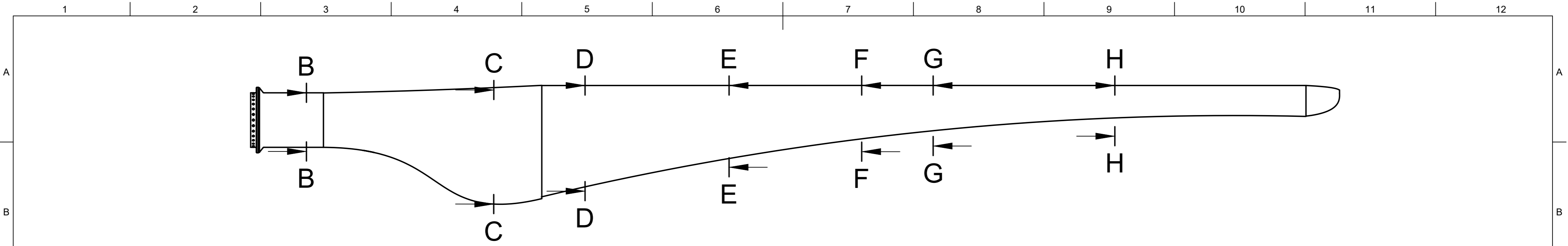


Notes:

- Fiberglass is cut into blade size and fitted into Mould.
- Route base attached to bottom of the blade.
- The carbon main spar cap is fitted in the centre of only one shell.
- Balsa wood sheets are cut and layered into the mould.
- 2 shells are attached to each other using adhesive to form a blade.
- The root has 0.08m holes drilled into it.

TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGUALR TOLERANCE $0^{\circ}15'$		BLADE DRAWN BY ZARA	
		SCALE: 1:200 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED	
ALL DIMENSIONS IN M		APPROVED BY MAHMOOD EL-MAHALAWY	
SCHOOL OF ENGINEERING		DRAWING PRODUCED IN ACCORDANCE WITH: BS8888	
SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 1 OF 17



B-B (1:50)

C-C (1:50)

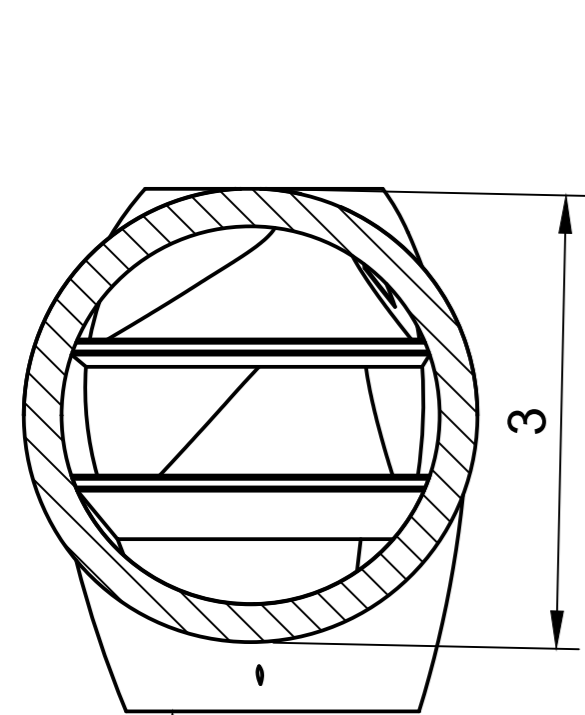
D-D (1:50)

E-E (1:50)

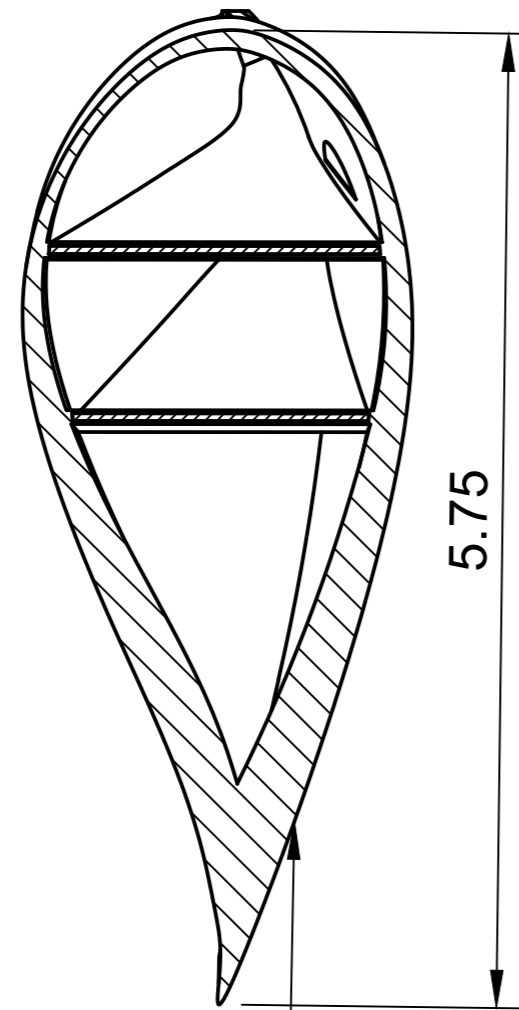
F-F (1:50)

G-G (1:50)

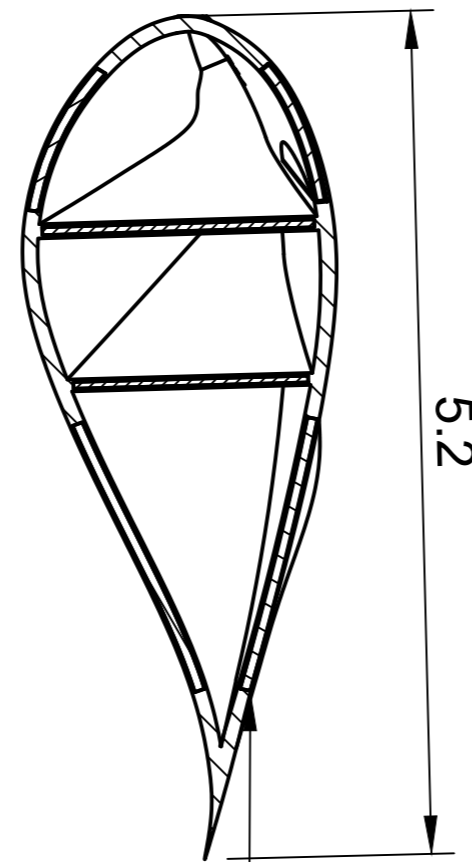
H-H (1:50)



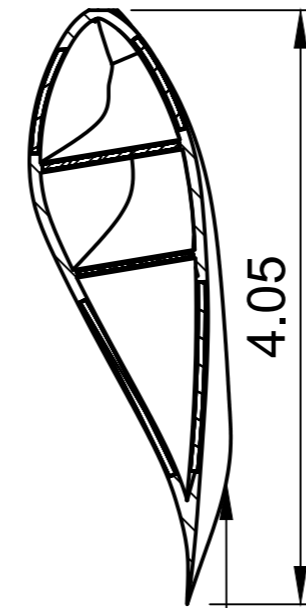
Cylinder Foil
Twist angle: 0°
Span: 0-9 m



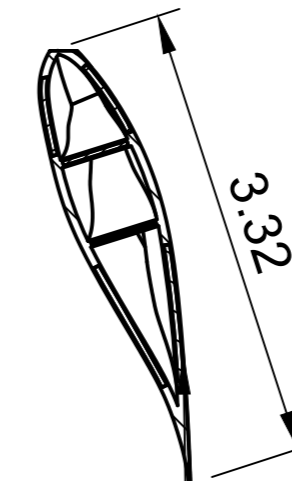
DU40_A17
Twist angle: 7°
Span: 12-15 m



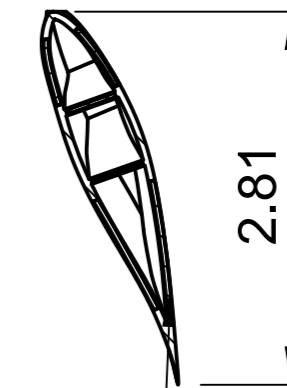
DU35_A17
Twist angle: 20°
Span: 18-21 m



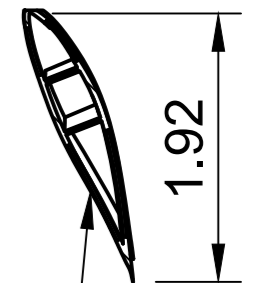
DU30_A17
Twist angle: 14°
Span: 24-27 m



DU25_A17
Twist angle: 8°
Span: 30-33 m

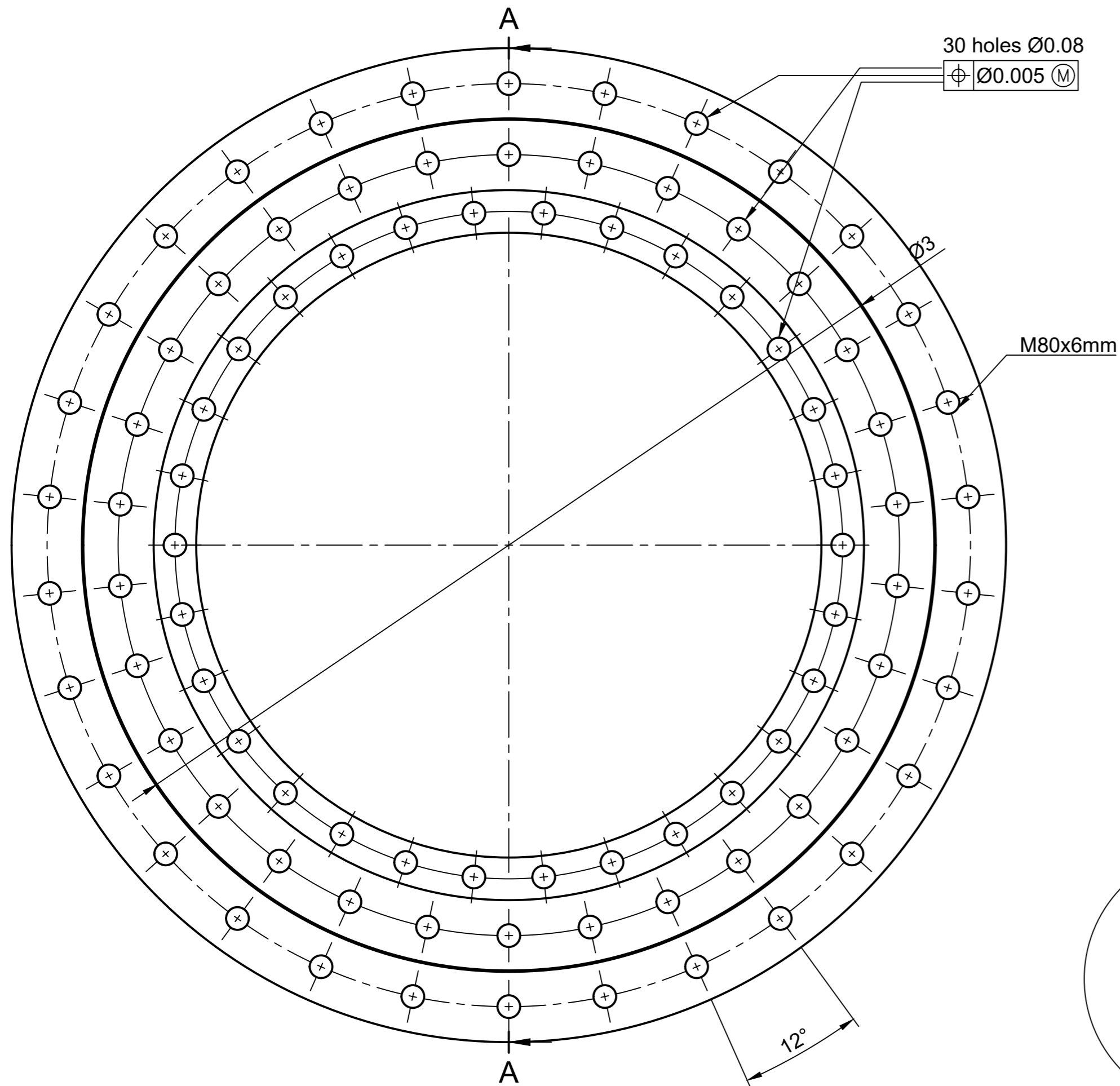
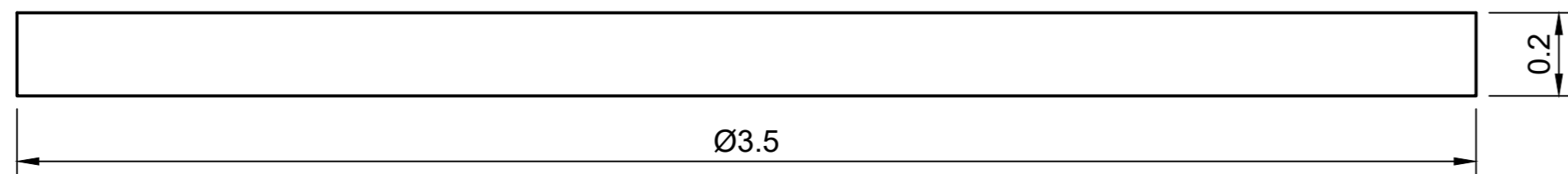


DU20_A17
Twist angle: 3°
Span: 36-39 m

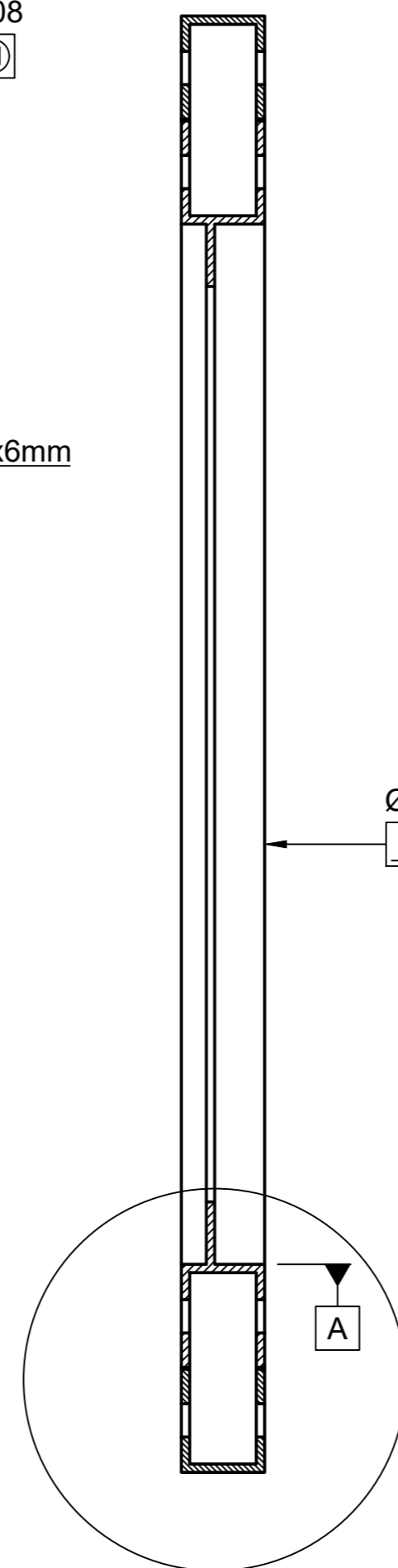


NACA64_A17
Twist angle: 1°
Span: 42-60 m

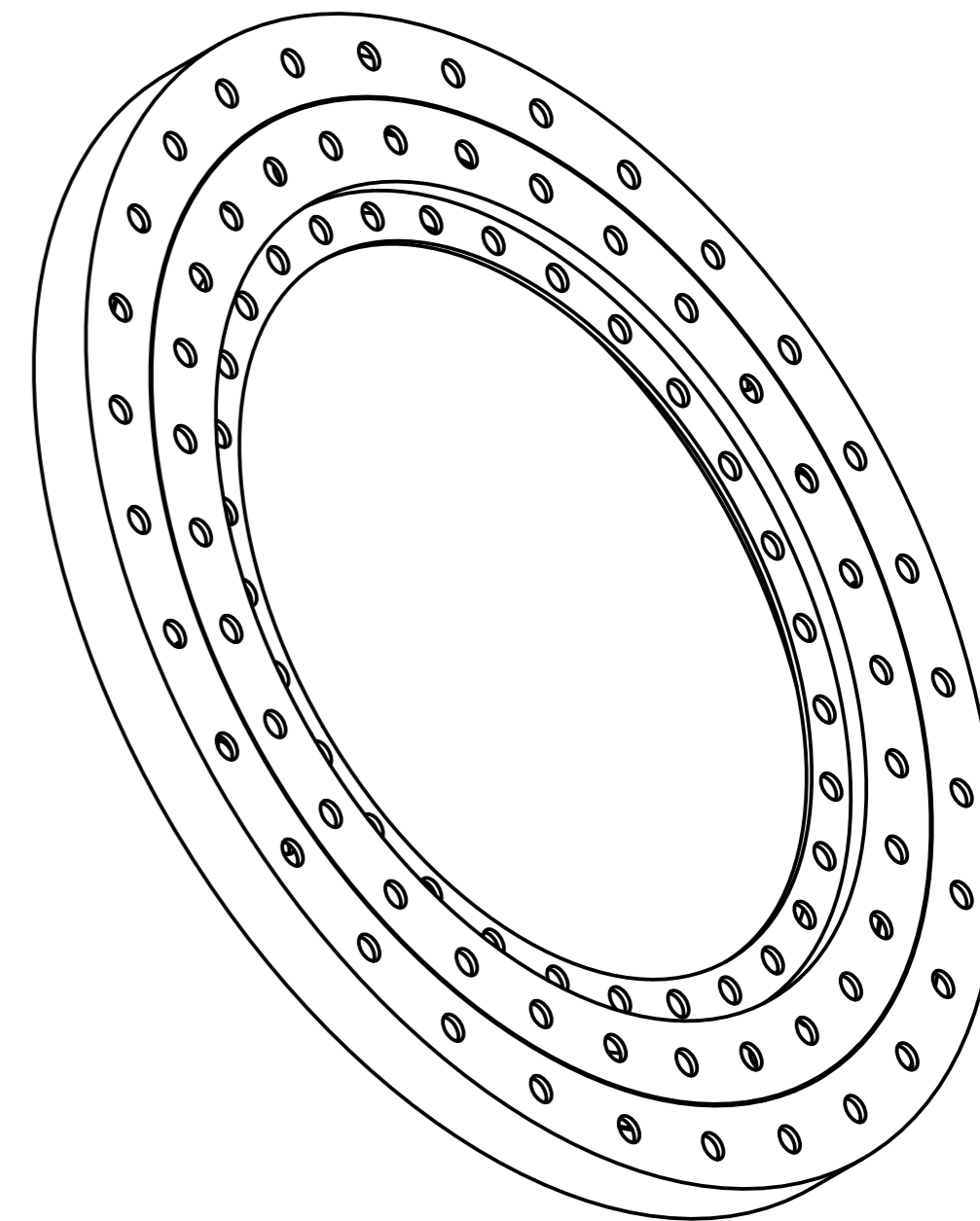
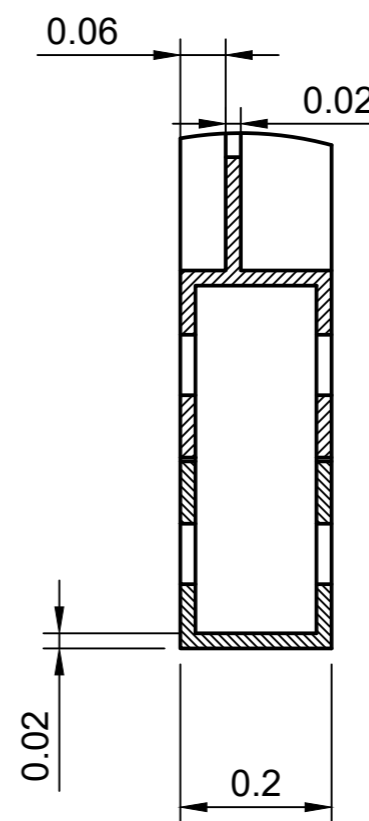
TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE 0°15'		BLADE AIRFOILS	
		PROJECTION 	DRAWN BY MAHMOOD SCALE: 1:150 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
ALL DIMENSIONS IN M		APPROVED BY ZARA IMAN	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 2 OF 17



A-A (1:15)

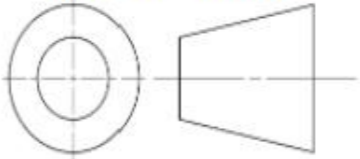


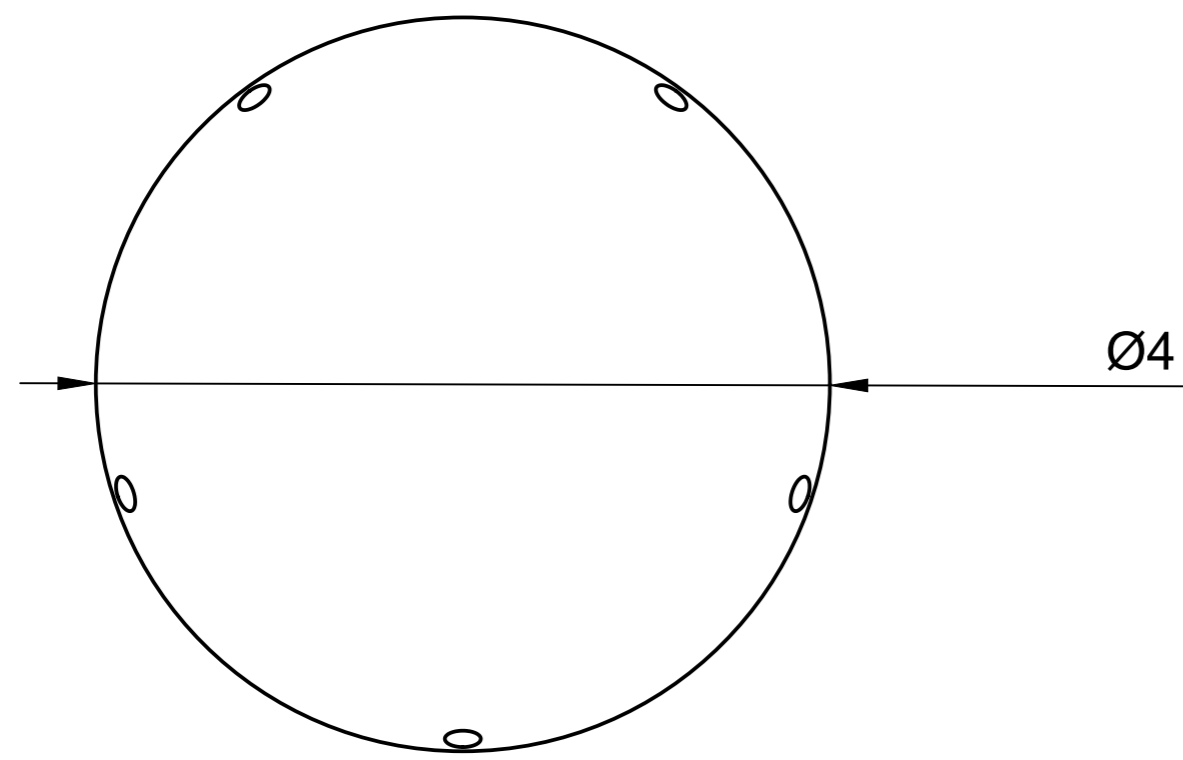
B (1:10)



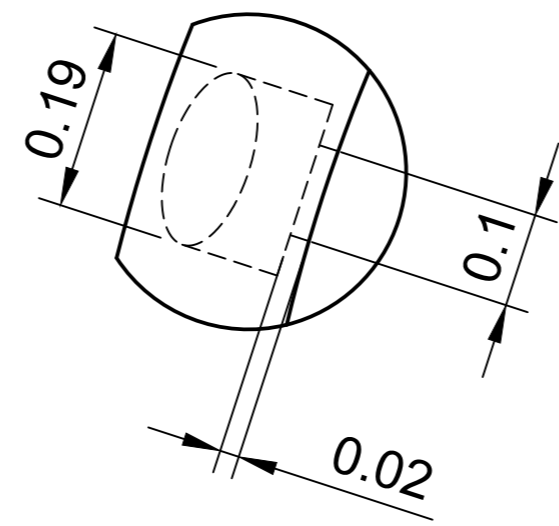
Notes:

- Drill 80 mm holes 90 times on the surface of the bearing housing
- General shape is machined

TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE $0^\circ 15'$		BEARING HOUSING	
		PROJECTION	DRAWN BY ZARA
ALL DIMENSIONS IN M SCHOOL OF ENGINEERING SHEET SIZE: A2 27/04/24		 APPROVED BY MAHMOOD EL-MAHALAWY ISSUE 1	SCALE: 1:15
			SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
		DRAWING PRODUCED IN ACCORDANCE WITH: BS8888 SHEET 3 OF 17	

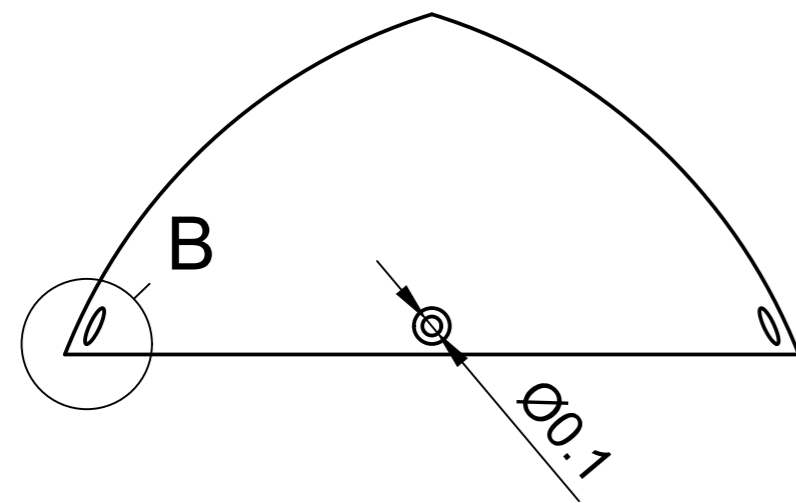


C (1:8)

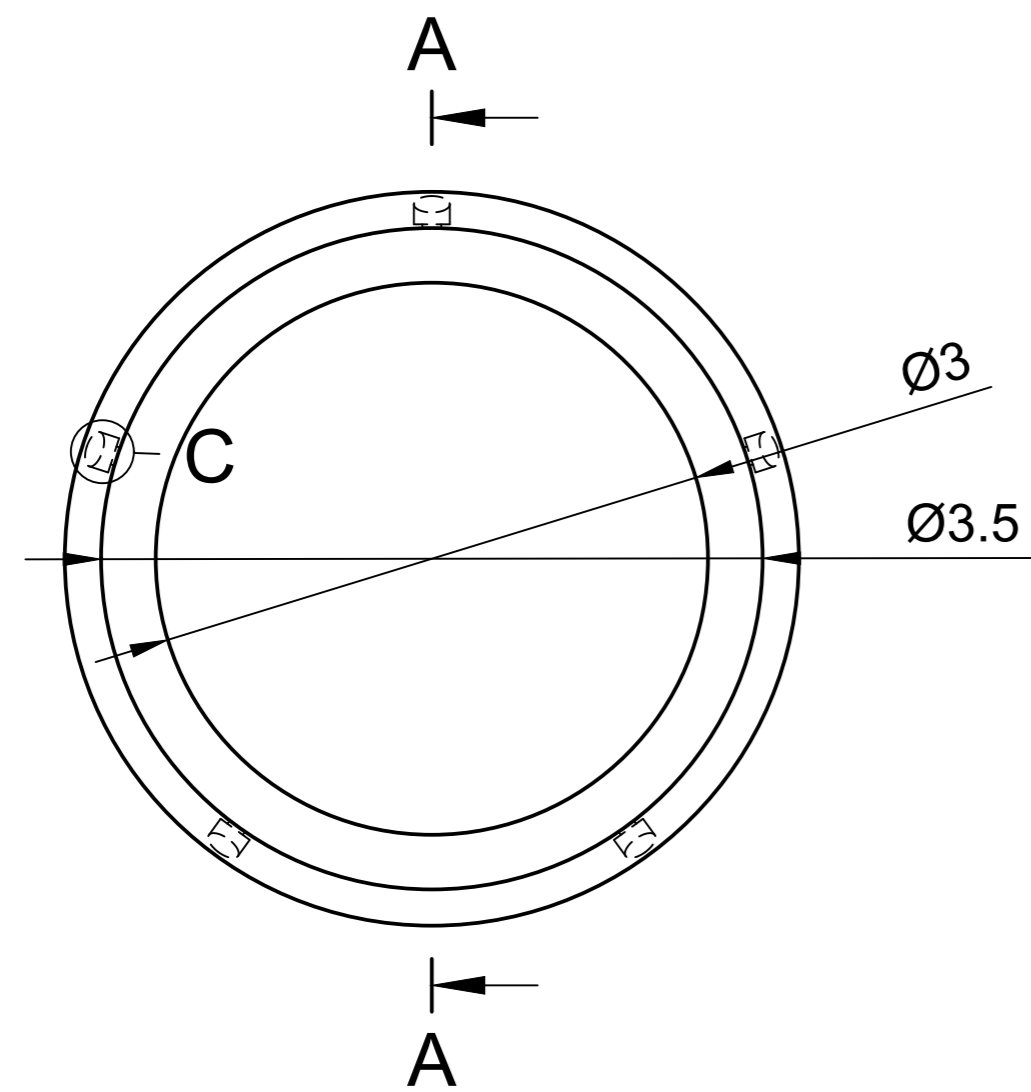
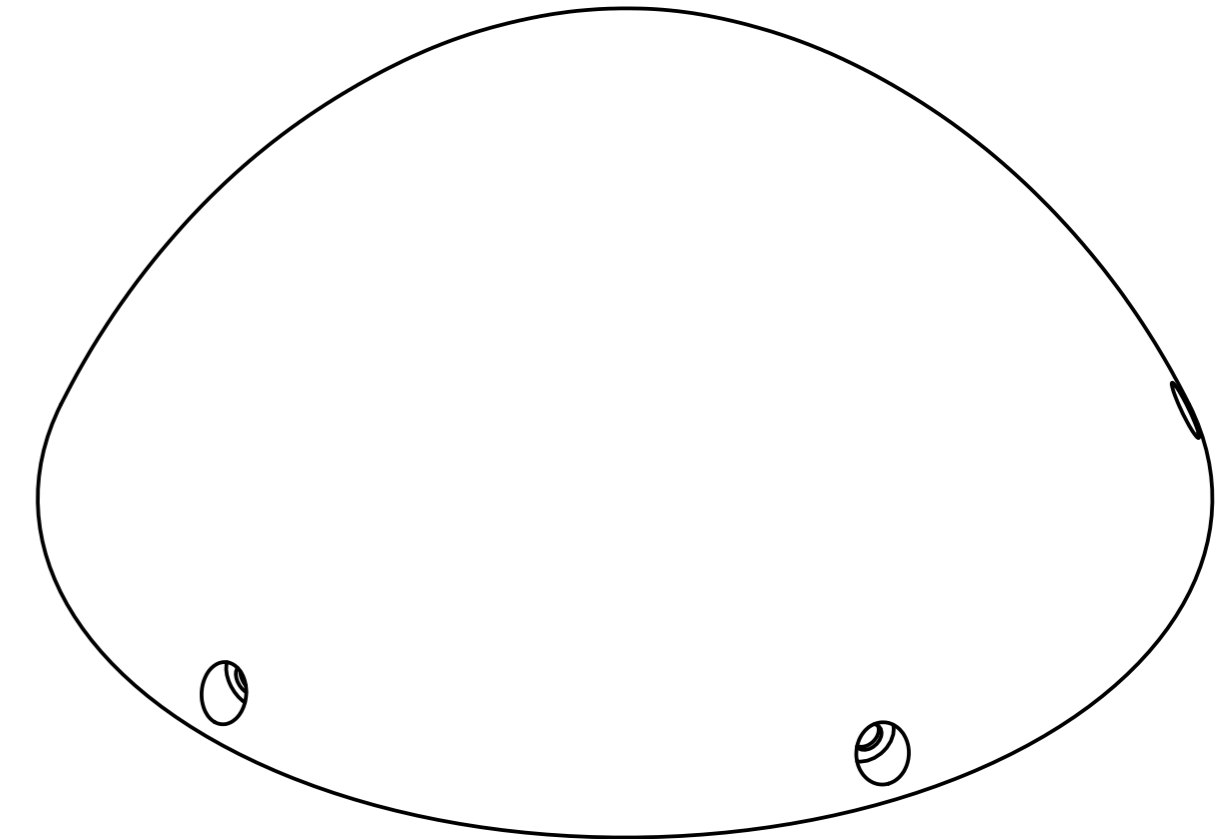
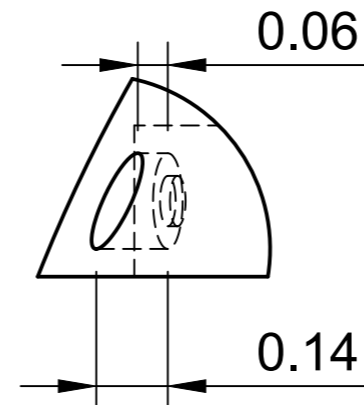


Notes:

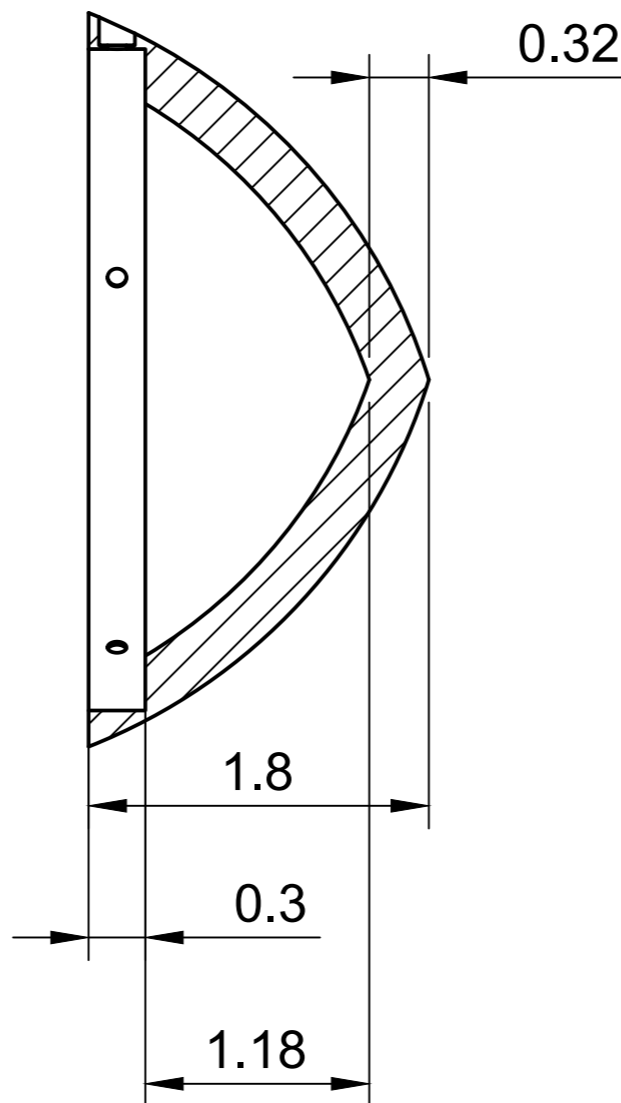
- Drill 80 mm diameter holes to create connection with turbine hub.
- Surface of nose is sanded and polished



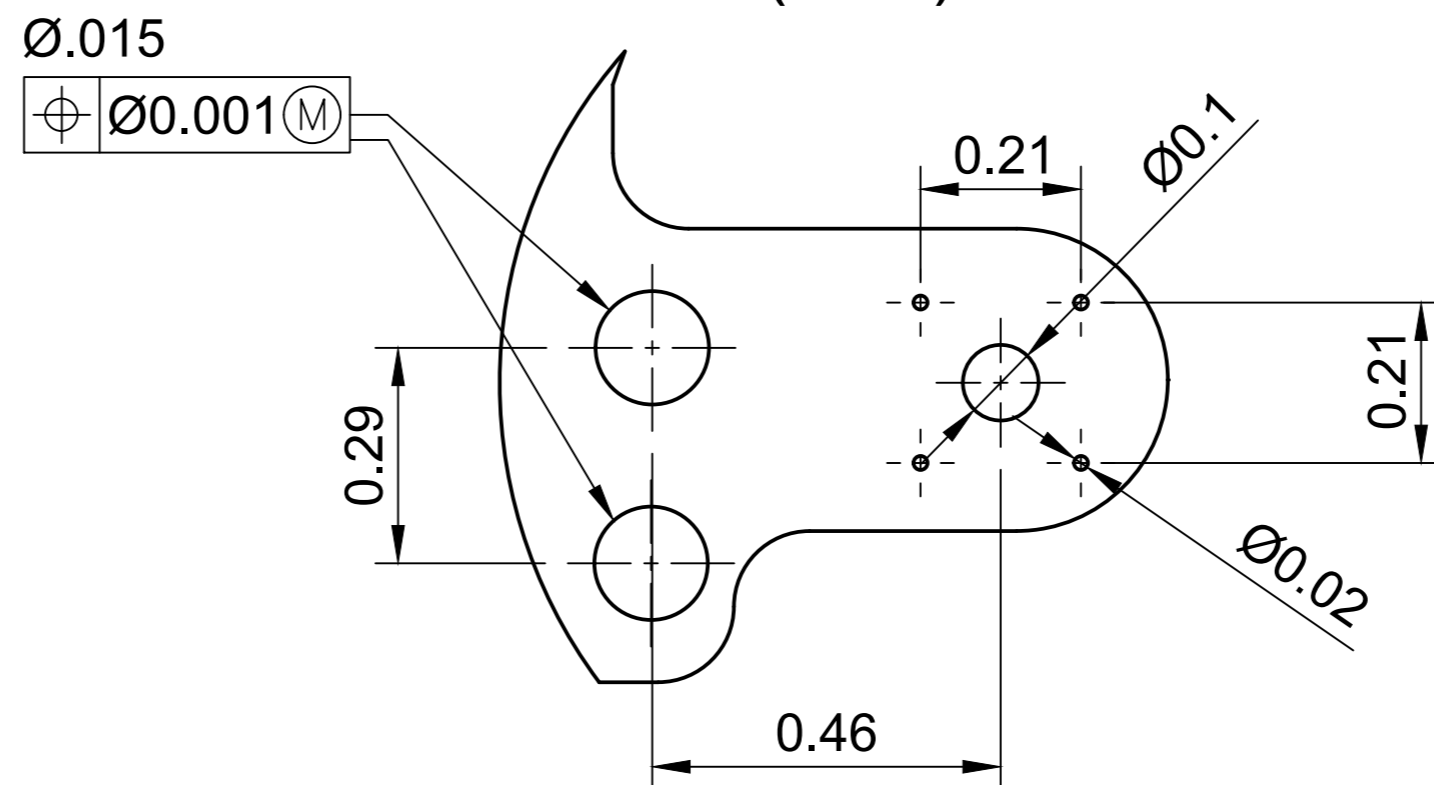
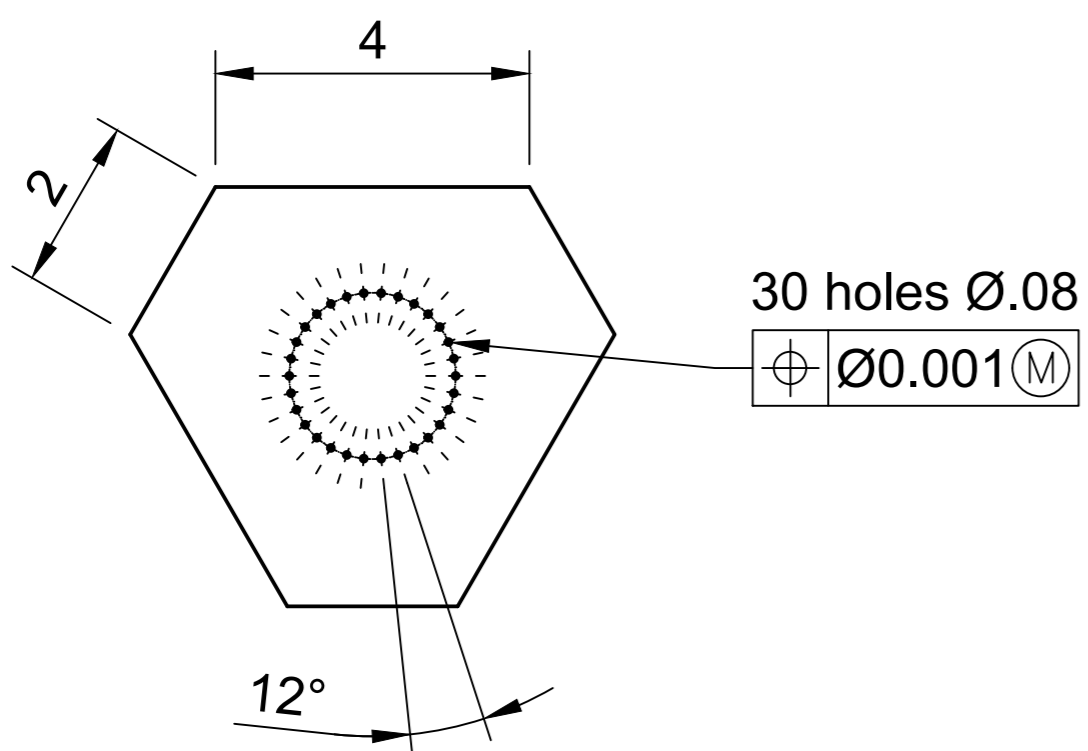
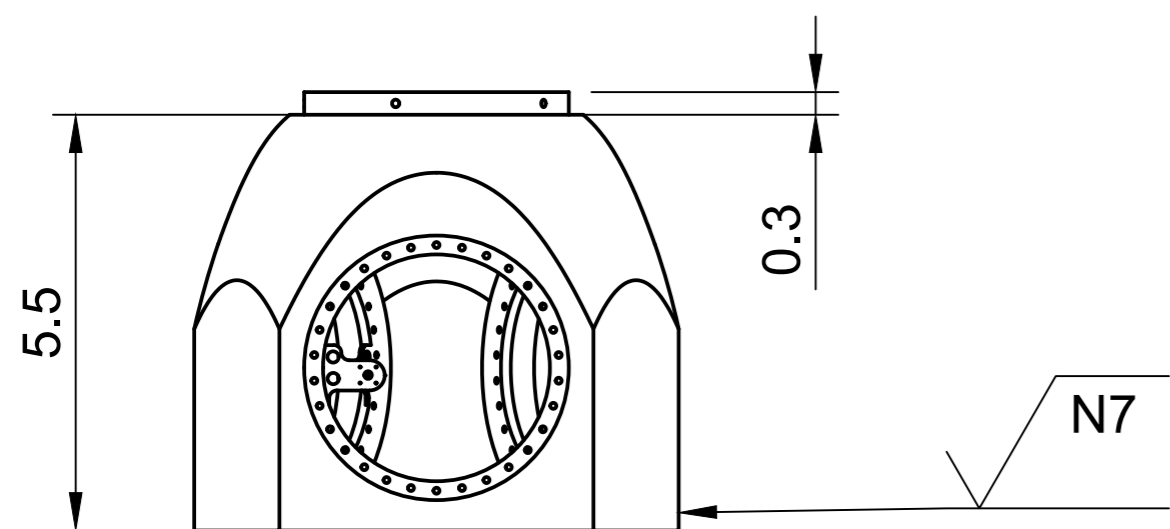
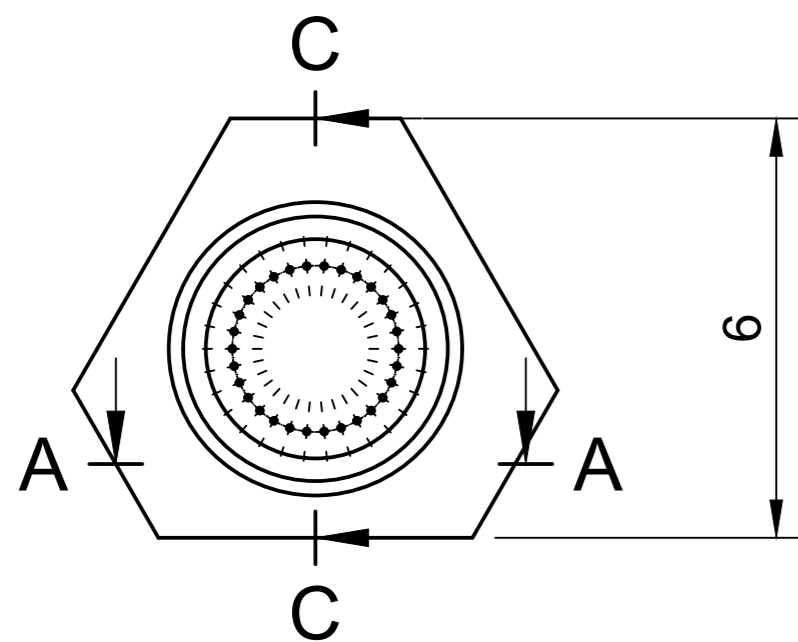
B (1:15)



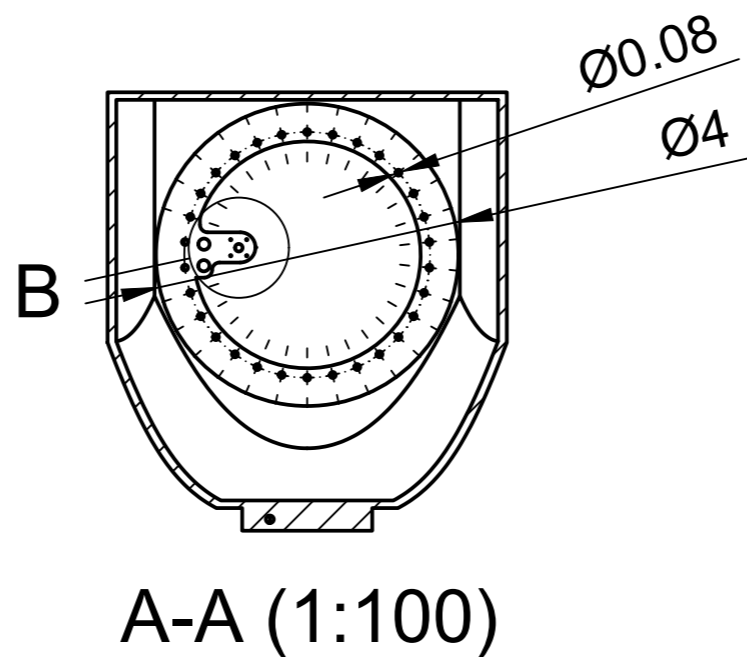
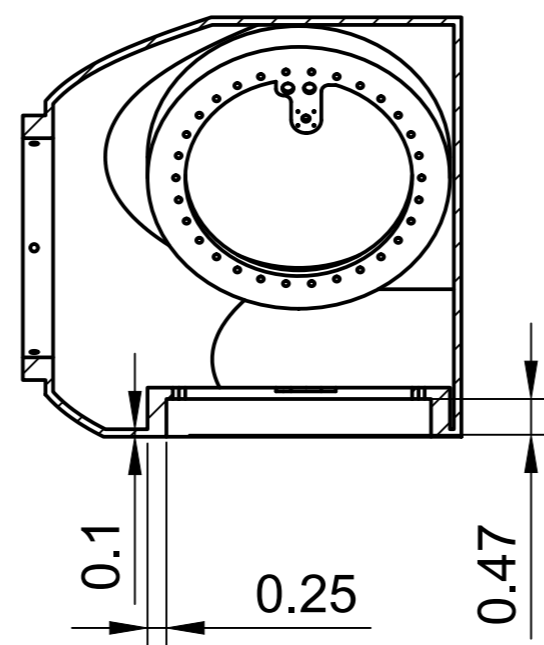
A-A (1:40)



<p>TOLERANCES UNLESS OTHERWISE STATED:</p> <p>WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE 0°15'</p> <p>ALL DIMENSIONS IN M</p>	<p>NOSE CONE</p>		
	<p>PROJECTION</p>	<p>DRAWN BY ZARA</p> <p>SCALE: 1:40</p> <p>SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED</p>	
<p>SCHOOL OF ENGINEERING</p>	<p>APPROVED BY MAHMOOD EL-MAHALAWY</p>	<p>DRAWING PRODUCED IN ACCORDANCE WITH: BS8888</p>	
<p>SHEET SIZE: A2</p>	<p>27/04/24</p>	<p>ISSUE 1</p>	<p>SHEET 4 OF 17</p>

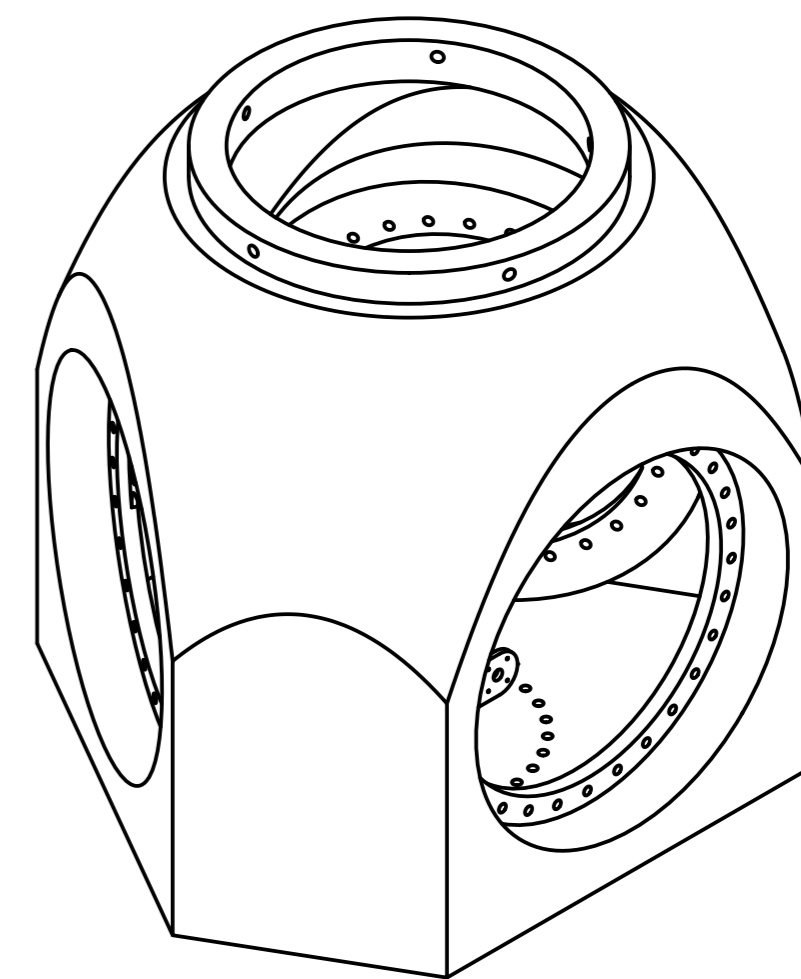


C-C (1:100)



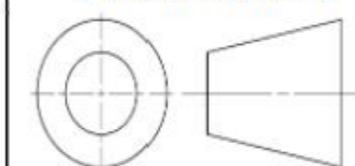
Notes:

- The surfaces and edges of hub body are milled.
- Drill 80 mm diameter holes to connect blades.
- Drill 80 mm diameter holes into surface to connect nose hub.



TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE 0°15'	HUB DRAWN BY ZARA	
	SCALE: 1:100	
ALL DIMENSIONS IN M	SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED	
SCHOOL OF ENGINEERING	APPROVED BY MAHMOOD EL-MAHALAWY	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SHEET SIZE: A2 27/04/24	ISSUE 1	SHEET 5 OF 17

PROJECTION

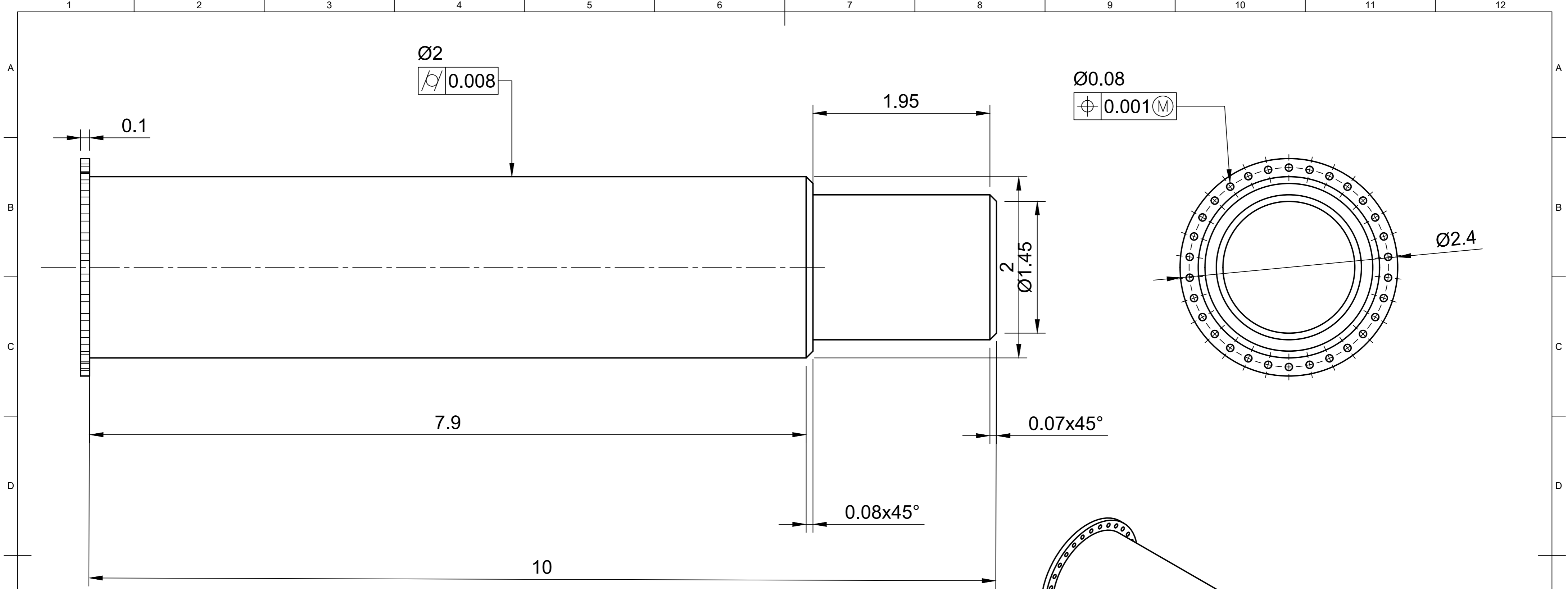


APPROVED BY
MAHMOOD EL-MAHALAWY

ISSUE 1

DRAWN BY ZARA
SCALE:
1:100
SURFACE ROUGHNESS: N7
UNLESS OTHERWISE STATED

DRAWING PRODUCED IN
ACCORDANCE WITH:
BS8888
SHEET 5 OF 17



A (1:35)

Notes:

- The general shape of shaft is forged
- Excess material is removed to achieve tight tolerances.
- Drill 8 mm holes into head
- Shaft chamfered at 8m from the root before being stepped down
- Shaft chamfered 9.95m from root

TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ±0.10 TWO DECIMAL PLACES ±0.05 ANGULAR TOLERANCE 0°15'		LOW SPEED SHAFT	
		PROJECTION 	DRAWN BY MAHMOOD SCALE: 1:40 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
ALL DIMENSIONS IN M		APPROVED BY ZARA IMANs	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 6 OF 16

A

B

C

D

E

F

G

H

A

B

C

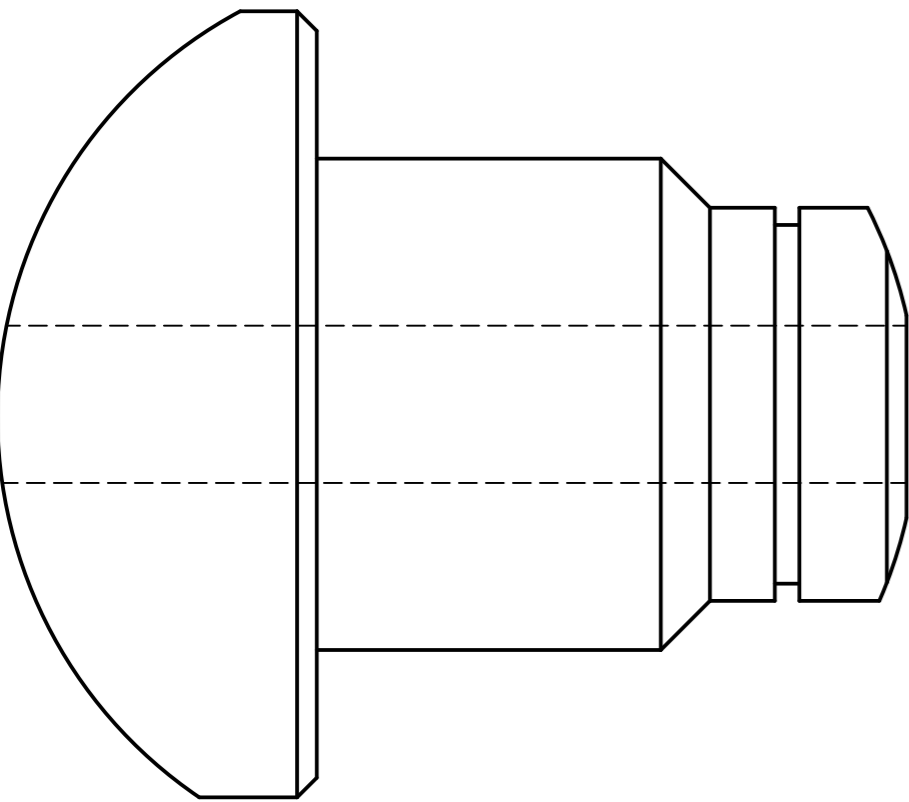
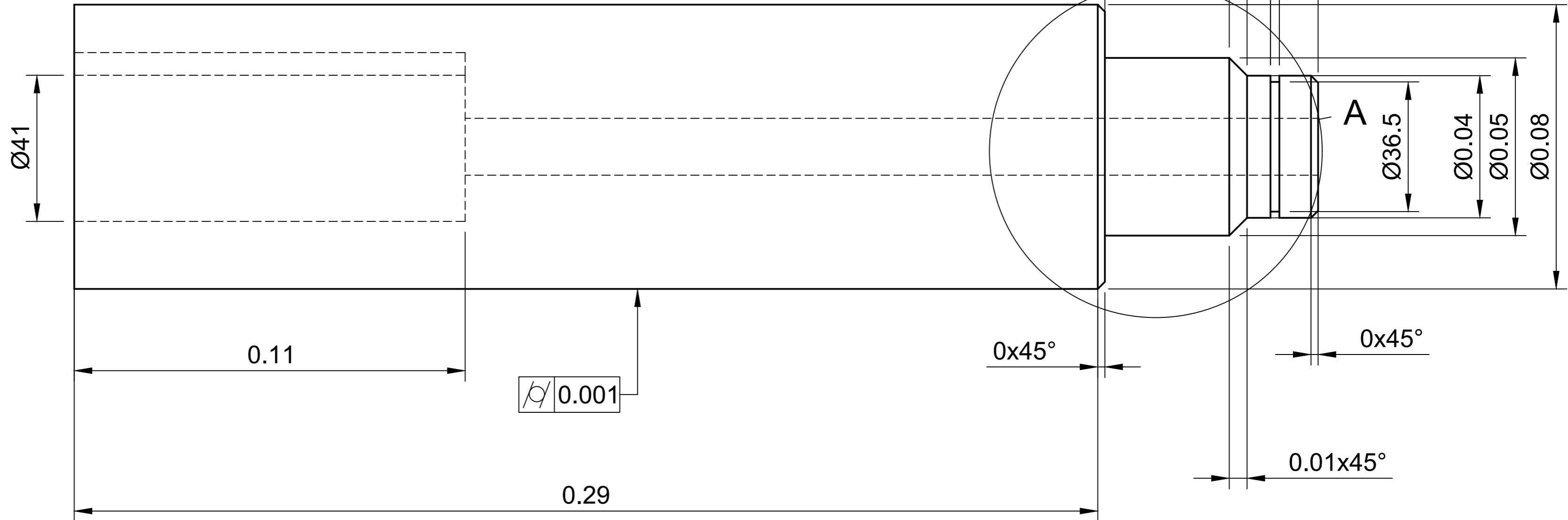
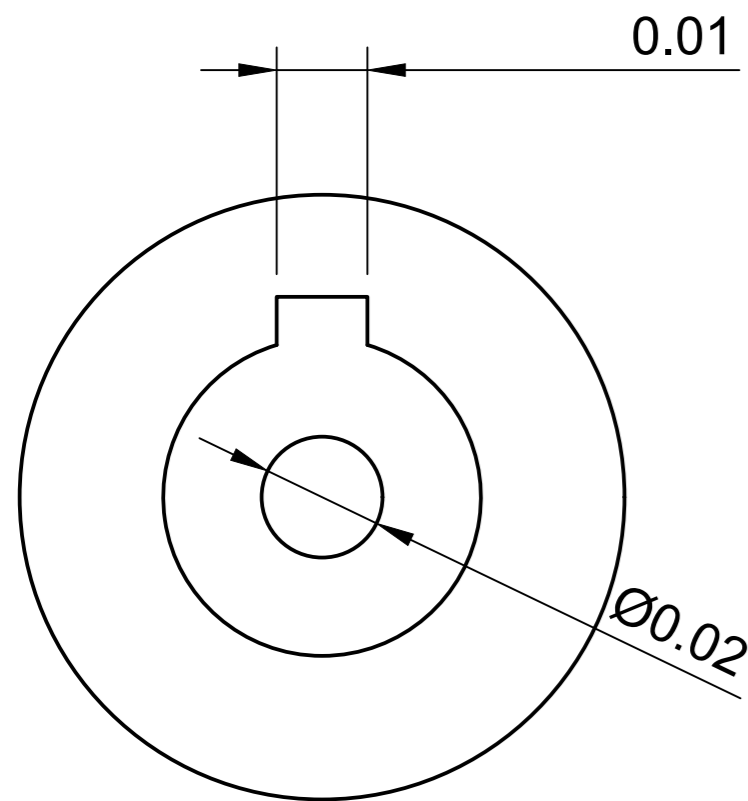
D

E

F

G


H



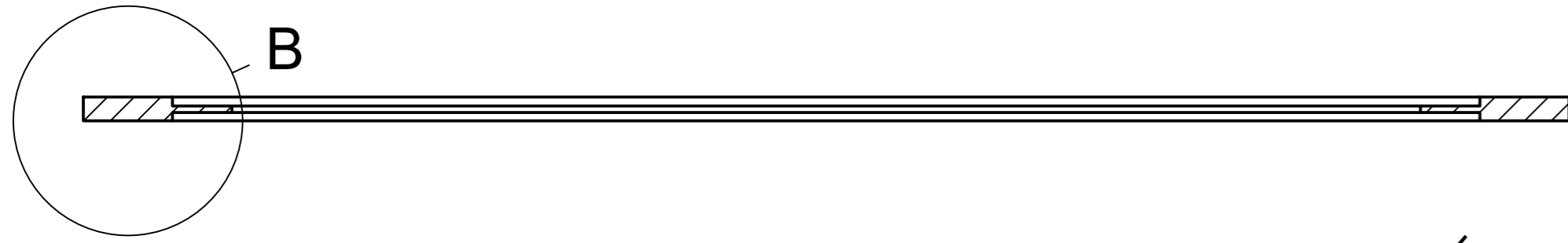
A (1.3)

Notes:

- Teeth are cut into the coupling.

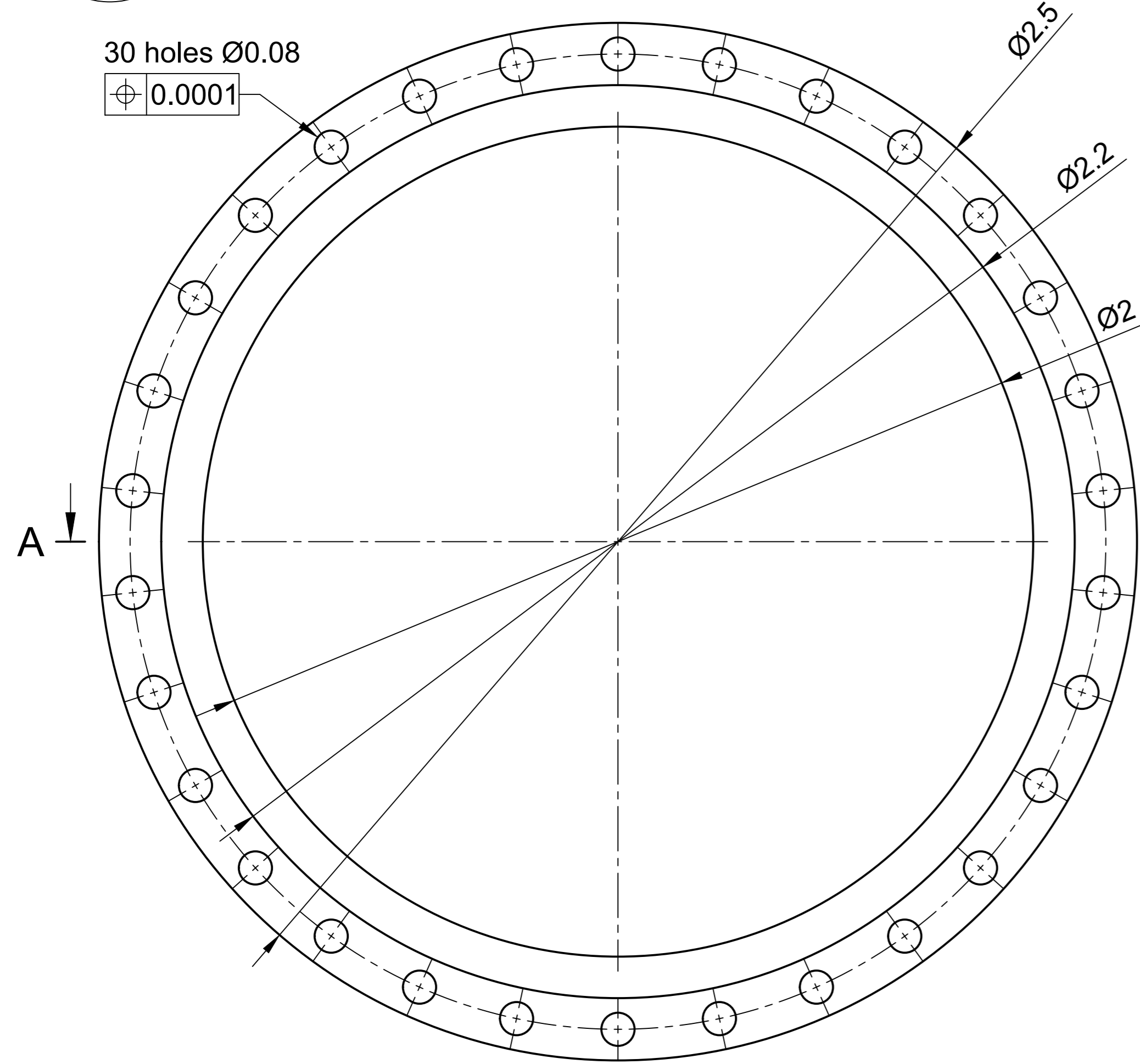
TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE 0°15'		PITCH DRIVE COUPLING	
		PROJECTION 	DRAWN BY ZARA SCALE: 1:1 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
ALL DIMENSIONS IN M		APPROVED BY MAHMOOD EL-MAHALAWY	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 7 OF 17

A-A (1:10)

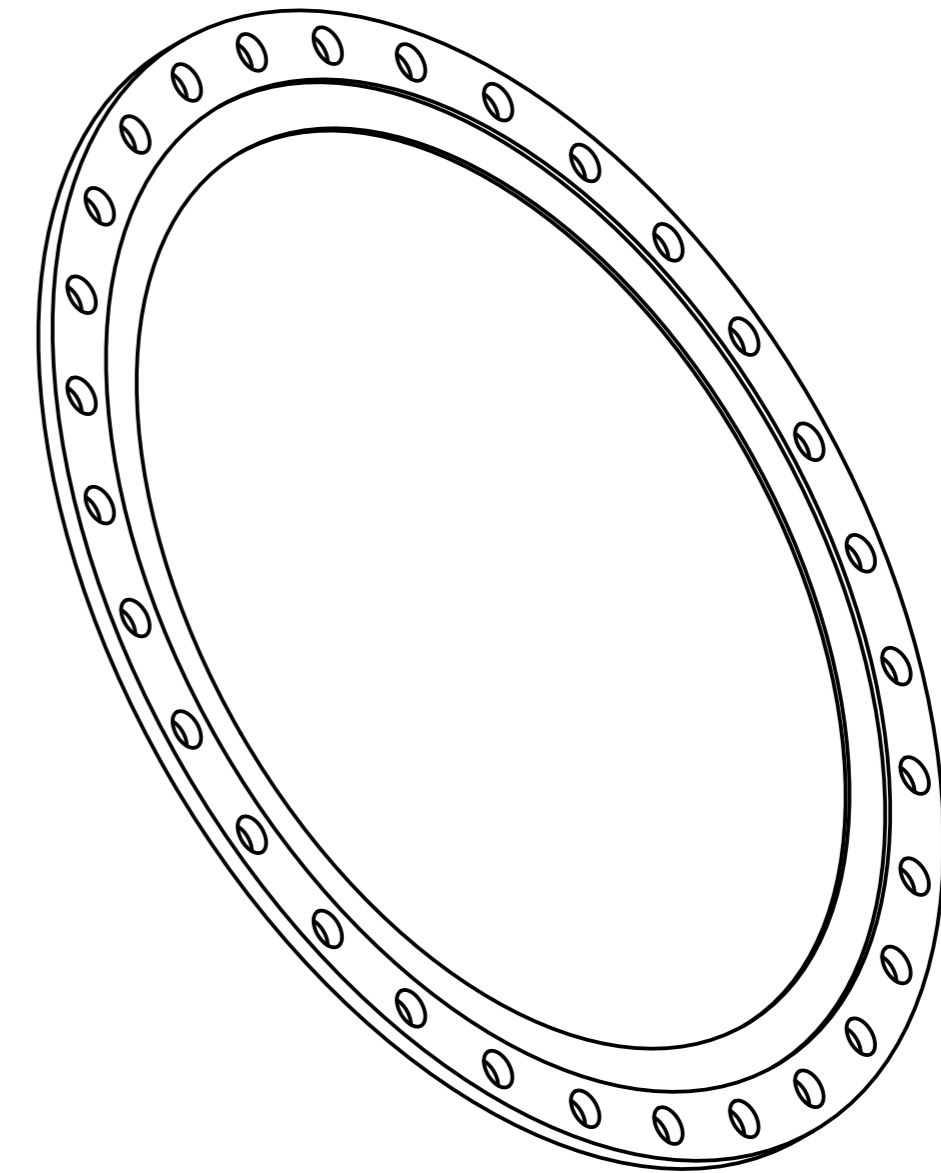
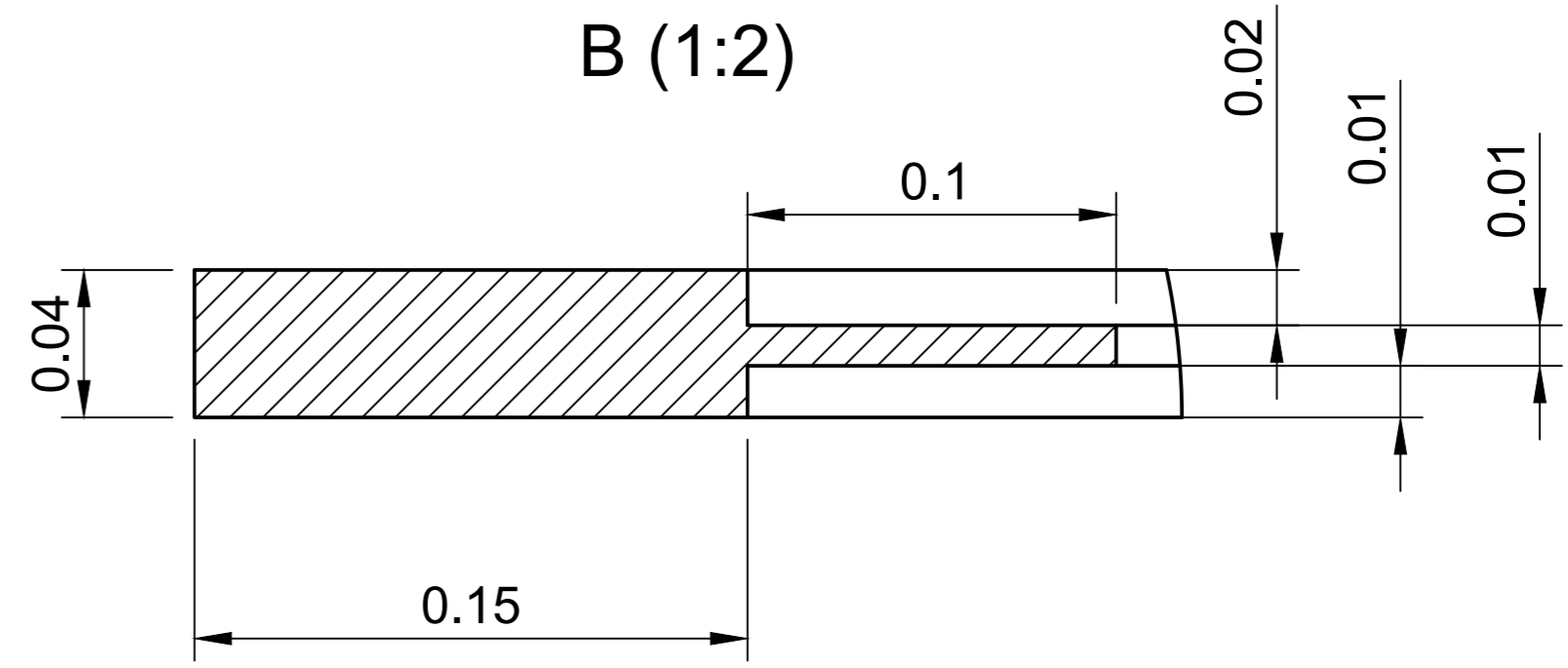


30 holes $\varnothing 0.08$

$\varnothing 0.0001$



B (1:2)



Notes:

- Internal teeth are machined.
- External teeth are broached on external circumference of the gear.
- 288 teeth
- Outer Diameter: 2500 mm
- Root Diameter: 2030 mm
- Pitch Circle Diameter: 2016 mm

TOLERANCES UNLESS OTHERWISE STATED:

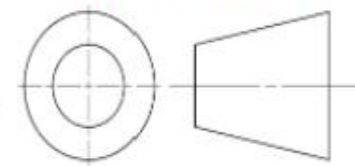
WHOLE NUMBERS ± 0.25
 ONE DECIMAL PLACE ± 0.10
 TWO DECIMAL PLACES ± 0.05
 ANGULAR TOLERANCE $0^{\circ}15'$

ALL DIMENSIONS IN M

SCHOOL OF ENGINEERING
 SHEET SIZE: A2 27/04/24

RING GEAR

PROJECTION



APPROVED BY
 ZARA IMAN

ISSUE 1

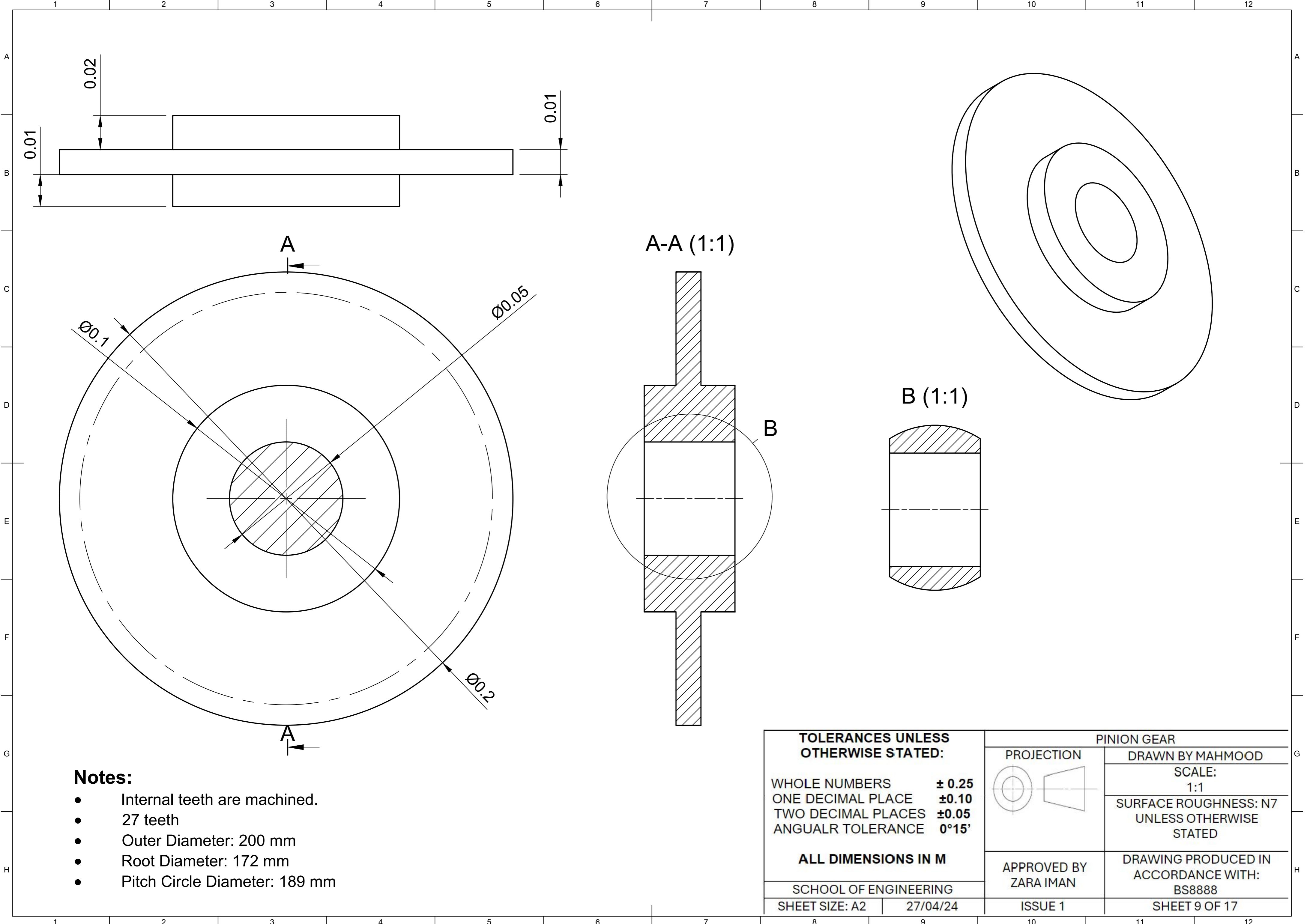
DRAWN BY MAHMOOD

SCALE:
 1:10

SURFACE ROUGHNESS: N7
 UNLESS OTHERWISE STATED

DRAWING PRODUCED IN
 ACCORDANCE WITH:
 BS8888

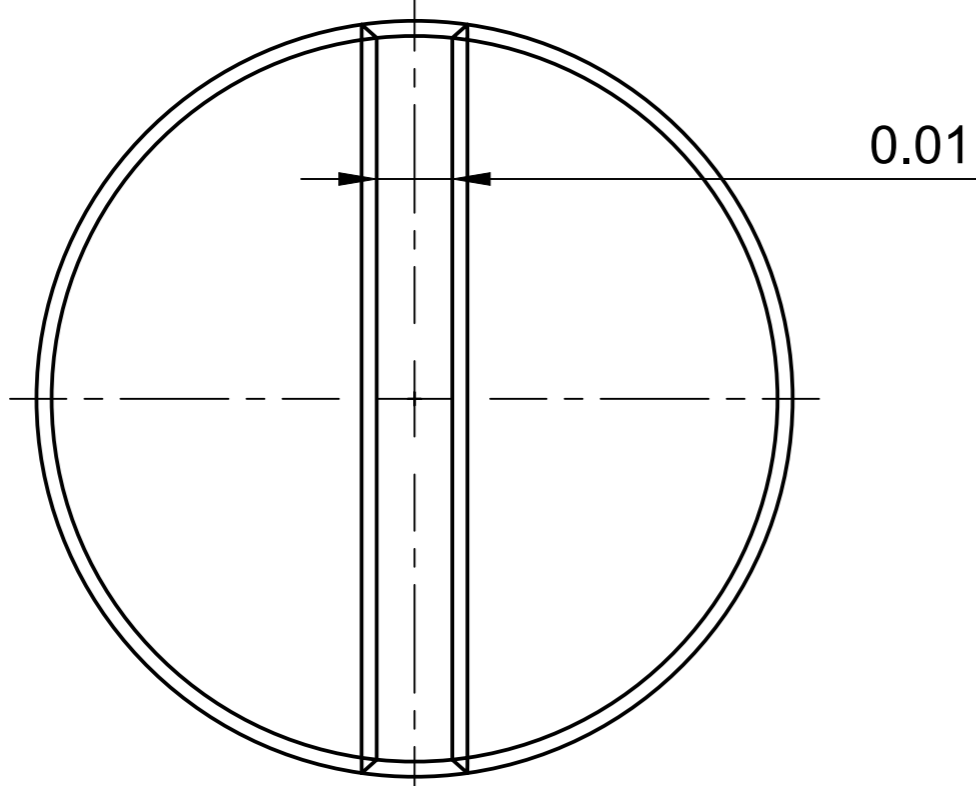
SHEET 8 OF 17



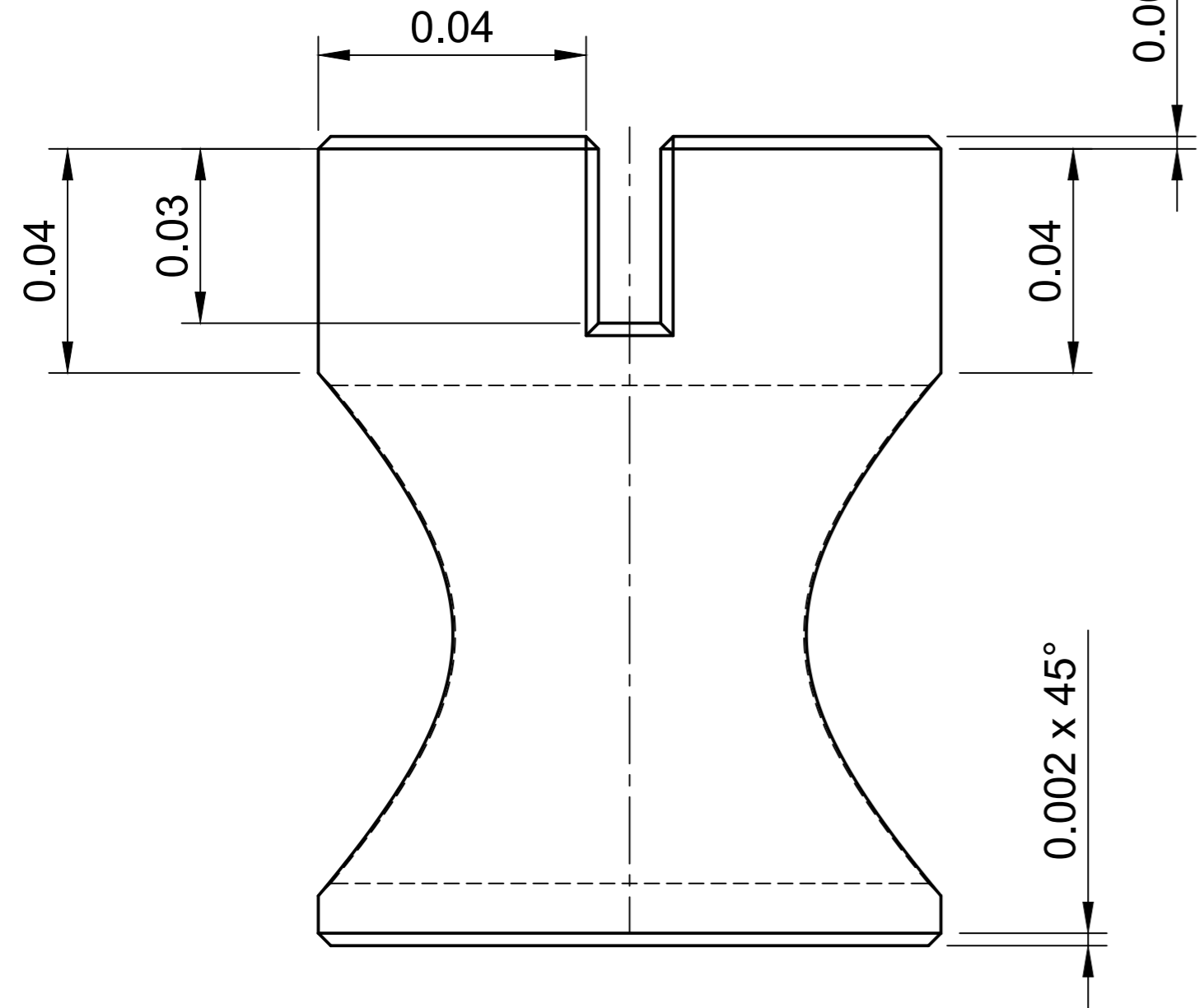
Notes:

- Internal teeth are machined.
- 27 teeth
- Outer Diameter: 200 mm
- Root Diameter: 172 mm
- Pitch Circle Diameter: 189 mm

TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE $0^{\circ}15'$	PINION GEAR	
	PROJECTION 	DRAWN BY MAHMOOD SCALE: 1:1
ALL DIMENSIONS IN M	APPROVED BY ZARA IMAN	SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
SCHOOL OF ENGINEERING SHEET SIZE: A2 27/04/24	ISSUE 1	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888 SHEET 9 OF 17



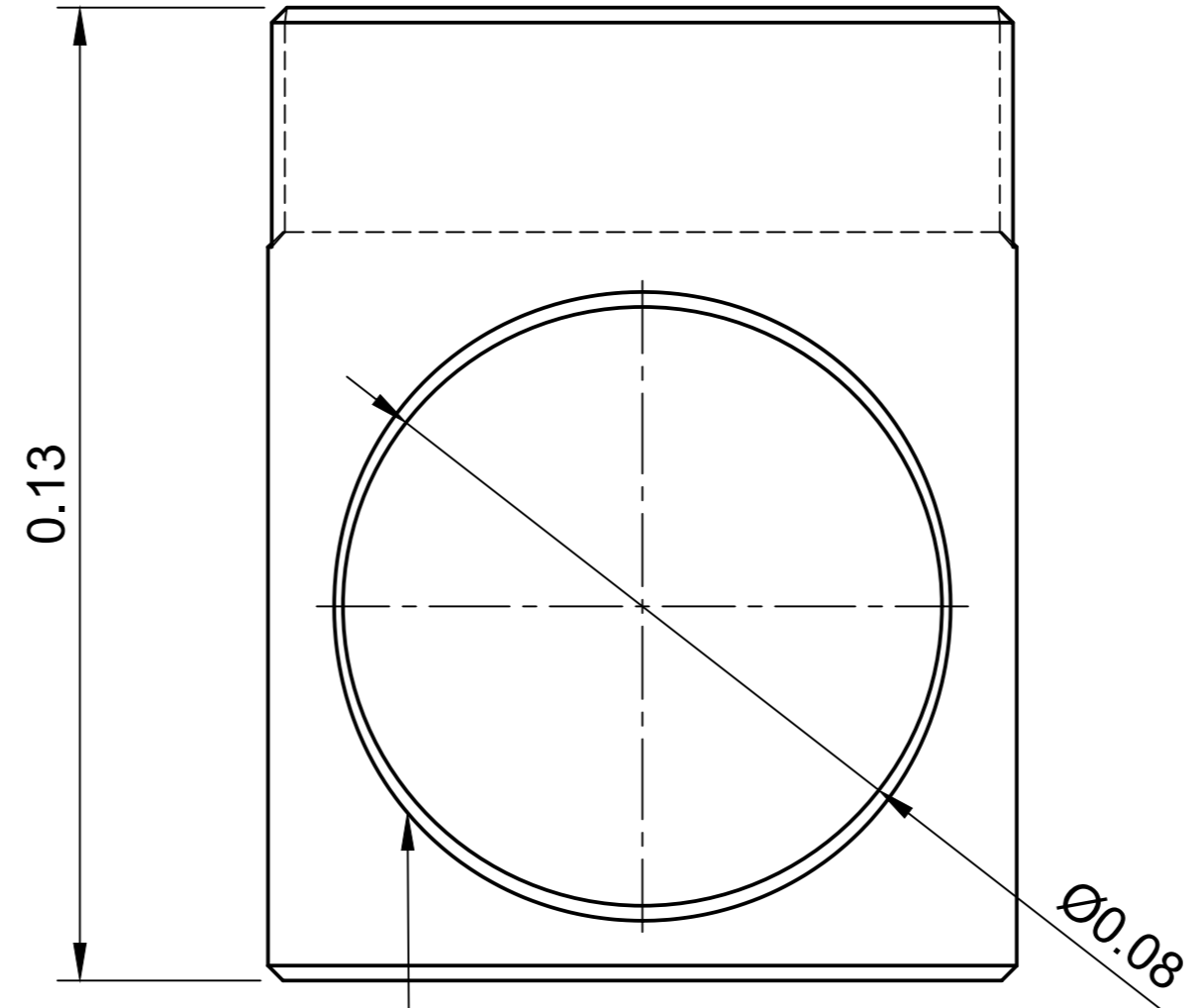
0.01



0.04

0.03

0.002 x 45°

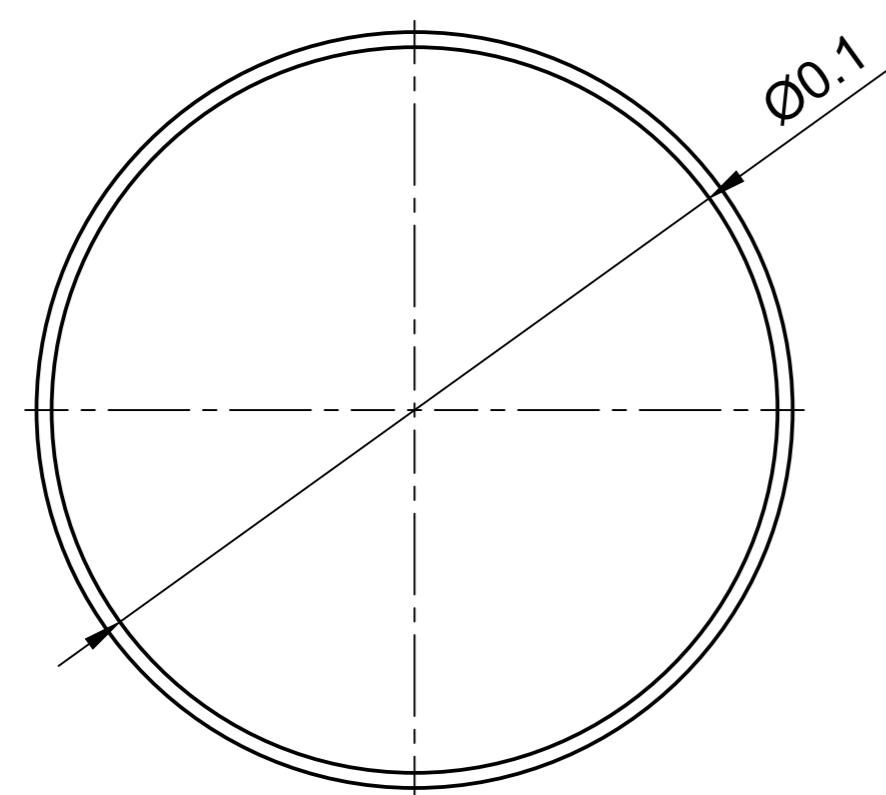
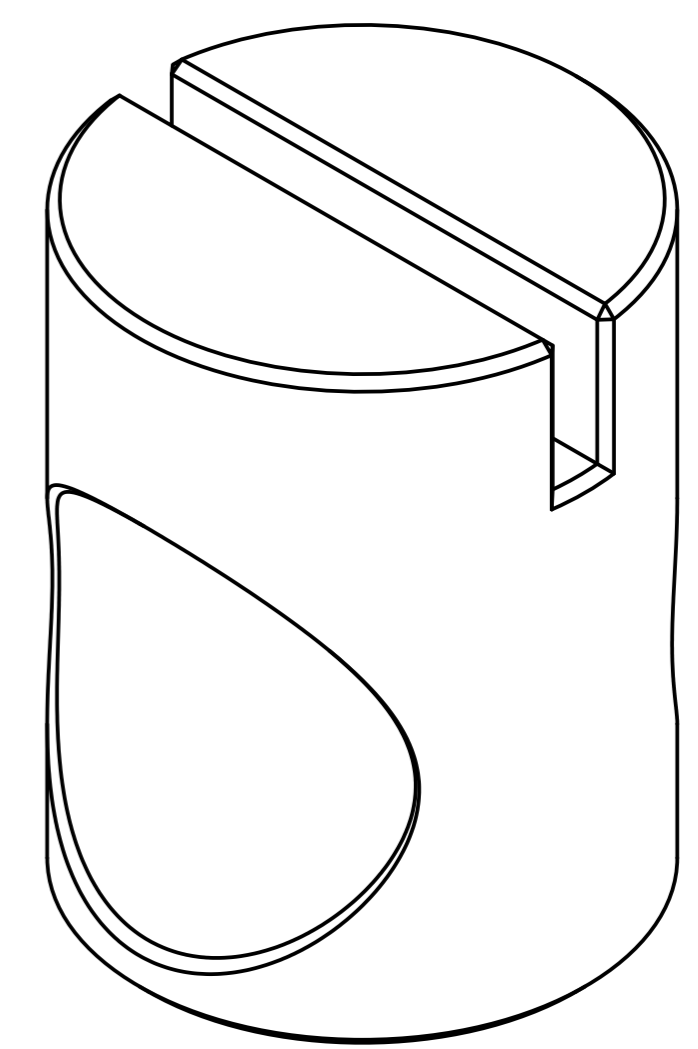


0.13

0.002 x 45°

Ø0.08

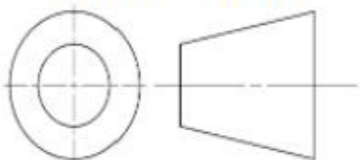
M80 x 60 mm

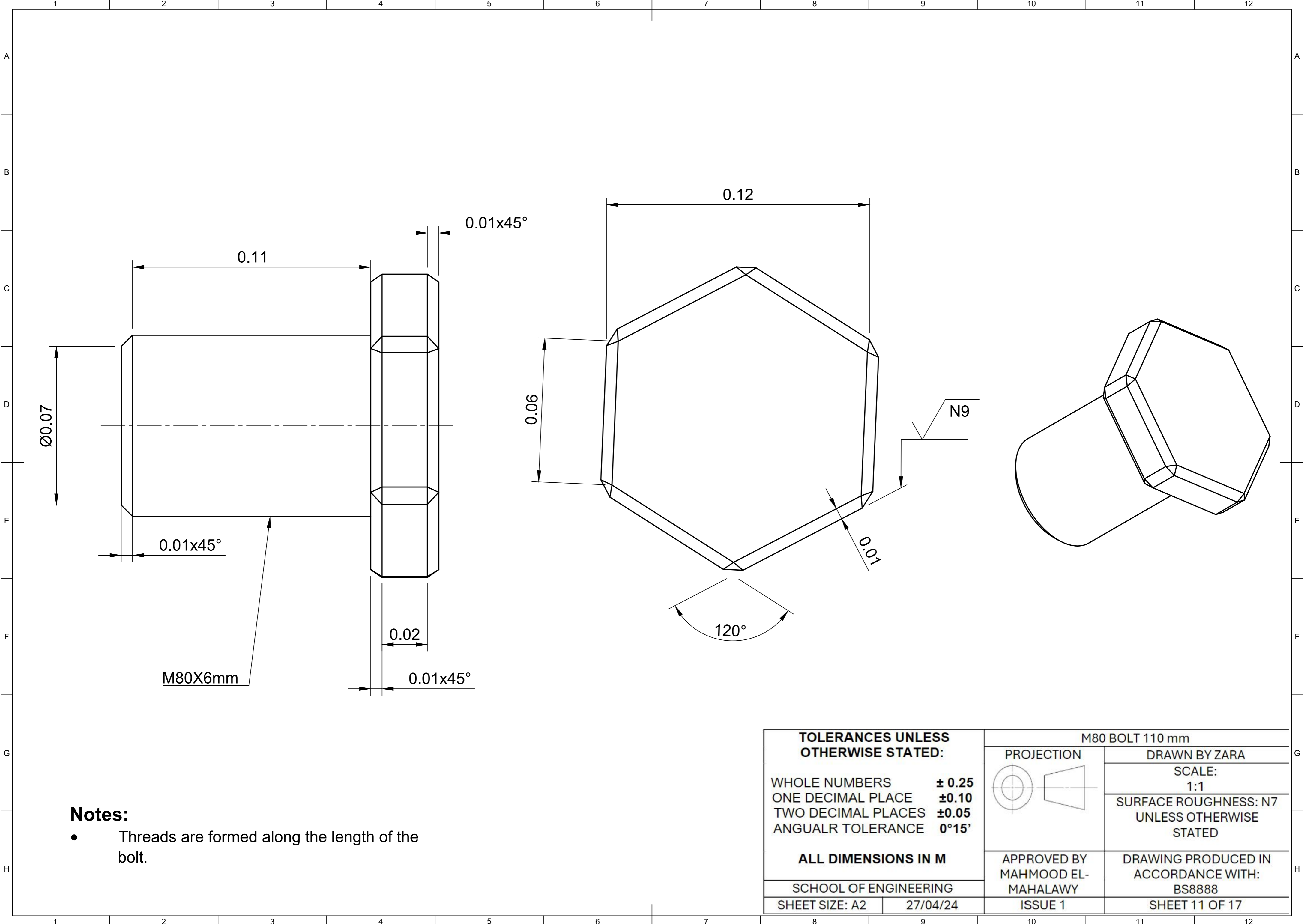


Ø0.1

Notes:

- Drill 80mm hole along the length of barrel nut.

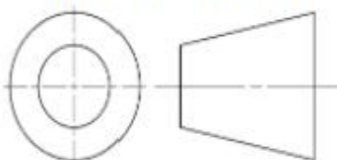
TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGUALR TOLERANCE 0°15'		M80 BARREL NUTS 100 mm	
		PROJECTION 	DRAWN BY MAHMOOD SCALE: 1:12
ALL DIMENSIONS IN M		SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED	
SCHOOL OF ENGINEERING		APPROVED BY ZARA IMAN	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 10 OF 17

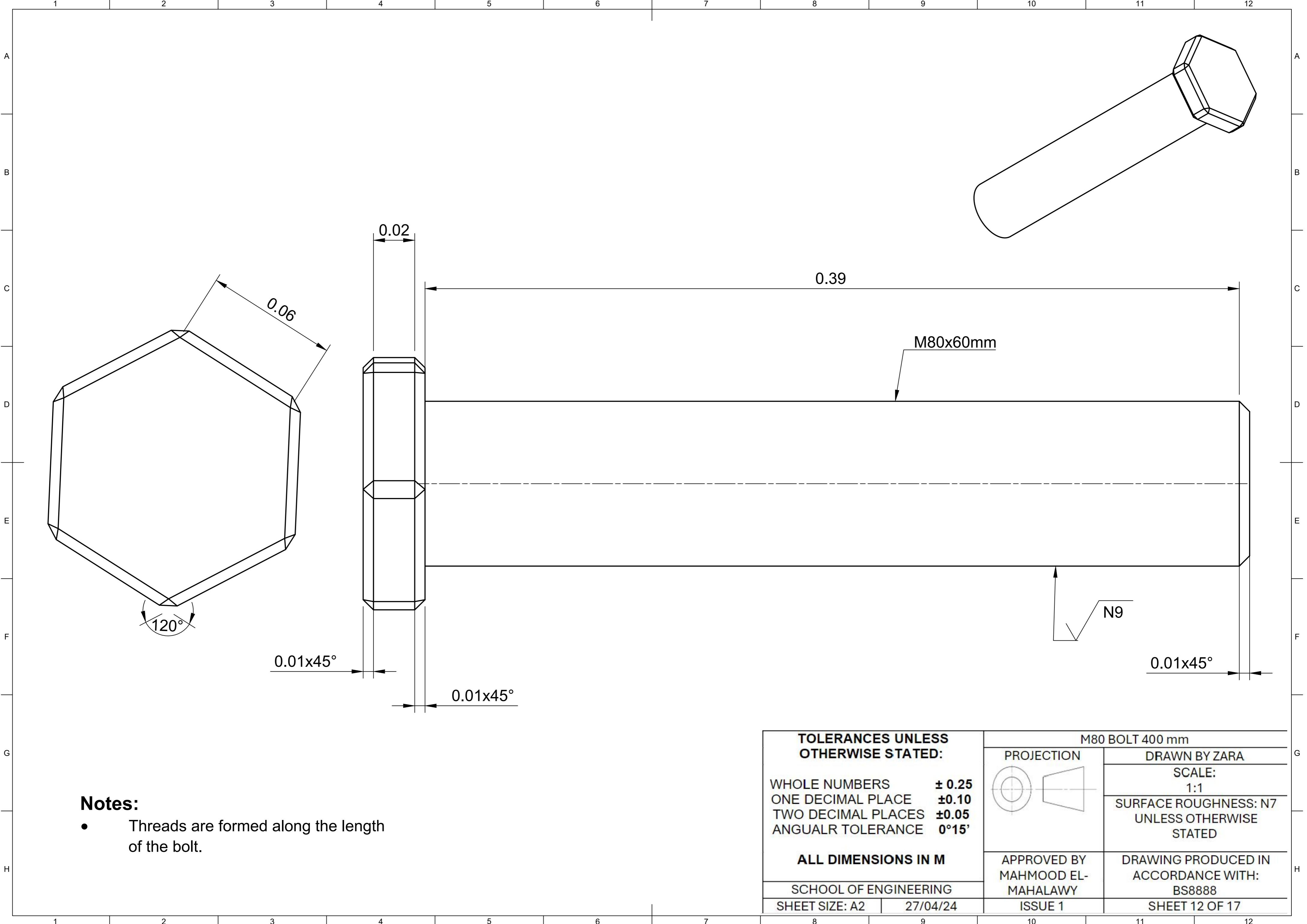


M80X6mm

Notes:

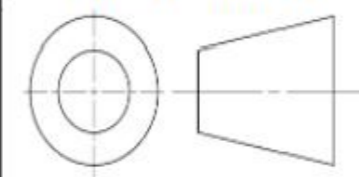
- Threads are formed along the length of the bolt.

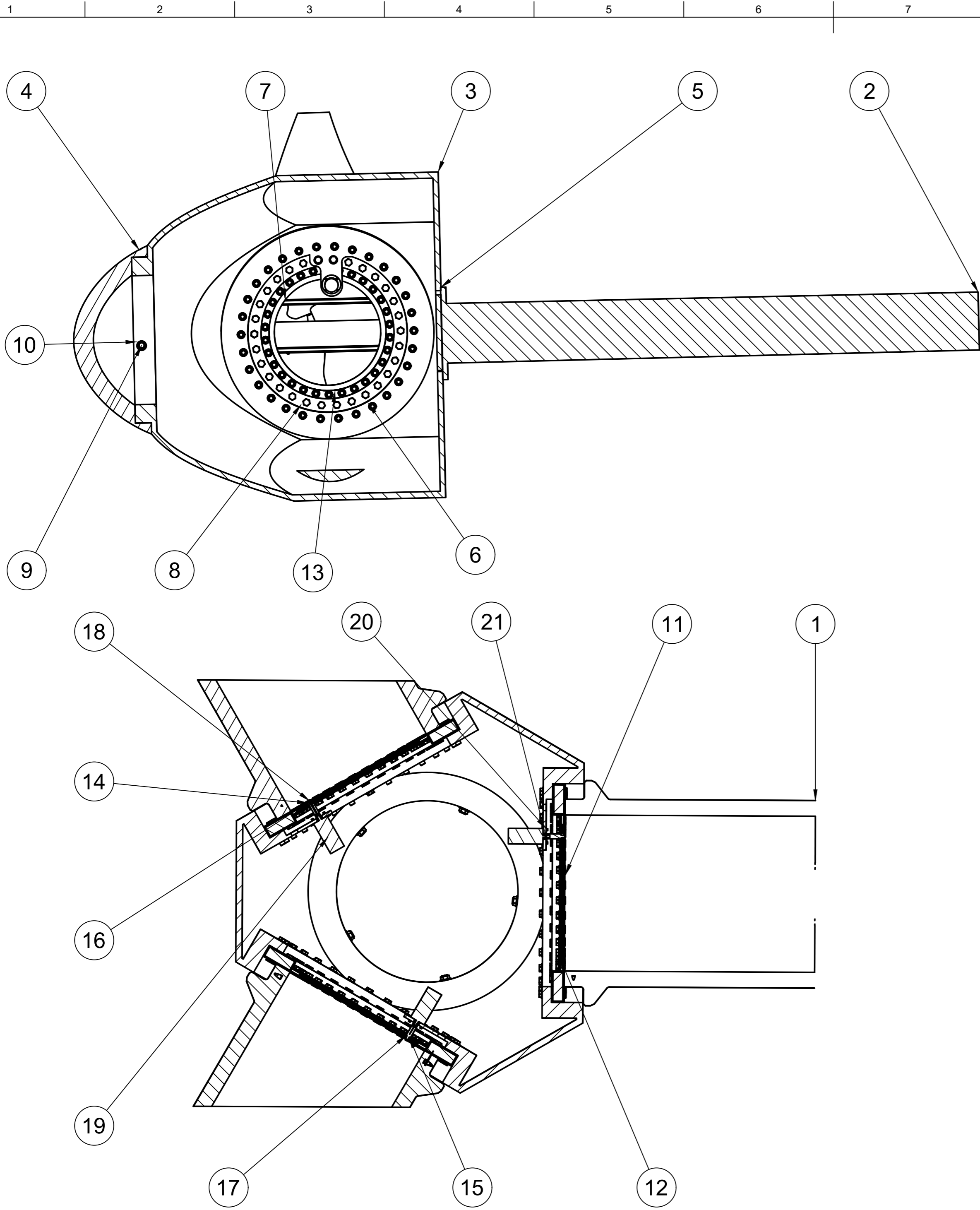
TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGUALR TOLERANCE $0^{\circ}15'$		M80 BOLT 110 mm	
		PROJECTION 	DRAWN BY ZARA SCALE: 1:1
ALL DIMENSIONS IN M		APPROVED BY MAHMOOD EL-MAHALAWY	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 11 OF 17



Notes:

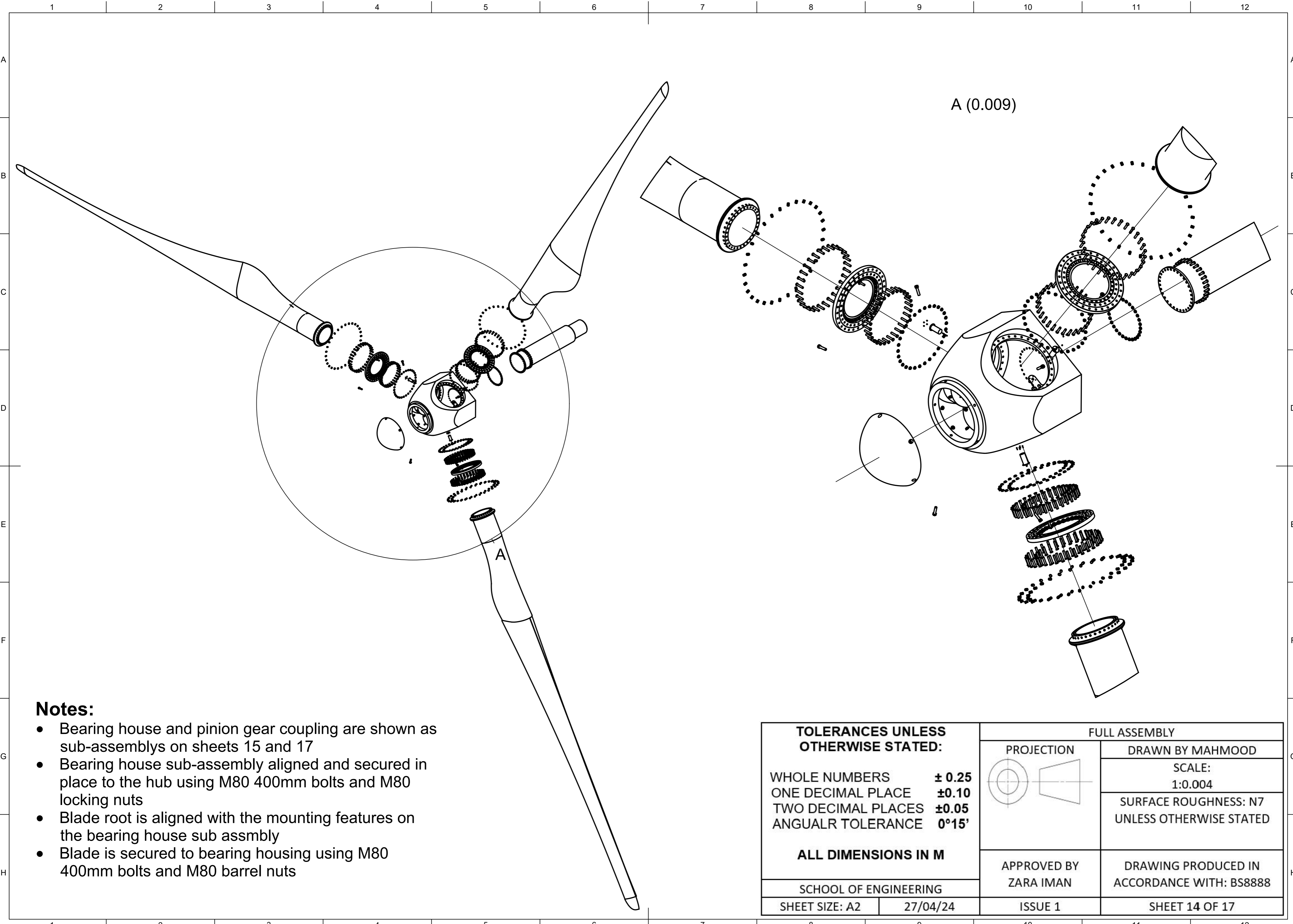
- Threads are formed along the length of the bolt.

TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE $0^{\circ}15'$		M80 BOLT 400 mm	
		PROJECTION 	DRAWN BY ZARA SCALE: 1:1
ALL DIMENSIONS IN M		APPROVED BY MAHMOOD EL-MAHALAWY	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 12 OF 17



Parts List				
Item	Qty	Part Name	Manufacturer	Material
1	3	Blades	Custom	Epoxy E Glass Fiber UD prepreg, UD lay-up + Balsa Wood
2	1	Low Speed Shaft	Custom	Stainless Steel AISI 410, intermediate temper
3	1	Turbine Hub	Custom	Stainless Steel AISI 410, intermediate temper
4	90	Nose Cone	Custom	Stainless Steel AISI 410, intermediate temper
5	180	M80 Barrel Nuts	Custom	Stainless Steel AISI 410, intermediate temper
6	90	M80 400mm Bolts	Custom	Stainless Steel AISI 410, intermediate temper
7	180	M80 110mm Bolts	Custom	Stainless Steel AISI 410, intermediate temper
8	5	M80 Locking Nuts	Bolts.co.uk FNMCS80	High Strength Class 10 Steel
9	5	M100 Locking Nuts	Custom	Stainless Steel AISI 410, intermediate temper
10	3	M100 400mm Bolts	McMaster 91290A640	Black-Oxide Class 12.9 Alloy Steel
11	3	Bearing Housing	Custom	Stainless Steel AISI 410, intermediate temper
12	3	Bearing	N/A	SKF High Endurance Slewing Bearing
13	3	Ring Gear	Custom	Carbon Steel, AISI 1095
14	3	Pinion Gear	Custom	Low Alloy Steel, AISI 4340
15	3	Pinion Coupling	Custom	Carbon Steel, AISI 1095
16	3	Pinion Gear Spacer	McMaster 93475A370	18-8 Stainless Steel
17	3	Retaining Gear	McMaster 90030A123	Black Phosphate 1060-1090 Spring Steel
18	3	M16 260mm Coupling Bolt	McMaster 90447A125	High Strength Black Class 10.9 Steel
19	3	Pitch Drive Motor	Hoyer IE4 HMA4 160L-4	Aluminium
20	3	M18 Motor Locking Nut	McMaster 903060A118	High Strength Class 10 Steel
21	12	M18 90mm Motor Bolts	McMaster 90447A138	High Strength Black Class 10.9 Steel

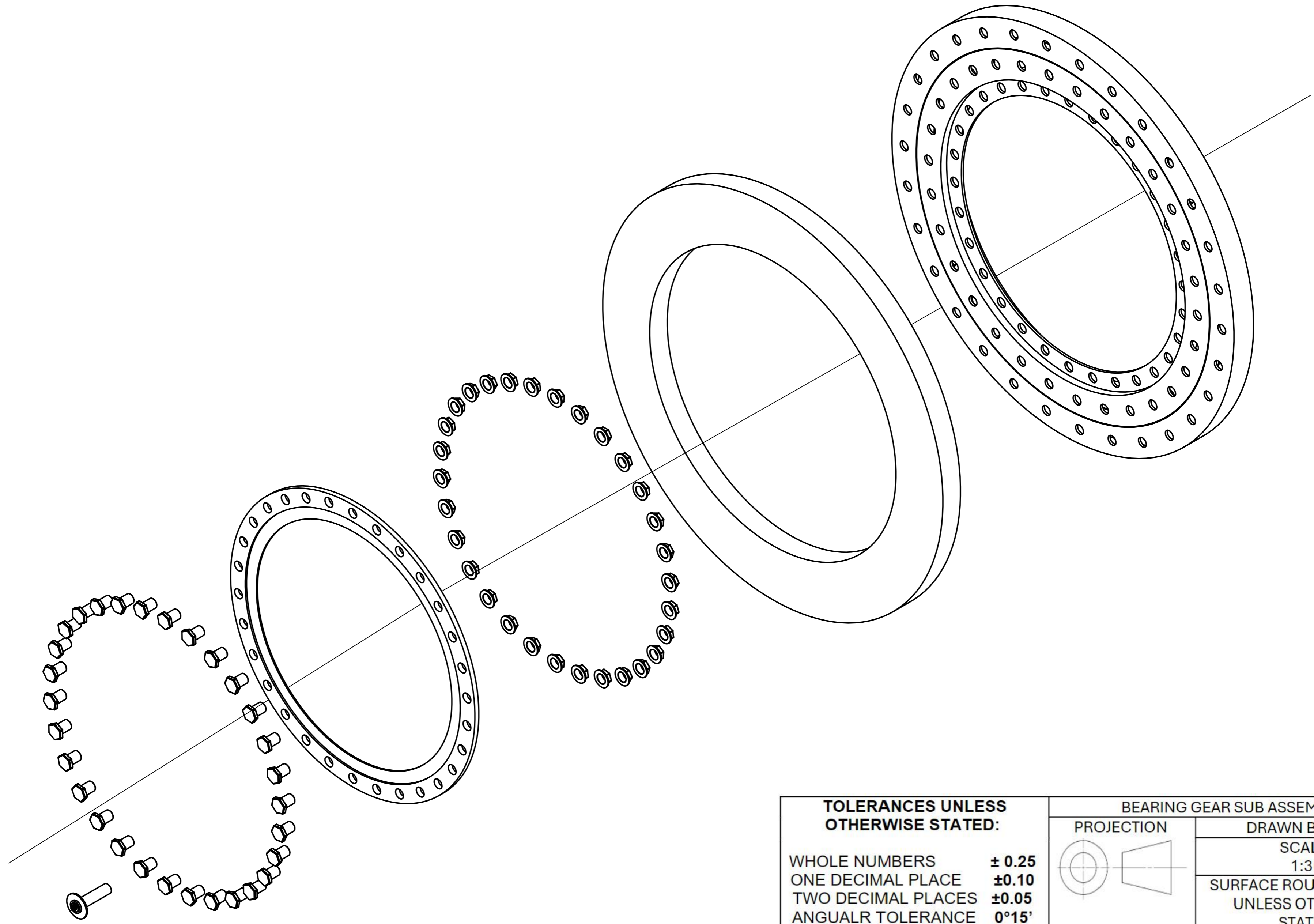
TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE $0^{\circ}15'$ ALL DIMENSIONS IN M	PROJECTION 	DRAWN BY ZARA	
		SCALE: 1:5	
	SCHOOL OF ENGINEERING	APPROVED BY MAHMOOD EL-MAHALAWY	SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
	SHEET SIZE: A2 27/04/24		DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
	ISSUE 1	SHEET 13 OF 17	

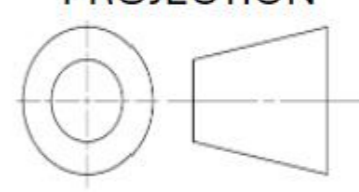


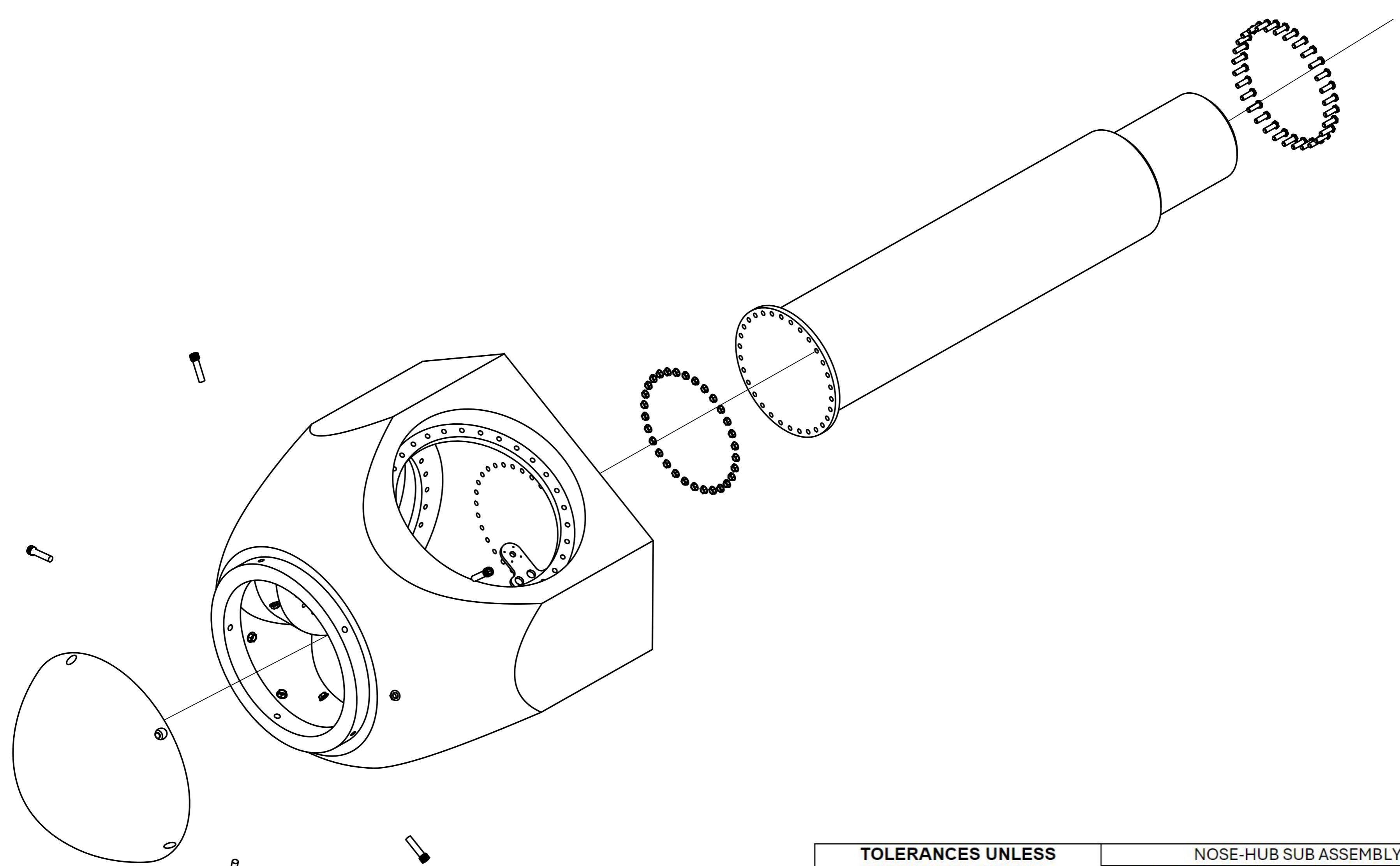
Notes:

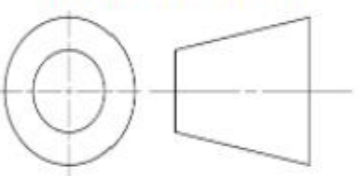
- Bearing house and pinion gear coupling are shown as sub-assemblies on sheets 15 and 17
- Bearing house sub-assembly aligned and secured in place to the hub using M80 400mm bolts and M80 locking nuts
- Blade root is aligned with the mounting features on the bearing house sub assembly
- Blade is secured to bearing housing using M80 400mm bolts and M80 barrel nuts

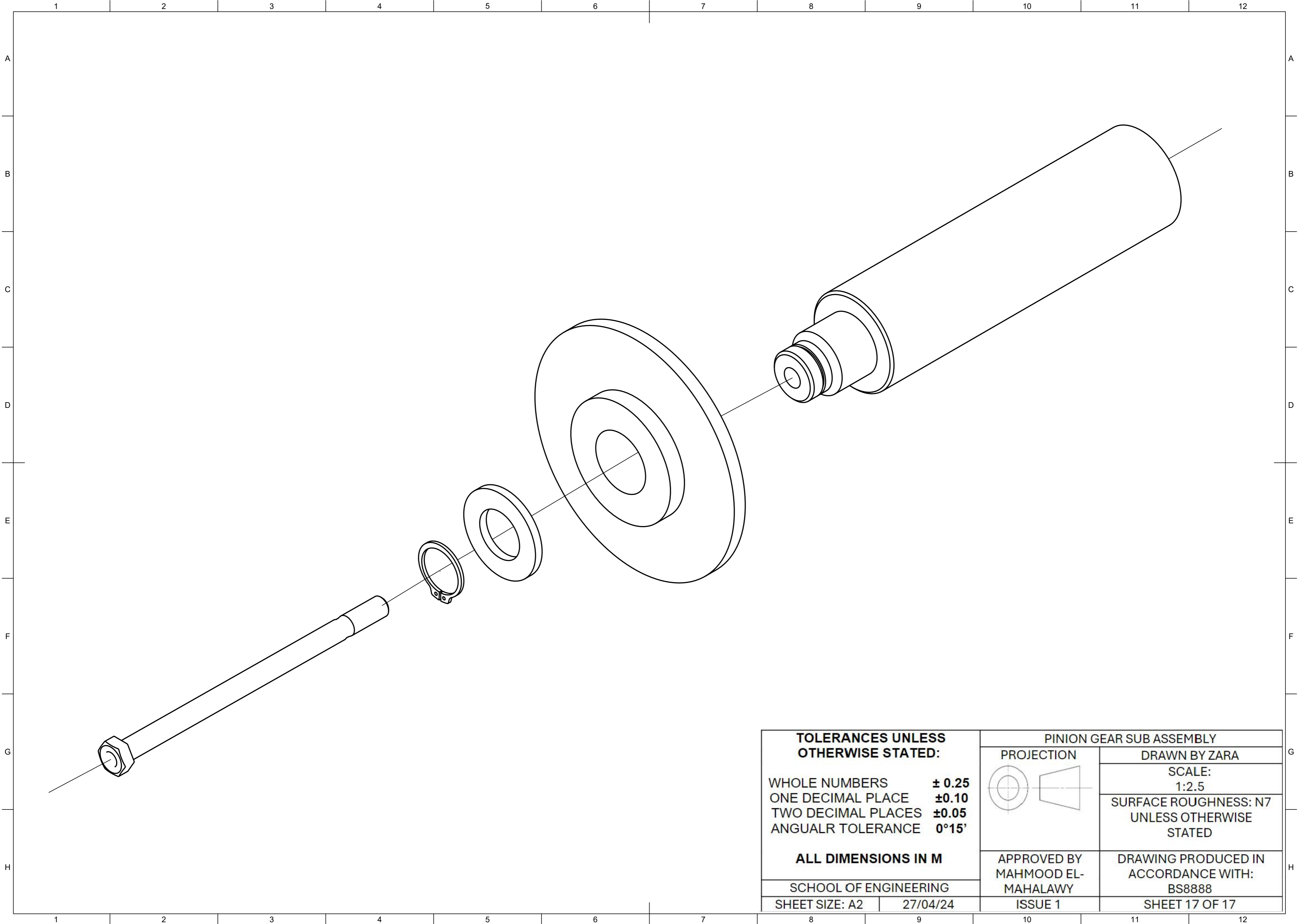
<p>TOLERANCES UNLESS OTHERWISE STATED:</p> <p>WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE $0^{\circ}15'$</p> <p>ALL DIMENSIONS IN M</p>		FULL ASSEMBLY	
		<p>PROJECTION</p>	<p>DRAWN BY MAHMOOD</p> <p>SCALE: 1:0.004</p> <p>SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED</p>
SCHOOL OF ENGINEERING		APPROVED BY ZARA IMAN	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 14 OF 17



TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGULAR TOLERANCE $0^{\circ}15'$		BEARING GEAR SUB ASSEMBLY	
		PROJECTION 	DRAWN BY ZARA SCALE: 1:30 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
ALL DIMENSIONS IN M		APPROVED BY MAHMOOD EL-MAHALAWY	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 15 OF 17



TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGUALR TOLERANCE $0^{\circ}15'$		NOSE-HUB SUB ASSEMBLY	
		PROJECTION 	DRAWN BY MAHMOOD SCALE: 1:0.015 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
ALL DIMENSIONS IN M		APPROVED BY ZARA IMAN	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING SHEET SIZE: A2	27/04/24	ISSUE 1	SHEET 16 OF 17



TOLERANCES UNLESS OTHERWISE STATED: WHOLE NUMBERS ± 0.25 ONE DECIMAL PLACE ± 0.10 TWO DECIMAL PLACES ± 0.05 ANGUALR TOLERANCE $0^{\circ}15'$		PINION GEAR SUB ASSEMBLY	
		PROJECTION 	DRAWN BY ZARA SCALE: 1:2.5 SURFACE ROUGHNESS: N7 UNLESS OTHERWISE STATED
ALL DIMENSIONS IN M		APPROVED BY MAHMOOD EL-MAHALAWY	DRAWING PRODUCED IN ACCORDANCE WITH: BS8888
SCHOOL OF ENGINEERING		ISSUE 1	SHEET 17 OF 17
SHEET SIZE: A2 27/04/24			