UNIVERSITY OF WATERLOO

FACULTY OF ENGINEERING
Department of Mechanical and Mechatronics Engineering

MTE 322 Project 1

Prepared for:

MTE 322 – Electromechanical Machine Design

By:

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1 Coloring Page

The gear train in **Figure 1.1** is colored in with four distinct colors: blue, green, red, and orange. Each color represents a different speed that the part is rotating at, with blue being the housing of the gear train, thus being stationary.

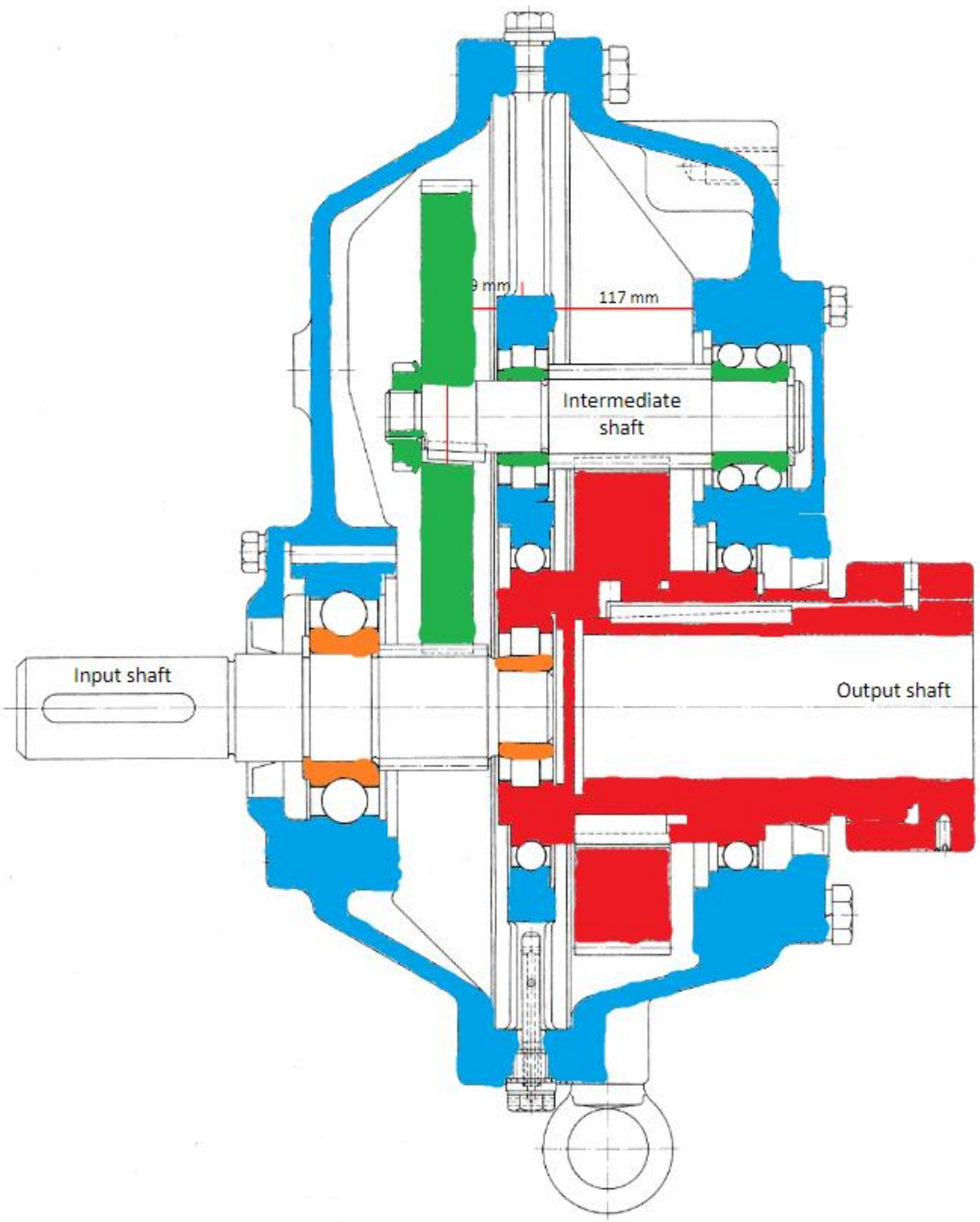


Figure 1.1: Gear train with colors representing different speeds (blue is stationary)

2 Assembly Model and Procedure

2.1 Cross Section and Model

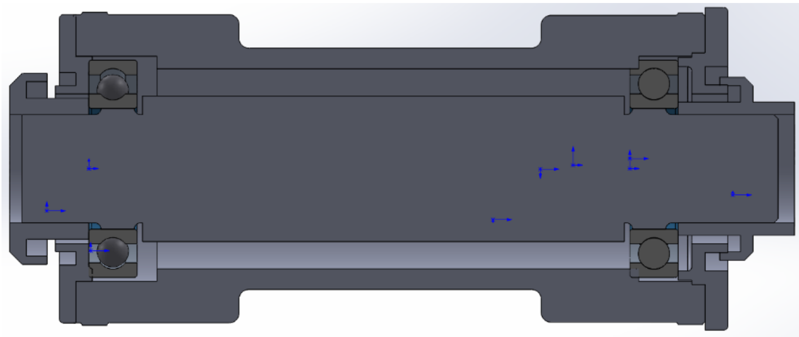
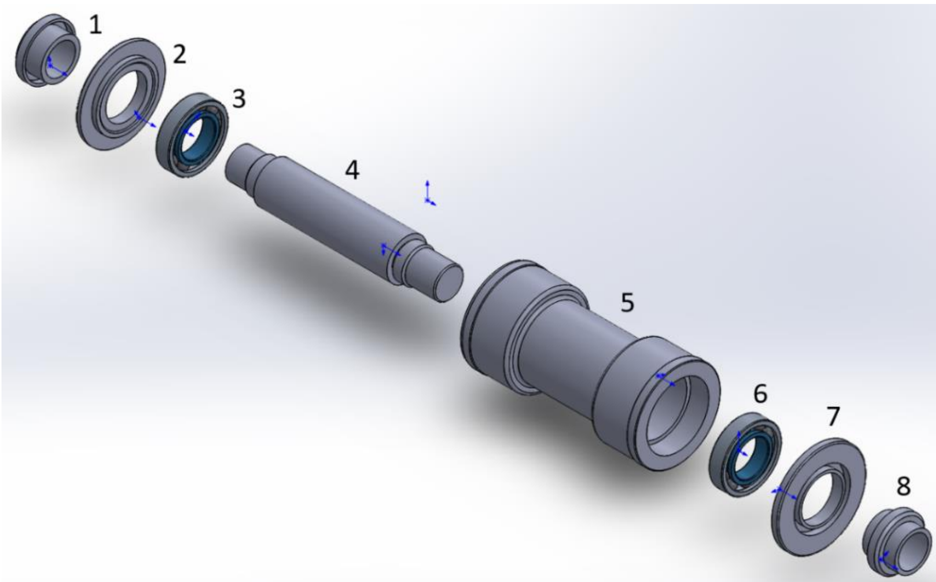


Figure 2.1: Cross section of the shaft and housing



#	Part
1	Shaft Bushing A
2	Housing Cover A
3	Bearing A
4	Shaft
5	Housing
6	Bearing B
7	Housing Cover B
8	Shaft Bushing B

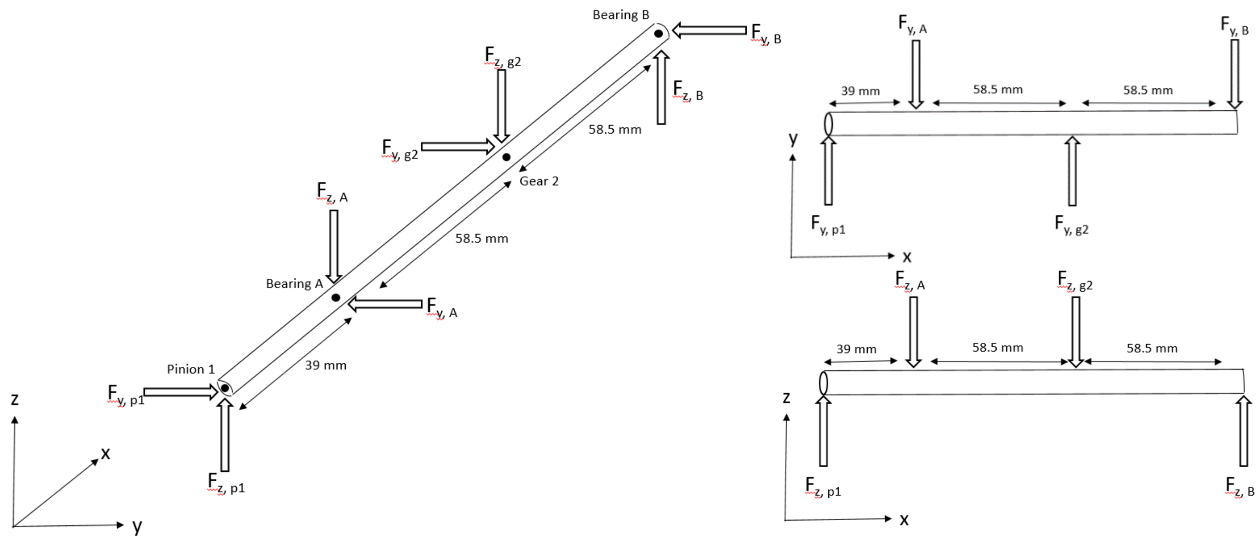
Figure 2.2: Exploded view of the shaft and housing with labelled parts

2.2 Procedure

1. Press-fit bearing A [3] onto the left side of the shaft [4]
2. Mount the housing [5] onto the shaft [4]
3. Slide in bearing B [6] onto the right side of the shaft [4]
4. Slide in housing cover A [2] into the housing [5] and around the shaft [4] on the left
5. Slide in shaft bushing A [1] into the housing [5] and around the shaft [4] on the left
6. Slide in housing cover B [7] into the housing [5] and around the shaft [4] on the right
7. Slide in shaft bushing B [8] into the housing [5] and around the shaft [4] on the right

3 Free Body Diagram and Calculations

3.1 Free Body Diagram



3.2 Calculations

The reduction ratio is:

$$N = \frac{D_{g1}}{D_{p1}} \frac{D_{g2}}{D_{p1}} = 19.216$$

The input and output torques are:

$$T_{in} = \frac{P}{n \times \eta} = 35.368\ N \cdot m \qquad T_{out} = T_{in} \cdot N \cdot \eta = 611.655\ N$$

The pinion and gear forces applied on the intermediate shaft are:

$$F_{z,p1} = \frac{T_{in}}{D_{p1}/_{2}} = 1178.926\ N \qquad F_{y,p1} = F_{z,p1} \cdot \tan(20°) = 429.094\ N$$

$$F_{z,g2} = \frac{T_{out}}{D_{g2}/_{2}} = 4993.105\ N \qquad F_{y,g2} = F_{z,g2} \cdot \tan(20°) = 1817.342\ N$$

On the x-y plane, the forces applied in the y-direction on bearing A and bearing B are:

$$F_{y,p1} + F_{y,g2} = F_{y,A} + F_{y,B}$$

$$-F_{y,p1} \cdot 0.156 + F_{y,A} \cdot 0.117 - F_{y,g2} \cdot 0.0585 = 0$$

$$F_{y,A} = 1480.796\ N \qquad F_{y,B} = 765.640\ N$$

On the x-z plane, the forces applied in the z-direction on bearing A and bearing B are:

$$F_{z,p1} - F_{z,g2} = F_{z,A} - F_{z,B}$$

$$-F_{z,p1} \cdot 0.039 - F_{z,g2} \cdot 0.0585 + F_{z,B} \cdot 0.117 = 0$$

$$F_{z,A} = 924.652\ N \qquad F_{z,B} = 2889.243\ N$$