INTRODUCTION TO ADVANCED MANUFACTURING PROCESSES

Report on

Industrial Summer Training Report

Submitted in partial fulfilment of the requirement for the Degree of

Bachelor of Technology

in

Mechanical Engineering

By

Siddhant Dey

MEB20047

DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF ENGINEERING

TEZPUR UNIVERSITY

TEZPUR, ASSAM

MONTH YEAR

सीएसआईआर - उत्तर पूर्व विज्ञान और प्रौद्योगिकी संस्थान
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*Certified that **Mr Siddhant Dey,** a student of Department of Mechanical Engineering, Tezpur University, Sonitpur, has undergone training and completed a project entitled "Introduction to Advanced Manufacturing Processes" during June 08 to July 14, 2023 under the guidance of Mr Dhanjit Das, Senior Scientist, General Engineering Division, Engineering Sciences and Technology Division of the Institute.*

Sri R Deka	**Dr G Narahari Sastry**
Pr. Scientist, RPBD	**Director**
CSIR-NEIST, Jorhat	**CSIR-NEIST, Jorhat**
Date: 24-08-2023	**Date: 24-08-2023**

ACKNOWLEDGMENT

I would like to express our appreciation to everyone who played a part in the successful completion of this project.

Firstly, I am deeply grateful to my project supervisor, *Sr. Scientist Mr. Dhanjit Das*, for his invaluable guidance, support, and motivation throughout my internship period. His expertise and recommendations have been crucial in shaping my ideas and ensuring that my research is of the highest quality. I feel fortunate to have had the opportunity to work under his supervision.

Furthermore, I would like to thank the H.O.D of Mechanical Engineering, *Er. Jayanta Jyoti Bora*, for giving me the opportunity to work on an important and relevant topic like *"Introduction to Advanced Manufacturing Processes".* This topic has allowed me to explore sustainable architecture in greater depth and discover innovative solutions for more efficient manufacturing processes. I would also take this opportunity to thank my instructors *Mr. Uttam Hazarika* and *Mr. Partha Pratim Hazarika* for their invaluable guidance and unwavering support throughout the course of this project.

I am also grateful to my parents, who have been a constant source of encouragement, support, and inspiration to me. Their unwavering faith in me has been a driving force behind my success.

Finally, I would like to express our thanks to my friends and colleagues, whose assistance and feedback have been instrumental in overcoming the challenges and obstacles I encountered during my project.

In conclusion, I am grateful to everyone who has contributed to the success of this project. Your guidance, support, and encouragement have played a critical role in helping me achieve my goals, and I appreciate everything you have done for me.

Siddhant Dey

DAY AND DATE WISE DIARY

DAY 1 DATE: 08-06-2023

On the first day of my internship, I completed administrative formalities at the start and then met with my guide Senior Scientist Dhanjit Das in the General Engineering Division to discuss my internship's direction. Although I had planned to meet with my instructors to discuss my project, they were occupied with official tasks. Therefore, Dhanjit sir allowed me to focus on administrative work, leading to an early departure.

DAY 2 DATE: 12-06-2023

Mr. Dhanjit, my guide, introduced me to my instructors, Mr. Uttam Hazarika and Mr. Partha Pratim Sharma, and also assigned me the project for my internship, titled "Introduction to Advanced Manufacturing Processes." Following this, I received a comprehensive overview of the safety measures that need to be followed in the workplace and around different machinery. Subsequently, I was instructed to proceed to the welding shop to begin my learning journey about various welding techniques.

DAY 3 DATE: 13-06-2023

Proceeded to the welding shop and got a small insight about Gas Metal Arc Welding like this process is based on the principle of developing weld by melting faying surfaces of the base metal using heat produced by a welding arc established between base metal and a consumable electrode. Welding arc and weld pool are well protected by a jet of shielding inactive gas coming out of the nozzle and forming a shroud around the arc and weld. Metal inert gas process is similar to TIG welding except that it uses the automatically fed consumable electrode therefore it offers high deposition rate and so it suits for good quality weld joints required for industrial fabrication. And depending upon the electrode diameter, material and electrode extension required. Welding may use either constant voltage or constant current type of the welding power source. For small diameter electrodes (< 2.4 mm) when electrical resistive heating controls the melting rate predominantly, constant voltage power source (DCEP) is used to take advantage of the self-regulating arc whereas in case of large diameter electrode constant current power source is used with variable speed electrode feed drive system to maintain the arc length.

Also learned about Shielded Metal Arc Welding which is performed using a consumable electrode covered with a flux coating. An electric arc is established between the electrode and the workpiece. The flux coating melts to create a shielding gas and slag to protect the weld pool. SMAW is known for its simplicity and robustness. It requires minimal equipment and can be used in adverse conditions, but it may require more skill to achieve high-quality welds. For joining mild steel plates in Shielded Metal Arc Welding (SMAW) or commonly known as stick welding, in India or anywhere else, a commonly used electrode type is the AWS E6013 electrode. It is a versatile and all-position electrode suitable for mild steel welding. The "E" in AWS E6013 stands for electrode, "60" signifies a tensile strength of 60,000 pounds per square inch (psi), and "13" indicates it can be used in all welding positions.

I then performed a butt joint using shielded metal arc welding (SMAW) on two mild steel plates, adhering to the required dimensions. I used a 3.2 mm (1/8 inch) electrode in a flat position, with amperage ranging between 70 and 140 amperes.

Throughout the entire process, appropriate safety measures were consistently followed, including the use of protective gloves, face shields, and covered shoes whenever performing the job.

Figure 1: Showing power source of MIG welding

Figure 2: Electrode holder or Welding Torch

Figure 3: Butt joint done in workshop

DAY 4 DATE: 15-06-2023

Today we learned about gas welding. In gas welding, heat is generated by the combustion reaction between fuel gas and oxygen. Oxy-Acetylene welding is a type of gas welding in which acetylene (C2H2) is used as the fuel gas. Here burning of acetylene with the help of oxygen forms a concentrated flame of high temperature. This flame directly strikes the weld area and melts the weld surface and filler material. The melted parts of welding plates diffused in one another and create a weld joint after cooling. This welding method can be used to join most of common metals used in daily life. In oxyacetylene gas welding, filler material is often added to the joint to create a stronger and more durable weld. The choice of filler material depends on the specific welding application and the type of materials being joined. Copper-Based alloys are most frequently used as filler material.

Reaction involved in gas welding

1st Stage: $C2H2+O_2 \rightarrow 2CO+H_2+Heat$

2nd Stage: $2CO+ O_2 \rightarrow 2CO_2+Heat$

3rd Stage: $H_2+ O_2 \rightarrow 2\ H_2O+ Heat$

Types of flames in oxy-acetylene welding:

1. Neutral Flame: The ratio of oxygen to acetylene is 1:1, all reactions are carried to completion and a neutral flame is produced. Most welding is done with a neutral flame. It is chemically neutral and neither oxidizes or carburizes the metal being welded. The flame temperature is around 3100°C. Neutral flame is commonly used to weld mild steel, cast iron, stainless steel.

2. Oxidizing Flame: Oxidizing Flame contains more oxygen than acetylene. Temperature of the flame is around 3600 °C. It is used to weld copper and copper alloys but harmful when welding steel because the excess oxygen reacts with carbon decarburizing the region around the weld.
3. Carburizing flame: The flame contains more acetylene than oxygen. Temperature of the flame is around 2900°C. It is also called Carburizing Flame due to its tendency to introduce carbon into the molten metal.

The components of oxy-acetylene gas include

a. Welding Torch

b. Pressure Regulators

c. Needle Valves

d. Oxygen Cylinder

e. Fuel Gas Cylinder

I practiced gas welding under supervision, and throughout the entire process, I consistently followed appropriate safety measures, including the use of protective gloves, face shields, and covered shoes whenever performing the job.

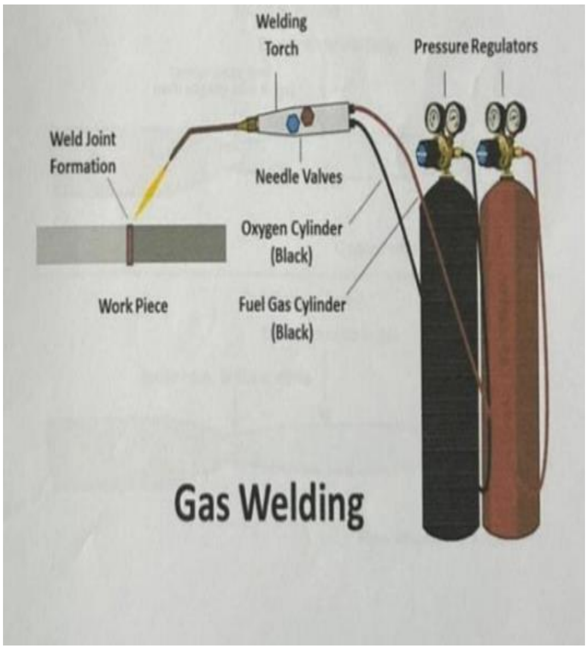

Figure 4: Gas welding setup

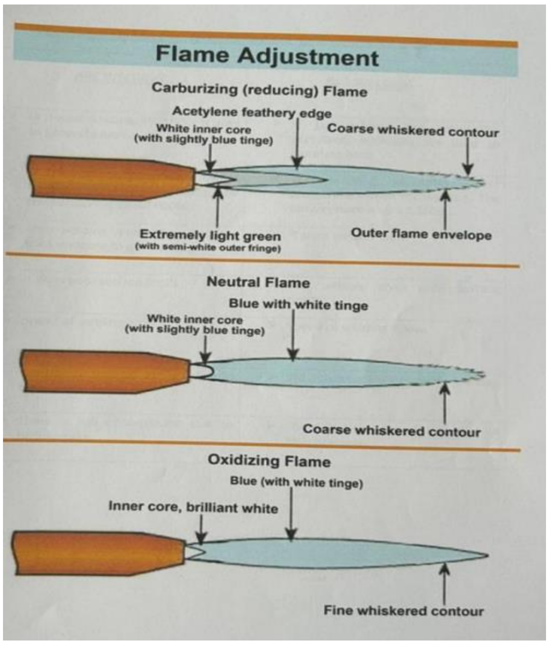

Figure 5: Types of oxy-acetylene flames

Figure 6: Oxygen & Acetylene gas cylinders

Figure 7: Gas welding torch

Figure 8: Job practice done in workshop

DAY 5 DATE: 16-06-2023

Today, we learned and practiced plasma arc cutting under the supervision of a professional. Plasma arc cutting is a widely used thermal cutting process that employs a high-velocity jet of ionized gas, known as plasma, to cut through electrically conductive materials. It is particularly effective for cutting metals such as steel, stainless steel, aluminum, and copper, offering advantages over other cutting methods in terms of speed, precision, and versatility.

The process begins by passing a high-temperature gas, typically compressed air or a gas mixture, through a small nozzle. An electric arc is then formed between an electrode and the workpiece, heating and ionizing the gas, transforming it into plasma. The plasma, reaching temperatures of up to 30,000 degrees Fahrenheit, creates a focused and intense heat source capable of melting through the metal. As the plasma jet is directed towards the workpiece, it rapidly heats and melts the material. Simultaneously, a high-velocity gas flow blows away the molten metal, effectively cutting through the material. The design of the nozzle and the choice of gases can influence the quality and characteristics of the cut, allowing for adjustments to achieve desired results.

Plasma arc cutting offers several advantages. Firstly, it is a highly efficient process, enabling fast cutting speeds that significantly reduce production time. Additionally, it provides excellent cut quality with narrow kerf widths, minimal heat-affected zones, and smooth, clean edges. The versatility of plasma cutting allows for cutting through a wide range of material thicknesses, making it suitable for various applications across industries such as manufacturing, automotive, shipbuilding, and construction.

However, it's important to note that plasma arc cutting has limitations. It is typically limited to electrically conductive materials and may not be as effective for non-metallic materials. The process also produces intense heat and UV radiation, necessitating appropriate safety measures and protective equipment.

I practiced plasma arc cutting under supervision, and throughout the entire process, I consistently followed appropriate safety measures, including the use of protective gloves, face shields, and covered shoes whenever performing the job.

Figure 9: Power Supply

Figure 10: Plasma Torch

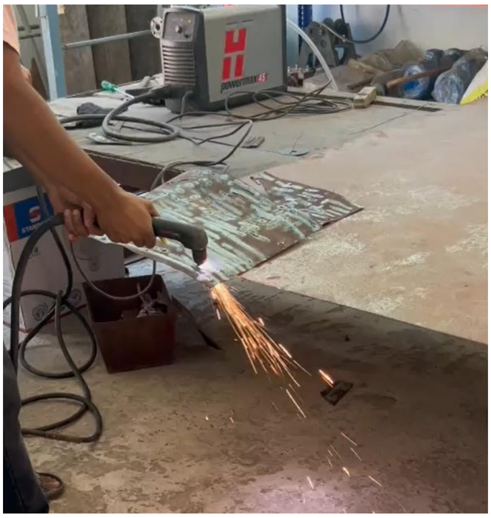

Figure 11: Job practice done in workshop

DAY 6 DATE: 19-06-2023

Next, I transitioned from the welding shop to Computer Numerical Control Machining (CNC). I learned that CNC involves the use of computerized controls and programming to precisely control the movement and operation of machining equipment, such as mills, lathes, routers, grinders, and other tools. This process is suitable for a wide range of materials, including metals, plastics, wood, glass, foam, and composites, and finds applications in various industries, such as large CNC machining, the production of parts and prototypes for telecommunications, and CNC machining for aerospace components, which require tighter tolerances than other industries.

When the CNC system is activated, the software is programmed with the desired cuts, and the corresponding tools and machinery receive instructions to carry out the specified dimensional tasks, similar to the functioning of a robot. In CNC programming, the code generator within the numerical system often assumes the perfection of the mechanisms, disregarding the possibility of errors. However, the probability of errors increases when the CNC machine is directed to cut in multiple directions simultaneously.

Figure 12: CNC milling machine with ATC (Automatic Tool Change)

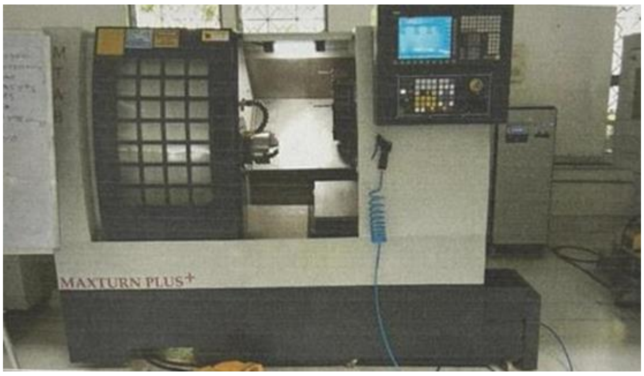

Figure 13: CNC lathe machine with ATC (Automatic Tool Change)

DAY 7 DATE: 21-06-2023

Today, I further learned about CNC programming. The arrangement of a tool in a numerical control system is defined through a series of inputs known as the part program. The language utilized in CNC machining, referred to as G-code and M-code, is written to govern various machine behaviours, including speed, feed rate, and coordination. In the CNC machining process, a 2D or 3D CAD drawing is created, and this drawing is then translated into computer code for execution by the CNC system.

G CODES

CODE	FUNCTION
G00	Rapid Positioning Motion (X, Y, Z, A, B)
G01	Linear Interpolation Motion (X ,Y,Z,A,B, F)
G02	Circular Interpolation Motion CW (X,Y,Z,A, I, J,K,R,F)
G03	Circular Interpolation Motion CCW (X,Y,Z,A, I, J,K,R,F)
G04	Dwell (P) (P=Seconds″.” Milliseconds)
G17	Circular Motion XY Plane Selection (G02 or G03)
G18	Circular Motion ZX Plane Selection (G02 or G03)
G19	Circular Motion YZ Plane Selection (G02 or G03)
G20	Inch Coordinate Positioning
G21	Metric Coordinate Positioning
G28	Machine Zero Return Thru Ref. Point (X,Y,Z,A,B)
G29	Move to Location Through G28 Ref. Point (X ,Y,Z,A,B)
G40	Cutter Comp Cancel G41/G42/G141 (X ,Y)
G41	2D Cutter Compensation, Left (X ,Y,D)
G42	2D Cutter Compensation, Right (X ,Y,D)
G43	Tool Length Compensation + (H,Z)
G49	Tool Length Compensation Cancel G43/G44/G43
G52	Work Offset Positioning Coordinate
G54	Work Offset Positioning Coordinate #1 (Setting 56)
G55	Work Offset Positioning Coordinate #2
G56	Work Offset Positioning Coordinate #3
G57	Work Offset Positioning Coordinate #4
G58	Work Offset Positioning Coordinate #5
G59	Work Offset Positioning Coordinate #6
G76	Fine Boring Canned Cycle (X,Y,A,B,Z,I,J,P,Q,R,L,F)
G80	Cancel Canned Cycle (Setting 56)
G81	Drill Canned Cycle (X ,Y,A,B,Z,R, L ,F)
G82	Spot Drill / Counterbore Canned Cycle (X,Y,A,B,Z,P,R, L, F)
G85	Bore In ~ Bore Out Canned Cycle (X ,Y,A,B,Z,R, L ,F)
G86	Bore In ~ Stop ~ Rapid Out Canned Cycle (X ,Y,A,B,Z,R, L, F)

G87	Bore In ~ Manual Retract Canned Cycle (X,Y,A,B,Z,R,L,F)
G89	Bore In ~ Dwell ~ Bore Out Canned Cycle (X,Y,A,B,Z,P,R,L,F)
G90	Absolute Positioning Command
G91	Incremental Positioning Command
G92	Global Work Coordinate System
G93	Inverse Time Feed Mode ON
G94	Inverse Time Feed OFF / Feed Per Minute ON
G97	Spindle Speed in RPM
G98	Canned Cycle Initial Point Return

M CODES

CODE	FUNCTION
M00	Program Stop
M01	Optional Program Stop
M02	Program End
M03	Spindle ON Clockwise
M04	Spindle ON Counterclockwise
M05	Spindle Stop
M06	Tool Change (T)
M08	Coolant ON
M09	Coolant OFF
M30	Program End and Reset
M31	Chip Auger Forward
M33	Chip Auger Stop
M34	Coolant Spigot Position Down, Increment
M35	Coolant Spigot Position Up, Decrement
M36	Pallet Part Ready
M41	Spindle Low Gear Override
M42	Spindle High Gear Override
M50	Execute Pallet Change
M83	Auto Air Jet ON
M84	Auto Air Jet OFF
M88	Coolant Through Spindle ON
M99	Routine Return of Loop

Also practised writing some CNC codes for different processes. One such is mentioned below

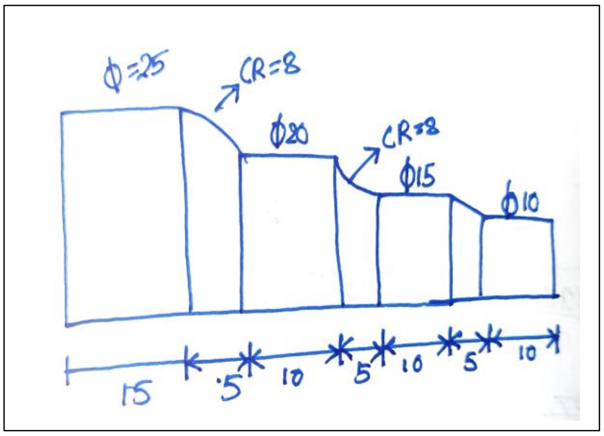

Figure 14: Practice code design

```
G71G94
G75X0Z0
G00X37Z5
CYCLE 62("NEIST”, 1,,)
CYCLE 952 (NEIST","1101311,200,150,3,0.5.1,0.1,0.1,0.1,0,0.125,45,,,,,2,2,,0,1,0,12,110)
CYCLE 952 (NEIST","2101321,150,100,3,02,1,0,0,0,0,0,125,45,,,,,2,2,,,0,1,,0,12,110)
G75X0Z0
M05
M30
NEIST.SPF
G00X0Z0
G01X10Z0
G01X10Z-10
G01X15Z-15
G01X15Z-25
G02X20Z-30CR=8
G01X20Z-40
G03X25Z-45CR=8
G01X25Z-60
M17
```

Start-up code

Cycle Code

End program code

Sub program code

DAY 8 DATE: 22-06-2023

Spent another day practicing writing the sub program CNC codes.

```
G21 G90G00X0Y0Z10
G00X0Z10
G01X20Y0Z0
G01X20Y10Z0
G01X-20Y10Z0
G01X-20Y20Z0
G01X20Y10Z0
G01X20Y10Z10
G00X0Y0Z0
M3
```

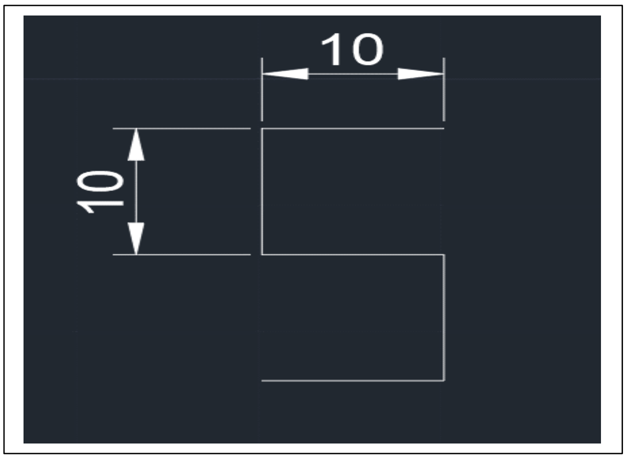

Figure 15: Practice code design

```
G71G94
G75X0Z0
G00X37Z5
CYCLE 62("NEIST", 1,,)
CYCLE 952
(NEIST","1101311,200,150,3,0.5.1,0.1,0.1,0.1,0,0.125,45,,,,,2,2,,0,1,0,12,110)
CYCLE 952 (NEIST","2101321,150,100,3,02,1,0,0,0,0,0,125,45,,,,,2,2,,,0,1,,0,12,110)
G75X0Z0
M05
M30
NEIST.SPF
G00X0Z0
G01X10Z-8
G01X10Z--8
G02X20Z-31CR=8
G01X205Z-41
G03X30Z-46CR=8
G01X30Z-56
G01X40Z-56
G02X50Z-61CR=8
G01X50Z-76
M17
```

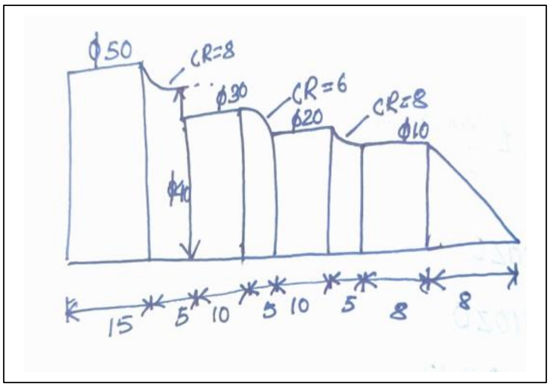

Figure 16: Practice code design

DAY 9 DATE: 23-06-2023

Proceeded to learning CNC Milling. Milling is a machining technique that employs rotating cutting tools with multiple points to remove material from the workpiece. In CNC milling, the workpiece is typically fed in the same direction as the cutting tool's rotation, while in manual milling, the workpiece is fed in the opposite direction to the tool's rotation. The milling process offers various operational capabilities, including face milling, which involves cutting shallow, flat surfaces and flat-bottomed cavities on the workpiece, and peripheral milling, which entails cutting deep cavities like slots and threads into the workpiece.

Figure 17: MTAB XLMILL.

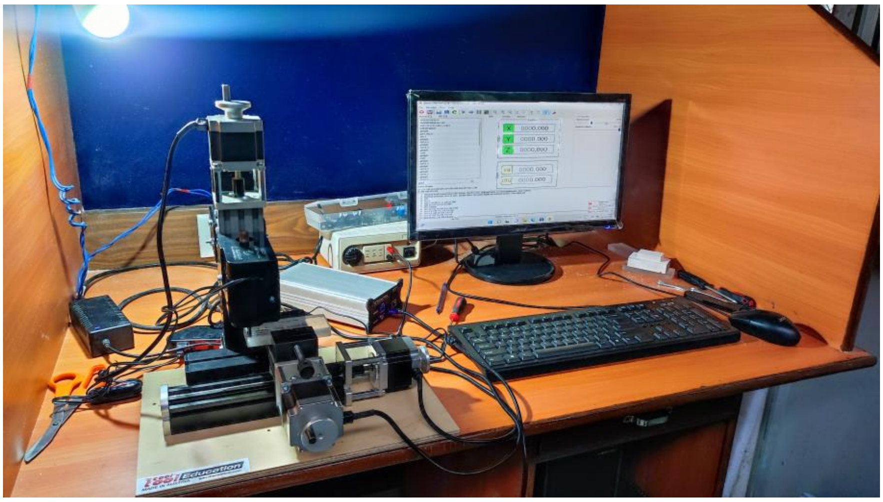

Figure 18: Unimat CNC milling machine.

DAY 10 **DATE: 26-06-2023**

Worked on Unimat CNC milling machine and did a project under supervision.

```
G21
G90G00X0Y0Z10
G01Y25
X2
Z-1
X8Y35
X33
X40Y25
X2Y25
Z10
X0Y0
X20.5Y30
Z-1
X14Y24
X28
X17.5Y14.5
Z10
X0Y0
M3
```

Figure 19: Design idea

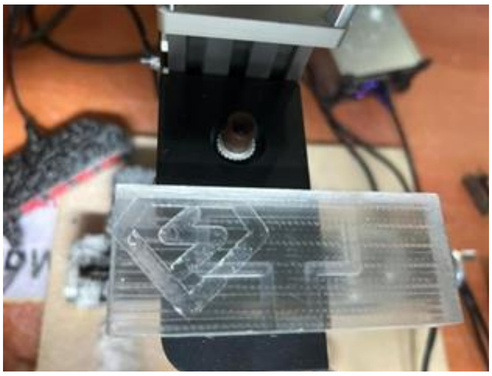

Figure 20: Final product image.

DAY 11 **DATE: 27-06-2023**

I proceeded to learning CNC Turning. Turning is a machining technique that utilizes cutting tools with a single point to remove material from a rotating workpiece. In CNC turning, the cutting tool is linearly fed along the surface of the rotating workpiece, typically on a CNC lathe machine. This process involves removing material from the circumference of the workpiece until the desired diameter is achieved, resulting in the production of cylindrical parts with both external and internal features, such as slots, tapers, and threads. The turning process offers various operational capabilities, including boring, facing, grooving, and thread cutting.

Figure 21: MTAB XLTURN.

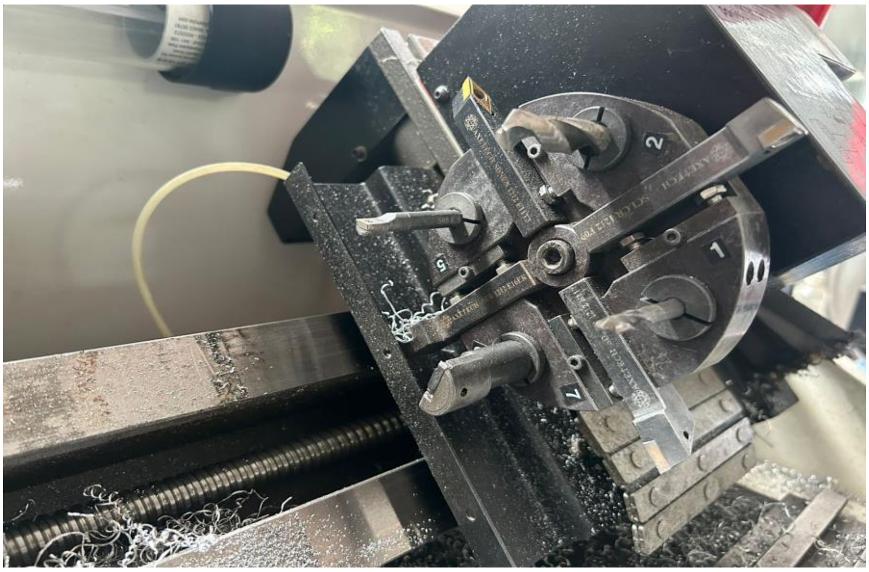

Figure 22: MTAB XLTURN different tools.

DAY 12 **DATE: 28-06-2023**

Worked on a sample design was prepared in the MTAB XLTURN machine on a mild steel workpiece of dimension 100 mm (L) x 25 mm (D). The code and the final product image are given below

```
G71G94
G75X0Z0
G00X37Z5
CYCLE62("NEIST", 1,,)
CYCLE 952 NEIST","1101311,200,150,3,0.5.1,0.1,0.1,0.1,0,0.125,45,,,,,2,2,,,0,1,0,12,110)
CYCLE 952 NEIST","2101321,150,100,3,02,1,0,0,0,0,0,125,45,,,,,2,2,,,0,1,,0,12,110)
G75X0Z0
M05
M30
NEIST.SPF
G00X0Z0
G01X10
G01Z-2
G02X7Z-7CR=12
G02X127Z-12CR=8
G01X12Z-20
G01X15Z-20
G01X18Z-25
G03X25Z-30CR=8
G01X25Z-35
M17
```

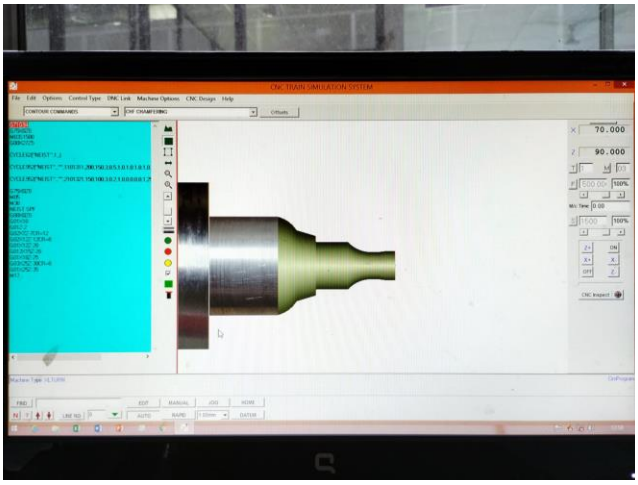

Figure 23: Turning simulation

Figure 24: Final product

DAY 13 **DATE: 30-06-2023**

I proceeded to learn about the Universal Testing Machine (UTM), which is a highly versatile mechanical testing instrument used to evaluate the mechanical properties of various materials. It is an essential tool in materials testing laboratories, research facilities, quality control departments, and educational institutions.

The UTM is designed to apply controlled forces and deformations to test specimens, allowing for the measurement and analysis of their mechanical behaviour. The machine can perform a wide range of tests, including tensile, compression, flexural, shear, and cyclic tests.

The core components of a UTM include a load frame, actuator, load cell, grips or fixtures, a control system, and software for data acquisition and analysis. The load frame provides the structural integrity of the machine, while the actuator generates the force required for deformation. The load cell converts the applied force into an electrical signal, which is used to measure and record the load accurately.

Grips or fixtures are used to securely hold the test specimen during the test, ensuring proper alignment and preventing slippage. They are designed to accommodate various types and sizes of specimens based on specific test requirements.

The control system of a UTM enables precise control over testing parameters such as force, displacement, and strain rate. It allows users to set up test configurations, monitor the test in real-time, and control the machine according to specific testing standards or protocols. Additionally, the software associated with the UTM facilitates data acquisition, analysis, and reporting, enabling users to calculate mechanical properties such as strength, modulus, yield point, elongation, and more.

Safety features are integral to UTMs to ensure operator safety and protect the machine. Emergency stop buttons, safety shields, and limit switches are incorporated to prevent overloading and accidents during testing.

UTMs are employed in a wide range of industries, including automotive, aerospace, construction, metals and alloys, plastics, textiles, and biomedical materials. They play a crucial role in material characterization, product development, quality control, and research and development activities. The data obtained from UTM tests helps engineers and scientists make informed decisions regarding material selection, design optimization, and performance evaluation, contributing to the advancement of various industries.

Figure 25: Universal Testing Machine

DAY 14 DATE: 03-07-2023

I learned more about operating the Universal Testing Machine and the BLUE HILL software. Additionally, I assisted in conducting a tensile test on a rod sample of brand X, which resulted in an ultimate tensile stress of 550 MPa. The tensile stress was found to be within the recommended range for construction according to Indian standards. This value was further confirmed when I again confirmed the experiment on the same sample the next day.

DAY 15 DATE: 04-07-2023

I conducted an experiment under supervision using the INSTRON machine by SATEC SYSTEMS, which can provide a maximum tensile force of 10 tons. For the test, I used a sample of an iron rod measuring 450 mm in length and 12 mm in diameter, with material properties specified as FE 550. The testing was performed according to the parameters outlined in IS code 1786. The workpiece was securely fixed in both the upper and lower jaws, with a distance of 300 mm between their faces. The machine was operated using the BLUE HILL operating system to define material parameters, such as sample size and geometry, with a feed rate set at 0.2 mm/s.

Following the experiment, the obtained results are as follows:

Yield strength of the rod = 370 MPa

Ultimate tensile stress = 422 MPa

Percentage of elongation = 12.5%

It's worth noting that the ultimate tensile stress was measured at 422 MPa, although it was expected to be around 550 MPa. This discrepancy may be due to a prior tensile stress test performed on the same rod sample.

Figure 26: UTM result interface.

DAY 16 DATE: 05-07-2023

On day 16, following the advice of my guide, I proceeded to the steam distillation unit where essential oils present in the different leaves are extracted. I learned that steam distillation is the most commonly used method for extracting essential oils from plants. During this process, we force pressurized steam through the plant material containing the desired oils. The volatile compounds can be distilled at temperatures lower than their boiling points, preserving the natural qualities of the plant material. Steam distillation is a multistage continuous distillation process where we use steam as a stripping gas to extract the oils. We collect the mixture of hot vapours and then condense it to produce a liquid in which the oil and water form two distinct layers. One of these layers is the essential oil, which contains oil-soluble compounds, and the other is a hydrolysate or hydrosol, which contains water-soluble components. We carry out hydro steam distillation when the perfumery plant material is susceptible to direct steam.

I also assisted the team in setting up the steam distillation unit that we were supposed to use in the later days.

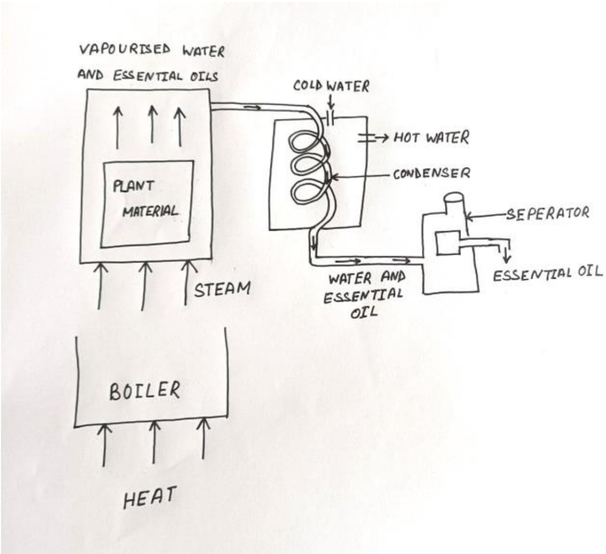

Figure 27: Steam distillation process

DAY 17 DATE: 06-07-2023

Today, I proceeded to observe the extraction of oil from eucalyptus leaves. Before commencing the experiment, we carefully sealed each seal and joint using vacuum grease. We loaded approximately 2 kg of raw eucalyptus leaves into the plant material chamber and filled the boiler with water. Cold water circulated around the condenser to facilitate the process.

We gradually increased the heat until the temperature reached 100°C, allowing the water to boil. At around 9:45 in the morning, we switched on the heater. After approximately 35 minutes, we noticed the first few drops collecting in the separator. The entire process continued throughout the day, concluding around 4 in the evening.

Following this, we separated the layer of oil from the water in the separator using the valve. We measured and collected 4 ml of oil. This oil was carefully stored in separate containers, each appropriately marked for future reference.

Later on, the oil was sent for Gas Chromatography-Mass Spectrometry (GC-MS) analysis. However, this aspect falls outside the scope of my internship.

Figure 28: Steam distillation unit

DAY 18 DATE: 07-07-2023

The next day, following my mentor's recommendation, I attempted to extract oil from tea leaves using the same steam distillation unit. Before introducing any new plant material, we ensured the unit was thoroughly cleaned. Fresh vacuum seals were placed on the joints, and the boiler and condenser were filled with fresh water.

We loaded 250 grams of tea leaves into the plant material chamber. At 10:15 am, we switched on the heater, and by 10:50 am, we observed the first few drops forming in the separator. The experiment continued until 4 in the evening. However, we noticed that no significant amount of oil was accumulating in the separator. It became evident that the oil was collecting in the boiler water rather than flowing into the condenser.

In an attempt to rectify the situation, we allowed the boiler water to pass directly through the condenser chamber. After running it for an additional hour and observing no significant changes in the oil collected, we made the decision to switch off the unit. Subsequently, we cleaned the equipment thoroughly and reported the issue to my mentor.

Figure 29: Tea leaves used for the experiment

DAY 19 DATE: 10-07-2023

The next day, we initiated a discussion to identify the potential issues that might have caused the failure of the previous experiment. After careful research and thorough discussion, we discovered that, to achieve better oil extraction from tea leaves, it is crucial to cut the leaves into smaller pieces and dry them before using them in the distillation process. Additionally, it was recommended that young tea leaf buds be used instead of fully grown leaves for more effective oil extraction. We promptly reported these findings to my mentor. However, given the unavailability of young tea leaf buds at the time, my mentor advised me to select an alternative plant material for the upcoming experiment.

After conducting further research and discussion, we decided to use neem leaves for the next day's experiment. The steam distillation unit was meticulously cleaned and prepared for use the following day.

DAY 20 DATE: 11-07-2023

The next day, following my mentor's recommendation, I attempted to extract oil from neem leaves using the same steam distillation unit. Before introducing any new plant material, we ensured the unit was thoroughly cleaned. Fresh vacuum seals were placed on the joints, and the boiler and condenser were filled with fresh water.

We decided to dry the neem leaves for 5 minutes in a dryer before placing them into the chamber. Subsequently, we loaded 250 grams of neem leaves into the plant material chamber. At 10:00 am, we switched on the heater, and by 10:40 am, we observed the first few drops forming in the separator. The experiment continued until 2 in the afternoon. Although not much, a layer of oil was seen forming on top of the oil separator, which we extracted using the valve. The hydrosol was then boiled once more to extract any remaining oil. After completing the entire process, we collected approximately 0.75 ml of oil from the separator. The oil was stored in a proper container and labeled for future use.

The unit was then thoroughly cleaned, dried, dismantled, and properly stored away.

Figure 30: Dried neem leaves used in the experiment

DAY 21 DATE: 12-07-2023

I decided to return to CNC machining to further enhance my machining skills and refine my CNC programming expertise. This presented an exciting opportunity for me to continue developing my knowledge and proficiency in the world of computer numerical control machining.

Practice code #1

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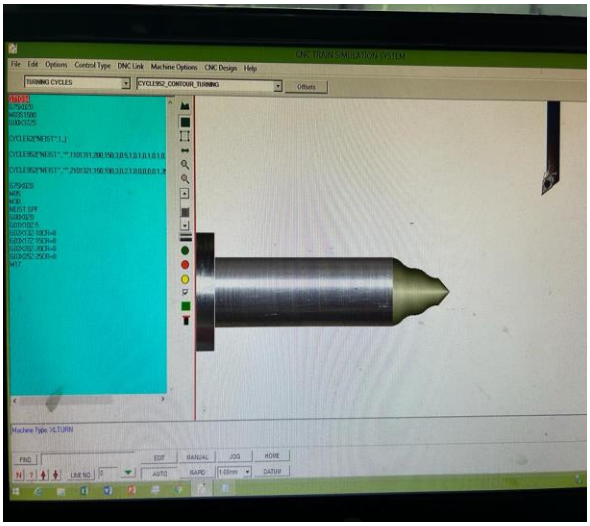

Figure 31: Turning Simulation of practice #1

Figure 32: Final product

Practice code #2

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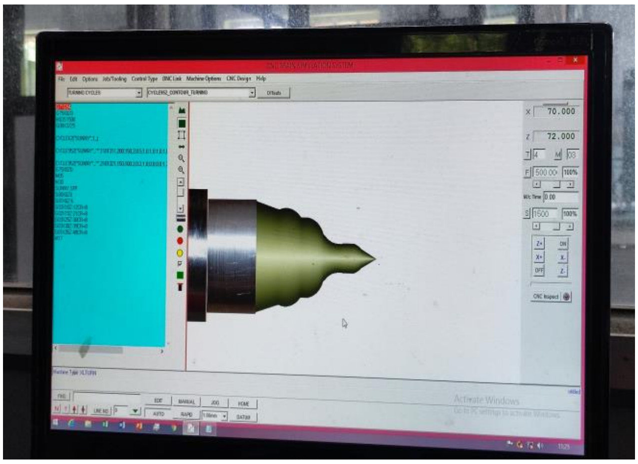

Figure 33: Turning Simulation of practice #2

DAY 22 DATE: 13-07-2023

I submitted my internship report to my mentor, eagerly awaiting their suggestions and corrections. After handing in the report, I dedicated the rest of the day to furthering my knowledge and skills by exploring different types of machinery. This hands-on experience allowed me to expand my understanding of various manufacturing processes and the equipment involved. It was a rewarding way to complement my theoretical knowledge with practical insights, giving me a more holistic perspective on the world of machining.

DAY 23 DATE: 14-07-2023

After diligently making the necessary corrections as suggested by my mentor, Mr. Dhanjit Das, I submitted to him a finalized copy of my internship report. In doing so, I expressed my sincere gratitude for his unwavering guidance and support throughout the entire internship journey. His insights and expertise had been invaluable in shaping my learning experience.

Taking the opportunity to extend my appreciation further, I also expressed my heartfelt thanks to my instructors, Mr. Uttam Hazarika and Mr. Partha Pratim Hazarika. Their dedicated guidance and encouragement had been instrumental in my professional development during the course of my internship.

With my polished report in hand, I proceeded to submit a copy to the HR department. Additionally, my mentor graciously provided me with a forwarded letter that would be pivotal in obtaining my internship completion certificate.

With these final steps, I conclude my internship with CSIR-NEIST, carrying forward the knowledge and skills I have acquired into the next phase of my professional life.

SUMMARY

My summer internship was a rich learning experience in welding, CNC machining, universal testing, and steam distillation for oil extraction. I worked closely with seasoned professionals, applying my academic knowledge to practical situations.

During the welding component of the internship, I learned various welding techniques, including MIG, TIG, and arc welding. I gained proficiency in interpreting technical drawings, selecting appropriate welding materials, and operating welding equipment safely. Additionally, I developed a strong understanding of welding principles, such as heat control and material compatibility.

In the CNC machining segment, I acquired practical skills in operating computer numerical control (CNC) machines. I learned how to program the machines, set up workpieces, and utilize various cutting tools for precision machining. This experience enhanced my knowledge of manufacturing processes and allowed me to appreciate the importance of accuracy and attention to detail in the production of complex parts.

Working with the universal testing machine provided me with insights into material testing and characterization. I learned how to conduct mechanical tests such as tensile, compressive, and hardness tests, and gained knowledge of the properties and behaviour of different materials under stress. This experience deepened my understanding of material science and its application in engineering.

Lastly, the extraction of oil using steam distillation taught me about the mechanical processes involved in extracting essential oils from plant materials. I learned the principles of steam distillation, including the proper setup of equipment, temperature control, and collection of distillates.

Overall, this summer internship allowed me to apply my theoretical knowledge to practical situations and develop essential skills relevant to my field of study. I am grateful for the opportunity and confident that the skills and experience gained during this internship will serve as a strong foundation for my future career in engineering.