

Laboratorium problemowe 2 - stanowisko wahadła rekacyjnego

Sprawozdanie z zajęć nr 4

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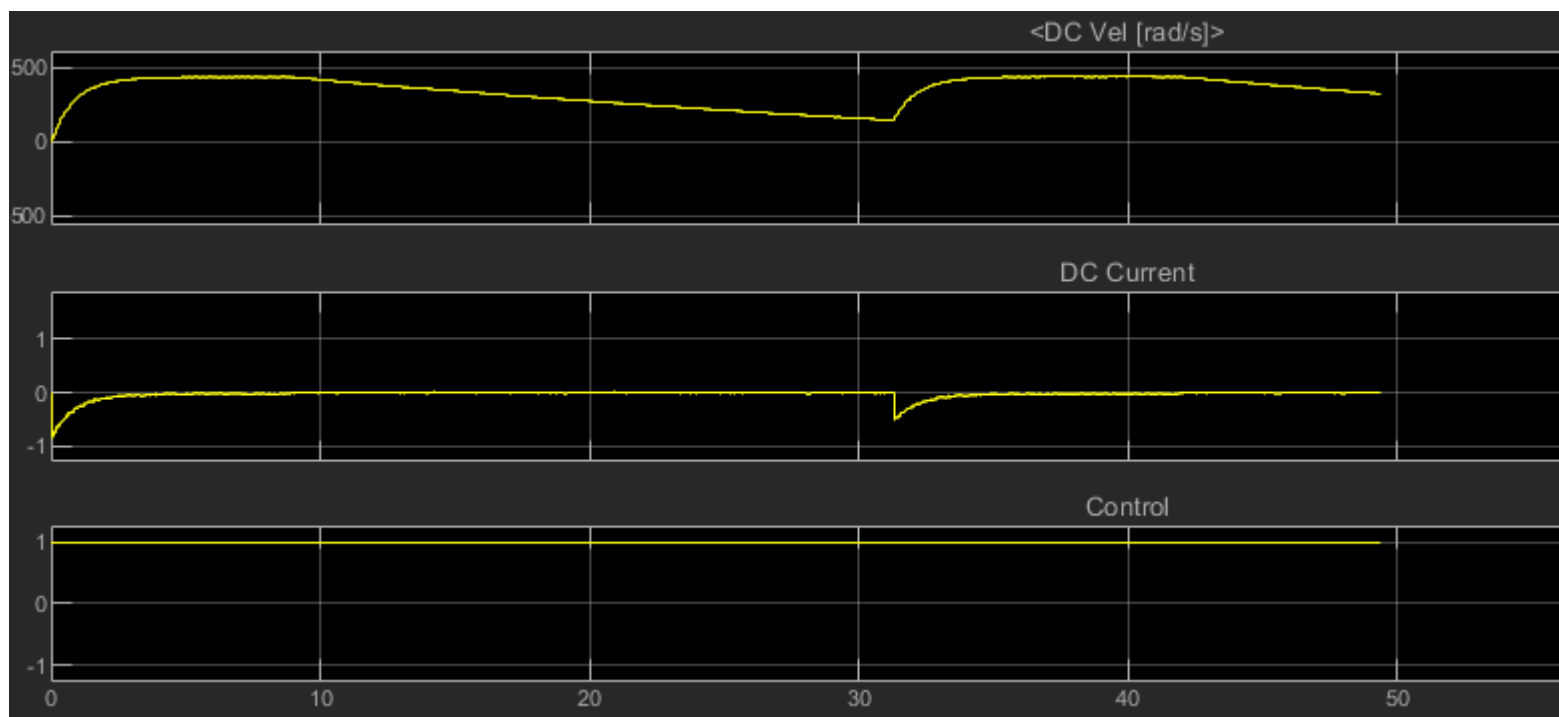
Pon. 8.00 23.10.2023

```
% time = [0, 3, 5, 7, 10, 13, 16, 19, 22]
% amp = [0, 0.2, 0.4, 0.6, 0.3, -0.3, -0.3, 0.2, -0.3]
```

```
time = [0, 3, 6, 9, 12, 15, 18, 21, 24];
amp = [0, 0.3, -0.3, 0.5, -0.5, 0.6, -0.6, 0.7, -0.7];
```

Na zajęciach z pomocą multimetra zostało zmierzone napięcie przy wysokich wartościach sterowania.

Widac na wykresie że silnik po jakimś czasie wyłącza się (ma przerwy w przepływie prądu) co skutkuje niedokładnym



Zauważono również różnice względem multimetra a napięcia (funkcja napięcia od sterowania nie jest liniowa) dlatego zrobiona została tabelka napięcia od sterowania pwm

```
voltage = [-11.71, -10.69, -9.51, -8.32, -7.13, -5.93, -4.74, -3.55, -2.36, -1.18, 0, 1.61, 2.36];
u = -1:0.1:1;
Sterowanie = transpose(u);
Napiecie = transpose(voltage);
```

Tabelka:

```
T = table(Sterowanie, Napiecie)
```

$T = 21 \times 2$ table

	Sterowanie	Napiecie
1	-1	-11.7100
2	-0.9000	-10.6900
3	-0.8000	-9.5100
4	-0.7000	-8.3200
5	-0.6000	-7.1300
6	-0.5000	-5.9300
7	-0.4000	-4.7400
8	-0.3000	-3.5500
9	-0.2000	-2.3600
10	-0.1000	-1.1800
11	0	0
12	0.1000	1.6100
13	0.2000	2.3300
14	0.3000	3.5300
15	0.4000	4.6900
16	0.5000	5.9100
17	0.6000	7.1000
18	0.7000	8.2700
19	0.8000	9.4700
20	0.9000	10.6600
21	1	11.7500

Następnie został sprawdzony sygnał schodkowy dla dużych wartości i działa

```
model_rzeczywisty = sygnal_schodkowy_nr1;  
signal_model_real = sygnal_schodkowy_nr1.signals;
```

```

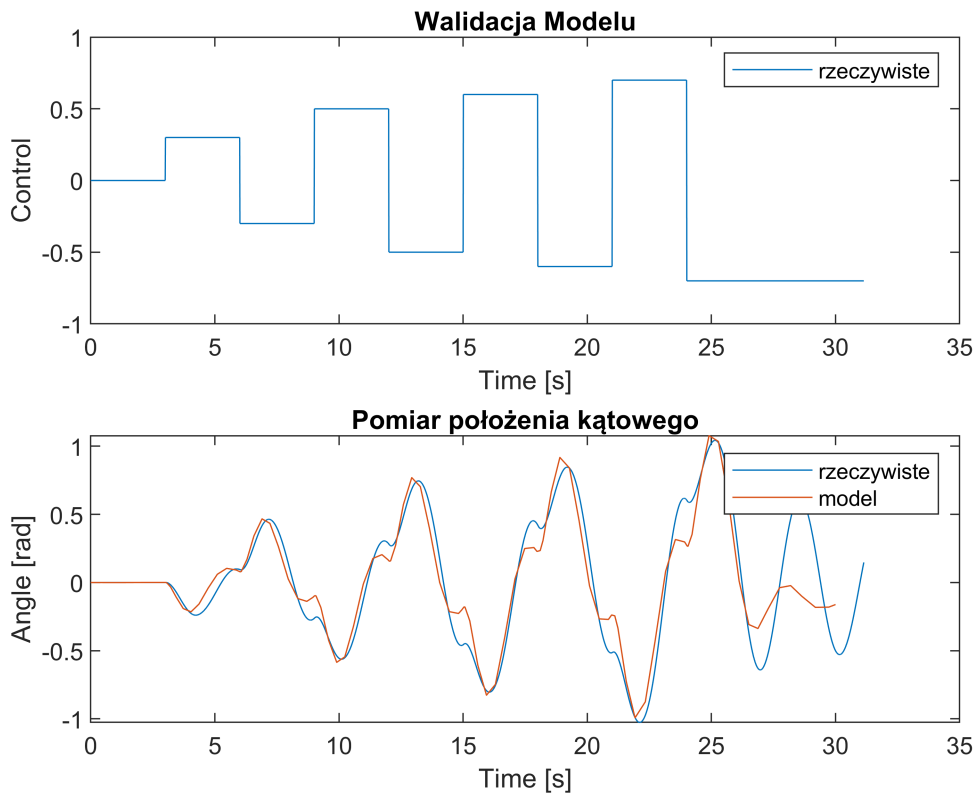
% model_rzeczywisty = walidacja_modelu_nr5;
% signal_model_real = walidacja_modelu_nr5.signals;
% sim("src\simulink_models\model_walidacyjny\model_matematyczny_2018a.slx");

model_matematyczny = out.model_matematyczny_nr1;
signal_model_mat = model_matematyczny.signals;

figure;
subplot(2, 1, 1)
plot(model_rzeczywisty.time, signal_model_real(8).values)
xlabel('Time [s]')
legend('rzeczywiste')
ylabel('Control')
title('Walidacja Modelu')

subplot(2, 1, 2)
plot(model_rzeczywisty.time, signal_model_real(1).values)
hold on;
val = reshape(signal_model_mat(1).values, 1, []);
plot(model_matematyczny.time, val)
hold off;
legend('rzeczywiste', 'model')
xlabel('Time [s]')
ylabel('Angle [rad]')
title('Pomiar położenia kątownego')

```

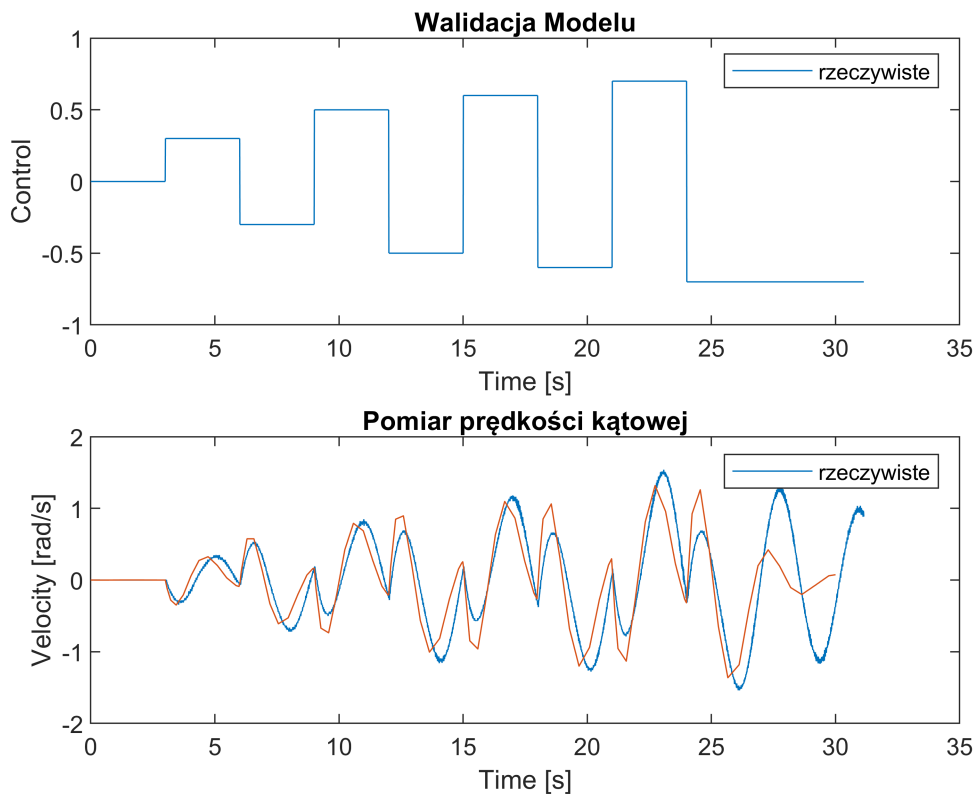


```
figure;
subplot(2, 1, 1)
plot(model_rzeczywisty.time, signal_model_real(8).values)
xlabel('Time [s]')
legend('rzeczywiste', 'model')
```

Warning: Ignoring extra legend entries.

```
ylabel('Control')
title('Walidacja Modelu')

subplot(2, 1, 2)
plot(model_rzeczywisty.time, signal_model_real(4).values)
hold on;
val = reshape(signal_model_mat(2).values, 1, []);
plot(model_matematyczny.time, val)
hold off;
xlabel('Time [s]')
legend('rzeczywiste')
ylabel('Velocity [rad/s]')
title('Pomiar prędkości kątowej')
```



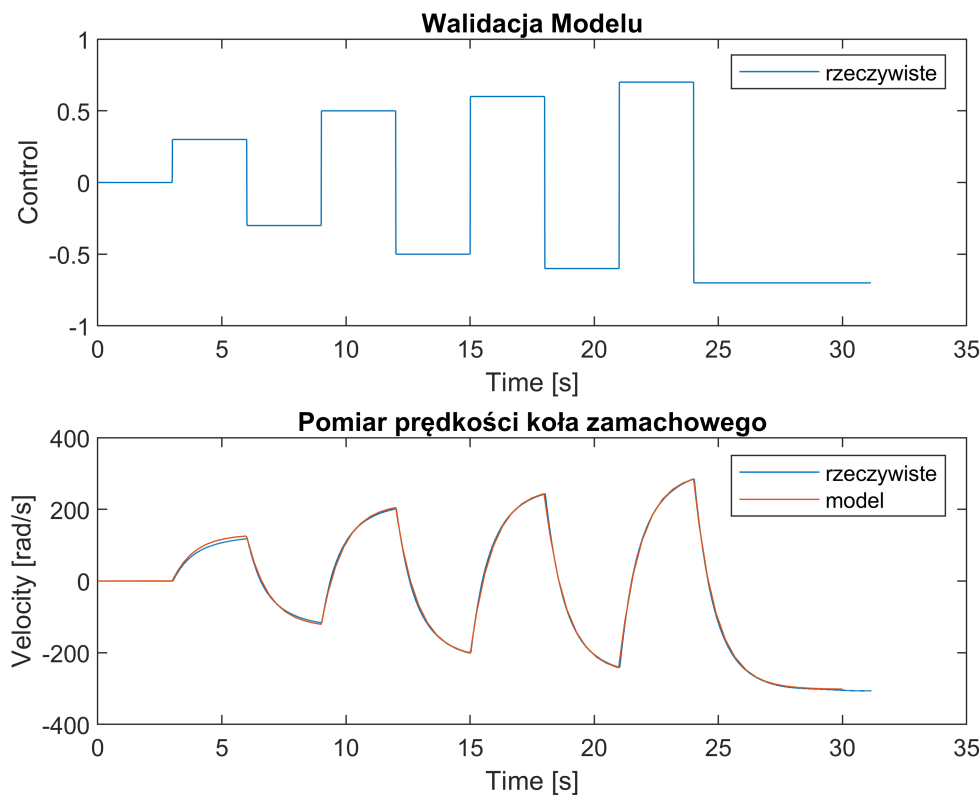
```
figure;
subplot(2, 1, 1)
```

```

plot(model_rzeczywisty.time, signal_model_real(8).values)
xlabel('Time [s]')
legend('rzeczywiste')
ylabel('Control')
title('Walidacja Modelu')

subplot(2, 1, 2)
plot(model_rzeczywisty.time, signal_model_real(6).values)
hold on;
val = reshape(signal_model_mat(3).values, 1, []);
plot(model_matematyczny.time, val)
hold off;
xlabel('Time [s]')
legend('rzeczywiste', 'model')
ylabel('Velocity [rad/s]')
title('Pomiar prędkości koła zamachowego')

```



Następnie sprawdziliśmy małe sterowania -0.1, 0, 0.1

```
model_rzeczywisty = sygnał_schodkowy_nr2;
```

Wartość napięcia zmierzona na silniku w zależności od sterowania:

```
voltage = [-11.71, -10.69, -9.51, -8.32, -7.13, -5.93, -4.74, -3.55, -2.36, -1.18, 0, 1.61, 2.36, 3.55, 4.74, 5.93, 7.13, 8.32, 9.51, 10.69, 11.71, 12.89, 14.07, 15.25, 16.43, 17.61, 18.79, 19.97, 21.15, 22.33, 23.51, 24.69, 25.87, 27.05, 28.23, 29.41, 30.59, 31.77, 32.95, 34.13, 35.31, 36.49, 37.67, 38.85, 40.03, 41.21, 42.39, 43.57, 44.75, 45.93, 47.11, 48.29, 49.47, 50.65, 51.83, 53.01, 54.19, 55.37, 56.55, 57.73, 58.91, 60.09, 61.27, 62.45, 63.63, 64.81, 65.99, 67.17, 68.35, 69.53, 70.71, 71.89, 73.07, 74.25, 75.43, 76.61, 77.79, 78.97, 80.15, 81.33, 82.51, 83.69, 84.87, 86.05, 87.23, 88.41, 89.59, 90.77, 91.95, 93.13, 94.31, 95.49, 96.67, 97.85, 99.03, 100.21, 101.39, 102.57, 103.75, 104.93, 106.11, 107.29, 108.47, 109.65, 110.83, 112.01, 113.19, 114.37, 115.55, 116.73, 117.91, 119.09, 120.27, 121.45, 122.63, 123.81, 124.99, 126.17, 127.35, 128.53, 129.71, 130.89, 132.07, 133.25, 134.43, 135.61, 136.79, 137.97, 139.15, 140.33, 141.51, 142.69, 143.87, 145.05, 146.23, 147.41, 148.59, 149.77, 150.95, 152.13, 153.31, 154.49, 155.67, 156.85, 158.03, 159.21, 160.39, 161.57, 162.75, 163.93, 165.11, 166.29, 167.47, 168.65, 169.83, 171.01, 172.19, 173.37, 174.55, 175.73, 176.91, 178.09, 179.27, 180.45, 181.63, 182.81, 183.99, 185.17, 186.35, 187.53, 188.71, 189.89, 191.07, 192.25, 193.43, 194.61, 195.79, 196.97, 198.15, 199.33, 200.51, 201.69, 202.87, 204.05, 205.23, 206.41, 207.59, 208.77, 209.95, 211.13, 212.31, 213.49, 214.67, 215.85, 217.03, 218.21, 219.39, 220.57, 221.75, 222.93, 224.11, 225.29, 226.47, 227.65, 228.83, 230.01, 231.19, 232.37, 233.55, 234.73, 235.91, 237.09, 238.27, 239.45, 240.63, 241.81, 242.99, 244.17, 245.35, 246.53, 247.71, 248.89, 250.07, 251.25, 252.43, 253.61, 254.79, 255.97, 257.15, 258.33, 259.51, 260.69, 261.87, 263.05, 264.23, 265.41, 266.59, 267.77, 268.95, 270.13, 271.31, 272.49, 273.67, 274.85, 276.03, 277.21, 278.39, 279.57, 280.75, 281.93, 283.11, 284.29, 285.47, 286.65, 287.83, 289.01, 290.19, 291.37, 292.55, 293.73, 294.91, 296.09, 297.27, 298.45, 299.63, 300.81, 301.99, 303.17, 304.35, 305.53, 306.71, 307.89, 309.07, 310.25, 311.43, 312.61, 313.79, 314.97, 316.15, 317.33, 318.51, 319.69, 320.87, 322.05, 323.23, 324.41, 325.59, 326.77, 327.95, 329.13, 330.31, 331.49, 332.67, 333.85, 335.03, 336.21, 337.39, 338.57, 339.75, 340.93, 342.11, 343.29, 344.47, 345.65, 346.83, 348.01, 349.19, 350.37, 351.55, 352.73, 353.91, 355.09, 356.27, 357.45, 358.63, 359.81, 360.99, 362.17, 363.35, 364.53, 365.71, 366.89, 368.07, 369.25, 370.43, 371.61, 372.79, 373.97, 375.15, 376.33, 377.51, 378.69, 379.87, 381.05, 382.23, 383.41, 384.59, 385.77, 386.95, 388.13, 389.31, 390.49, 391.67, 392.85, 394.03, 395.21, 396.39, 397.57, 398.75, 399.93, 401.11, 402.29, 403.47, 404.65, 405.83, 407.01, 408.19, 409.37, 410.55, 411.73, 412.91, 414.09, 415.27, 416.45, 417.63, 418.81, 419.99, 421.17, 422.35, 423.53, 424.71, 425.89, 427.07, 428.25, 429.43, 430.61, 431.79, 432.97, 434.15, 435.33, 436.51, 437.69, 438.87, 440.05, 441.23, 442.41, 443.59, 444.77, 445.95, 447.13, 448.31, 449.49, 450.67, 451.85, 453.03, 454.21, 455.39, 456.57, 457.75, 458.93, 460.11, 461.29, 462.47, 463.65, 464.83, 466.01, 467.19, 468.37, 469.55, 470.73, 471.91, 473.09, 474.27, 475.45, 476.63, 477.81, 478.99, 480.17, 481.35, 482.53, 483.71, 484.89, 486.07, 487.25, 488.43, 489.61, 490.79, 491.97, 493.15, 494.33, 495.51, 496.69, 497.87, 499.05, 500.23, 501.41, 502.59, 503.77, 504.95, 506.13, 507.31, 508.49, 509.67, 510.85, 512.03, 513.21, 514.39, 515.57, 516.75, 517.93, 519.11, 520.29, 521.47, 522.65, 523.83, 525.01, 526.19, 527.37, 528.55, 529.73, 530.91, 532.09, 533.27, 534.45, 535.63, 536.81, 537.99, 539.17, 540.35, 541.53, 542.71, 543.89, 545.07, 546.25, 547.43, 548.61, 549.79, 550.97, 552.15, 553.33, 554.51, 555.69, 556.87, 558.05, 559.23, 560.41, 561.59, 562.77, 563.95, 565.13, 566.31, 567.49, 568.67, 569.85, 571.03, 572.21, 573.39, 574.57, 575.75, 576.93, 578.11, 579.29, 580.47, 581.65, 582.83, 584.01, 585.19, 586.37, 587.55, 588.73, 589.91, 591.09, 592.27, 593.45, 594.63, 595.81, 596.99, 598.17, 599.35, 600.53, 601.71, 602.89, 604.07, 605.25, 606.43, 607.61, 608.79, 609.97, 611.15, 612.33, 613.51, 614.69, 615.87, 617.05, 618.23, 619.41, 620.59, 621.77, 622.95, 624.13, 625.31, 626.49, 627.67, 628.85, 630.03, 631.21, 632.39, 633.57, 634.75, 635.93, 637.11, 638.29, 639.47, 640.65, 641.83, 643.01, 644.19, 645.37, 646.55, 647.73, 648.91, 650.09, 651.27, 652.45, 653.63, 654.81, 655.99, 657.17, 658.35, 659.53, 660.71, 661.89, 663.07, 664.25, 665.43, 666.61, 667.79, 668.97, 670.15, 671.33, 672.51, 673.69, 674.87, 676.05, 677.23, 678.41, 679.59, 680.77, 681.95, 683.13, 684.31, 685.49, 686.67, 687.85, 689.03, 690.21, 691.39, 692.57, 693.75, 694.93, 696.11, 697.29, 698.47, 699.65, 700.83, 702.01, 703.19, 704.37, 705.55, 706.73, 707.91, 709.09, 710.27, 711.45, 712.63, 713.81, 714.99, 716.17, 717.35, 718.53, 719.71, 720.89, 722.07, 723.25, 724.43, 725.61, 726.79, 727.97, 729.15, 730.33, 731.51, 732.69, 733.87, 735.05, 736.23, 737.41, 738.59, 739.77, 740.95, 742.13, 743.31, 744.49, 745.67, 746.85, 748.03, 749.21, 750.39, 751.57, 752.75, 753.93, 755.11, 756.29, 757.47, 758.65, 759.83, 761.01, 762.19, 763.37, 764.55, 765.73, 766.91, 768.09, 769.27, 770.45, 771.63, 772.81, 773.99, 775.17, 776.35, 777.53, 778.71, 779.89, 781.07, 782.25, 783.43, 784.61, 785.79, 786.97, 788.15, 789.33, 790.51, 791.69, 792.87, 794.05, 795.23, 796.41, 797.59, 798.77, 799.95, 801.13, 802.31, 803.49, 804.67, 805.85, 807.03, 808.21, 809.39, 810.57, 811.75, 812.93, 814.11, 815.29, 816.47, 817.65, 818.83, 819.99, 821.17, 822.35, 823.53, 824.71, 825.89, 827.07, 828.25, 829.43, 830.61, 831.79, 832.97, 834.15, 835.33, 836.51, 837.69, 838.87, 840.05, 841.23, 842.41, 843.59, 844.77, 845.95, 847.13, 848.31, 849.49, 850.67, 851.85, 853.03, 854.21, 855.39, 856.57, 857.75, 858.93, 860.11, 861.29, 862.47, 863.65, 864.83, 866.01, 867.19, 868.37, 869.55, 870.73, 871.91, 873.09, 874.27, 875.45, 876.63, 877.81, 878.99, 880.17, 881.35, 882.53, 883.71, 884.89, 886.07, 887.25, 888.43, 889.61, 890.79, 891.97, 893.15, 894.33, 895.51, 896.69, 897.87, 899.05, 900.23, 901.41, 902.59, 903.77, 904.95, 906.13, 907.31, 908.49, 909.67, 910.85, 912.03, 913.21, 914.39, 915.57, 916.75, 917.93, 919.11, 920.29, 921.47, 922.65, 923.83, 925.01, 926.19, 927.37, 928.55, 929.73, 930.91, 932.09, 933.27, 934.45, 935.63, 936.81, 937.99, 939.17, 940.35, 941.53, 942.71, 943.89, 945.07, 946.25, 947.43, 948.61, 949.79, 950.97, 952.15, 953.33, 954.51, 955.69, 956.87, 958.05, 959.23, 960.41, 961.59, 962.77, 963.95, 965.13, 966.31, 967.49, 968.67, 969.85, 971.03, 972.21, 973.39, 974.57, 975.75, 976.93, 978.11, 979.29, 980.47, 981.65, 982.83, 984.01, 985.19, 986.37, 987.55, 988.73, 989.91, 991.09, 992.27, 993.45, 994.63, 995.81, 996.99, 998.17, 999.35, 1000.53, 1001.71, 1002.89, 1004.07, 1005.25, 1006.43, 1007.61, 1008.79, 1009.97, 1011.15, 1012.33, 1013.51, 1014.69, 1015.87, 1017.05, 1018.23, 1019.41, 1020.59, 1021.77, 1022.95, 1024.13, 1025.31, 1026.49, 1027.67, 1028.85, 1030.03, 1031.21, 1032.39, 1033.57, 1034.75, 1035.93, 1037.11, 1038.29, 1039.47, 1040.65, 1041.83, 1043.01, 1044.19, 1045.37, 1046.55, 1047.73, 1048.91, 1050.09, 1051.27, 1052.45, 1053.63, 1054.81, 1055.99, 1057.17, 1058.35, 1059.53, 1060.71, 1061.89, 1063.07, 1064.25, 1065.43, 1066.61, 1067.79, 1068.97, 1070.15, 1071.33, 1072.51, 1073.69, 1074.87, 1076.05, 1077.23, 1078.41, 1079.59, 1080.77, 1081.95, 1083.13, 1084.31, 1085.49, 1086.67, 1087.85, 1089.03, 1090.21, 1091.39, 1092.57, 1093.75, 1094.93, 1096.11, 1097.29, 1098.47, 1099.65, 1100.83, 1102.01, 1103.19, 1104.37, 1105.55, 1106.73, 1107.91, 1109.09, 1110.27, 1111.45, 1112.63, 1113.81, 1114.99, 1116.17, 1117.35, 1118.53, 1119.71, 1120.89, 1122.07, 1123.25, 1124.43, 1125.61, 1126.79, 1127.97, 1129.15, 1130.33, 1131.51, 1132.69, 1133.87, 1135.05, 1136.23, 1137.41, 1138.59, 1139.77, 1140.95, 1142.13, 1143.31, 1144.49, 1145.67, 1146.85, 1148.03, 1149.21, 1150.39, 1151.57, 1152.75, 1153.93, 1155.11, 1156.29, 1157.47, 1158.65, 1159.83, 1161.01, 1162.19, 1163.37, 1164.55, 1165.73, 1166.91, 1168.09, 1169.27, 1170.45, 1171.63, 1172.81, 1173.99, 1175.17, 1176.35, 1177.53, 1178.71, 1179.89, 1181.07, 1182.25, 1183.43, 1184.61, 1185.79, 1186.97, 1188.15, 1189.33, 1190.51, 1191.69, 1192.87, 1194.05, 1195.23, 1196.41, 1197.59, 1198.77, 1199.95, 1201.13, 1202.31, 1203.49, 1204.67, 1205.85, 1207.03, 1208.21, 1209.39, 1210.57, 1211.75, 1212.93, 1214.11, 1215.29, 1216.47, 1217.65, 1218.83, 1219.99, 1221.17, 1222.35, 1223.53, 1224.71, 1225.89, 1227.07, 1228.25, 1229.43, 1230.61, 1231.79, 1232.97, 1234.15, 1235.33, 1236.51, 1237.69, 1238.87, 1240.05, 1241.23, 1242.41, 1243.59, 1244.77, 1245.95, 1247.13, 1248.31, 1249.49, 1250.67, 1251.85, 1253.03, 1254.21, 1255.39, 1256.57, 1257.75, 1258.93, 1260.11, 1261.29, 1262.47, 1263.65, 1264.83, 1266.01, 1267.19, 1268.37, 1269.55, 1270.73, 1271.91, 1273.09, 1274.27, 1275.45, 1276.63, 1277.81, 1278.99, 1280.17, 1281.35, 1282.53, 1283.71, 1284.89, 1286.07, 1287.25, 1288.43, 1289.61, 1290.79, 1291.97, 1293.15, 1294.33, 1295.51, 1296.69, 1297.87, 1299.05, 1300.23, 1301.41, 1302.59, 1303.77, 1304.95, 1306.13, 1307.31, 1308.49, 1309.67, 1310.85, 1312.03, 1313.21, 1314.39, 1315.57, 1316.75, 1317.93, 1319.11, 1320.29, 1321.47, 1322.65, 1323.83, 1325.01, 1326.19, 1327.37, 1328.55, 1329.73, 1330.91, 1332.09, 1333.27, 1334.45, 1335.63, 1336.81, 1337.99, 1339.17, 1340.35, 1341.53, 1342.71, 1343.89, 1345.07, 1346.25, 1347.43, 1348.61, 1349.79, 1350.97, 1352.15, 1353.33, 1354.51, 1355.69, 1356.87, 1358.05, 1359.23, 1360.41, 1361.59, 1362.77, 1363.95, 1365.13, 1366.31, 1367.49, 1368.67, 1369.85, 1371.03, 1372.21, 1373.39, 1374.57, 1375.75, 1376.93, 1378.11, 1379.29, 1380.47, 1381.65, 1382.83, 1384.01, 1385.19, 1386.37, 1387.55, 1388.73, 1389.91, 1391.09, 1392.27, 1393.45, 1394.63, 1395.81, 1396.99, 1398.17, 1399.35, 1400.53, 1401.71, 1402.89, 1404.07, 1405.25, 1406.43, 1407.61, 1408.79, 1409.97, 1411.15, 1412.33, 1413.51, 1414.69, 1415.87, 1417.05, 1418.23, 1419.41, 1420.59, 1421.77, 1422.95, 1424.13, 1425.31, 1426.49, 1427.67, 1428.85, 1430.03, 1431.21, 1432.39, 1433.57, 1434.75, 1435.93, 1437.11, 1438.29, 1439.47, 1440.65, 1441.83, 1443.01, 1444.19, 1445.37, 1446.55, 1447.73, 1448.91, 1450.09, 1451.27, 1452.45, 1453.63, 1454.81, 1455.99, 1457.17, 1458.35, 1459.53, 1460.71, 1461.89, 1463.07, 1464.25, 1465.43, 1466.61, 1467.79, 1468.97, 1470.15, 1471.33, 1472.51, 1473.69, 1474.87, 1476.05, 1477.23, 1478.41, 1479.59, 1480.77, 1481.95, 1483.13, 1484.31, 1485.49, 1486.67, 1487.85, 1489.03, 1490.21, 1491.39, 1492.57, 1493.75, 1494.93, 1496.11, 1497.29, 1498.47, 1499.65, 1500.83, 1502.01, 1503.19, 1504.37, 1505.55, 1506.73, 1507.91, 1509.09, 1510.27, 1511.45, 1512.63, 1513.81, 1514.99, 1516.17, 1517.35, 1518.53, 1519.71, 1520.89, 1522.07, 1523.25, 1524.43, 1525.61, 1526.79, 1527.97, 1529.15, 1530.33, 1531.51, 1532.69, 1533.87, 1535.05, 1536.23, 1537.41, 1538.59, 1539.77, 1540.95, 1542.13, 1543.31, 1544.49, 1545.67, 1546.85, 1548.03, 1549.21, 1550.39, 1551.57, 1552.75, 1553.93, 1555.11, 1556.29, 1557.47, 1558.65, 1559.83, 1561.01, 1562.19, 1563.37, 1564.55, 1565.73, 1566.91, 1568.09, 1569.27, 1570.45, 1571.63, 1572.81, 1573.99, 1575.17, 1576.35, 1577.53, 1578.71, 1579.89, 1581.07, 1582.25, 1583.43, 1584.61, 1585.79, 1586.97, 1588.15, 1589.33, 1590.51, 1591.69, 1592.87, 1594.05, 1595.23, 1596.41, 1597.59, 1598.77, 1599.95, 1601.13, 1602.31, 1603.49, 1604.67, 1605.85, 1607.03, 1608.21, 1609.39, 1610.57, 1611.75, 1612.93, 1614.11, 1615.29, 1616.47, 1617.65, 1618.83, 1619.99, 1621.17, 1622.35, 1623.53, 1624.71, 1625.89, 1627.07, 1628.25, 1629.43, 1630.61, 1631.79, 1632.97, 1634.15, 1635.33, 1636.51, 1637.69, 1638.87, 16
```

```
voltage = 1×21
-11.7100 -10.6900 -9.5100 -8.3200 -7.1300 -5.9300 -4.7400 -3.5500 ...
```

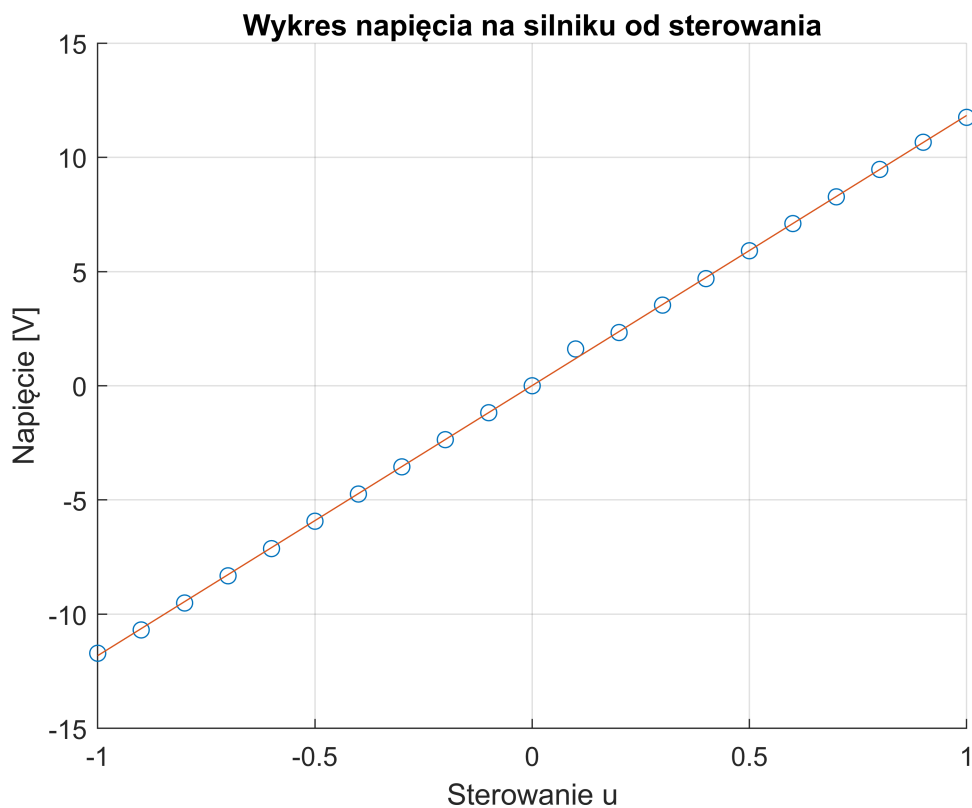
```
u = -1:0.1:1
```

```
u = 1×21
-1.0000 -0.9000 -0.8000 -0.7000 -0.6000 -0.5000 -0.4000 -0.3000 ...
```

```
p_volt = polyfit(u, voltage, 1)
```

```
p_volt = 1×2
11.8238 0.0095
```

```
figure
hold on
plot(u, voltage, 'o')
plot(u, polyval(p_volt, u))
hold off
grid on
title('Wykres napięcia na silniku od sterowania')
xlabel('Sterowanie u')
ylabel('Napięcie [V]')
```



Następnie przy pomocy narzędzie model linearizer został wyznaczony punkt równowagi w dolnym położeniu wahadła. Wyznaczona została macierz stanu oraz sterowalności. Na podstawie macierzy stanu oraz macierzy wejść obliczone zostały wzmacnienia dla regulatora LQR, który będzie testowany na następnych zajęciach oraz dostrajany.

```
linsys1.A
```

```
ans = 3×3
      0    1.0000    0
    -4.9764 -1.1417    0.0145
      0      0   -1.1309
```

```
linsys1.B
```

```
ans = 3×1
      0
    -5.2369
   488.6480
```

```
linsys1.C
```

```
ans = 3×3
      1      0      0
      0      1      0
      0      0      1
```

```
linsys1.D
```

```
ans = 3×1
      0
      0
      0
```

```
co = ctrb(linsys1.A, linsys1.B)
```

```
co = 3×3
      0    -5.2369   13.0867
    -5.2369  13.0867    3.0816
   488.6480 -552.6005  624.9228
```

```
rank(co)
```

```
ans = 3
```

```
K = lqr(linsys1.a, linsys1.b, eye(3), 1)
```

```
K = 1×3
    -0.0278    -0.0041    0.9977
```