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**IN**

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# ABSTRACT

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Abstract should be in English, contain only 1 paragraph, and not exceed 1 page.

**Key Words:** Keyword 1, Keyword 2, Keyword 3, Keyword 4, Keyword 5.

# ÖZET

**TEZİN BAŞLIĞI**

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**Lisans Tezi, Bölüm Adı**

**Danışman: Prof. Dr. Adı SOYADI**

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Özet Türkçe ve tek paragraf olmalı, 1 sayfayı geçmemelidir.

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# LIST OF SYMBOLS

|  |  |
| --- | --- |
| **α** | Alfa |
| **β** | Beta |
| **Ω** | Ohm |
| **π** | Pi |

# LIST OFABBREVIATIONS

|  |  |
| --- | --- |
| **A/D** | Analog to Digital |
| **B-SPM** | Bilinear Static Parametric Model |
| **CE** | Certainty Equivalence |
| **D/A** | Digital to Analog |
| **DC** | Direct Current |
| **DIN** | Dynamic Inertial System |
| **FD** | Fault Detection |
| **FDD** | Fault Detection Diagnosis |
| **FDI** | Fault Detection and Isolation |
| **FTC** | Fault Tolerant Control |
| **g-DIN** | Generalized Dynamic Inertial System |
| **ISE** | Integral Square Error |
| **ISR** | Interrupt Service Routine |
| **LQR** | Linear Quadratic Regulator |
| **LTI** | Linear Time Invariant |
| **MIMO** | Multi Input Multi Output |
| **MRAC** | Model Reference Adaptive Control |
| **MSE** | Mean Square Error |
| **PDJ** | Positive Diagonal Jordan |
| **PEA** | Parametric Eigenstructure Assignment |
| **PSUPA** | Power Supply/Power Amplifier Unit |
| **SISO** | Single Input Single Output |
| **SPR** | Strictly Positive Real |

# CHAPTER I

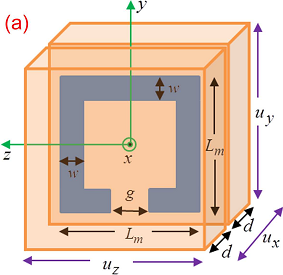
# INTRODUCTION

## 1.1 Motivation of Study

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**Figure 1.1** Equivalent control system block diagram for time-varying gain control equivalent is system block diagram for time-varying gains.

There are wide varieties of control methods in FTC and an extensive research is still conducted. However the lack of a systematical approach is still an open problem. The equation sample can be given as follows:

 (1.1)

Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum. The table sample is given in Table 1.1.

(1.2)

**Table 1.1** Process parameters

|  |  |
| --- | --- |
| **Parameters** | **Value** |
| Tank height, *hmax* | 25 cm |
| Pomp voltage level | 0-5 V |
| Bottom area, Tank1, Tank2, *A1*, *A2* | 0.01389 m2 |
| Bottom area, Tank3, Tank4, *A3*, *A4* | 0.01389 m2 |
| Out pipe cross-sectional area, *a1,a3,,a2,a4* | 50.26e-6 m2 |
| Pomp constant, *k* | 2.2e-3 lt/Vs |
| Tank1 operating point level *h1o* | 8.0 cm |
| Tank2 operating point level *h2o* | 5.0 cm |
| Tank3 operating point level *h3o* | 1.5 cm |

**Table 1.2** System operating point

|  |  |  |
| --- | --- | --- |
| Control Method | Output1 ISE | Output2 ISE (×103) |
| Design I | 391.59 | 1.0151 |
| Design II | 389.58 | 0.6418 |
| Design III | 379.61 | 0.0001 |

# 

# REFERENCES

1. Srinivas, P., Lakshmi, K. V., Kumar, V. N. (2014). A Comparison of PID Controller Tuning Methods for Three Tank Level Process, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*. **3(1)**, 6810-6820. **(Journal Sample)**
2. Iqbal, M., Bhatti, A. I., Butt, Q. R. (2008). Controller Synthesis of an Uncertain Three Tank System Using Polytypic system Approach, *Proceedings of the 17th World Congress, The International Federation of Automatic Control*. 9910-9915. **(Conference Sample)**
3. Tao, G., Chen, S. H., Tang, X. D., Joshi, S. M. (2004). *Adaptive control of systems with actuator failures*. Springer-Verlag: London. **(Book Sample)**
4. AOAC. Association of Official Analytical Chemists. (1998). AOAC peer verified methods program. Manual on policies and procedures. AOAC Intl.: www.aoac.org.tr, 17.05.2010. **(For internet citation)**.
5. Srinivas, P., Lakshmi, K. V., Kumar, V. N. (2014). A Comparison of PID Controller Tuning Methods for Three Tank Level Process, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering.* **3(1)**, 6810-6820. **(Journal Sample)**
6. Iqbal, M., Bhatti, A. I., Butt, Q. R. (2008). Controller Synthesis of an Uncertain Three Tank System Using Polytypic system Approach, *Proceedings of the 17th World Congress, The International Federation of Automatic Control*. 9910-9915. **(Conference Sample)**
7. Tao, G., Chen, S. H., Tang, X. D., Joshi, S. M. (2004). *Adaptive control of systems with actuator failures*. Springer-Verlag: London. **(Book Sample**
8. Srinivas, P., Lakshmi, K. V., Kumar, V. N. (2014). A Comparison of PID Controller Tuning Methods for Three Tank Level Process, *International Journal of Advanced Research.* **3(1)**, 6810-6820. **(Journal Sample)**
9. Iqbal, M., Bhatti, A. I., Butt, Q. R. (2008). Controller Synthesis of an Uncertain Three Tank System Using Polytypic system Approach, *Proceedings of the 17th World Congress, The International Federation of Automatic Control*. 9910-9915. **(Conference Sample)**
10. Tao, G., Chen, S. H., Tang, X. D., Joshi, S. M. (2004). *Adaptive control of systems with actuator failures*. Springer-Verlag: London. **(Book Sample)**
11. AOAC. Association of Official Analytical Chemists. (1998). AOAC peer verified methods program. Manual on policies and procedures. AOAC Intl.: www.aoac.org.tr, 17.05.2010. **(For internet citation)**

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