.00/hour	Rs.0.00
63	Sheets		Material		Rs.0.00	Rs.1200.00
64	Electricity for CO2 laser cu...		Material		Rs.0.00	Rs.20.00
65	Electricity for heat gun		Material		Rs.0.00	Rs.4.00
66	Motor Stand		Material		Rs.0.00	Rs.692.00
67	SP Project Kit		Material		Rs.0.00	Rs.396.00
68	Scrubber		Material		Rs.0.00	Rs.400.00
69	Carbon Brush		Material		Rs.0.00	Rs.36.00
70	PVC pipe cutter		Material		Rs.0.00	Rs.370.00
71	Water pump and aquarium...		Material		Rs.0.00	Rs.460.00
72	Rubber washers		Material		Rs.0.00	Rs.1774.00
73	Screws		Material		Rs.0.00	Rs.130.00
74	Nuts and bolts		Material		Rs.0.00	Rs.525.00

## References

- [1] *16 Best Solvent Based Upholstery Cleaner In 2024: [Latest Updated]*. en. (Accessed 01/12/2024).
- [2] *3 Ways to Remove Oil Stains*. en. (Accessed 01/20/2024).
- [3] *4 Ways to Remove Grease or Oil Stains from Clothing*. en. (Accessed 01/20/2024).
- [4] *5 Easy Ways to Remove Grease and Oil Stains*. en. (Accessed 01/20/2024).
- [5] *Amazon.com: K2R Spot-Lifter, 5 Ounces, Pack of 6 : Home & Kitchen*. (Accessed 01/20/2024).
- [6] Aqualogic. *Hot, warm or cold wash: How to make the right choice for your laundry*. en-AU. Aug. 2023. (Accessed 01/12/2024).
- [7] *Buy Unbranded Electro Graphite Brushes Carbon brush, Warranty 1 year online / Government e Marketplace (GeM)*. en. (Accessed 02/13/2024).
- [8] Atcharaporn Chailoet et al. “Analytical and Experimental Studies of Rapid Cloth Drying for Technological Innovation”. en. In: *MATEC Web of Conferences* 220 (2018). Ed. by V.V. Koryanov, M. Polyakova, and H. Yuan, p. 04007. (Accessed 01/12/2024).
- [9] Kelly’s Dry Cleaners. *Dry Cleaning 101: Seven Fabrics That Need To Be Dry Cleaned*. en-US. Jan. 2020. (Accessed 01/12/2024).
- [10] *Conservation physics: The physics of drying cloth*. (Accessed 01/20/2024).
- [11] *Conservation physics: The physics of drying cloth*. (Accessed 01/20/2024).
- [12] *Danco 88569 Rubber Flat Washer, 1/2-Inch, 10-Pack : Amazon.in: Home & Kitchen*. (Accessed 02/13/2024).
- [13] Daniela. *How to remove machine oil or grease stains from clothes*. en-US. Feb. 2017. (Accessed 01/20/2024).
- [14] *Differences between the Front Load and Top Load Washing Machine*. en-IN. (Accessed 01/12/2024).
- [15] *Does Hot Water Shrink Clothes? Why? - Display Cloths*. (Accessed 01/12/2024).
- [16] *Dry Cleaning Chemicals 101: How Are Chemicals Used for Dry Cleaning?* (Accessed 01/12/2024).
- [17] *Electronic Spices Mini Water Pump DC 4V 12V Micro Submersible Motor Pump + 1M Clear Vinyl Tubing Flexible PVC Tubing for Fish Tank Fountain Aquarium Garden Plant Flower (1 PUMP + 1 M PIPE) : Amazon.in: Garden & Outdoors*. (Accessed 02/13/2024).
- [18] *EPA cracks down on dry-cleaning solvent perchloroethylene*. en. (Accessed 01/20/2024).
- [19] *Garment Spotting, Process of Spotting and Spotting Equipment*. en. (Accessed 01/12/2024).

- [20] Gentleman's Gazette. *How to Remove Stains From Clothes At Home Better Than The Dry Cleaner*. Apr. 2019.
- [21] Gentleman's Gazette. *The RIGHT Ways to Remove Grease Stains from Clothes & Fabric*. Sept. 2023. (Accessed 01/20/2024).
- [22] *GSK Cut® Metal Heavy Duty 12 Inch Hacksaw Frame with Free Hacksaw Blade 10 Pieces : Amazon.in: Home Improvement*. (Accessed 02/13/2024).
- [23] *GSK Cut® Metal Heavy Duty 12 Inch Hacksaw Frame with Free Hacksaw Blade 10 Pieces : Amazon.in: Home Improvement*. (Accessed 02/13/2024).
- [24] *How Cotton Fabric Is Made: Harvesting & Cleaning Cotton / Vision Linens*. en. (Accessed 01/12/2024).
- [25] *How to Get Oil Out of Clothes*. en-GB. (Accessed 01/20/2024).
- [26] *How To Remove Stains From Any Garment At Home*. en-US. Running Time: 699 Section: Clothing. Apr. 2019.
- [27] *How to Use a Clothes Steamer*. en.
- [28] *Immech - 40 Pcs Set, M8 x 50mm Hex Head Screws, Hex Head bolt With Nut & Washer, Zinc-Coated 30 (10 Pcs Each) : Amazon.in: Industrial & Scientific*. (Accessed 02/13/2024).
- [29] *Immech - M3 X 10mm Phillips Head (Hybrid Head), Nickel Coated Self Tapping Screw- 50 Pcs : Amazon.in: Industrial & Scientific*. (Accessed 02/13/2024).
- [30] *Industrial Washing Machine - Commercial Laundry Machine Manufacturer from Salem*. en. (Accessed 01/12/2024).
- [31] Mazharul Islam Kiron. *Classification of Stain and Removal Techniques from Clothes*. en-US. Nov. 2014. (Accessed 01/12/2024).
- [32] Mazharul Islam Kiron. *Comparison of High Thread Count Cotton Fabrics for Comfort and Mechanical Properties*. en-US. Dec. 2020. (Accessed 01/12/2024).
- [33] Mazharul Islam Kiron. *Dry Cleaning and Wet Cleaning: Differences, Effects, Benefits & Limitations*. en-US. July 2021. (Accessed 01/12/2024).
- [34] Mazharul Islam Kiron. *Drying Machine in Textile Industry: Types, Working Principle & Parameters*. en-US. Feb. 2013. (Accessed 01/12/2024).
- [35] Alysha Mahagaonkar. *How To Remove Grease Or Oil Stains In Clothes*. en-US. Nov. 2020. (Accessed 01/20/2024).
- [36] Daiva Mikučionienė and Ginta Laureckienė. "The Influence of Drying Conditions on Dimensional Stability of Cotton Weft Knitted Fabrics". In: 15 (Jan. 2009).
- [37] *Oil marks, stain marks, dust marks, and grease marks in the fabric, cause and remedies*. en. (Accessed 01/12/2024).

- [38] Miao Qian et al. “Study on drying characters of a thin cotton fabric under uneven radial heating by the hot air jet”. In: *Drying Technology* 40.15 (Nov. 2022), pp. 3115–3127. (Accessed 01/12/2024).
- [39] RamsonsBangalore. *Ramsons Stain Removing Machine*. Oct. 2012.
- [40] Remove Yellow Stains From Cotton Sheets With Hydrogen Peroxide - Bulk Peroxide. en-US. Section: Hydrogen Peroxide. June 2022. (Accessed 01/12/2024).
- [41] Sambit Satpathy. *Liquid vs powder detergents: What is better for your washing machine?* en-US. (Accessed 01/12/2024).
- [42] Hye-Joon Seok et al. “Effects of Tentering and Washing on the Shrinkage and Elasticity of Cotton/Spandex Fabric”. kor. In: *Textile Science and Engineering* 46.5 (2009). Publisher: The Korean Fiber Society, pp. 269–275. (Accessed 01/12/2024).
- [43] SP Project Kit, (Fan Blade, DC Motor, 9V Battery, 2 LED, 1 m Wire, Battery Connector, Switch for Project, Science, DIYs) Electronic Components : Amazon.in: Industrial & Scientific. (Accessed 02/13/2024).
- [44] testextextile. *Textile Pretreatment Processes: Singeing, Desizing, Scouring, Bleaching, mercerizing...* en-US. Mar. 2022. (Accessed 01/12/2024).
- [45] The Proper Detergent for Automatic Washing Machines – Ariel. en. (Accessed 01/12/2024).
- [46] The Ultimate Guide to Removing Every Type of Fabric Stain from Clothing. en. Section: Better Homes & Gardens. (Accessed 01/12/2024).
- [47] The Ultimate Guide to Using Washing Powder: Dosage, Tips, and More. en-US. Section: Tips and tricks. (Accessed 01/12/2024).
- [48] THEMISTO - built with passion RS775 Stand Motor Bracket and Screws for DIY Project- 2 PC : Amazon.in: Industrial & Scientific. (Accessed 02/13/2024).
- [49] Vanish 800 Ml, All In One Stain Remover / Removes Tough Stains & Brightens Colours / Detergent Add On / Suitable With All Washing Detergent Powders And Liquids, 2 Count : Amazon.in: Health & Personal Care.
- [50] Washing Machine Spin Cycles & Speeds Explained | CDA Appliances. en-GB. Sept. 2016. (Accessed 01/12/2024).
- [51] We Tested the Best Laundry Stain Removers for Easier Laundry Days. en. Section: The Spruce. (Accessed 01/20/2024).
- [52] What is the best Industrial cleaner? Water-based cleaners or solvent cleaners? en. (Accessed 01/12/2024).
- [53] What is Water consumption per Wash? en-IN. (Accessed 01/12/2024).
- [54] Which of the solvents tested would be best to remove an oil stain from clothing? en.

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# Glossary

**Apparatus** A set of equipment or tools designed for a specific purpose. i

**Arduino** Arduino is an open-source electronics platform used for creating interactive electronic projects . 11

**Areal density** mass per unit area. 9

**Bidirectional** Functioning in two directions. 11

**Biodegradable** Capable of being decomposed by bacteria or other living organisms. 20

**Bone-Dry** Completely dry, with no moisture remaining. 2

**CaCO<sub>3</sub>** Calcium carbonate, a common substance that can contribute to water hardness.  
3

**Carcinogen** potential to cause cancer. 20

**Compliance** Adherence to rules, regulations, or standards. iii, 2

**Conceptualization** The action or process of forming a concept or idea of something. 28

**Configuration** An arrangement of elements in a particular form, figure, or combination.  
ii

**Contemporary** Living or occurring at the same time; belonging to or occurring in the present. i

**Controller** In this context, a controller is a device that regulates or manages the operation of the dryer. It could involve setting and maintaining specific conditions such as temperature and drying time. 11

**Culmination** the end point or final stage of something you've been working toward or something that's been building up. 29

**Current** The flow of electric charge through a conductor. 31

**Denier** A unit of measurement for the linear mass density of fibers. It is the mass in grams per 9000 meters of the fiber. 1

**Deterioration** The process of becoming progressively worse. i

- Efficiency** Achieving maximum productivity with minimum wasted effort or expense. 9
- Empirical** Based on, concerned with, or verifiable by observation or experience rather than theory or pure logic. 27
- Fabrication** The action or process of inventing or manufacturing something. 30
- Filletted** Somewhat stuck to the side or attached to side walls. 5
- Guiding Frame** A frame used to fold the cloth in half vertically. 5
- Hygiene** Conditions or practices conducive to maintaining health and preventing disease, especially through cleanliness. 15
- Ideation** The process of forming ideas or concepts. 27
- Inconspicuous** Not clearly visible or not easily noticed or prominent. 23
- Iterations** The repetition of a process or utterance. i
- Lipase** An enzyme the body uses to break down fats. 19
- Microcontroller** A small computer on a single integrated circuit. 11
- Modulated** Adjusted or adapted to a certain level or proportion; modified in a certain way. 11
- Modulation** The act of modifying or adjusting something to a certain measure or proportion; alteration. 11
- Prototype** An early model of a product to test concepts. 30, 31
- Pulse-Width Modulated (PWM)** A modulation technique used to encode a message into a pulsing signal. 11
- Relay Module** A chemical compound commonly found in rocks as the minerals calcite and aragonite, and is the main component of pearls and the shells of marine organisms, snails, and eggs. iv, 13
- Scrubber** A device used for cleaning. 30
- Solvent** A substance, typically a liquid, capable of dissolving other substances. i
- Solvents** Substances that dissolve other substances to form a solution. 27

**Spot Lifter** A unique cleaning aid that removes oil and grease spots and stains from several types of fabrics and clothing. 19

**Sustainability** The ability to maintain or support ecological balance over the long term, including considerations for energy consumption and material choices. iii, 3

**Sustainable** Avoiding depletion of natural resources to maintain ecological balance. 3

**Systematic** Done or acting according to a fixed plan or system; methodical. i

**Thread Count** The number of threads woven together per square inch in a fabric. A higher thread count is generally associated with a finer and more luxurious fabric. 1

**Volatile** Easily evaporated at normal temperatures, or liable to change rapidly and unpredictably. 20

# Appendix

Word Count	11301
Number of Sentences	617
Number of Characters (Without Spaces)	59698

Table 14: Document Statistics

Readability (0-100) <sup>1</sup>	69.5
Gunning Fog Index (0-20) <sup>2</sup>	11.4
Flesch Reading Ease (0-100) <sup>3</sup>	55.1
Coleman Liau Index (0-17+) <sup>4</sup>	10.6

Table 15: Readability Indices

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## 1. Readability

*Score Range: 0-100*

Explanation: The Readability (0-100) score measures how easy or difficult a piece of text is to read. The higher the score, the easier the text is to understand. The score is calculated based on the average sentence length and the average number of syllables per word in the text.

## 2. Gunning Fog Readability

*Score Range: 0-20*

Explanation: The Gunning Fog Index estimates the years of formal education needed to understand a piece of text. The higher the index, the more difficult the text is to comprehend. It considers the average sentence length and the percentage of complex words (words with three or more syllables).

## 3. Flesch Reading Ease

*Score Range: 0-100*

Explanation: The Flesch Reading Ease score is a measure of how easy or difficult a piece of text is to read. The higher the score, the easier the text is to understand. The formula considers the average sentence length and the average number of syllables per word.

## 4. Coleman Liau Readability Index

*Score Range: 0-17+*

Explanation: The Coleman Liau Index determines the readability of a text by using characters per word and words per sentence. It provides an estimate of the U.S. school grade level required to comprehend the text. Higher scores indicate more difficult readability.