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Lampiran 1. Harga penutupan masing masing aset

Date	GME	MSFT	DAX	DJI	JPY	Price
10/1/2023	13.77	338.11	14,810.34	33,052.74	0.66845	0.6336
9/1/2023	16.46	315.75	15,386.58	33,507.76	0.6693	0.6434
8/1/2023	18.55	327.76	15,947.08	34,721.16	0.687	0.6483
7/1/2023	22.2	335.92	16,446.83	35,559.53	0.7027	0.672
6/1/2023	24.25	340.54	16,147.90	34,407.60	0.6928	0.6666
5/1/2023	24.05	328.39	15,664.02	32,908.27	0.7176	0.65
4/1/2023	19.29	307.26	15,922.38	34,098.16	0.7336	0.6607
3/1/2023	23.02	288.3	15,628.84	33,274.15	0.7529	0.6685
2/1/2023	19.23	249.42	15,365.14	32,656.70	0.734	0.6728
1/1/2023	21.87	247.81	15,128.27	34,086.04	0.7685	0.7054
12/1/2022	18.46	239.82	13,923.59	33,147.25	0.7625	0.6813
11/1/2022	26.21	255.14	14,397.04	34,589.77	0.7243	0.6786
10/1/2022	28.31	232.13	13,253.74	32,732.95	0.6723	0.6397
9/1/2022	25.13	232.9	12,114.36	28,725.51	0.6907	0.6402
8/1/2022	28.64	261.47	12,834.96	31,510.43	0.7196	0.6839
7/1/2022	34.01	280.74	13,484.05	32,845.13	0.7506	0.6985
6/1/2022	30.58	256.83	12,783.77	30,775.43	0.7366	0.6901
5/1/2022	31.18	271.87	14,388.35	32,990.12	0.7769	0.7173
4/1/2022	31.27	277.52	14,097.88	32,977.21	0.7701	0.7063
3/1/2022	41.65	308.31	14,414.75	34,678.35	0.8216	0.748
2/1/2022	30.83	298.79	14,461.02	33,892.60	0.8694	0.7262
1/1/2022	27.23	310.98	15,471.20	35,131.86	0.8686	0.7064
12/1/2021	37.1	336.32	15,884.86	36,338.30	0.8687	0.726
11/1/2021	49.05	330.59	15,100.13	34,483.72	0.8835	0.7123
10/1/2021	45.88	331.62	15,688.77	35,819.56	0.877	0.7521
9/1/2021	43.87	281.92	15,260.69	33,843.92	0.8985	0.7226
8/1/2021	54.56	301.88	15,835.09	35,360.73	0.9087	0.7315
7/1/2021	40.28	284.91	15,544.39	34,935.47	0.9113	0.7344
6/1/2021	53.53	270.9	15,531.04	34,502.51	0.8999	0.7498
5/1/2021	55.5	249.68	15,421.13	34,529.45	0.9127	0.7734
4/1/2021	43.4	252.18	15,135.91	33,874.85	0.9149	0.7716
3/1/2021	47.46	235.77	15,008.34	32,981.55	0.9031	0.7596
2/1/2021	25.43	232.38	13,786.29	30,932.37	0.938	0.7705
1/1/2021	81.25	231.96	13,432.87	29,982.62	0.955	0.7642

Lampiran 1. Harga penutupan masing masing aset (lanjutan)						
12/1/2020	4.71	222.42	13,718.78	30,606.48	0.9683	0.7694
11/1/2020	4.14	214.07	13,291.16	29,638.64	0.9588	0.7345
10/1/2020	2.62	202.47	11,556.48	26,501.60	0.9554	0.7026
9/1/2020	2.55	210.33	12,760.73	27,781.70	0.9484	0.7161
8/1/2020	1.67	225.53	12,945.38	28,430.05	0.9441	0.7375
7/1/2020	1	205.01	12,313.36	26,428.32	0.9445	0.7142
6/1/2020	1.09	203.51	12,310.93	25,812.88	0.9264	0.6902
5/1/2020	1.01	183.25	11,586.85	25,383.11	0.9274	0.6666
4/1/2020	1.43	179.21	10,861.64	24,345.72	0.9328	0.651
3/1/2020	0.88	157.71	9,935.84	21,917.16	0.9297	0.6135
2/1/2020	0.9	162.01	11,890.35	25,409.36	0.9251	0.6509
1/1/2020	0.96	170.23	12,981.97	28,256.03	0.9224	0.6691
12/1/2019	1.52	157.7	13,249.01	28,538.44	0.9205	0.7021
11/1/2019	1.59	151.38	13,236.38	28,051.41	0.9131	0.6764
10/1/2019	1.36	143.37	12,866.79	27,046.23	0.9255	0.6893
9/1/2019	1.38	139.03	12,428.08	26,916.83	0.9252	0.6749
8/1/2019	0.99	137.86	11,939.28	26,403.28	0.9406	0.6736
7/1/2019	1	136.27	12,189.04	26,864.27	0.9194	0.6844
6/1/2019	1.37	133.96	12,398.80	26,599.96	0.9267	0.702
5/1/2019	1.89	123.68	11,726.84	24,815.04	0.9234	0.6938
4/1/2019	2.16	130.6	12,344.08	26,592.91	0.8973	0.7048
3/1/2019	2.54	117.94	11,526.04	25,928.68	0.902	0.7094
2/1/2019	2.92	112.03	11,515.64	25,916.00	0.8977	0.7094
1/1/2019	2.84	104.43	11,173.10	24,999.67	0.9183	0.7272
12/1/2018	3.15	101.57	10,558.96	23,327.46	0.9125	0.7049
11/1/2018	3.41	110.89	11,257.24	25,538.46	0.8811	0.7315
10/1/2018	3.65	106.81	11,447.51	25,115.76	0.8853	0.7073
9/1/2018	3.82	114.37	12,246.73	26,458.31	0.8794	0.7228
8/1/2018	3.32	112.33	12,364.06	25,964.82	0.9003	0.719
7/1/2018	3.6	106.08	12,805.50	25,415.19	0.8937	0.7426
6/1/2018	3.64	98.61	12,306.00	24,271.41	0.9033	0.7402
5/1/2018	3.3	98.84	12,604.89	24,415.84	0.9189	0.7567
4/1/2018	3.41	93.52	12,612.11	24,163.15	0.9146	0.7531
3/1/2018	3.15	91.27	12,096.73	24,103.11	0.9408	0.7678
2/1/2018	3.92	93.77	12,435.85	25,029.20	0.9374	0.7761
1/1/2018	4.2	95.01	13,189.48	26,149.39	0.9156	0.8054

Lampiran 1. Harga penutupan masing masing aset (lanjutan)						
12/1/2017	4.49	85.54	12,917.64	24,719.22	0.8873	0.7801
11/1/2017	4.69	84.17	13,023.98	24,272.35	0.8885	0.7566
10/1/2017	4.67	83.18	13,229.57	23,377.24	0.8799	0.7655
9/1/2017	5.16	74.49	12,828.86	22,405.09	0.8888	0.7833
8/1/2017	4.63	74.77	12,055.84	21,948.10	0.9092	0.7946
7/1/2017	5.42	72.7	12,118.25	21,891.12	0.9069	0.8002
6/1/2017	5.4	68.93	12,325.12	21,349.63	0.8896	0.7686
5/1/2017	5.53	69.84	12,615.06	21,008.65	0.9026	0.7429
4/1/2017	5.67	68.46	12,438.01	20,940.51	0.8964	0.7484
3/1/2017	5.64	65.86	12,312.87	20,663.22	0.8976	0.7628
2/1/2017	6.11	63.98	11,834.41	20,812.24	0.8864	0.7657
1/1/2017	6.12	64.65	11,535.31	19,864.09	0.8864	0.7583
12/1/2016	6.32	62.14	11,481.06	19,762.60	0.8553	0.7215
11/1/2016	6.17	60.26	10,640.30	19,123.58	0.8734	0.7382
10/1/2016	6.01	59.92	10,665.01	18,142.42	0.9539	0.7609
9/1/2016	6.9	57.6	10,511.02	18,308.15	0.9866	0.7654
8/1/2016	7.1	57.46	10,592.69	18,400.88	0.9668	0.7514
7/1/2016	7.74	56.68	10,337.50	18,432.24	0.9795	0.7595
6/1/2016	6.64	51.17	9,680.09	17,929.99	0.9678	0.745
5/1/2016	7.28	53	10,262.74	17,787.20	0.903	0.7229
4/1/2016	8.2	49.87	10,038.97	17,773.64	0.94	0.7602
3/1/2016	7.93	55.23	9,965.51	17,685.09	0.8882	0.7654
2/1/2016	7.7	50.88	9,495.40	16,516.50	0.8872	0.7138
1/1/2016	6.55	55.09	9,798.11	16,466.30	0.8259	0.7082
12/1/2015	7.01	55.48	10,743.01	17,425.03	0.831	0.7275
11/1/2015	8.76	54.35	11,382.23	17,719.92	0.8122	0.7226
10/1/2015	11.52	52.64	10,850.14	17,663.54	0.8289	0.7137
9/1/2015	10.3	44.26	9,660.44	16,284.70	0.8341	0.7017
8/1/2015	10.62	43.52	10,259.46	16,528.03	0.8248	0.711
7/1/2015	11.46	46.7	11,308.99	17,689.86	0.8067	0.7302
6/1/2015	10.74	44.15	10,944.97	17,619.51	0.8163	0.7704
5/1/2015	10.85	46.86	11,413.82	18,010.68	0.8053	0.7636
4/1/2015	9.64	48.64	11,454.38	17,840.52	0.8376	0.7897
3/1/2015	9.49	40.65	11,966.17	17,776.12	0.8323	0.7605
2/1/2015	9.24	43.85	11,401.66	18,132.70	0.8363	0.7809
1/1/2015	8.81	40.4	10,694.32	17,164.95	0.8513	0.7766

Lampiran 1. Harga penutupan masing masing aset (lanjutan)						
12/1/2014	8.45	46.45	9,805.55	17,823.07	0.8354	0.8168
11/1/2014	9.45	47.81	9,980.85	17,828.24	0.8427	0.8509
10/1/2014	10.69	46.95	9,326.87	17,390.52	0.8901	0.8794
9/1/2014	10.3	46.36	9,474.30	17,042.90	0.9118	0.8745
8/1/2014	10.55	45.43	9,470.17	17,098.45	0.9606	0.9333
7/1/2014	10.49	43.16	9,407.48	16,563.30	0.9728	0.9295
6/1/2014	10.12	41.7	9,833.07	16,826.60	0.9867	0.943
5/1/2014	9.46	40.94	9,943.27	16,717.17	0.9824	0.9309
4/1/2014	9.92	40.4	9,603.23	16,580.84	0.9777	0.9283
3/1/2014	10.27	40.99	9,555.91	16,457.66	0.9686	0.9262
2/1/2014	9.33	38.31	9,692.08	16,321.71	0.9822	0.8926
1/1/2014	8.77	37.84	9,306.48	15,698.85	0.98	0.8753
12/1/2013	12.31	37.41	9,552.16	16,576.66	0.9494	0.8913
11/1/2013	12.06	38.13	9,405.30	16,086.41	0.9758	0.911
10/1/2013	13.7	35.4	9,033.92	15,545.75	1.0167	0.9458
9/1/2013	12.41	33.28	8,594.40	15,129.67	1.0178	0.9312
8/1/2013	12.55	33.4	8,103.15	14,810.31	1.0185	0.8896
7/1/2013	12.27	31.84	8,275.97	15,499.54	1.0216	0.898
6/1/2013	10.51	34.54	7,959.22	14,909.60	1.0086	0.9136
5/1/2013	8.29	34.9	8,348.84	15,115.57	0.9949	0.957
4/1/2013	8.73	33.1	7,913.71	14,839.80	1.0263	1.0369
3/1/2013	6.99	28.6	7,795.31	14,578.54	1.061	1.0417
2/1/2013	6.26	27.8	7,741.70	14,054.49	1.0798	1.0212
1/1/2013	5.8	27.45	7,776.05	13,860.58	1.0922	1.0422

Lampiran 2. Nilai *return* masing masing aset

GME	MSFT	DAX	DJI	JPY	AUD
-0.16343	0.070816	-0.03745	-0.01358	-0.00127	-0.01523
-0.11267	-0.03664	-0.03515	-0.03495	-0.02576	-0.00756
-0.16441	-0.02429	-0.03039	-0.02358	-0.02234	-0.03527
-0.08454	-0.01357	0.018512	0.033479	0.01429	0.008101
0.008316	0.036999	0.030891	0.045561	-0.03456	0.025538
0.24676	0.068769	-0.01623	-0.0349	-0.02181	-0.01619
-0.16203	0.065765	0.018782	0.024764	-0.02563	-0.01167
0.197088	0.155882	0.017162	0.018907	0.025749	-0.00639

Lampiran 2. Nilai *return* masing masing aset (lanjutan)					
-0.12071	0.006497	0.015657	-0.04193	-0.04489	-0.04621
0.184724	0.033317	0.086521	0.028322	0.007869	0.035374
-0.29569	-0.06005	-0.03289	-0.0417	0.052741	0.003979
-0.07418	0.099125	0.086262	0.056726	0.077346	0.06081
0.126542	-0.00331	0.094052	0.139508	-0.02664	-0.00078
-0.12256	-0.10927	-0.05614	-0.08838	-0.04016	-0.0639
-0.15789	-0.06864	-0.04814	-0.04064	-0.0413	-0.0209
0.112165	0.093097	0.054779	0.067252	0.019006	0.012172
-0.01924	-0.05532	-0.11152	-0.06713	-0.05187	-0.03792
-0.00288	-0.02036	0.020604	0.000391	0.00883	0.015574
-0.24922	-0.09987	-0.02198	-0.04905	-0.06268	-0.05575
0.350957	0.031862	-0.0032	0.023184	-0.05498	0.030019
0.132207	-0.0392	-0.06529	-0.03527	0.000921	0.028029
-0.26604	-0.07534	-0.02604	-0.0332	-0.00012	-0.027
-0.24363	0.017333	0.051968	0.053781	-0.01675	0.019233
0.069093	-0.00311	-0.03752	-0.03729	0.007412	-0.05292
0.045817	0.176291	0.028051	0.058375	-0.02393	0.040825
-0.19593	-0.06612	-0.03627	-0.0429	-0.01122	-0.01217
0.354518	0.059563	0.018701	0.012173	-0.00285	-0.00395
-0.24752	0.051717	0.00086	0.012549	0.012668	-0.02054
-0.0355	0.084989	0.007127	-0.00078	-0.01402	-0.03051
0.278802	-0.00991	0.018844	0.019324	-0.0024	0.002333
-0.08555	0.069602	0.0085	0.027085	0.013066	0.015798
0.8663	0.014588	0.088642	0.066247	-0.03721	-0.01415
-0.68702	0.001811	0.02631	0.031677	-0.0178	0.008244
16.25053	0.042892	-0.02084	-0.02038	-0.01374	-0.00676
0.137681	0.039006	0.032173	0.032655	0.009908	0.047515
0.580153	0.057292	0.150105	0.118372	0.003559	0.045403
0.027451	-0.03737	-0.09437	-0.04608	0.007381	-0.01885
0.526946	-0.0674	-0.01426	-0.02281	0.004555	-0.02902
0.67	0.100093	0.051328	0.075742	-0.00042	0.032624
-0.08257	0.007371	0.000197	0.023842	0.019538	0.034773
0.079208	0.110559	0.062492	0.016931	-0.00108	0.035404
-0.29371	0.022543	0.066768	0.042611	-0.00579	0.023963
0.625	0.136326	0.093178	0.110806	0.003334	0.061125

Lampiran 2. Nilai *return* masing masing aset (lanjutan)					
-0.02222	-0.02654	-0.16438	-0.13744	0.004972	-0.05746
-0.0625	-0.04829	-0.08409	-0.10075	0.002927	-0.0272
-0.36842	0.079455	-0.02016	-0.0099	0.002064	-0.047
-0.04403	0.041749	0.000954	0.017362	0.008104	0.037995
0.169118	0.055869	0.028724	0.037165	-0.0134	-0.01871
-0.01449	0.031216	0.0353	0.004807	0.000324	0.021336
0.393939	0.008487	0.04094	0.01945	-0.01637	0.00193
-0.01	0.011668	-0.02049	-0.01716	0.023059	-0.01578
-0.27007	0.017244	-0.01692	0.009936	-0.00788	-0.02507
-0.27513	0.083118	0.057301	0.071929	0.003574	0.011819
-0.125	-0.05299	-0.05	-0.06686	0.029087	-0.01561
-0.14961	0.107343	0.070973	0.025618	-0.00521	-0.00648
-0.13014	0.052754	0.000903	0.000489	0.00479	0
0.028169	0.072776	0.030658	0.036654	-0.02243	-0.02448
-0.09841	0.028158	0.058163	0.071684	0.006356	0.031636
-0.07625	-0.08405	-0.06203	-0.08658	0.035637	-0.03636
-0.06575	0.038199	-0.01662	0.01683	-0.00474	0.034215
-0.0445	-0.0661	-0.06526	-0.05074	0.006709	-0.02144
0.150602	0.018161	-0.00949	0.019006	-0.02321	0.005285
-0.07778	0.058918	-0.03447	0.021626	0.007385	-0.03178
-0.01099	0.075753	0.04059	0.047125	-0.01063	0.003242
0.10303	-0.00233	-0.02371	-0.00592	-0.01698	-0.02181
-0.03226	0.056886	-0.00057	0.010458	0.004702	0.00478
0.08254	0.024652	0.042605	0.002491	-0.02785	-0.01915
-0.19643	-0.02666	-0.02727	-0.037	0.003627	-0.01069
-0.06667	-0.01305	-0.05714	-0.04284	0.02381	-0.03638
-0.06459	0.110708	0.021044	0.057857	0.031895	0.032432
-0.04264	0.016277	-0.00816	0.018411	-0.00135	0.03106
0.004283	0.011902	-0.01554	0.03829	0.009774	-0.01163
-0.09496	0.11666	0.031235	0.04339	-0.01001	-0.02272
0.114471	-0.00374	0.06412	0.020821	-0.02244	-0.01422
-0.14576	0.028473	-0.00515	0.002603	0.002536	-0.007
0.003704	0.054693	-0.01678	0.025363	0.019447	0.041114
-0.02351	-0.01303	-0.02298	0.01623	-0.0144	0.034594
-0.02469	0.020158	0.014235	0.003254	0.006917	-0.00735
0.005319	0.039478	0.010163	0.013419	-0.00134	-0.01888

Lampiran 2. Nilai *return* masing masing aset (lanjutan)					
-0.07692	0.029384	0.04043	-0.00716	0.012635	-0.00379
-0.00163	-0.01036	0.025929	0.047732	0	0.009759
-0.03165	0.040393	0.004725	0.005135	0.036362	0.051005
0.024311	0.031198	0.079017	0.033415	-0.02072	-0.02262
0.026622	0.005674	-0.00232	0.054081	-0.08439	-0.02983
-0.12899	0.040278	0.01465	-0.00905	-0.03314	-0.00588
-0.02817	0.002436	-0.00771	-0.00504	0.02048	0.018632
-0.08269	0.013761	0.024686	-0.0017	-0.01297	-0.01066
0.165663	0.10768	0.067914	0.028012	0.012089	0.019463
-0.08791	-0.03453	-0.05677	0.008028	0.071761	0.030571
-0.1122	0.062763	0.02229	0.000763	-0.03936	-0.04907
0.034048	-0.09705	0.007371	0.005007	0.05832	-0.00679
0.02987	0.085495	0.049509	0.070753	0.001127	0.072289
0.175573	-0.07642	-0.03089	0.003049	0.074222	0.007907
-0.06562	-0.00703	-0.08795	-0.05502	-0.00614	-0.02653
-0.19977	0.020791	-0.05616	-0.01664	0.023147	0.006781
-0.23958	0.032485	0.04904	0.003192	-0.02015	0.01247
0.118447	0.189336	0.123152	0.084671	-0.00623	0.017101
-0.03013	0.017004	-0.05839	-0.01472	0.011275	-0.01308
-0.0733	-0.06809	-0.0928	-0.06568	0.022437	-0.02629
0.067039	0.057758	0.033259	0.003993	-0.01176	-0.05218
-0.01014	-0.05783	-0.04108	-0.02172	0.01366	0.008905
0.125519	-0.0366	-0.00354	0.009538	-0.03856	-0.03305
0.015806	0.196556	-0.04277	0.003623	0.006368	0.038396
0.027056	-0.07298	0.049511	-0.01967	-0.00478	-0.02612
0.048808	0.085396	0.066142	0.056379	-0.01762	0.005537
0.042604	-0.13025	0.090639	-0.03693	0.019033	-0.04922
-0.10582	-0.02845	-0.01756	-0.00029	-0.00866	-0.04008
-0.116	0.018317	0.070118	0.02517	-0.05325	-0.03241
0.037864	0.012726	-0.01556	0.020397	-0.0238	0.005603
-0.0237	0.020471	0.000436	-0.00325	-0.0508	-0.063
0.00572	0.052595	0.006664	0.032309	-0.01254	0.004088
0.036561	0.035012	-0.04328	-0.01565	-0.01409	-0.01432
0.069767	0.018564	-0.01108	0.006546	0.004377	0.012998
-0.04637	0.013366	0.035409	0.008222	0.004807	0.002801
-0.03408	-0.01439	0.004952	0.007485	0.009395	0.002267

Lampiran 2. Nilai *return* masing masing aset (lanjutan)					
0.10075	0.069956	-0.01405	0.008329	-0.01385	0.037643
0.063854	0.012421	0.041433	0.039676	0.002245	0.019765
-0.28757	0.011494	-0.02572	-0.05295	0.032231	-0.01795
0.02073	-0.01888	0.015615	0.030476	-0.02705	-0.02162
-0.11971	0.077119	0.04111	0.034779	-0.04023	-0.03679
0.103948	0.063702	0.05114	0.027501	-0.00108	0.015679
-0.01116	-0.00359	0.060625	0.021563	-0.00069	0.046763
0.02282	0.048995	-0.02088	-0.04447	-0.00303	-0.00935
0.16746	-0.07817	0.039797	0.039568	0.012889	-0.01708
0.267793	-0.01032	-0.04667	-0.01363	0.01377	-0.04535
-0.0504	0.054381	0.054984	0.018583	-0.0306	-0.07706
0.248927	0.157343	0.015189	0.017921	-0.0327	-0.00461
0.116613	0.028777	0.006925	0.037287	-0.01741	0.020074
0.07931	0.01275	-0.00442	0.01399	-0.01135	-0.02015

Lampiran 3. Syntax Google Colab

```
import math as mt
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from scipy.stats import norm
#load the data
from google.colab import files
files.upload()
data=pd.read_csv("DATA13.csv")
data
x1=data["GME"]
x2=data["DAX"]
x3=data["JPY"]
x4=data["DJI"]
x5=data["AUD"]
x6=data["MSFT"]
i=1j
N=len(data)
N
exp = [np.cos(2*np.pi*(k/N)) + 1j*np.sin(2*np.pi*(k/N)) for k in range(N)]
exp
sgn1=-i*np.sign(1-N/2)
rk1=x1*exp
sig1=sum(rk1)
hdr1=sgn1*sig1
z1t=x1+i*hdr1
```

```
sgn2=-i*np.sign(2-N/2)
rk2=x2*exp
sig2=sum(rk2)
hdr2=sgn2*sig2
z2t=x2+i*hdr2
sgn3=-i*np.sign(3-N/2)
rk3=x3*exp
sig3=sum(rk3)
hdr3=sgn3*sig3
z3t=x3+i*hdr3
sgn4=-i*np.sign(4-N/2)
rk4=x4*exp
sig4=sum(rk4)
hdr4=sgn4*sig4
z4t=x4+i*hdr4
sgn5=-i*np.sign(5-N/2)
rk5=x5*exp
sig5=sum(rk5)
hdr5=sgn5*sig5
z5t=x5+i*hdr5
sgn6=-i*np.sign(6-N/2)
rk6=x6*exp
sig6=sum(rk6)
hdr6=sgn6*sig6
z6t=x6+i*hdr6

# membentuk matriks diagonal E[z1t-E(z1t)]*[(z1t-E(z1t))*]
e1=sum(z1t)/N
ze1=z1t-e1
z1tk=np.conj(z1t)
ze1k=np.conj(ze1)
z1tot=ze1*ze1k
ez1t=sum(z1tot)/N
z1=complex(round(ez1t.real,18),round(ez1t.imag,18))
e2=sum(z2t)/N
ze2=z2t-e2
z2tk=np.conj(z2t)
ze2k=np.conj(ze2)
z2tot=ze2*ze2k
ez2t=sum(z2tot)/N
z2=complex(round(ez2t.real,18),round(ez2t.imag,18))
e3=sum(z3t)/N
ze3=z3t-e3
z3tk=np.conj(z3t)
ze3k=np.conj(ze3)
z3tot=ze3*ze3k
ez3t=sum(z3tot)/N
z3=complex(round(ez3t.real,18),round(ez3t.imag,18))
e4=sum(z4t)/N
ze4=z4t-e4
```

```
z4tk=np.conj(z4t)
ze4k=np.conj(ze4)
z4tot=ze4*ze4k
ez4t=sum(z4tot)/N
z4=complex(round(ez4t.real,18),round(ez4t.imag,18))
e5=sum(z5t)/N
ze5=z5t-e5
z5tk=np.conj(z5t)
ze5k=np.conj(ze5)
z5tot=ze5*ze5k
ez5t=sum(z5tot)/N
z5=complex(round(ez5t.real,18),round(ez5t.imag,18))
e6=sum(z6t)/N
ze6=z6t-e6
z6tk=np.conj(z6t)
ze6k=np.conj(ze6)
z6tot=ze6*ze6k
ez6t=sum(z6tot)/N
z6=complex(round(ez6t.real,18),round(ez6t.imag,18))

#membentuk matriks non diagonal
z7tot=ze1*ze2
ez7t=sum(z7tot)/N
z7=complex(round(ez7t.real,18),round(ez7t.imag,18))
z8tot=ze1*ze3
ez8t=sum(z8tot)/N
z8=complex(round(ez8t.real,18),round(ez8t.imag,18))
z9tot=ze1*ze4
ez9t=sum(z9tot)/N
z9=complex(round(ez9t.real,18),round(ez9t.imag,18))
z10tot=ze1*ze5
ez10t=sum(z10tot)/N
z10=complex(round(ez10t.real,18),round(ez10t.imag,18))
z11tot=ze1*ze6
ez11t=sum(z11tot)/N
z11=complex(round(ez11t.real,18),round(ez11t.imag,18))
z12tot=ze2*ze1
ez12t=sum(z12tot)/N
z12=complex(round(ez12t.real,18),round(ez12t.imag,18))
z13tot=ze2*ze3
ez13t=sum(z13tot)/N
z13=complex(round(ez13t.real,18),round(ez13t.imag,18))
z14tot=ze2*ze4
ez14t=sum(z14tot)/N
z14=complex(round(ez14t.real,18),round(ez14t.imag,18))
z15tot=ze2*ze5
ez15t=sum(z15tot)/N
z15=complex(round(ez15t.real,18),round(ez15t.imag,18))
z16tot=ze2*ze6
ez16t=sum(z16tot)/N
```

```
z16=complex(round(ez16t.real,18),round(ez16t.imag,18))
z17tot=ze3*ze1
ez17t=sum(z17tot)/N
z17=complex(round(ez17t.real,18),round(ez17t.imag,18))
z18tot=ze3*ze2
ez18t=sum(z18tot)/N
z18=complex(round(ez18t.real,18),round(ez18t.imag,18))
z19tot=ze3*ze4
ez19t=sum(z19tot)/N
z19=complex(round(ez19t.real,18),round(ez19t.imag,18))
z20tot=ze3*ze5
ez20t=sum(z20tot)/N
z20=complex(round(ez20t.real,18),round(ez20t.imag,18))
z21tot=ze3*ze6
ez21t=sum(z21tot)/N
z21=complex(round(ez21t.real,18),round(ez21t.imag,18))
z22tot=ze4*ze1
ez22t=sum(z22tot)/N
z22=complex(round(ez22t.real,18),round(ez22t.imag,18))
z23tot=ze4*ze2
ez23t=sum(z23tot)/N
z23=complex(round(ez23t.real,18),round(ez23t.imag,18))
z24tot=ze4*ze3
ez24t=sum(z24tot)/N
z24=complex(round(ez24t.real,18),round(ez24t.imag,18))
z25tot=ze4*ze5
ez25t=sum(z25tot)/N
z25=complex(round(ez25t.real,18),round(ez25t.imag,18))
z26tot=ze4*ze6
ez26t=sum(z26tot)/N
z26=complex(round(ez26t.real,18),round(ez26t.imag,18))
z27tot=ze5*ze1
ez27t=sum(z27tot)/N
z27=complex(round(ez27t.real,18),round(ez27t.imag,18))
z28tot=ze5*ze2
ez28t=sum(z28tot)/N
z28=complex(round(ez28t.real,18),round(ez28t.imag,18))
z29tot=ze5*ze3
ez29t=sum(z29tot)/N
z29=complex(round(ez29t.real,18),round(ez29t.imag,18))
z30tot=ze5*ze4
ez30t=sum(z30tot)/N
z30=complex(round(ez30t.real,18),round(ez30t.imag,18))
z31tot=ze5*ze6
ez31t=sum(z31tot)/N
z31=complex(round(ez31t.real,18),round(ez31t.imag,18))
z32tot=ze6*ze1
ez32t=sum(z32tot)/N
z32=complex(round(ez32t.real,18),round(ez32t.imag,18))
z33tot=ze6*ze2
```

```
ez33t=sum(z33tot)/N
z33=complex(round(ez33t.real,18),round(ez33t.imag,18))
z34tot=ze6*ze3
ez34t=sum(z34tot)/N
z34=complex(round(ez34t.real,18),round(ez34t.imag,18))
z35tot=ze6*ze4
ez35t=sum(z35tot)/N
z35=complex(round(ez35t.real,18),round(ez35t.imag,18))
z36tot=ze6*ze5
ez36t=sum(z36tot)/N
z36=complex(round(ez36t.real,18),round(ez36t.imag,18))

#matriks varians-kovarians
matrix=np.matrix([[z1,z7,z8,z9,z10,z11],[z12,z2,z13,z14,z15,z16],[z17,z18,z3,z19,z
        20,z21],[z22,z23,z24,z4,z25,z26],[z27,z28,z29,z30,z5,z31],[z32,z33,z34,z35,
        z36,z6]])
invers=np.linalg.inv(matrix)
invers
vector = np.array([1, 1, 1, 1, 1, 1]).reshape(-1, 1)
vt=np.transpose(vector)
invers
print(matrix)

mu = np.array([ez1t, ez2t, ez3t, ez4t, ez5t, ez6t]).reshape(-1, 1)
mut=np.transpose(mu)
# Melanjutkan dengan perhitungan
iv = invers @ vector
vi = vt @ invers
viv = vi @ vector
imu = invers @ mu
vim = vi @ mu
ipv = vim / viv
bot = imu - (iv * ipv)
bobot1 = iv / viv
# Inisialisasi bobot awal
bobot = bobot1
# Menghitung dan mencetak total sum untuk bobot awal
total_sum = np.sum(bobot)
print(f"Inisial bobot: {bobot}")
print(f"Total sum: {total_sum}")
print("\n")
# Inisialisasi variabel untuk menyimpan bobot terakhir yang valid
bobot_optimal = None

# Iterasi untuk nilai t dari 0.01 hingga 0.09
for t in np.arange(0.01, 0.1, 0.01):
    # Menghitung bobot untuk nilai t saat ini
    bobot = bobot + (t * bot)
    # Pengecekan apakah ada elemen negatif dalam bobot
    if any(i < 0 for i in bobot):
```

```
        print("Ditemukan bobot minus. Iterasi dihentikan.")
        break
    # Menyimpan bobot saat ini sebagai bobot terakhir yang valid
    bobot_optimal = bobot
    # Menghitung dan mencetak total sum untuk bobot saat ini
    total_sum = np.sum(bobot)
    print(f"Bobot untuk t={t}: {bobot}")
    print(f"Total sum untuk t={t}: {total_sum}")
    print("\n")
# Menggunakan bobot terakhir yang valid sebagai hasil
hasil_akhir = bobot_optimal
print(f"Bobot akhir yang tidak negatif: {hasil_akhir}")

z1w = z1t * hasil_akhir[0, 0]
z2w = z2t * hasil_akhir[1, 0]
z3w = z3t * hasil_akhir[2, 0]
z4w = z4t * hasil_akhir[3, 0]
z5w = z5t * hasil_akhir[4, 0]
z6w = z6t * hasil_akhir[5, 0]
zw=z1w+z2w+z3w+z4w+z5w+z6w

volatility = np.std(np.real(zw))
confidence_level = 0.95
#Menghitung VaR
VaR = norm.ppf(confidence_level)*volatility
#Menghitung CVaR
CVaR = (1-confidence_level)**-1 * norm.pdf(norm.ppf(1-confidence_level))*volatility
print(f"Value at Risk (VaR) at {confidence_level * 100}% confidence level: {VaR}")
print(f"Conditional Value at Risk (CVaR) at {confidence_level * 100}% confidence
      level: {CVaR}")
```