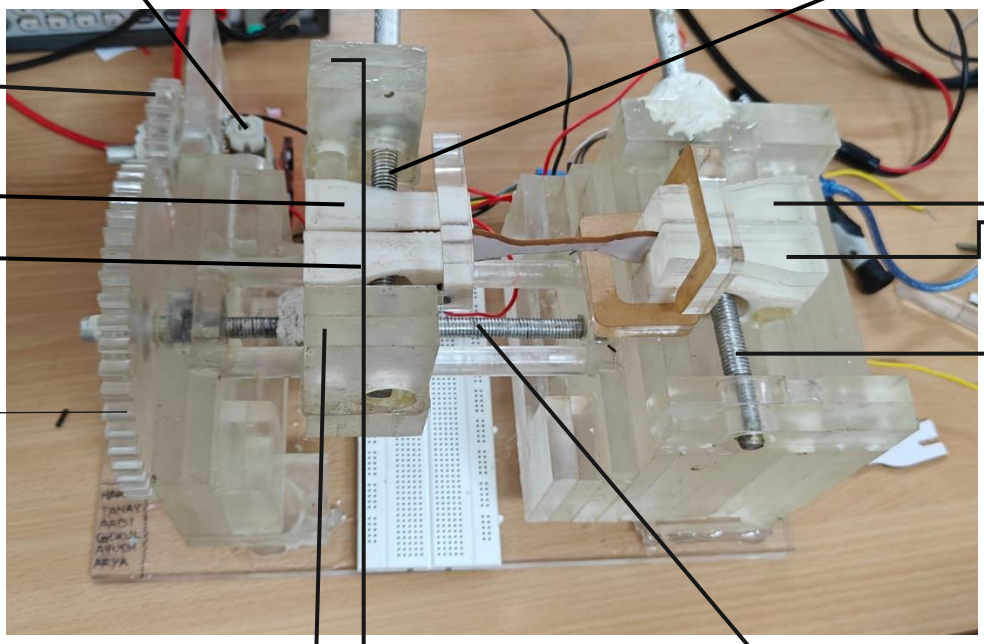
Team B10 – I Report

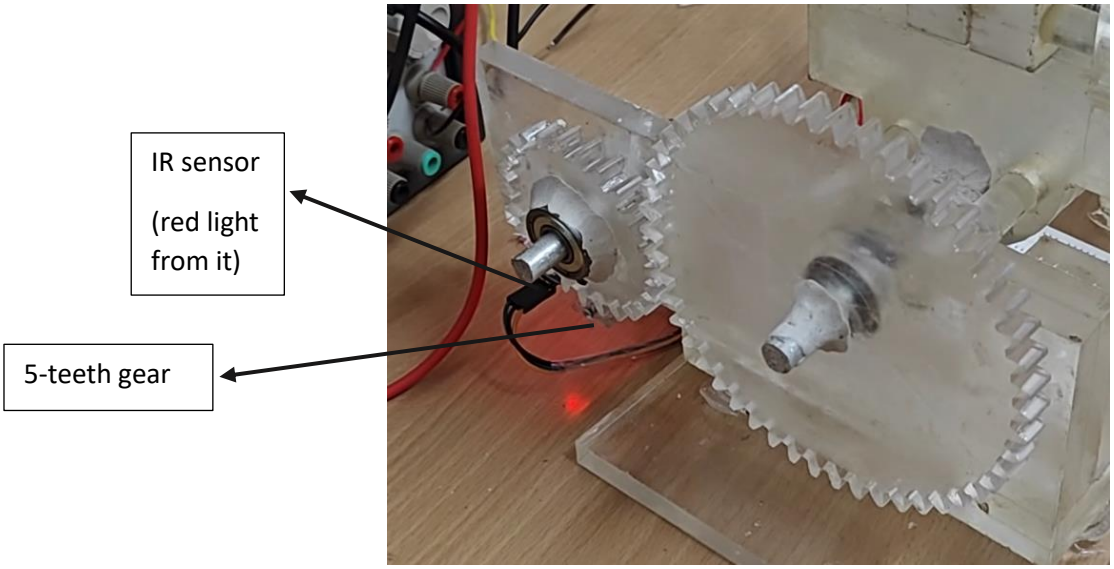
Arduino code

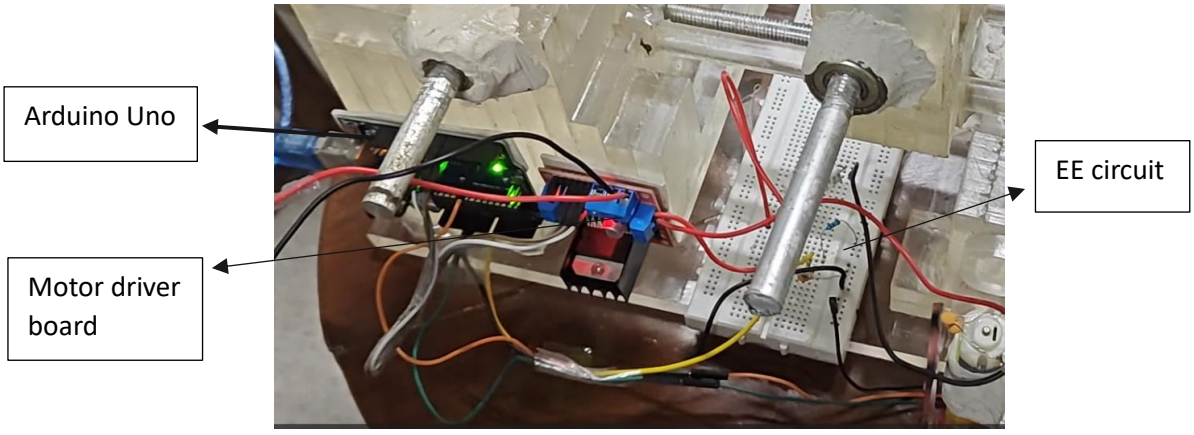
```
/* CODE - Team B10/I
Gokularamanan R S 23B1854
Arya Joshi 23B1853 - calibration
*/

#define mtrDirPin1 7  // In1 Pin on Motor Driver - Controls Motor Direction
#define mtrDirPin2 8  // In2 Pin on Motor Driver - Controls Motor Direction
#define mtrEnPin 10    // EnA Pin on Motor Driver - Turns Motor ON/OFF
#define irPin 2       // This is the IR sensor's (near the encoder disc) Pin
#define currentPin A0 // This pin will be used to sense Motor Current
#define isrTestPin 13 // This pin will toggle every time ISR is called

unsigned long pulseCount=0;  // No of pulses counted
unsigned char index=0;      // A dummy index used to store time, Current and extension readings in an array
/* we have used 3 gears - i) 5 teeth gear (attached to motor), ii) 25 teeth gear (intermediate), iii) 50 teeth gear (attached to leadscrew)
Hence, total gear ratio = 50/5 = 10 (intermediate gear doesn't contribute to gear ratio, it is just involved in reversing direction)
For every rotation made by 5-teeth gear, the 50-teeth gear moves 0.1 revolution (gear ratio = 10)*/
float rot = 0.0; // rot =  number of rotations completed by the gear connected to the motor
float big = 0.0; // big = no. of rotations of 50-teeth gear
float extension = 0.0; // variable to store the displacements/ extension of sample in mm


void setup()
{
  // This code will run once initially
  pinMode(mtrDirPin1,OUTPUT);
  pinMode(mtrDirPin2,OUTPUT);
  pinMode(mtrEnPin,OUTPUT);
  pinMode(irPin,INPUT);
  attachInterrupt(digitalPinToInterrupt(irPin),pulseDetected,FALLING);
  pinMode(isrTestPin,OUTPUT);
  Serial.begin(9600);
  digitalWrite(mtrDirPin1,LOW);
  digitalWrite(mtrDirPin2,HIGH);
  // LOW(dir1) - HIGH(dir2) TO MAKE IT MOVE SUCH THAT SAMPLE STRETCHES AND BREAKS
  // HIGH(dir1) - LOW(dir2) TO MAKE IT MOVE IN FRONT
  digitalWrite(mtrEnPin,HIGH);    // Full Speed
  analogWrite(mtrEnPin, 128); // Variable Speed, set second parameter 0 - 255 /*
  Serial.print("Time, ");
  Serial.print("Extension, ");
  Serial.print("Current, ");
  Serial.println("PulseCount");
  //above print statements print in a csv format : Time, Extension, Current, PluseCount
}
```

```
void loop(){

}

void pulseDetected()  // This is the Interrupt Service Routine
{ // This will run everytime a falling edge is detected on the irPin
  digitalWrite(isrTestPin,!digitalRead(isrTestPin));
  // The ISR Test Pin toggled everytime a falling edge is detected!
  pulseCount++; // detected a pulse; Increase the pule count by 1
  index++;
  if (index>=100)
  {
    index = 0;
  }
  // Index incrments with pulseCount but if it goes above 99, its resetted to 0
  if (pulseCount % 8 ==0){ // checking whether one revolution is complete=> pulseCount/8 because, the disk given to us had 8 white sectors and 8 black sectors. The ir sensor detects a falling edge i.e., White to black strip transition. There are 8 such transitions in revolution.
      rot = pulseCount/8;
      big = rot/10;
      extension =  big * 1.5/2; // pitch of leadscrew = 1.5 mm => 1.5 mm displacement in 1 revolution of leadscrew; and dividing by 2 for calibration (we're getting almost double the actual extension; we verified this by measuring the elongation in length of the broken sample)
      float arr[4] = {millis()/1000,extension,analogRead(A0),pulseCount};
      // to print timestamp, extension,current,pulsecount in csv format, i have printed commas below
      Serial.print(arr[0],2); // arr[0] is the time and 2 is for no. of decimal places to display
      Serial.print(",");
      Serial.print(arr[1],3);
      Serial.print(",");
      Serial.print(arr[2],3);
      Serial.print(",");
      Serial.println(arr[3]);
  }
}
```

Name	Work done
Arya Sameer Joshi 23B1853	1. **Determination of gear ratio** and designing and 3D modelling of gears on fusion 360 2. **Threading of leadscrews** 3. Operated on LaserCAD (minimized the area of print) 4. Carried out the stress vs current experiment
Gokularamanan R S 23B1854	1. Designing and 3D modelling of gears (before gear generator was uploaded on Moodle) 2. **Fabrication** – operated LaserCAD (exported as .dxf files -> laserCAD -> .ud5) for gears, base, platform, jaw gripper. **3. Coding and** EE circuit **4.** Sanding of nuts and jaws; Review 1 video
Tanay Amit Agrawal 23B1855	1. Provided the **idea of a horizontal setup**. 2. Designing and 3D modelling of individual parts (base, platform, jaws) **3. EE circuit and** carried out the stress vs current experiment 4. Threading of leadscrews
Ayush Singh 23B1856	**(Before project objectives were changed on 26/10/23)** 1. Idea of moving platform for automated loading of samples and gripping 2. Moving jaw mechanism
Haris Narrendran R 23B1857	1. **3D modelling** of individual parts – base, platform, jaws, gearbox 2. Fabrication - **3D printing** – Fracktal works - .stl file 3. **Assembly** of all parts by gluing 4. Sanding
Aadi Suketu Bharatia 23B1858	1. **Designing of jaws** – idea of serrated edges to provide better gripping 2. **Fabrication of nuts**, leadscrew – internal threading on nuts 3. Sawing of acrylic rods 4. Review 1 video


Motor connected to 5-teeth gear and disk
Leadscrew 3
25-teeth gear
L Jaw (movable)
Jaws (both movable)
R Jaw (fixed)
Leadscrew 1 (loosening and tightening of jaws)
50-teeth gear
Moving platform
Leadscrew 2 (connected to 50 teeth gear)


IR sensor (red light from it)
5-teeth gear


Arduino Uno
EE circuit
Motor driver board

Not actually current, but the PWM value of voltage

RAW DATA captured using application called CoolTerm.exe – saved to file named "Capture 2023-11-10 10-01-46.csv"

	A	B	C	D	E
1	Time	Extension	Current	pulseCount	
2	0.029	0.075	309	8	
3	0.052	0.15	377	16	
4	0.303	0.225	446	24	
5	0.349	0.3	490	32	
6	0.379	0.375	549	40	
7	0.622	0.45	598	48	
8	0.668	0.525	676	56	
9	0.729	0.6	700	64	
10	0.949	0.675	796	72	
11	0.981	0.75	790	80	
12	1.015	0.825	804	88	
13	1.236	0.9	781	96	
14	1.272	0.975	798	104	
15	1.305	1.05	814	112	
16	1.52	1.125	755	120	
17	1.562	1.2	792	128	
18	1.592	1.275	793	136	
19	1.706	1.35	808	144	
20	1.804	1.425	802	152	
21	1.842	1.5	800	160	
22	1.873	1.575	751	168	
23	2.054	1.65	793	176	
24	2.092	1.725	812	184	
25	2.111	1.8	806	192	
26	2.135	1.875	795	200	
27	2.165	1.95	776	208	
28	2.2	2.025	773	216	
29	2.427	2.1	785	224	
30	2.47	2.175	751	232	
31	2.502	2.25	795	240	
32	2.789	2.325	805	248	
33	2.841	2.4	753	256	
34	2.881	2.475	746	264	
35	3.214	2.55	808	272	
36	3.263	2.625	752	280	

36	3.263	2.625	752	280
37	3.31	2.7	806	288
38	3.712	2.775	780	296
39	3.76	2.85	807	304
40	4.086	2.925	764	312
41	4.139	3	771	320
42	4.179	3.075	805	328
43	4.483	3.15	765	336
44	4.528	3.225	809	344
45	4.568	3.3	799	352
46	4.573	3.375	767	360
47	4.849	3.45	789	368
48	4.892	3.525	791	376
49	4.937	3.6	773	384
50	5.178	3.675	765	392
51	5.224	3.75	800	400
52	5.262	3.825	808	408
53	5.361	3.9	791	416
54	5.535	3.975	809	424
55	5.582	4.05	755	432
56	5.616	4.125	815	440
57	5.887	4.2	767	448
58	5.94	4.275	785	456
59	5.984	4.35	761	464
60	6.405	4.425	770	472
61	6.469	4.5	754	480
62	6.534	4.575	763	488
63	6.536	4.65	759	496
64	6.873	4.725	790	504
65	6.95	4.8	749	512
66	7.024	4.875	764	520
67	7.027	4.95	778	528
68	8.187	5.025	804	536
69	8.249	5.1	802	544
70	8.301	5.175	795	552
71	9.327	5.25	755	560

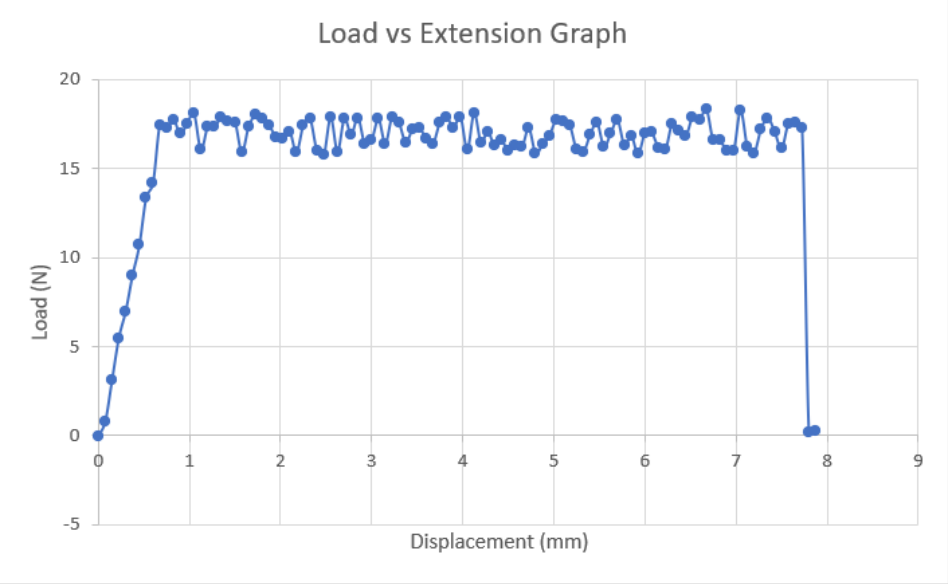
CoolTerm Capture 2023-11-10

	A	B	C	D
70	8.301	5.175	795	552
71	9.327	5.25	755	560
72	9.402	5.325	751	568
73	9.471	5.4	780	576
74	10.3	5.475	799	584
75	10.325	5.55	760	592
76	10.435	5.625	782	600
77	10.966	5.7	803	608
78	11.02	5.775	762	616
79	11.071	5.85	778	624
80	11.433	5.925	748	632
81	11.485	6	782	640
82	11.531	6.075	783	648
83	12.001	6.15	758	656
84	12.06	6.225	755	664
85	12.111	6.3	798	672
86	12.615	6.375	786	680
87	12.676	6.45	778	688
88	12.721	6.525	809	696
89	13.124	6.6	803	704
90	13.188	6.675	821	712
91	13.415	6.75	770	720
92	13.452	6.825	770	728
93	13.488	6.9	753	736
94	13.736	6.975	754	744
95	13.806	7.05	819	752
96	13.808	7.125	759	760
97	14.075	7.2	801	768
98	14.153	7.275	789	776
99	14.406	7.35	807	784
100	14.444	7.425	784	792
101	14.481	7.5	757	800
102	14.715	7.575	798	808
103	14.78	7.65	800	816
104	15.011	7.725	790	824
105	15.056	7.8	292	832
106	15.096	7.875	294	840

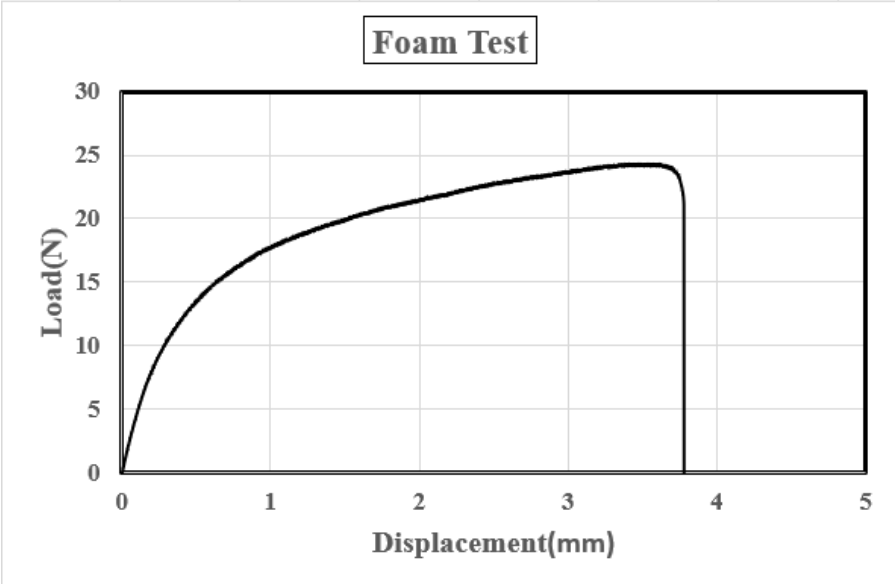
Processed Data:

Please note – the current obtained in raw data is not actually current; it is the pulse width modulated (PWM) value of voltage. Hence,

$$Actual\ Current\ (mA) = \frac{(5\ Volts * PWM\ ) * 1000}{1024 * 5\ ohms}$$



Obtained plot



Plot from data uploaded on Moodle

	A	B	C	D	E
1	Time (sec)	Extension (mm)	Current (mA)	Load(kgf)	Load(N)
2	0	0	279.296875	-0.002128	-0.02128
3	0.029	0.075	301.7578125	0.07670992	0.767099
4	0.052	0.15	368.4584	0.31082898	3.10829
5	0.303	0.225	436.22487	0.54868929	5.486893
6	0.349	0.3	478.7109375	0.69781539	6.978154
7	0.379	0.375	536.328125	0.90005172	9.000517
8	0.622	0.45	584.375	1.06869625	10.68696
9	0.668	0.525	660.7421875	1.33674508	13.36745
10	0.729	0.6	683.671875	1.41722828	14.17228
11	0.949	0.675	777.34375	1.74601656	17.46017
12	0.981	0.75	771.484375	1.72545016	17.2545
13	1.015	0.825	785.15625	1.77343844	17.73438
14	1.236	0.9	762.6953125	1.69460055	16.94601
15	1.272	0.975	779.296875	1.75287203	17.52872
16	1.305	1.05	794.921875	1.80771578	18.07716
17	1.52	1.125	737.3046875	1.60547945	16.05479
18	1.562	1.2	773.4375	1.73230563	17.32306
19	1.592	1.275	774.4140625	1.73573336	17.35733
20	1.706	1.35	789.0625	1.78714938	17.87149
21	1.804	1.425	783.203125	1.76658297	17.66583
22	1.842	1.5	781.25	1.7597275	17.59728
23	1.873	1.575	733.3984375	1.59176852	15.91769
24	2.054	1.65	774.4140625	1.73573336	17.35733
25	2.092	1.725	792.96875	1.80086031	18.0086
26	2.111	1.8	787.109375	1.78029391	17.80294
27	2.135	1.875	776.3671875	1.74258883	17.42589
28	2.165	1.95	757.8125	1.67746188	16.77462
29	2.2	2.025	754.8828125	1.66717867	16.67179
30	2.427	2.1	766.6015625	1.70831148	17.08311
31	2.47	2.175	733.3984375	1.59176852	15.91769
32	2.502	2.25	776.3671875	1.74258883	17.42589
33	2.789	2.325	786.1328125	1.77686617	17.76866
34	2.841	2.4	735.3515625	1.59862398	15.98624
35	2.881	2.475	728.515625	1.57462984	15.7463
36	3.214	2.55	789.0625	1.78714938	17.87149
37	3.263	2.625	734.375	1.59519625	15.95196
38	3.31	2.7	787.109375	1.78029391	17.80294
39	3.712	2.775	761.71875	1.69117281	16.91173
40	3.76	2.85	788.0859375	1.78372164	17.83722
41	4.086	2.925	746.09375	1.63632906	16.36329
42	4.139	3	752.9296875	1.6603232	16.60323
43	4.179	3.075	786.1328125	1.77686617	17.76866
44	4.483	3.15	747.0703125	1.6397568	16.39757
45	4.528	3.225	790.0390625	1.79057711	17.90577
46	4.568	3.3	780.2734375	1.75629977	17.563
47	4.573	3.375	749.0234375	1.64661227	16.46612
48	4.849	3.45	770.5078125	1.72202242	17.22022
49	4.892	3.525	772.4609375	1.72887789	17.28878
50	4.937	3.6	754.8828125	1.66717867	16.67179
51	5.178	3.675	747.0703125	1.6397568	16.39757
52	5.224	3.75	781.25	1.7597275	17.59728
53	5.262	3.825	789.0625	1.78714938	17.87149
54	5.361	3.9	772.4609375	1.72887789	17.28878
55	5.535	3.975	790.0390625	1.79057711	17.90577
56	5.582	4.05	737.3046875	1.60547945	16.05479
57	5.616	4.125	795.8984375	1.81114352	18.11144
58	5.887	4.2	749.0234375	1.64661227	16.46612
59	5.94	4.275	766.6015625	1.70831148	17.08311
60	5.984	4.35	743.1640625	1.62604586	16.26046
61	6.405	4.425	751.953125	1.65689547	16.56895
62	6.469	4.5	736.328125	1.60205172	16.02052
63	6.534	4.575	745.1171875	1.63290133	16.32901
64	6.536	4.65	741.2109375	1.61919039	16.1919
65	6.873	4.725	771.484375	1.72545016	17.2545
66	6.95	4.8	731.4453125	1.58491305	15.84913
67	7.024	4.875	746.09375	1.63632906	16.36329
68	7.027	4.95	759.765625	1.68431734	16.84317
69	8.187	5.025	785.15625	1.77343844	17.73438
70	8.249	5.1	783.203125	1.76658297	17.66583
71	8.301	5.175	776.3671875	1.74258883	17.42589
72	9.327	5.25	737.3046875	1.60547945	16.05479
73	9.402	5.325	733.3984375	1.59176852	15.91769
74	9.471	5.4	761.71875	1.69117281	16.91173
75	10.3	5.475	780.2734375	1.75629977	17.563
76	10.325	5.55	742.1875	1.62261813	16.22618
77	10.435	5.625	763.671875	1.69802828	16.98028
78	10.966	5.7	784.1796875	1.7700107	17.70011
79	11.02	5.775	744.140625	1.62947359	16.29474
80	11.071	5.85	759.765625	1.68431734	16.84317
81	11.433	5.925	730.46875	1.58148531	15.81485
82	11.485	6	763.671875	1.69802828	16.98028
83	11.531	6.075	764.6484375	1.70145602	17.01456
84	12.001	6.15	740.234375	1.61576266	16.15763
85	12.06	6.225	737.3046875	1.60547945	16.05479
86	12.111	6.3	779.296875	1.75287203	17.52872
87	12.615	6.375	767.578125	1.71173922	17.11739
88	12.676	6.45	759.765625	1.68431734	16.84317
89	12.721	6.525	790.0390625	1.79057711	17.90577
90	13.124	6.6	784.1796875	1.7700107	17.70011
91	13.188	6.675	801.7578125	1.83170992	18.3171
92	13.415	6.75	751.953125	1.65689547	16.56895
93	13.452	6.825	751.953125	1.65689547	16.56895
94	13.488	6.9	735.3515625	1.59862398	15.98624
95	13.736	6.975	736.328125	1.60205172	16.02052
96	13.806	7.05	799.8046875	1.82485445	18.24854
97	13.808	7.125	741.2109375	1.61919039	16.1919
98	14.075	7.2	732.2265625	1.58765523	15.87655
99	14.153	7.275	770.5078125	1.72202242	17.22022
100	14.406	7.35	788.0859375	1.78372164	17.83722
101	14.444	7.425	765.625	1.70488375	17.04884
102	14.481	7.5	739.2578125	1.61233492	16.12335
103	14.715	7.575	779.296875	1.75287203	17.52872
104	14.78	7.65	781.25	1.7597275	17.59728
105	15.011	7.725	771.484375	1.72545016	17.2545
106	15.056	7.8	285.15625	0.01843844	0.184384
107	15.096	7.875	287.109375	0.02529391	0.252939

Processed Data from Excel

Load (N) = 0.0351*current−9.8246

Fabrication sheet

MS 101 Makerspace Fabrication Request Form – Autumn 2023

Team ID: B10, I

Team Member Names and Roll Numbers: (I) ARYA SAMEER JOSHI, 23B1853 (II) AADI SUKETU BHARATIA, 23B1752
(III) GOKULARAMANAN R S, 23B1854 (IV) HARIS NARRENDRAN, 23B1857
(V) AYUSH SINGH, 23B1856 (VI) TANAY AMIT AGRAWAL, 23B1856

Team Mentor (Project TA) Names and Signatures: (ME Mentor) GANESH RAO (EE Mentor) MAYANK GOYAL

What we are going to provide:

1. Acrylic sheets: 5 mm and 10 mm thickness. Maximum sheet size available to you is 60 cm X 60 cm, of each.
2. Acrylic rods: 3 rods of 12 mm diameter and 30 cm long.
3. Aluminium rods for leadscrew: 3 each of 10 mm diameter and 20 cm length. +1
4. Aluminium Hexagonal Rod with 18 mm Diameter (Nut making): 10 cm length.
5. 10mm (3) NOS Brass 2/11/23, Brass 10mm (1) NOS

Section 1: Lathe for screw and nut

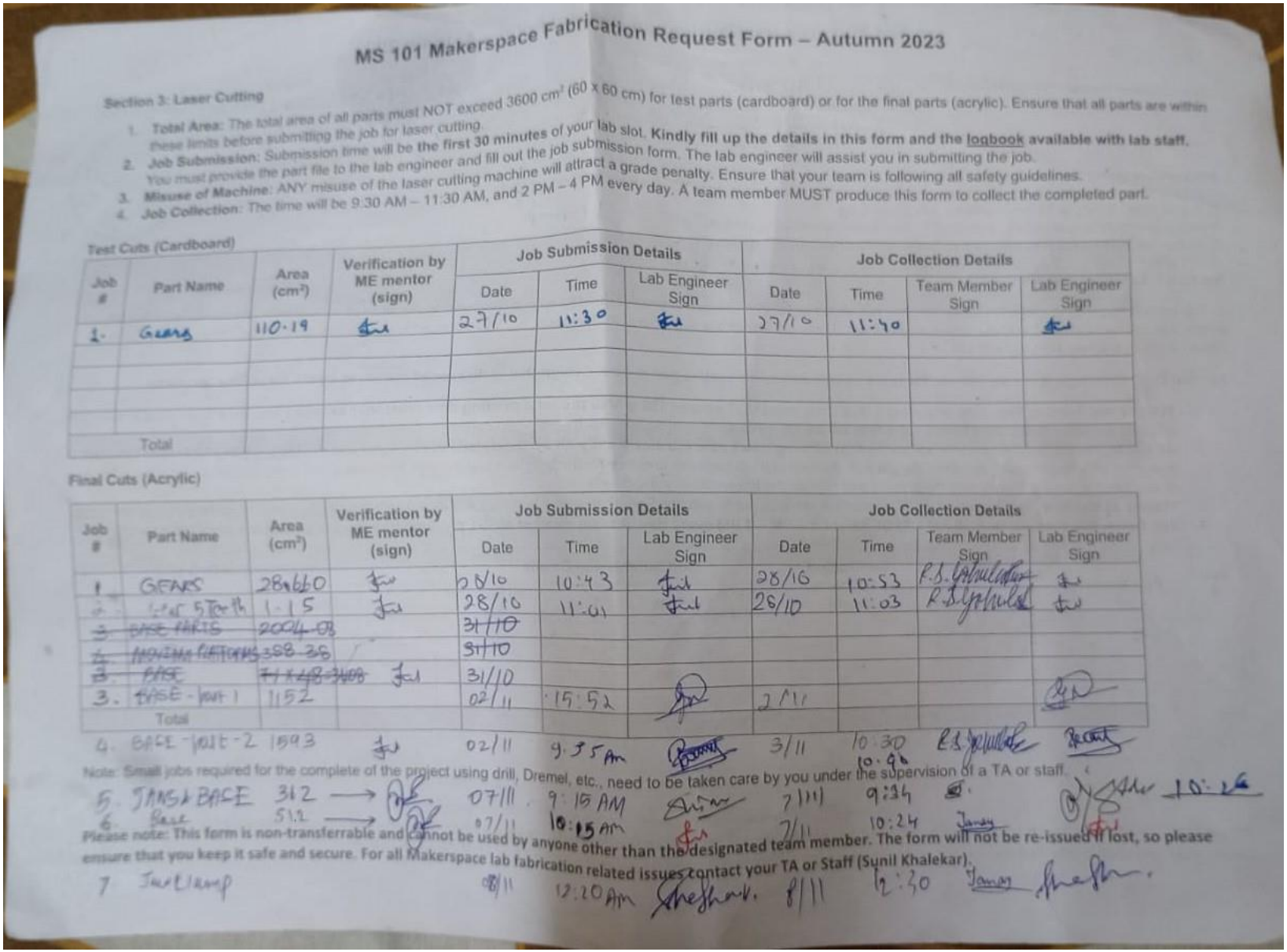
1. The lathe is required to make the leadscrew and nut combination. A maximum of three (3) leadscrew-nut components are allowed to be made. The maximum threaded length that can be fabricated in Makerspace lab is 10 cm. There are few lathes available in makerspace. So, you will need to ensure that your lab period is used to make these jobs with the help lab staff and TAs.

Section 2: 3D Printing – It is only allowed for grips as well as any innovative part in your design that is discussed approved by the respective instructor.

1. **Weight and Printing Time**: The total weight of all parts **must NOT exceed 150 g AND the total printing time must NOT exceed 5 hrs**. Your team must ensure that all parts are within these limits before submitting the job for printing.
2. **Job Submission**: Submission time will be the **first 30 minutes of your lab slot. Kindly fill up the details in this form and the logbook available with lab staff. It** is your team's responsibility to submit the job with the help of a lab engineer and monitor the progress (for the first 10 minutes and every 30 minutes after that). In case of any printing issues, please stop the printing and contact the lab engineer immediately.
3. **Misuse of Machine**: ANY misuse of the 3D printer will attract a grade penalty. Ensure that your team is following all safety guidelines and using the 3D printer correctly.
4. **Job Collection time will be 9:30 AM – 11:30 AM, and 2 PM – 4 PM every day. A team member MUST produce this form to collect the completed part.**

Job #	Part Name	Weight (g)	Printing Time (min)	Verification by ME mentor (sign)	Job Submission Details				Job Collection Details			
					Machine Number	Date	Time	Lab Engineer Sign	Date	Time	Team Member Sign	Lab Engineer Sign
1	Jaws	499	4h 2min		3D11	28/10	11:10					
	Total											

Please note: This form is non-transferrable and cannot be used by anyone other than the designated team member. The form will not be re-issued if lost, so please keep it safe and secure. For all Makerspace lab fabrication related issues contact your TA or Staff (Sunil Khalekar).



MS 101 Makerspace Fabrication Request Form – Autumn 2023

Section 3: Laser Cutting

1. **Total Area:** The total area of all parts must NOT exceed 3600 cm² (60 x 60 cm) for test parts (cardboard) or for the final parts (acrylic). Ensure that all parts are within these limits before submitting the job for laser cutting.
2. **Job Submission:** Submission time will be **the first 30 minutes** of your lab slot. **Kindly fill up the details in this form and the logbook available with lab staff.** You must provide the part file to the lab engineer and fill out the job submission form. The lab engineer will assist you in submitting the job.
3. **Misuse of Machine:** ANY misuse of the laser cutting machine will attract a grade penalty. Ensure that your team is following all safety guidelines.
4. **Job Collection:** The time will be 9:30 AM – 11:30 AM, and 2 PM – 4 PM every day. A team member MUST produce this form to collect the completed part.

Test Cuts (Cardboard)

Job #	Part Name	Area (cm²)	Verification by ME mentor (sign)	Job Submission Details			Job Collection Details			
				Date	Time	Lab Engineer Sign	Date	Time	Team Member Sign	Lab Engineer Sign
1.	Gears	110.19	✓	27/10	11:30	✓	27/10	11:40		✓
	Total									

Final Cuts (Acrylic)

Job #	Part Name	Area (cm²)	Verification by ME mentor (sign)	Job Submission Details			Job Collection Details			
				Date	Time	Lab Engineer Sign	Date	Time	Team Member Sign	Lab Engineer Sign
1.	GEARS	28.660	✓	28/10	10:43	✓	28/10	10:53	R.S. Khalekar	✓
2.	Gear 5 Teeth	1.15	✓	28/10	11:01	✓	28/10	11:03	R.S. Khalekar	✓
~~3.~~	~~BASE PARTS~~	~~2004.03~~		~~31/10~~						
~~4.~~	~~MOVING FIXTURES~~	~~388.36~~		~~31/10~~						
~~3.~~	~~BASE~~	~~71×48=3408~~	✓	31/10						
3.	BASE - part 1	1152		02/11	15:52		2/11			
	Total									
4.	BASE - part 2	1593	✓	02/11	9.35 AM		3/11	10.30 10.40	R.S. Khalekar	

Note: Small jobs required for the complete of the project using drill, Dremel, etc., need to be taken care by you under the supervision of a TA or staff.

5.	JAWS+BASE	312 →		07/11	9:15 AM		7/11	9:34		10:26
6.	Base	51.2 →		07/11	10:15 AM		7/11	10:24		
7	Jaw clamp	9.1 →		8/11	12:20 AM		8/11	12:30		

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1. Gears – 28.66 cm^2
2. Gear 5 teeth – 1.15 cm^2
3. Base part 1 – 1152 cm^2
4. Base part 2 – 1593 cm^2
5. Jaws and base – 312 cm^2
6. Base – 51.2 cm^2
7. Jaw clamp – 9.1 cm^2

Total = 3157.4 cm^2

Items bought:

S.No.	Item	Cost (Rs.)
1	Acrylic glue x 2	402
2	Mseal x 2	60
3	Lubricant	25
4	Nail + screw	5
5	Feviqwik x 2	70
	Total Cost =	Rs. 562/-

YouTube Link to video: **https://youtu.be/UxlTlBXdOjU**

Google Drive link for raw data and final processed data: **https://drive.google.com/drive/folders/17-lyhXIEoWhwhJbMZq46x7ABxOXxxbGI?usp=drive_link**

Bibliography (external sources):

1. https://www.arduino.cc/reference/en/

2. https://www.ourpcb.com/coolterm-2.html

3. https://learn.sparkfun.com/tutorials/terminal-basics/coolterm-windows-mac-linux