AUTOMATION OF STANDARD TECHNOLOGICAL PROCESSES MANUFACTURING

**Scenario 1. Industrial technological process.**

**#SIS\_4**

Task 1. According the chosen mathematical model create the control system. Type of regulator depend on of technological process (examples P, PI, PID, on/off control).

Report should contain the following steps:

1. Description of the regulator type. Describe the "control law" with formulas. Determine which controller you will synthesize (PID, optimal control, robust control, adaptive control, modal regulator and etc.).
2. Specification and calculation of the general parameters of the mathematical model and regulator (if it's necessary).
3. Modeling of the mathematical model and control system in the MATLAB software. It's possible to use the special instruments in MATLAB like a Simulink or m-file MATLAB.
4. If you are going to use the PID control law, you need to justify the choice of the control law. Make an experimental study with different coefficients and different types of regulators. The best solution will be your regulator.
   1. It is necessary to determine the desired dynamics of the system. Mark on the graph. Information about the desired dynamics is indicated in the table.
   2. Show the selection of the regulator coefficients in two ways. The first method is autotuning. The second is any method of your choice, for example, Ziegler-Nichols, AI methods, etc.
   3. The coefficients should be shown in the table.
5. Results plots with regulator and mathematical model, which show the control system dynamic. Insert a table with the characteristics of the process dynamics (overshoot, error, etc.). Analyze the resulting graphs.
6. Compare system dynamics using different controller coefficients.
7. Find the best solution.
8. Conclusion.
9. References.
10. Appendix (Add in appendix all listing of the mathematical models analysis in MATLAB).

Table 1 – Check list for PID control

Table 1 - Checklist for students what should be in the SIS 3.

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| --- | --- | --- | --- |
| Position | Description | Software | Done/not done |
| Part 1 | Description of the regulator type. (Theoretical description). | Describe the "control law" with formulas. Determine which controller you will synthesize (PID, optimal control, robust control, adaptive control, modal regulator and etc.). Show the theory in the form of formulas for the PID controller. In the form of an algorithm or pseudocode for other types of controllers. Do not confuse theoretical information and experimental results.  Describe the influence of each component on the dynamics of the process (What give P components? What give I component? What give D component?) |  |
| Part 2 | Modeling of the mathematical model and control system in the MATLAB file MATLAB | Show model in MATLAB (if it’s Simulink model, like figure, if m-file code in Appendix).  https://www.researchgate.net/publication/303595709/figure/fig3/AS:366729977974788@1464446648876/Design-of-a-PID-controller_W640.jpg  https://www.researchgate.net/publication/303595709/figure/fig4/AS:366729977974789@1464446648901/Matlab-Simulink-PID-controller_W640.jpg  - Show a graph of the desired system dynamics with a table describing the characteristics;  - Show on one graph the dynamics that tend to the desired trajectory with different coefficients.  Advanced controllers tuning | TECHNOSOFT MOTION Knowledge Base  pid |  |
| Part 3 | Compare system dynamics using different controller coefficients | figure 8  Intelligent PID Controller for Automatic Voltage Regulation |  |

DESCRIPTION OF THE SECOND SECTION

OF THE COURSE PROJECT

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| --- | --- | --- | --- |
| **№** | **Name of the chapter** | **Content of the chapter** | **Software** |
| 1 | Regulator synthesis | If the mathematical model meets the properties of the ACS in terms of stability, controllability and observability, it is necessary to synthesize a controller. The section of the course project must include a theoretical justification for the selected control law for the unit in question. Carry out modeling in the MATLAB software product. Include a table describing the graphs. It is necessary to show the values of the coefficients Ki, Kp, Kd. Regulation time (system speed), overshoot, etc. | In the MATLAB software product, the Simulink section, it is necessary to assemble a circuit without a controller and with a controller to control system parameters. The use of other software products is permitted. The graph trajectories must be displayed on one screen for comparison. The graph axes must be labeled. |

**REMARK 1. Work should be created according the STANDARDS of KBTU for writing works.**

**Scenario 2. Robot manipulator control system**

**#SIS\_4**

Task 1. According the chosen mathematical model create the control system. Type of regulator depend on of technological process (examples P, PI, PID, on/off control).

Report should contain the following steps:

1. Description of the regulator type. Describe the "control law" with formulas.
2. Specification and calculation of the general parameters of the mathematical model and regulator (if it's necessary).
3. Modeling of the mathematical model and control system in the MATLAB software. It's possible to use the special instruments in MATLAB like a Simulink, PID tuner and etc.
4. You can show the adjustment of the controller parameters using other methods, for example using artificial intelligence methods. This item is a bonus to work.
5. Results plots with regulator and mathematical model, which show the control system dynamic.
6. Compare system dynamics using different controller coefficients.
7. Find the best solution.
8. Value time of control and value of error.
9. Conclusion.
10. References.
11. Appendix (Add in appendix all listing of the mathematical models analysis in MATLAB).

DESCRIPTION OF THE SECOND SECTION

OF THE COURSE PROJECT

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| --- | --- | --- | --- |
| **№** | **Name of the chapter** | **Content of the chapter** | **Software** |
| 1. | Regulator synthesis | If the mathematical model meets the controllability and observability properties of the ACS, it is necessary to synthesize a controller. The section of the course project must include a theoretical justification for the selected control law for the unit in question. For robotic manipulators, PD, robust controller, optimal control, adaptive control, etc. can be synthesized. The main criteria for the quality of the control process are: overshoot, oscillation and transition time. It is necessary to carry out modeling in the MATLAB software product or other available software product for conducting engineering research. Include a table describing the graphs. It is necessary to show the values of the adjustment coefficients of the controller parameters, if any. Regulation time (system speed), overshoot, etc. In case of nonlinearity, the linearization method with feedback can be used. | In the MATLAB software product, the Simulink section, it is necessary to assemble a circuit without a controller and with a controller to control system parameters. The use of alternative software products is permitted. The graph trajectories must be displayed on one screen for comparison. The graph axes must be labeled. |

**REMARK 1. Work should be created according the STANDARDS of KBTU for writing works.**

**Scenario 3. Smart city concept**

**#SIS\_4**

Task 1. According the chosen mathematical model create the control system. Type of regulator depend on of technological process (examples P, PI, PID, on/off control).

Report should contain the following steps:

1. Description of the regulator type. Describe the "control law" with formulas. Determine which controller you will synthesize (PID, optimal control, robust control, adaptive control, modal regulator and etc.).
2. Specification and calculation of the general parameters of the mathematical model and regulator (if it's necessary).
3. Modeling of the mathematical model and control system in the MATLAB software. It's possible to use the special instruments in MATLAB like a Simulink or m-file MATLAB.
4. If you are going to use the PID control law, you need to justify the choice of the control law. Make an experimental study with different coefficients and different types of regulators. The best solution will be your regulator.
   1. It is necessary to determine the desired dynamics of the system. Mark on the graph. Information about the desired dynamics is indicated in the table.
   2. Show the selection of the regulator coefficients in two ways. The first method is autotuning. The second is any method of your choice, for example, Ziegler-Nichols, AI methods, etc.
   3. The coefficients should be shown in the table.
5. Results plots with regulator and mathematical model, which show the control system dynamic. Insert a table with the characteristics of the process dynamics (overshoot, error, etc.). Analyze the resulting graphs.
6. Compare system dynamics using different controller coefficients.
7. Find the best solution.
8. Conclusion.
9. References.
10. Appendix (Add in appendix all listing of the mathematical models analysis in MATLAB).

DESCRIPTION OF THE SECOND SECTION OF

THE COURSE PROJECT

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| **№** | **Name of the chapter** | **Content of the chapter** | **Software** |
| 1 | Regulator synthesis | If the mathematical model meets the properties of the ACS in terms of stability, controllability and observability, it is necessary to synthesize a controller. The section of the course project must include a theoretical justification for the selected control law for the unit in question. Carry out modeling in the MATLAB software product. Include a table describing the graphs. It is necessary to show the values of the coefficients Ki, Kp, Kd. Regulation time (system speed), overshoot, etc. | In the MATLAB software product, the Simulink section, it is necessary to assemble a circuit without a controller and with a controller to control system parameters. The use of other software products is permitted. The graph trajectories must be displayed on one screen for comparison. The graph axes must be labeled. |

**REMARK 1. Work should be created according the STANDARDS of KBTU for writing works.**

SEE table 1 for example.