

## GLOSSARY

SCARA	The Selective Compliance Articulated Robot Arm
PID	Proportional Integral Derivative
K <sub>p</sub>	Proportional Factor
K <sub>i</sub>	Integral Factor
K <sub>d</sub>	Derivative Factor
DC	Direct Current
Q <sub>c</sub>	Quad-counts
PWM	Pulse-Width Modulation

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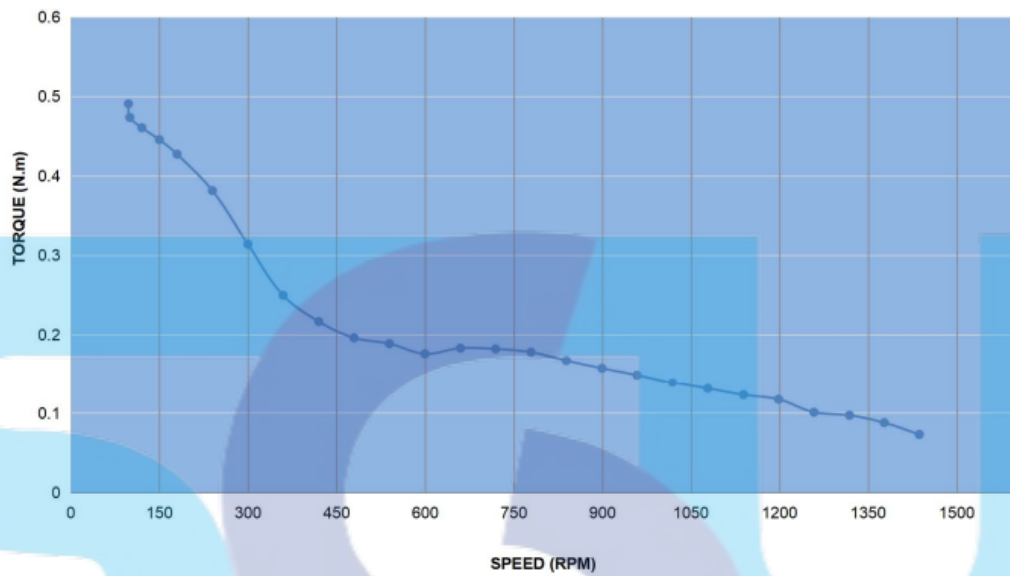
Universitas Miguel Hernández. n.d. *Industrial Circuit Application Note: Stepper motor and driver selection*. <https://isa.umh.es/micros/doc/StepperMotorSelection.pdf>, Accessed on April 4, 2023.

## APPENDICES

### APPENDIX A. SPEED – TORQUE CURVES OF STEPPER MOTORS

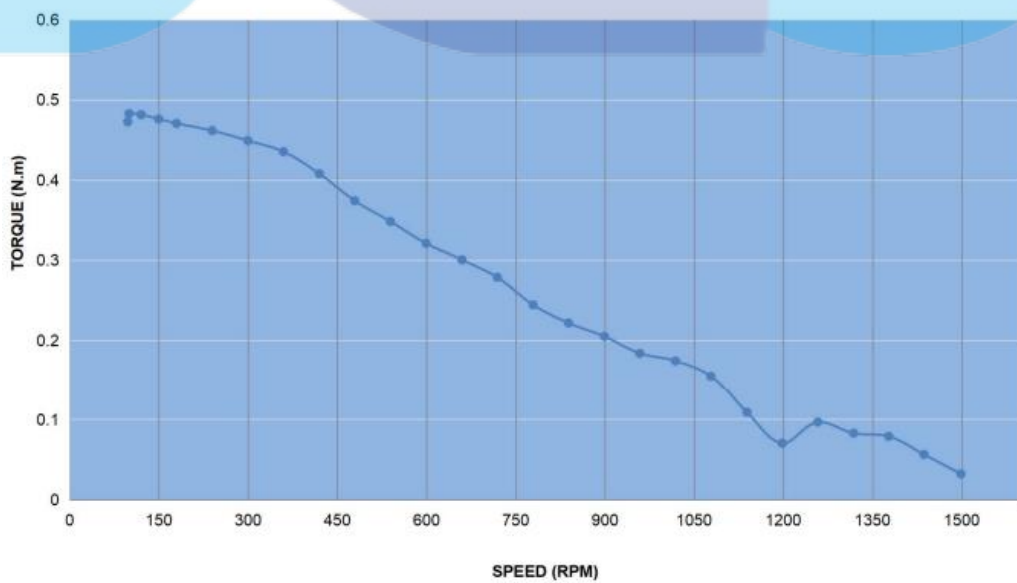
PULL OUT TORQUE CURVE OF 17E1K-05

—●— 24V 2A



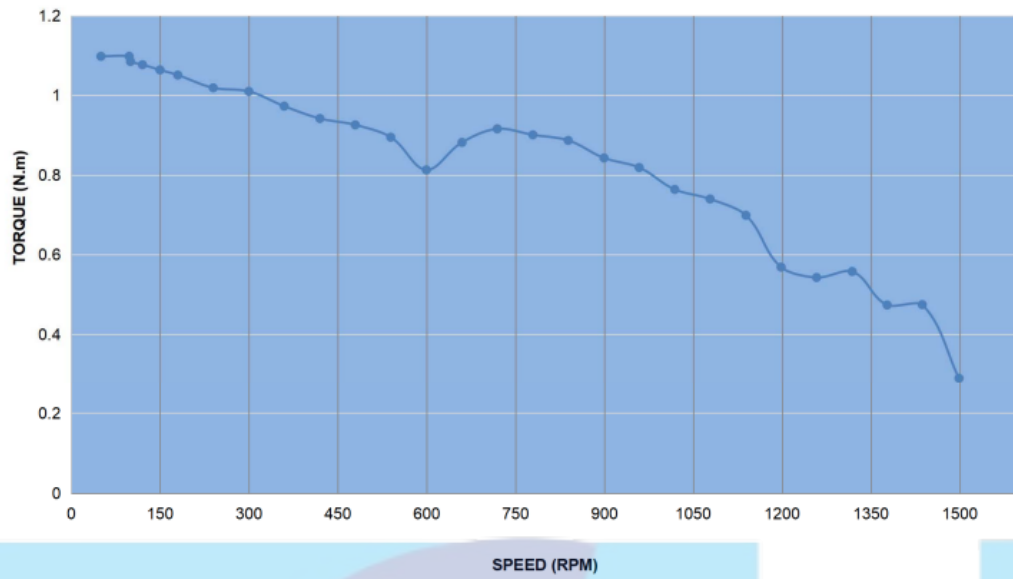
PULL OUT TORQUE CURVE OF 17E1K-07

—●— 24V 2A

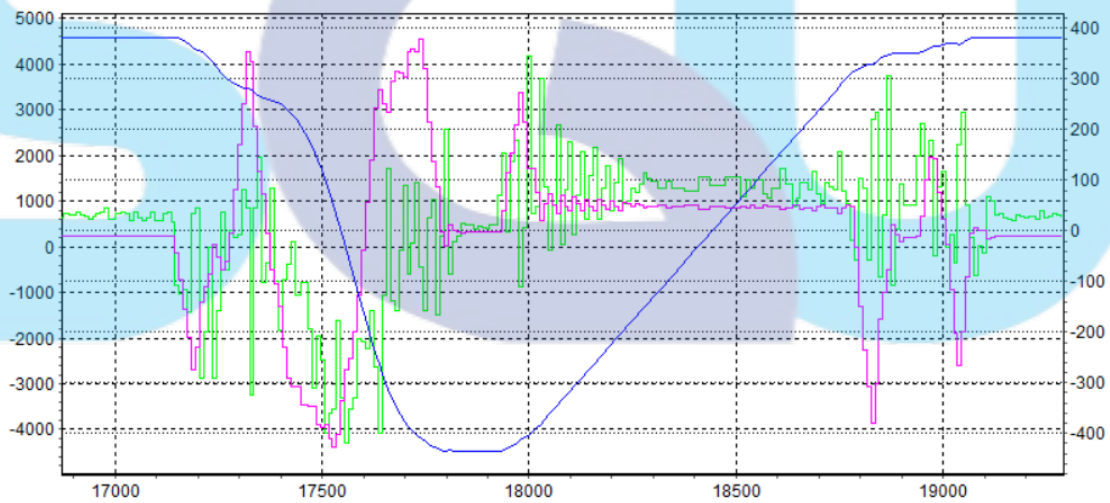


**PULL OUT TORQUE CURVE OF 23E1K-12**

— 48V 4A

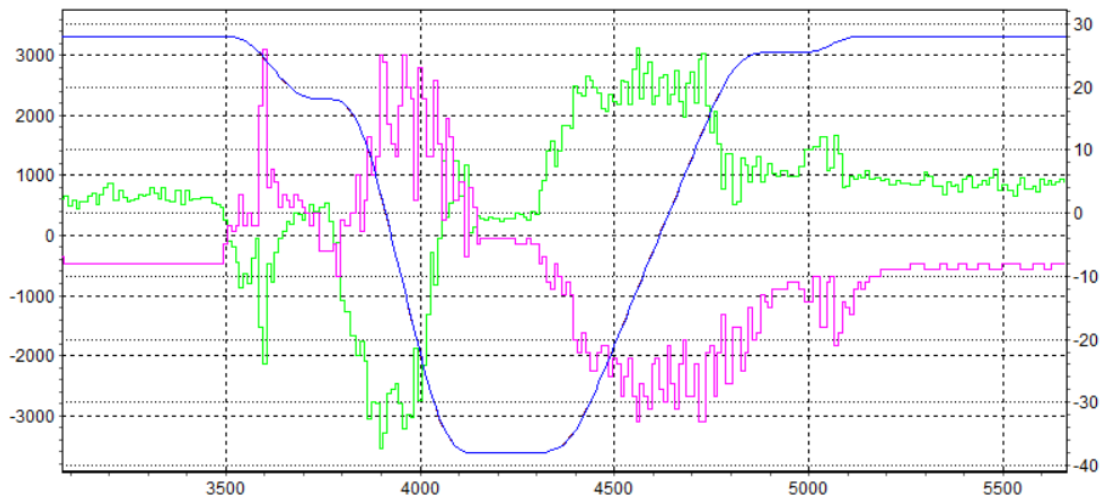


**APPENDIX B. OSCILLOSCOPE IMAGES OF PARAMETERS TUNING**



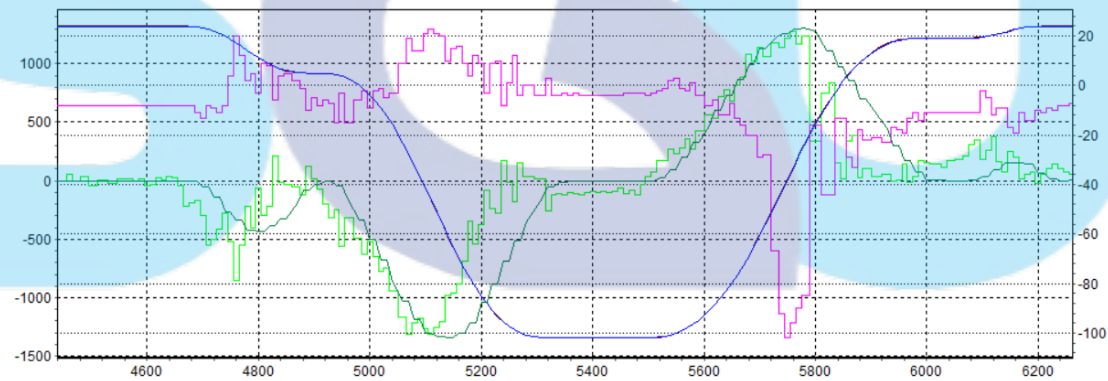
#	Name	Grid	Status	Active	Last	Minimum	Maximum
Test Group (Free Run)							
<input checked="" type="checkbox"/>	1 PO_HWAMP_CURRENT	⊙ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	740	-4486	4594
<input type="checkbox"/>	1 REG_ACTPOS	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-654	-675	17039
<input type="checkbox"/>	1 REG_AVEL	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	-458	1354
<input checked="" type="checkbox"/>	1 REG_TRACKERR	○ ⊙	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-11	-436	383

*Feed-forward constants = 200*



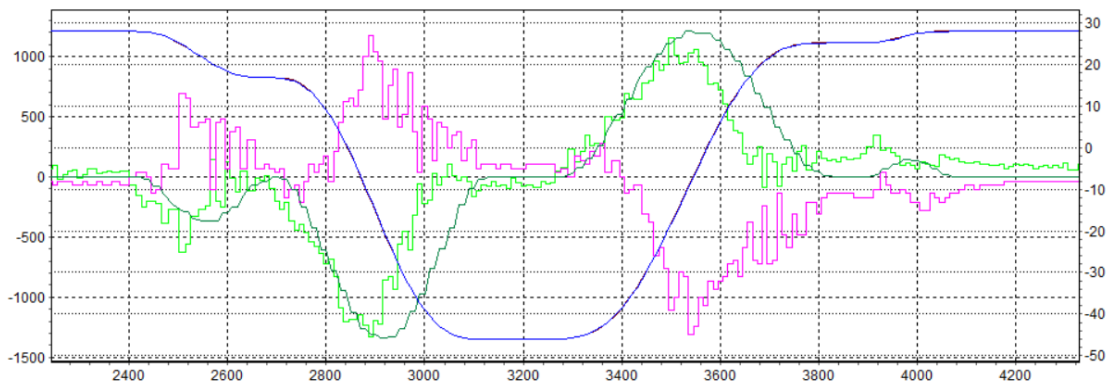
#	Name	Grid	Status	Active	3339.4	Last	Minimum	Maximum
Test Group (Free Run)								
<input checked="" type="checkbox"/>	1 PO_HWAMP_CURRENT	⊙ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	796	1700	-3622	3318
<input type="checkbox"/>	1 REG_ACTPOS	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-657	2302	-660	17005
<input type="checkbox"/>	1 REG_AVEL	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	-786	-816	1351
<input checked="" type="checkbox"/>	1 REG_TRACKERR	○ ⊙	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-8	-25	-38	28

*Feed-forward constants = 50*



#	Name	Grid	Status	Active	Last	Minimum	Maximum	A	B	B-
Test Group (Free Run)										
<input checked="" type="checkbox"/>	1 PO_HWAMP_CURRENT	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	696	-3534	4624			
<input type="checkbox"/>	1 REG_ACTPOS	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-659	-662	17005			
<input type="checkbox"/>	1 REG_AVEL	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-1	-1321	1344			
<input checked="" type="checkbox"/>	1 REG_TRACKERR	○ ⊙	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-6	-102	24			
<input type="checkbox"/>	zero	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	0	0			
<input checked="" type="checkbox"/>	setpoint_position	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	665	-17000	665			
<input type="checkbox"/>	1 REG_REFERENCE	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-22543	-309061	113323			
<input checked="" type="checkbox"/>	Z_position	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	659	-17005	662			
<input checked="" type="checkbox"/>	Z_speed	⊙ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1	-1344	1321			
<input type="checkbox"/>	1 REG_COMPOS	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-665	-665	17000			

*JERKMIN = 60 ms*



#	Name	Grid	Status	Active	3521.4	Last	Minimum	Maximum	A	B	B
	Test Group (Free Run)			<input checked="" type="checkbox"/>							
<input checked="" type="checkbox"/>	1 PO_HWAMP_CURRENT	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	3518	790	-3716	4370			
<input type="checkbox"/>	1 REG_ACTPOS	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9212	-658	-660	17005			
<input type="checkbox"/>	1 REG_AVEL	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-1159	0	-1210	1348			
<input checked="" type="checkbox"/>	1 REG_TRACKERR	○ ⊗	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-30	-7	-46	28			
<input type="checkbox"/>	zero	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	0	0	0			
<input checked="" type="checkbox"/>	setpoint_position	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-9099.4	665	-17000	665			
<input type="checkbox"/>	1 REG_REFERENCE	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-121295	-25472	-165644	122279			
<input checked="" type="checkbox"/>	Z_position	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	-9129.5	658	-17005	660			
<input checked="" type="checkbox"/>	Z_speed	⊗ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1166.0	0	-1348	1210			
<input type="checkbox"/>	1 REG_COMPOS	○ ○	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9182	-665	-665	17000			

JERKMIN = 100 ms

**APPENDIX C. HARVESTING CYCLE TIME TEST RESULT**

No	Cutting Height [mm]:	Z Axis GoDown [ms]:	C Axis Cut [ms]:	Z Axis GoUp [ms]:	M Axis GoBack [ms]:	Cycle time [ms]:
1	0	729.75	151.35	916.26	472.15	1385.85
2	0	405.76	151.35	697.68	472.15	978.92
3	0	305.80	151.35	697.68	472.15	903.96
4	0	260.70	151.35	697.68	472.15	870.13
5	0	774.47	151.35	916.26	472.15	1419.39
6	0	469.01	151.35	697.68	472.15	1026.36
7	0	383.26	151.35	697.68	472.15	962.05
8	0	352.61	151.35	697.68	472.15	939.06
9	0	803.35	151.35	916.26	472.15	1441.05
10	0	509.85	151.35	697.68	472.15	1056.99
11	0	433.28	151.35	697.68	472.15	999.57
12	0	424.92	151.35	697.68	472.15	993.29
13	0	826.45	151.35	916.26	472.15	1458.38
14	0	542.51	151.35	697.68	472.15	1081.49
15	0	478.57	151.35	697.68	472.15	1033.53
16	0	478.57	151.35	697.68	472.15	1033.53
<b>AVERAGE</b>		<b>511.18</b>	<b>151.35</b>	<b>752.32</b>		<b>1098.97</b>



1	50	663.44	151.35	849.95	472.15	1286.38
2	50	372.60	151.35	673.61	472.15	936.00
3	50	283.70	151.35	673.61	472.15	869.32
4	50	244.12	151.35	673.61	472.15	839.64
5	50	708.16	151.35	849.95	472.15	1319.92
6	50	435.85	151.35	673.61	472.15	983.43
7	50	361.16	151.35	673.61	472.15	927.42
8	50	340.84	151.35	673.61	472.15	912.18
9	50	737.04	151.35	849.95	472.15	1341.58
10	50	476.69	151.35	673.61	472.15	1014.07
11	50	411.18	151.35	673.61	472.15	964.93
12	50	410.74	151.35	673.61	472.15	964.61
13	50	760.14	151.35	849.95	472.15	1358.91
14	50	509.36	151.35	673.61	472.15	1038.57
15	50	462.60	151.35	673.61	472.15	1003.50
16	50	462.60	151.35	673.61	472.15	1003.50
<b>AVERAGE</b>		<b>477.51</b>	<b>151.35</b>	<b>717.69</b>		<b>1047.75</b>
1	100	597.12	151.35	783.63	472.15	1186.91
2	100	339.45	151.35	647.68	472.15	891.69
3	100	261.59	151.35	647.68	472.15	833.30
4	100	227.54	151.35	647.68	472.15	807.76
5	100	641.84	151.35	783.63	472.15	1220.45
6	100	402.69	151.35	647.68	472.15	939.12
7	100	339.05	151.35	647.68	472.15	891.39
8	100	328.20	151.35	647.68	472.15	883.26
9	100	670.72	151.35	783.63	472.15	1242.11
10	100	443.53	151.35	647.68	472.15	969.75
11	100	395.51	151.35	647.68	472.15	933.73
12	100	395.51	151.35	647.68	472.15	933.73
13	100	693.82	151.35	783.63	472.15	1259.43
14	100	476.20	151.35	647.68	472.15	994.25
15	100	445.44	151.35	647.68	472.15	971.18
16	100	445.44	151.35	647.68	472.15	971.18
<b>AVERAGE</b>		<b>443.98</b>	<b>151.35</b>	<b>681.67</b>		<b>995.58</b>
1	150	530.81	151.35	717.32	472.15	1087.44
2	150	306.29	151.35	619.49	472.15	845.68
3	150	239.49	151.35	619.49	472.15	795.58
4	150	210.96	151.35	619.49	472.15	774.18

5	150	575.53	151.35	717.32	472.15	1120.98
6	150	369.53	151.35	619.49	472.15	893.11
7	150	316.95	151.35	619.49	472.15	853.67
8	150	314.51	151.35	619.49	472.15	851.84
9	150	604.41	151.35	717.32	472.15	1142.64
10	150	410.37	151.35	619.49	472.15	923.74
11	150	379.00	151.35	619.49	472.15	900.21
12	150	379.00	151.35	619.49	472.15	900.21
13	150	627.51	151.35	717.32	472.15	1159.96
14	150	443.04	151.35	619.49	472.15	948.24
15	150	426.85	151.35	619.49	472.15	936.10
16	150	426.85	151.35	619.49	472.15	936.10
<b>AVERAGE</b>		<b>410.07</b>	<b>151.35</b>	<b>643.95</b>		<b>941.86</b>
1	200	464.49	151.35	651.00	472.15	987.97
2	200	273.13	151.35	588.47	472.15	797.55
3	200	217.38	151.35	588.47	472.15	755.73
4	200	194.39	151.35	588.47	472.15	738.49
5	200	509.21	151.35	651.00	472.15	1021.51
6	200	336.38	151.35	588.47	472.15	844.98
7	200	299.50	151.35	588.47	472.15	817.32
8	200	299.50	151.35	588.47	472.15	817.32
9	200	538.09	151.35	651.00	472.15	1043.17
10	200	377.22	151.35	588.47	472.15	875.61
11	200	360.92	151.35	588.47	472.15	863.39
12	200	360.92	151.35	588.47	472.15	863.39
13	200	561.19	151.35	651.00	472.15	1060.49
14	200	409.89	151.35	588.47	472.15	900.11
15	200	406.48	151.35	588.47	472.15	897.56
16	200	406.48	151.35	588.47	472.15	897.56
<b>AVERAGE</b>		<b>375.95</b>	<b>151.35</b>	<b>604.10</b>		<b>886.38</b>

## CURRICULUM VITAE

### Personal Information

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### Experience

#### **Neubauer GreenSolutions**

Bachelor Thesis Student  
Internship

*Welver, Germany  
March – June 2023  
March – August 2022*

#### **Academy of Mechanical and Industrial Engineering (ATMI)**

*November – December 2021*  
Practical Training

*Cikarang, Indonesia*

#### **Mechatronics Department at Swiss German University**

*September – November 2020*  
Internship

*Remote*

### Education

#### **Swiss German University**

*August 2019 – Present*

Bachelor of Engineering, Mechatronics

*Tangerang, Indonesia*

#### **South Westphalia University of Applied Science**

*February – August 2022*

Double degree program

*Soest, Germany*

### Skills

#### **Programming**

C++  
Python

#### **Mechanical**

3D Design with SOLIDWORKS

#### **Languages**

English (professional working proficiency)  
German (elementary proficiency)  
Indonesian (native)