



TA212A: Manufacturing Processes II



Electronic Spirograph with Selection Center

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Abstract

Objective: The motivation behind embarking on the journey of creating an electronic spirograph project is to explore the convergence of creativity and technology. Spirographs have fascinated artists, mathematicians, and enthusiasts alike for decades, captivating with their intricate and repetitive patterns. By infusing this traditional art form with the precision and automation offered by modern tools, we are presented with an exciting opportunity to re-imagine the spirograph experience.

Number of Parts Manufactured: 23

Cost of The Project: ₹17362.5

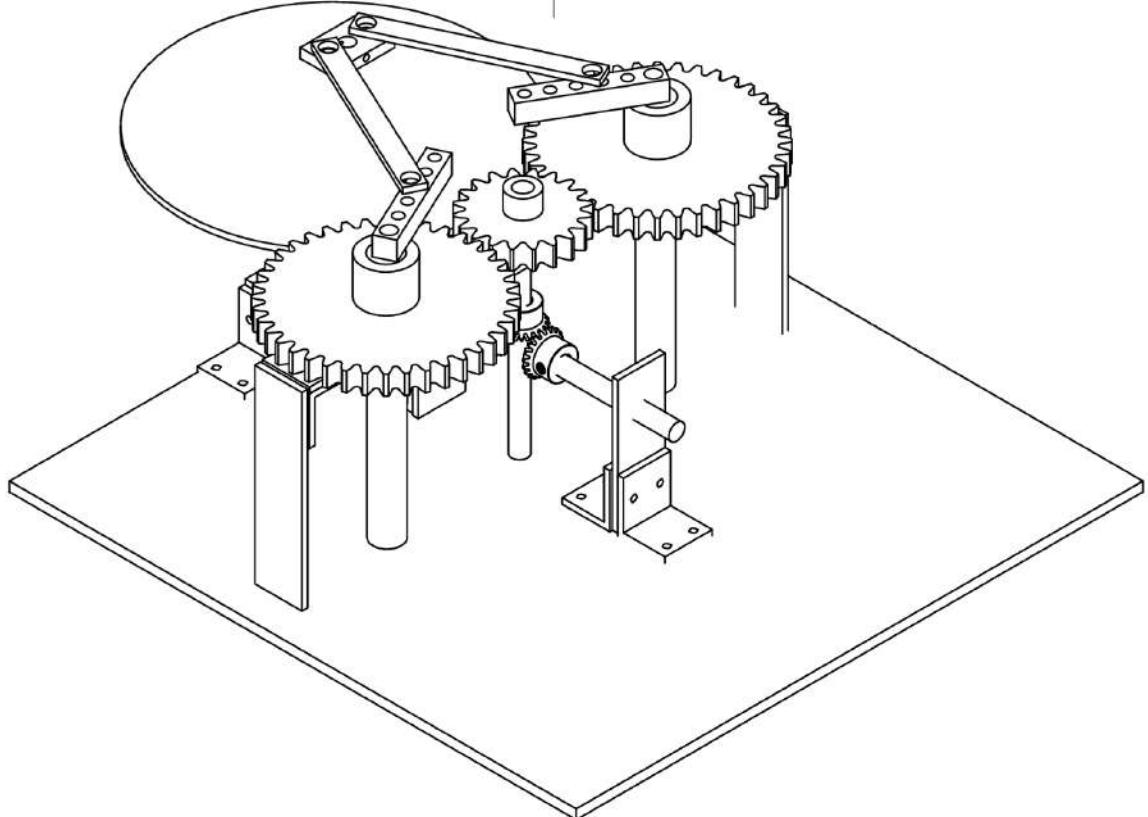
Suggested Improvements: Integrate algorithms for automatic pattern generation, enabling the spirograph to create complex designs independently, based on predefined parameters or random inputs. Incorporate LED lights to illuminate the drawing surface, adding visual appeal and creating a dynamic display of the drawing process.

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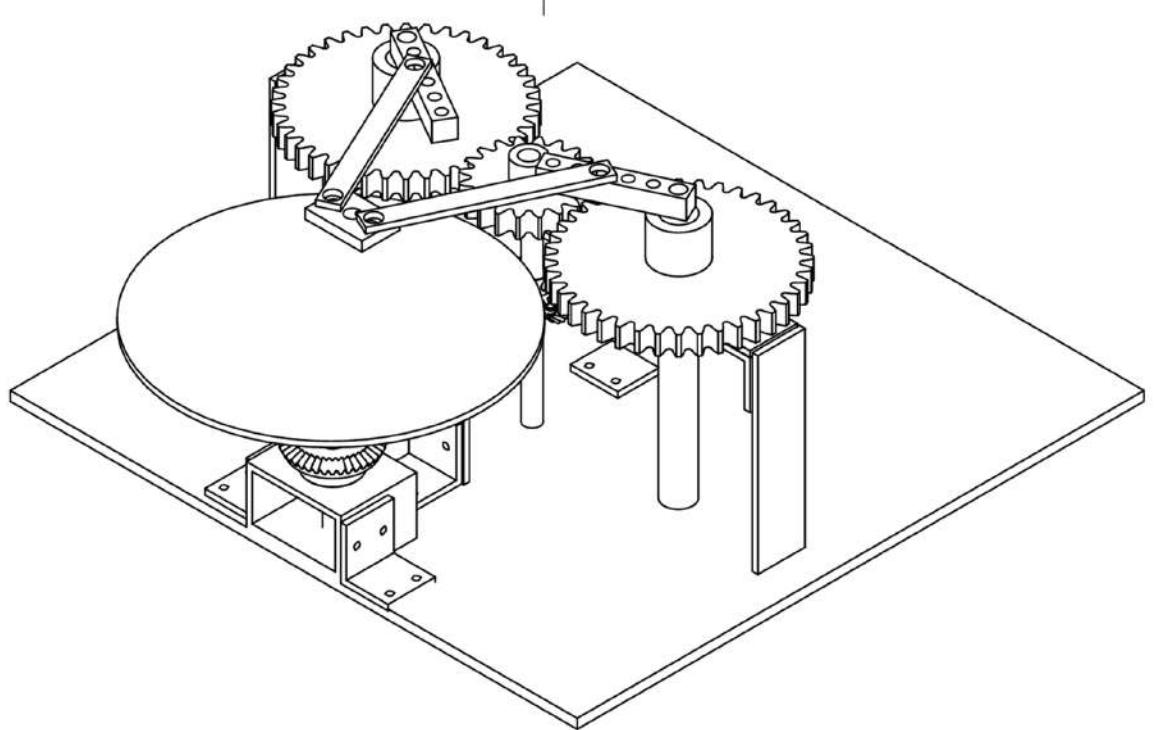
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PART LIST

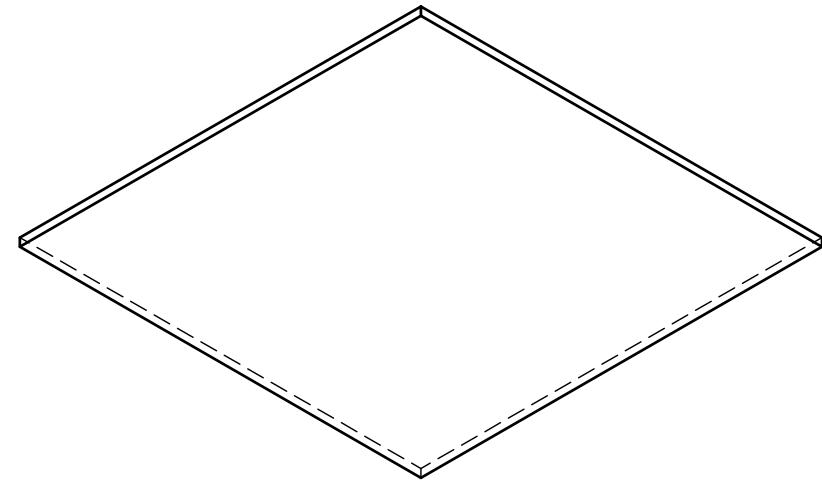
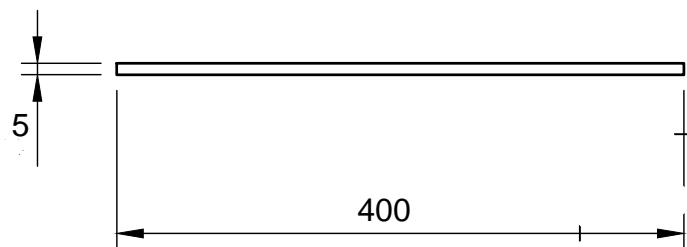
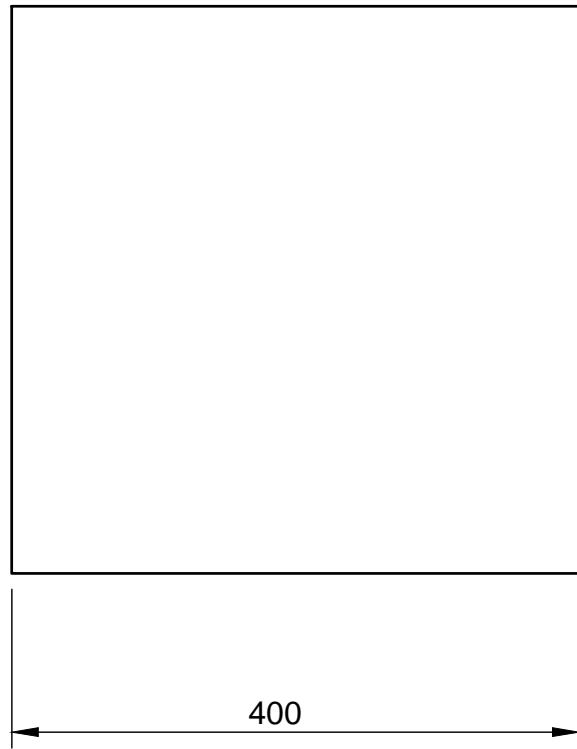
Part No.	Part Name	Qty.	Material (in MM)	Part Manufactured (OR) Bought	Machining Operation
1	Base Plate 1	1	MS 400×400×5	Manufactured	Drilling, Cutting
2	Base Plate 2	1	Wood $\Phi 160 \times 5$	Manufactured	Drilling, Cutting
3	Horizontal Big Holder	2	MS 150×50×10	Manufactured	Drilling, Cutting
4	Horizontal Small Holder	2	MS 100×8× $\Phi 20$	Manufactured	Miling, Driling
5	Spur Gear(40) Spur Gear(60)	2,1	MS 1.5Module 40 teeth 1.5Module 60 teeth	Manufactured	Lathing, Miling, Driling
6	Hands Joint	2	MS $\Phi 5 \times \Phi 7 \times 60$	Manufactured	Driling, Cutting
7	Pencil Holder	1	PLA $\Phi 5 \times 20 \times 30$	Manufactured	3d-Printing
8	Rod	1	MS $\Phi 12.7 \times 150$	Manufactured	Cutting, Drilling
9	Hands	2	MS $\Phi 6.5 \times 100$	Manufactured	Cutting, Drilling
10	Bevel Gear(20) Bevel Gear(40)	4,1	MS 1.5 Module 20 teeth 1.5 Module 40 teeth	Manufactured	Lathing, Miling, Driling
11	Horizontal Rod	2	MS $\Phi 12.7 \times 200$	Manufactured	Cutting, Drilling



ISOMETRIC VIEW

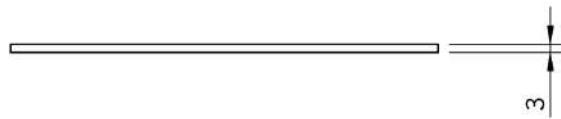
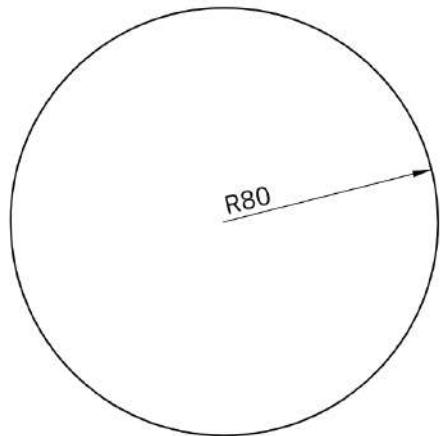


ISOMETRIC VIEW



Part Name -Base Plate 1
Quantity -1

ALL DIMENSIONS ARE IN MM



Part Name - Base Plate

Quantity - 1

Bevel Gear

QUANTITY – 1

MODULE (M) – 1.5

NUMBER OF TEETH (N) – 40

OUTER DIAMETER (OD) = $M*(N+2) = 63$

DEPTH OF CUT = $2.157*M = 3.236$

ROD DIAMETER – 12.7

INDEXING = $40/N = 1$

BEVEL GEAR

QUANTITY - 4

MODULE (M) - 1.5

NUMBER OF TEETH (N) - 20

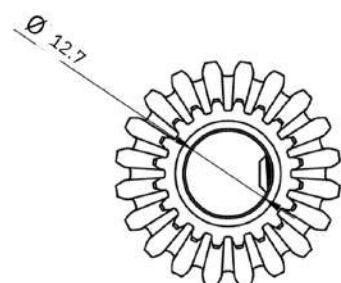
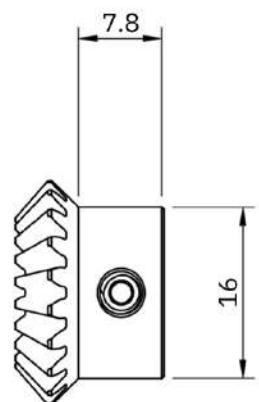
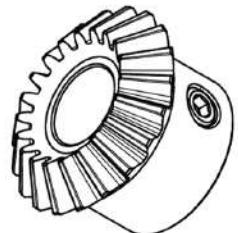
OUTER DIAMETER (OD) = $M \times (N+2)$ = 33

DEPTH OF CUT = $2.157 \times M$ = 3.236

ROD DIAMTER = 12.7

INDEXING = $40/N$ = 2

ALL DIMENSION ARE IN MM

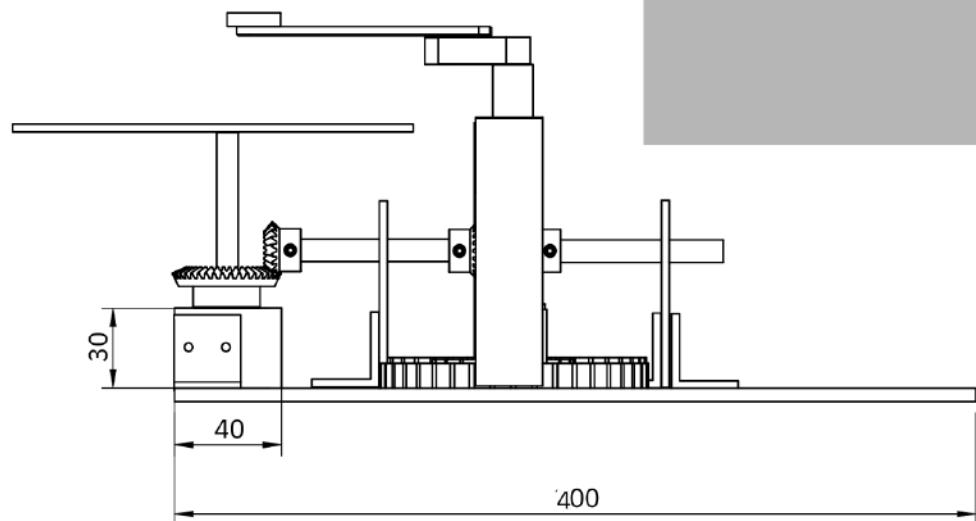


PART NAME - BEVEL GEAR

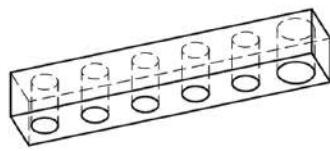
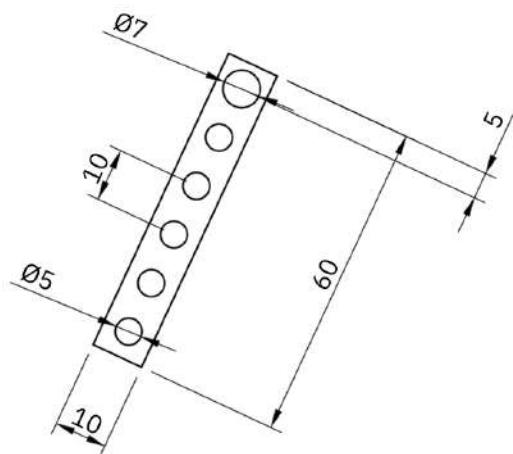
QUANTITY - 4

ALL DIMENSIONS ARE IN MM

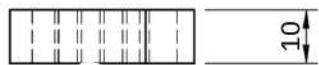
Electronic Spirograph



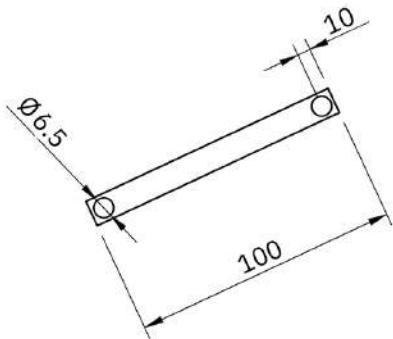
ALL MEASRUEMENTS ARE IN MM



PART NAME - HANDS JOINT
QUANTITY -2



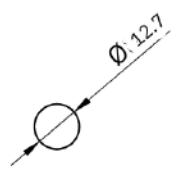
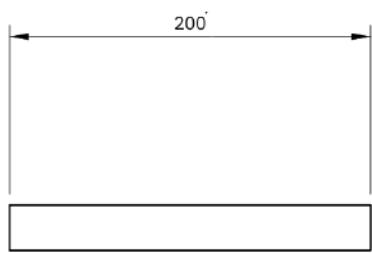
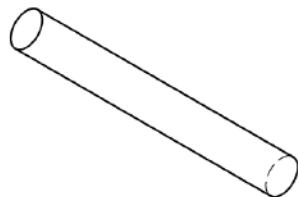
ALL DIMENSIONS ARE IN MM



Part Name - Hands

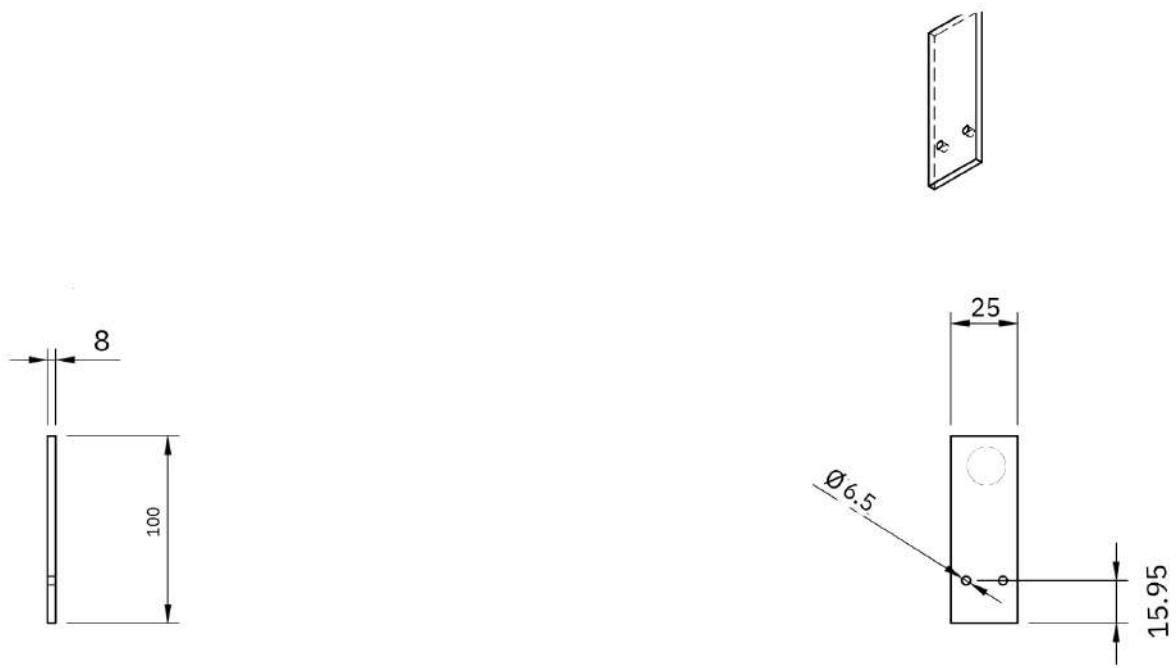
Quantity - 2

ALL DIMENSION ARE IN MM



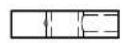
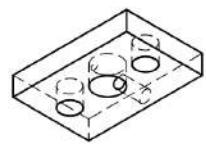
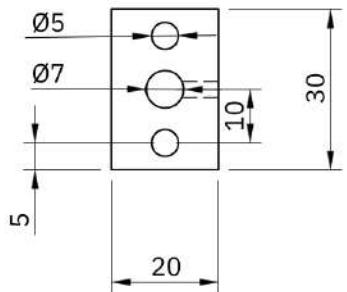
PART NAME - HORIZONTAL ROD
QUANTITY - 2

ALL DIMENSIONS ARE IN MM



Small Horizontal Holder
Quantity-2

ALL DIMENSIONS ARE IN MM

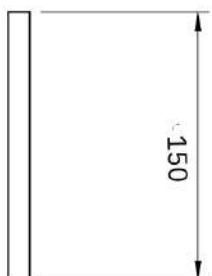


Part Name - Pencil Holder

Quantity - 1

ALL DIMENSIONS ARE IN MM

 Ø12.7



Part name - Rod
Quantity - 1

SPUR GEAR

QUANTITY = 1

MODULE (M) = 1.5

NUMBER OF TEETH (N) = 40

OUTER DIAMETER (OD) = $M \times (N + 2) = 63$

DEPTH OF CUT = $2.157 \times M = 3.236$

ROD DIAMETER = 12.7

INDEXING = $40/N = 1$

SPUR GEAR

QUANTITY = 2

MODULE (M) = 1.5

NUMBER OF TEETH (N) = 60

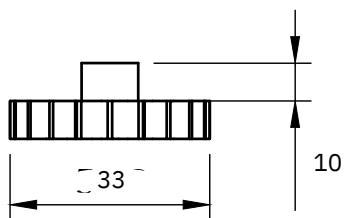
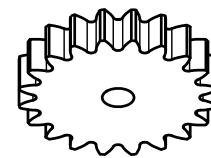
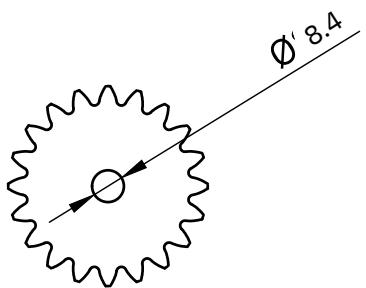
OUTER DIAMETER (OD) = $M \times (N+2)$ = 93

DEPTH OF CUT = $2.157 \times M$ = 3.236

ROD DIAMETER = 12.7

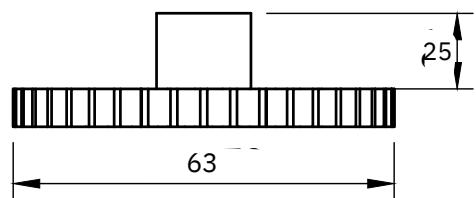
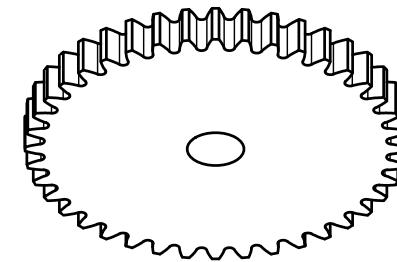
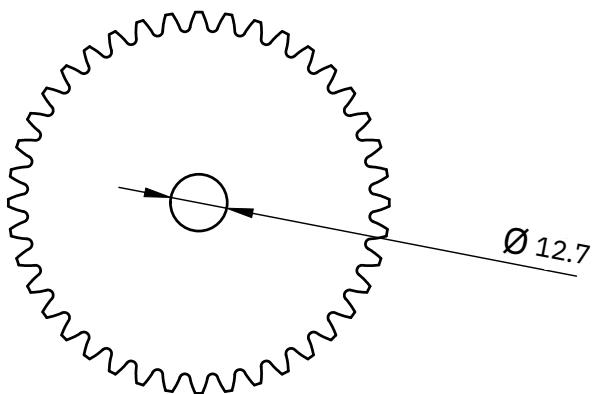
INDEXING = $40/N$ = 0.66

All dimensions are in mm



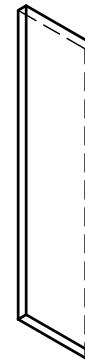
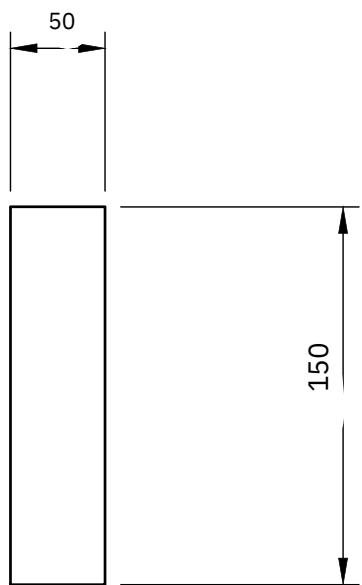
Part Name-Spur Gear(40)
Quantity - 1

All Dimensions are in mm



Part Name - Spur Gear(60)
Quantity - 2

All Dimensions are in mm



Part Name - Horizontal Big Holder
Quantity - 2

Motor Load Calculations

Analysis for the motion

Motor Provided : 12V DC

*Motor Specifications – Max Speed: 30RPM , Max Torque: 1 Nm
Load (m)*

$$\begin{aligned} &= \text{Mass} = \text{Volume of load} * \text{Density} \\ &\text{Volume} = 3.63 \times 10^{-4} \text{m}^3 \\ &\text{Density} = 7700 \text{Kg/m}^3 \end{aligned}$$

$$\begin{aligned} \text{Mass} &= 2.7951 \text{ kg} = 2.8 \text{kg (approx)} \\ \text{Friction coeff. between load and guide} &= 0 \\ (\text{Rolling friction is approximately}) &= 0 \end{aligned}$$

Screw specifications:

*Diameter : 10mm
Length : 350mm*

*Material density : 0.62 kg/m (for M.S. Rod .1 Omm)
Pitch : 1.5mm/rev*

Load inertia (J) =

$$\begin{aligned} \text{Load} \times \left(\frac{\text{pitch}}{2\pi}\right)^2 + \frac{\pi}{32} \times (\text{screw} - \text{density}) \times (\text{screw} - \text{length}) \times (\text{screw} - \text{diameter})^4 \\ = 0.159 \text{ kg m}^2 \end{aligned}$$

Acceleration torque ;

Where V = Velocity of screw in r/min and ta = time of acceleration/deceleration

$$\begin{aligned} Ta &= \frac{(J \times V)}{9.55 \times ta} \\ V &= 30 \text{rpm (assume max) and } ta = 1 \text{sec} \\ Ta &= 0.4995 \text{Nm} \\ \text{Load Torque} &\approx 0 \end{aligned}$$

Hence our net torque:

$$\begin{aligned} T &= (Ta + Tl) \times FOS \\ FOS &= 2(\text{recommended}) \\ T &= 0.4995 \times 2 \\ \text{Total Torque} &= 0.999 \approx 1 \text{Nm} \\ \text{Hence our motor is expected to work} \end{aligned}$$

COST ANALYSIS

Item	Total Time/ Amount	Rate	Total Price
Material	23 Kg	100/Kg	2300
Motor Kit	1	1000/Kit	1000
Labour Cost	18 hrs	650/per day(8 hours)	11700
Clips and Fold	2.5 Kg	120/Kg	300
Nuts and Bolts	750g	130/Kg	97.5
Drilling	3 hr	75/hr	225
Turning	4 hr	150/hr	600
Milling	4 hr	250/hr	1000
Cutting	1 hr	60/hr	60
Clips,Sketch pen,A3 sheets	N/A	N/A	80
SUM			17362.5
TOTAL			