

LAMPIRAN 1

BIODATA PENULIS

BIODATA PENULIS



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Hobi : *Traveling*
Motto : hidup yang tidak dipertaruhkan tidak akan pernah
dimenangkan.

Riwayat pendidikan :

Jenjang	Nama Institusi	Jurusan	Tahun
SD	SD Negeri 1 Klinting	-	2006-2013
SMP	MTs PPPI Miftahussalam Banyumas	-	2013-2016
SMA	SMK Negeri 2 Banyumas	Teknik Pengelasan	2016-2019
Perguruan Tinggi	Politeknik Negeri Cilacap	Teknik Mesin	2019-2022

LAMPIRAN 2

PERHITUNGAN PROSES PRODUKSI

MATERIAL	CUTTING SPEED (sfpm) 2			
	PLAIN MILLING CUTTERS		END MILLING CUTTERS	
	Roughing	Finishing	Roughing	Finishing
Aluminum.....	400 to 1,000	400 to 1,000	400 to 1,000	400 to 1,000
Brass, composition.....	125 to 200	90 to 200	90 to 150	90 to 150
Brass, yellow.....	150 to 200	100 to 250	100 to 200	100 to 200
Bronze, phosphor and manganese.....	30 to 80	25 to 100	30 to 80	30 to 80
Cast iron (hard).....	25 to 40	10 to 30	25 to 40	20 to 45
Cast iron (soft and medium).....	40 to 75	25 to 80	35 to 65	30 to 80
Monel metal.....	50 to 75	50 to 75	40 to 60	40 to 60
Steel, hard.....	25 to 50	25 to 70	25 to 50	25 to 70
Steel, soft.....	60 to 120	45 to 110	50 to 85	45 to 100

Tabel 7 1. Kecepatan potong untuk proses frais untuk pasangan benda kerja dan pisau HSS.

TYPE OF CUTTER	ALUMINUM		BRONZE		CAST IRON		FREE MACHINING STEEL		ALLOY STEEL	
	HSS	CAR BIDE	HSS	CAR BIDE	HSS	CAR BIDE	HSS	CAR BIDE	HSS	CAR BIDE
FACE MILLS	.007	.007	.005	.004	.004	.006	.003	.004	.002	.003
	to	to	to	to	to	to	to	to	to	to
HELICAL MILLS	.022	.020	.014	.012	.016	.020	.012	.016	.008	.014
	to	to	to	to	to	to	to	to	to	to
SIDE CUTTING MILLS	.006	.006	.003	.004	.004	.002	.002	.003	.002	.003
	to	to	to	to	to	to	to	to	to	to
END MILLS	.018	.016	.011	.010	.018	.018	.010	.013	.007	.012
	to	to	to	to	to	to	to	to	to	to
FORM RELIEVED CUTTERS	.004	.004	.003	.003	.002	.003	.002	.003	.001	.002
	to	to	to	to	to	to	to	to	to	to
CIRCULAR SAWS	.013	.012	.008	.007	.009	.012	.007	.009	.005	.008
	to	to	to	to	to	to	to	to	to	to
FORM RELIEVED CUTTERS	.003	.003	.003	.002	.002	.003	.001	.002	.001	.002
	to	to	to	to	to	to	to	to	to	to
CIRCULAR SAWS	.011	.010	.007	.006	.008	.010	.006	.008	.004	.007
	to	to	to	to	to	to	to	to	to	to
CIRCULAR SAWS	.002	.002	.001	.001	.002	.002	.001	.002	.001	.001
	to	to	to	to	to	to	to	to	to	to
CIRCULAR SAWS	.007	.006	.004	.004	.005	.006	.004	.005	.003	.004
	to	to	to	to	to	to	to	to	to	to
CIRCULAR SAWS	.002	.002	.001	.001	.001	.002	.001	.001	.005	.001
	to	to	to	to	to	to	to	to	to	to
CIRCULAR SAWS	.005	.005	.003	.003	.004	.006	.003	.004	.002	.004
	to	to	to	to	to	to	to	to	to	to

Tabel 7 2. Tebal beram per gigi untuk beberapa tipe pisau frais dan benda kerja yang dikerjakan (satuan dalam inchi).

Tabel 8.1 Kecepatan Potong Beberapa Jenis Bahan (Anonim, 2016ar)

Bahan	Cutter HSS		Cutter Karbida	
	Halus	kasar	Halus	kasar
Baja Perkakas	75 - 100	25 - 45	185 - 230	110 - 140
Baja Karbon Rendah	70 - 90	25 - 40	170 - 215	90 - 120
Baja karbon Menengah	60 - 85	20 - 40	140 - 185	75 - 110
Besi Cor Kelabu	40 - 45	25 - 30	110 - 140	60 - 75
Kuningan	85 - 110	45 - 70	185 - 215	120 - 150
Aluminium	70 - 110	30 - 45	140 - 215	60 - 90

MATERIAL	STRAIGHT TURNING SPEED		THREADING SPEED	
	FEET PER MINUTE	METERS PER MINUTE	FEET PER MINUTE	METERS PER MINUTE
LOW-CARBON STEEL	80-100	24.4-30.5	35-40	10.7-12.2
MEDIUM-CARBON STEEL	60-80	18.3-24.4	25-30	7.6-9.1
HIGH-CARBON STEEL	35-40	10.7-12.2	15-20	4.6-6.1
STAINLESS STEEL	40-50	12.2-15.2	15-20	4.6-6.1
ALUMINUM AND ITS ALLOYS	200-300	61.0-91.4	50-60	15.2-18.3
ORDINARY BRASS AND BRONZE	100-200	30.5-61.0	40-50	12.2-15.2
HIGH-TENSILE BRONZE	40-60	12.2-18.3	20-25	6.1-7.6
CAST IRON	50-80	15.2-24.4	20-25	6.1-7.6
COPPER	60-80	18.3-24.4	20-25	6.1-7.6

NOTE: Speeds for carbide-tipped bits can be 2 to 3 times the speed recommended for high-speed steel

Tabel 6 8. Kecepatan potong proses bubut rata dan proses bubut ulir untuk pahat HSS.

Workpiece material	Tensile strength in kp/mm ²	Tool	Cutting angle clearance/top		Feed in mm/rev.				Coolant and Lubricant	
			α°	γ°	cutting speed v				Roughing	Finishing
					0,1	0,2	0,4	0,8		
Steel St 34, St 37, St 42	up to 50.	SS	8	14		60	45	34	E	E or P
		S ₁	5	10	280'	236	200	170		
St 50, St 60	50...70	SS	8	14		44	32	24	E	E or P
		S ₁	5	10	240	205	175	145		
St 70	70...85	SS	8	14		32	24	18	E	E or P
		S ₁	5	10	200	170	132	106		
Cast steel	50...70	SS	8	10		34	25	19	E	dry
		S ₁	5	6	118	100	85	71		
Alloyed steel	85...100	SS	8	10		24	17	12	E	E or P
		S ₁	5	6	150	118	95	75		
Mn-Steel, Cr-Ni-steel, Cr-Mo-steel	100...140	SS	8	6		18	11	8	E	E or P
		S ₁	5	6	95	75	60	50		
other alloyed steels	140...180	SS	8	6		9,5	6		E	E or P
		S ₁	5	6	60	48	38	32		
Tool steel	150...180	SS	8	6					E	Colza oil or P
		S ₁	5	6	50	40	32	27		
C.1.20, C.1.25	hardness Brinell 200...250	SS	8	0		32	18	13		
		H ₁	5	0	106	90	75	63		
Copper alloys	hardness Brinell 80...120	SS	8	0		125	85	56	dry, E or L	dry
		G ₁	5	6	600	530	450	400		
Cast bronze		SS	8	0		63	53	43	E or L	dry
		G ₁	5	6	355	280	236	200		
Light alloys aluminium		SS	12	30		400	300	200	E or P	E or P
		G ₁	12	30	1320	1120	950	850		
Aluminium alloys (11...13%Si)		SS	12	18		100	67	45	E	Oil S II or P
		G ₁	12	18	224	190	160	140		
Magnesium alloys*		SS	8	8		1000	900	800	dry or with non-combustible oil	dry or with non-combustible oil
		G ₁	5	6	1800	1500	1250	1060		
Plastics and hard rubber		SS	12	10					dry	dry
		G ₁	12	10	300	280	250	224		
Bakelite, Novotext, Pertinax hard plastic		SS	12	14					dry	dry
		G ₁	12	14	280	212	170	132		

Tabel 6 3. Penentuan jenis pahat, geometri pahat, v, dan f (EMCO).

MATERIAL AND CUTTING SPEED (FT PER MINUTE)											
Diameter of drill (in.)	Aluminum	Brass & Bronze	Cast iron	Mild steel 0.2-0.3 carbon (LOW)	Steel 0.4-0.5 carbon (MED)	Tool steel 1.2 carbon and drop forgings	Conn. rod molyb- denum steel	3.5 nickel steel	Stainless steel and nickel metal	Malleable iron	Feed per revo- lution (in.)
	300	300	100	110	80	80	55	80	80	85	
	Revolutions per minute										
1/16.....	18,338	12,224	8,112	6,724	4,883	3,688	3,404	3,978	3,066	5,182	0.0015
1/8.....	9,188	6,112	3,058	3,362	2,444	1,834	1,702	1,988	1,538	2,598	0.002-0.003
3/16.....	6,108	4,072	2,036	2,242	1,630	1,222	1,120	1,324	1,018	1,734	0.004
1/4.....	4,684	3,058	1,528	1,681	1,222	917	851	984	784	1,288	0.006
5/16.....	3,888	2,444	1,222	1,344	978	733	672	784	611	1,038	0.008
3/8.....	3,084	2,036	1,018	1,121	815	611	560	662	509	867	0.008
7/16.....	2,822	1,748	874	921	699	524	481	568	437	742	0.007
1/2.....	2,282	1,528	784	840	611	458	420	487	382	648	0.008
9/16.....	2,037	1,388	678	747	545	407	373	441	340	577	0.008
5/8.....	1,838	1,224	612	673	489	367	337	398	308	520	0.008
11/16.....	1,665	1,110	555	611	444	333	300	360	273	472	0.009
3/4.....	1,524	1,018	508	558	408	308	279	330	254	433	0.010
13/16.....	1,422	948	474	521	379	285	261	308	237	403	0.010
7/8.....	1,314	878	436	482	349	262	241	285	219	371	0.011
15/16.....	1,221	814	407	448	325	244	224	260	204	346	0.012
1.....	1,148	784	382	420	308	229	210	258	191	308	0.013
1 1/16.....	1,077	718	368	385	287	215	197	235	180	305	0.013
1 1/8.....	1,020	660	340	374	272	204	187	221	170	288	0.014
1 3/16.....	968	644	322	354	258	193	177	208	161	274	0.014
1 1/4.....	918	612	308	337	248	183	168	199	153	260	0.015
1 5/16.....	873	582	291	320	233	173	160	189	146	248	0.016
1 3/8.....	834	558	278	308	222	167	153	180	138	236	0.015
1 7/16.....	796	530	265	292	212	159	146	172	133	226	0.016
1 1/2.....	762	508	254	279	204	153	140	165	127	216	0.015
1 9/16.....	732	488	244	268	195	148	134	158	122	207	0.016
1 5/8.....	702	468	234	257	188	141	129	152	117	201	0.016
1 11/16.....	678	452	228	249	181	138	124	147	113	192	0.016
1 3/4.....	654	438	218	240	178	131	120	142	109	186	0.016
1 13/16.....	630	420	210	231	168	126	116	137	105	178	0.016
1 7/8.....	612	408	204	224	163	122	112	133	102	173	0.016
1 15/16.....	591	394	197	216	158	118	108	125	99	168	0.016
2.....	573	382	191	210	153	115	105	124	96	162	0.016

1. Rotational speed value for carbide twist drills are 250 to 300 percent higher than H.S.S.

Tabel 8.2. Putaran mata bor dan gerak makan pada beberapa jenis bahan.

MATERIAL	CUTTING SPEEDS % (METERS/MINUTE) (FEET/MINUTE)		POINT ANGLE	LIP CLEARANCE	COOLANTS
	MPM	FPM			
Aluminum And Alloys	61.00 - 91.50	200 - 300	90 - 130 deg	12 - 15 deg	Kerosene/Kerosene & Lard Oil/Soluble Oil
Armor Plate	12.20 - 18.25	40 - 50	135 - 140 deg	6 - 9 deg	Light Machine Oil
Brass	61.00 - 91.50	200 - 300	118 - 118 deg	12 - 15 deg	Dry/Soluble Oil/Kerosene/Lard Oil
Bronze	61.00 - 91.50	200 - 300	110 - 118 deg	12 - 15 deg	Dry/Soluble Oil/Mineral Oil/Lard Oil
Bronze, High Tensile	21.25 - 45.75	70 - 150	100 - 110 deg	12 - 15 deg	Dry/Soluble Oil/Mineral Oil/Lard Oil
Cast Iron, Soft	30.50 - 45.75	100 - 150	90 - 100 deg	12 - 15 deg	Air Jet Dry/ Soluble Oil
Cast Iron, Medium	21.25 - 30.50	70 - 100	100 - 110 deg	12 - 15 deg	Air Jet Dry/ Soluble Oil
Cast Iron, Hard	21.25 - 30.50	70 - 100	100 - 118 deg	8 - 12 deg	Air Jet Dry/ Soluble Oil
Cast Iron, Chilled	9.15 - 12.20	30 - 40	118 - 135 deg	5 - 9 deg	Air Jet Dry/ Soluble Oil
Copper	61.00 - 91.50	200 - 300	100 - 118 deg	12 - 15 deg	Air Jet Dry/ Soluble Oil
Copper Graphite Alloy (Carbon Drills)	18.20 - 21.25	60 - 70	**_**	**_**	Soluble Oil/Dry/Mineral Oil/Kerosene
Glass (Carbon Drills)	6.10 - 9.15	20 - 30	**_**	**_**	Soluble Oil/Dry/Mineral Oil/Kerosene
Iron, Malleable	15.25 - 27.45	50 - 90	90 - 100 deg	12 - 15 deg	Light Machine Oil
Magnesium And Alloys	76.25 - 122.0	250 - 400	70 - 118 deg	12 - 15 deg	Soluble Oil
Monel Nickel	4.15 - 15.20	30 - 50	118 - 125 deg	10 - 12 deg	Compressed Air/Mineral Oil
Nickel Alloys	12.20 - 18.20	40 - 60	135 - 140 deg	5 - 7 deg	Lard Oil/Soluble Oil
Plastic, Hot Set	30.50 - 91.50	100 - 300	60 - 90 deg	10 - 12 deg	Lard Oil/Soluble Oil
Plastic, Cold Set	30.50 - 91.50	100 - 300	118 - 135 deg	12 - 20 deg	Soap Solution
Steel, Low Carbon, 0.2-0.3%	24.48 - 33.55	80 - 110	110 - 118 deg	7 - 9 deg	Soap Solution
Steel, Medium Carbon, 0.4-0.5%	21.25 - 24.40	70 - 80	118 - 125 deg	7 - 9 deg	Soluble Oil/Mineral Oil/Sulfur Oil/Lard Oil
Steel (High Carbon 1.2%)	15.25 - 18.20	50 - 60	118 - 145 deg	7 - 9 deg	Soluble Oil/Mineral Oil/Sulfur Oil/Lard Oil
Steel, Forged	15.25 - 18.20	50 - 60	118 - 145 deg	7 - 9 deg	Soluble Oil/Mineral Oil/Sulfur Oil/Lard Oil
Steel, Alloy	15.25 - 21.25	50 - 70	118 - 125 deg	10 - 12 deg	Mineral Lard Oil
Steel, Alloy 300 To 400 Brinell	6.10 - 9.15	20 - 30	130 - 140 deg	7 - 10 deg	Soluble Oil
Steel, Stainless, Free Machining	9.15 - 24.40	30 - 80	110 - 118 deg	8 - 12 deg	Soluble Oil
Steel, Stainless, Hard	4.57 - 15.25	15 - 50	118 - 135 deg	6 - 8 deg	Soluble Oil
Steel, Manganese	3.66 - 4.57	12 - 15	140 - 150 deg	7 - 10 deg	Soluble Oil
Stone (Carbide Drills)	7.62 - 9.15	25 - 30	**_**	**_**	Water Solution
Wood	91.50 - 122.2	300 - 400	60 - 70 deg	10 - 15 deg	Dry

Tabel 8 I. Data material, kecepatan potong, sudut mata bor HSS, dan cairan pendingin proses gurdi.

LAMPIRAN 3

STANDAR PENGUJIAN KEKERASAN MATERIAL

Standar pengujian kekerasan *rockwell ASTM E18-15*

A4.5 Standardization Procedure

A4.5.1 A test block is standardized by calibrating the average hardness of the test surface to a specific Rockwell hardness standard. Only one surface of the test block shall be calibrated. When possible, the test blocks should be calibrated traceable to national Rockwell standards (see **Note A4.2**). The Rockwell standard to which the test blocks are traceable shall be stated in the certification.

NOTE A4.2—In the United States, the national Rockwell hardness standardizing laboratory is the National Institute of Standards and Technology (NIST), Gaithersburg, MD 20899.

NOTE A4.3—Primary standardized test blocks are available as Standard Reference Material from NIST, Gaithersburg, MD 20899.

TABLE A4.1 Physical Requirements of Standardized Test Blocks

Test Block Parameter	Tolerance
Thickness	≥6.0 mm (0.236 in.) ≤16.0 mm (0.630 in.)
Test surface area	≤2600 mm ² (4 in. ²)
Deviation from surface flatness (test & bottom)	≤0.005 mm (0.0002 in.)
Deviation from surface parallelism (test & bottom)	≤0.0002 mm per mm (0.0002 in. per in.)
Mean surface roughness (test & bottom)	R_a ≤ 0.003 mm (12 μin.) center line average

Tabel 3.6 Skala Kekerasan Rockwell (Bolton, 1998: 59)

Scale	Indenter	Additional load kg	Typical applications
A	Diamond	60	Extremely hard materials, e.g. tool steels
B	Ball 1.588 mm dia.	100	Softer materials, e.g. Cu alloys, Al alloys, mild steel
C	Diamond	150	Hard materials, e.g. steels, hard cast irons, alloy steels
D	Diamond	100	Medium case hardened materials
E	Ball 3.175 mm dia.	100	Soft materials, e.g. Al alloys, Mg alloys, bearing metals
F	Ball 1.588 mm dia.	60	As E, the smaller ball being more appropriate where inhomogeneities exist
G	Ball 1.588 mm dia.	150	Malleable irons, gun metals, bronzes
H	Ball 3.175 mm dia.	60	Soft aluminium, lead, zinc, thermoplastics
K	Ball 3.175 mm dia.	150	Aluminium and magnesium alloys
L	Ball 6.350 mm dia.	60	Soft thermoplastics
M	Ball 6.350 mm dia.	100	Thermoplastics
R	Ball 12.70 mm dia.	60	Very soft thermoplastics

Note: the diameter of the balls arise from standard sizes in inches, 1.588 mm being 1/16 in, 3.175 mm being 1/8 in, 6.350 mm being 1/4 in, and 12.70 mm being 1/2 in.

LAMPIRAN 4

DOKUMENTASI PROSES PRODUKSI

Proses pemotongan



Proses pengelasan



Proses gurdi



Proses frais



Proses bubut



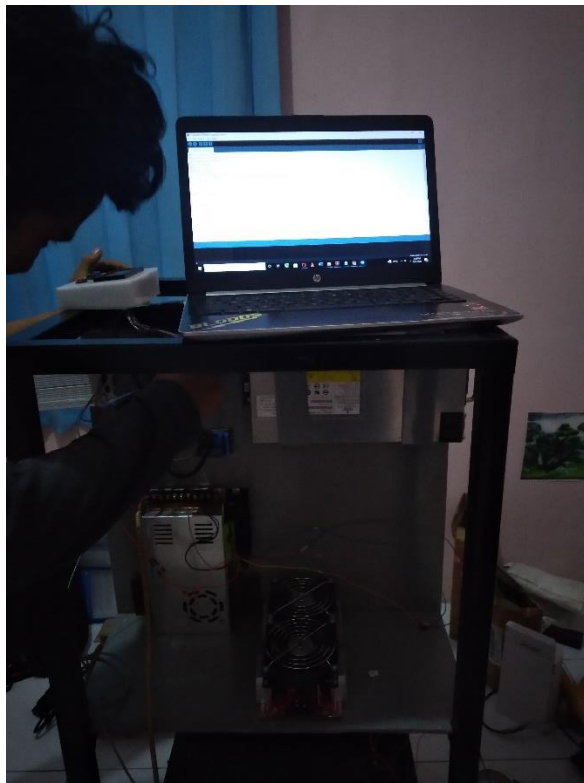
Proses kerja plat



Proses perakitan



Proses uji coba mesin



LAMPIRAN 5

DOKUMENTASI PENGUJIAN MESIN

Pengujian fungsi pemanas



Pengujian fungsi pendingin



Pengujian fungsi penggerak



LAMPIRAN 6

DOKUMENTASI PENGUJIAN MATERIAL

Material uji *raw material*



Material uji *hardening*



Material uji *tempering*



Proses pengujian kekerasan



Angka kekerasan *raw material*



Angka Kekerasan *Hardening*



Angka Kekerasan *Tempering*



LAMPIRAN 7

BIAYA OPERASIONAL MATERIAL

BIAYA OPERASIONAL MATERIAL

No	Nama Komponen	No Komponen	Spesifikasi	Satuan	Harga per satuan	Jumlah Pemakaian per satuan		Harga Komponen
						Panjang (mm)	Jumlah	
A Rangka Mesin								
1	Rangka bawah	A-01	Besi <i>hollow</i> 30x30x1.2 mm	batang	Rp 138.000	500	4	Rp 46.000,00
2	Rangka atas	A-02	Besi <i>hollow</i> 30x30x1.2 mm	batang	Rp 138.000	500	4	Rp 46.000,00
3	Rangka kaki	A-03	Besi <i>hollow</i> 30x30x1.2 mm	batang	Rp 138.000	940	4	Rp 86.480,00
4	Rangka tengah	A-04	Besi <i>hollow</i> 30x30x1.2 mm	batang	Rp 138.000	440	5	Rp 50.600,00
Jumlah								Rp 229.080,00
B Sistem Penggerak								
1	<i>Main shaft</i>	B-01	<i>Stainless steel 304</i>	batang	Rp 50.000	500	2	Rp 100.000,00
2	<i>Ballscrew + ballsrew nut</i>	B-02 & B-03	$\varnothing 12 \times 500$ mm	buah	Rp 344.900	500	1	Rp 344.900,00
3	<i>Nut housing</i>	B-04	<i>Aluminium alloy $\varnothing 24$ mm</i>	buah	Rp 49.900	24	1	Rp 49.900,00
4	<i>Main shaft holder</i>	B-05	<i>Aluminium alloy $\varnothing 12$ mm</i>	buah	Rp 19.900	12	4	Rp 79.600,00
5	<i>pillow block $\varnothing 10$ mm</i>	B-06	<i>Pillow block $\varnothing 10$ mm</i>	buah	Rp 21.000	10	1	Rp 21.000,00
6	<i>pillow block $\varnothing 8$ mm</i>	B-07	<i>Pillow block $\varnothing 8$ mm</i>	buah	Rp 15.500	10	1	Rp 15.500,00
7	<i>Linear bearing</i>	B-08	$\varnothing 12$ mm	buah	Rp 33.000	12	2	Rp 66.000,00
8	<i>Bracket siku</i>	B-09	<i>Aluminium 20x20 mm</i>	buah	Rp 3.900	20	2	Rp 7.800,00
9	<i>Shaft support mount</i>	B-10	<i>Aluminium alloy $\varnothing 20$ mm</i>	buah	Rp 30.500	20	1	Rp 30.500,00
10	<i>Rigid shaft coupler</i>	B-11	<i>Aluminium $\varnothing 6 \times \varnothing 8$ mm</i>	buah	Rp 15.900	20	1	Rp 15.900,00
11	<i>Motor stepper</i>	B-12	<i>Nema 23</i>	buah	Rp 239.800	50	1	Rp 239.800,00
12	<i>Baut L M5</i>	B-13	<i>M5</i>	buah	Rp 700	10	23	Rp 16.100,00
13	<i>Bracket pillow block $\varnothing 10$ mm</i>	B-14	<i>Plat SPHC 8 mm</i>	lembar	Rp 10.000	67	1	Rp 10.000,00
14	<i>Bracket pillow block $\varnothing 8$ mm</i>	B-15	<i>Plat SPHC 9 mm</i>	lembar	Rp 10.000	55	1	Rp 10.000,00
15	<i>Socket set screw M8</i>	B-16	<i>M8</i>	buah	Rp 1.500	10	2	Rp 3.000,00
16	<i>Base holder</i>	B-17	<i>Plat SPHC 3 mm</i>	lembar	Rp 15.000	180	1	Rp 15.000,00
17	<i>Holder arm (L)</i>	B-18	<i>Aluminium alloy 12 mm</i>	lembar	Rp 15.000	180	1	Rp 15.000,00
18	<i>Joint arm</i>	B-19	<i>Aluminium alloy 10 mm</i>	lembar	Rp 15.000	40	1	Rp 15.000,00
19	<i>Holder arm (R)</i>	B-20	<i>Aluminium alloy 12 mm</i>	lembar	Rp 15.000	180	1	Rp 15.000,00
20	<i>Shaft holder</i>	B-21	<i>Aluminium alloy $\varnothing 21$ mm</i>	batang	Rp 10.000	225	1	Rp 10.000,00
21	<i>Object holder</i>	B-22	<i>S45C $\varnothing 32 \times 80$ mm</i>	buah	Rp 33.000	80	1	Rp 33.000,00
Jumlah								Rp 1.113.000,00

C Dudukan Komponen Elektronik								
1	Lantai pemanas	C-01	Plat besi	lembar	Rp 40.000	495	1	Rp 40.000,00
2	Dinding komponen	C-02	<i>Triplek</i>	lembar	Rp 20.000	500	1	Rp 20.000,00
3	Dudukan pemanas	C-03	<i>Triplek</i>	lembar	Rp 20.000	495	1	Rp 20.000,00
4	Dudukan elektronik	C-04	<i>Calsiboard</i>	lembar	Rp 10.000	160	1	Rp 10.000,00
5	Klem psu 48V	C-05	Plat besi	lembar	Rp 10.000	251	2	Rp 20.000,00
6	Klem psu 24V	C-06	Besi siku	batang	Rp 5.000	70	2	Rp 10.000,00
7	<i>Spacer</i>	C-07	<i>Aluminium</i>	buah	Rp 1.500	30	4	Rp 6.000,00
Jumlah								Rp 126.000,00
D Plat Penutup								
1	Lantai	D-01	<i>Plat zinc</i>	lembar	Rp 75.000	500	1	Rp 75.000,00
2	<i>Cover</i>	D-02	<i>Plat zinc</i>	lembar	Rp 117.000	1500	1	Rp 117.000,00
3	Atap	D-03	<i>Plat zinc</i>	lembar	Rp 16.000	500	1	Rp 16.000,00
4	Pintu depan	D-04	<i>Plat zinc</i>	lembar	Rp 32.000	1000	1	Rp 32.000,00
5	Pintu belakang	D-05	<i>Plat zinc</i>	lembar	Rp 16.000	500	1	Rp 16.000,00
Jumlah								Rp 256.000,00
E Komponen Elektronik								
1	Modul pemanas induksi	-	2000 watt	buah	Rp 1.004.100	-	1	Rp 1.004.100,00
2	<i>Driver motor stepper</i>	-	TB6600	buah	Rp 109.900	-	1	Rp 109.900,00
3	<i>MCB</i>	-	DC 1 pole 600 Vdc	buah	Rp 40.000	-	1	Rp 40.000,00
4	<i>Thermocouple</i>	-	Type K	buah	Rp 150.000	-	1	Rp 150.000,00
5	<i>Thermocontrol</i>	-	MAX6675	buah	Rp 45.000	-	1	Rp 45.000,00
6	Modul relay 2 channel	-	Relay 5V	buah	Rp 14.500	-	1	Rp 14.500,00
7	<i>Lcd 20 x 4</i>	-	20 x 4	buah	Rp 71.000	-	1	Rp 71.000,00
8	<i>Relay SSR</i>	-	Fotek 50 amper	buah	Rp 65.000	-	1	Rp 65.000,00
9	<i>Psu 24V 15A</i>	-	24V 15A	buah	Rp 115.000	-	1	Rp 115.000,00
10	<i>Psu 48V 43A</i>	-	48V 43A	buah	Rp 500.000	-	1	Rp 500.000,00
11	<i>Modul step down</i>	-	In 3.40V out 1,5-35V 3A	buah	Rp 12.400	-	1	Rp 12.400,00
12	Pompa pendingin	-	1000 liter / jam (7 watt)	buah	Rp 45.000	-	1	Rp 45.000,00
13	<i>Arduino uno R3</i>	-	R3 CH340 ATMEGA 328P	buah	Rp 109.500	-	1	Rp 109.500,00
Jumlah								Rp 2.281.400,00

F	Lain-lain							
1	Socket AC	-	-	buah	Rp 30.000	-	1	Rp 30.000,00
2	Kabel power PSU	-	-	buah	Rp 9.500	-	1	Rp 9.500,00
3	Kabel motor stepper	-	-	buah	Rp 7.900	-	1	Rp 7.900,00
4	Roda castro	-	-	buah	Rp 6.900	-	4	Rp 27.600,00
5	Timah solder	-	-	buah	Rp 3.500	-	1	Rp 3.500,00
6	Kabel jumper	-	-	buah	Rp 15.000	-	1	Rp 15.000,00
7	Kabel telfon 4mm 50ohm	-	-	buah	Rp 9.000	-	1	Rp 9.000,00
8	Lem besi	-	-	buah	Rp 16.000	-	1	Rp 16.000,00
9	Ember besi	-	-	buah	Rp 29.300	-	1	Rp 29.300,00
10	Engsel	-	-	buah	Rp 2.500	-	2	Rp 5.000,00
11	Papan pcb	-	-	buah	Rp 5.000	-	1	Rp 5.000,00
12	Batu gerinda poles	-	-	buah	Rp 9.500	-	1	Rp 9.500,00
13	Batu gerinda potong	-	-	buah	Rp 3.500	-	2	Rp 7.000,00
14	Mata gerinda amplas	-	-	buah	Rp 7.000	-	2	Rp 14.000,00
15	Elektroda	-	-	box	Rp 36.000	-	1	Rp 36.000,00
16	Cat	-	-	buah	Rp 42.000	-	1	Rp 42.000,00
17	E-poxy	-	-	buah	Rp 22.000	-	1	Rp 22.000,00
18	Thinner	-	-	buah	Rp 38.000	-	1	Rp 38.000,00
19	Amplas	-	-	lembar	Rp 10.000	-	1	Rp 10.000,00
20	Pompa Plastik	-	-	buah	Rp 16.000	-	1	Rp 16.000,00
21	Rivet	-	-	buah	Rp 300	-	50	Rp 15.000,00
22	Tombol push on	-	-	buah	Rp 3.000	-	3	Rp 9.000,00
23	Socket 3p	-	-	buah	Rp 2.500	-	1	Rp 2.500,00
24	Baut L M5 x 40 + mur	-	-	buah	Rp 1.700	-	16	Rp 27.200,00
25	Glasswool	-	-	lembar	Rp 5.200	-	6	Rp 31.200,00
26	Panel akrilik	-	-	buah	Rp 50.000	-	1	Rp 50.000,00
27	Kabel	-	-	meter	Rp 8.500	-	2	Rp 17.000,00
28	Jek DC	-	-	buah	Rp 1.500	-	1	Rp 1.500,00
29	Klem kabel	-	-	buah	Rp 2.500	-	1	Rp 2.500,00
Jumlah								Rp 508.200
G	Jumlah Biaya Material							Rp 4.513.680,00
H	Biaya Sewa Mesin							Rp 250.450,00
I	Biaya Listrik							Rp 26.200,32
J	Biaya Tenaga Kerja							Rp 624.097,80
Jumlah Total								Rp 5.414.428,12