

**Development of an Adjustable Spring-Mass-Damper Prototype with Real-Time
Digital Overshoot Monitoring**

By

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STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.



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ABSTRACT

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The research develops a modular prototype with real-time digital monitoring capabilities to address critical deficiencies in the existing Spring-Mass-Damper system at Swiss German University. The current laboratory system requires both adjustable damping coefficients and proper spring stiffness, and automatic actuation systems for complete control system testing. The horizontal mechanical configuration was built with a Glued Laminated wood frame, which provides both dimensional stability and vibration damping, and includes precision linear bearing guides that deliver frictionless movement and 3D-printed modular components, which allow for fast system changes. The system uses customized spring and damper assemblies, which can be adjusted to create different response patterns, including underdamped, critically damped, and overdamped behavior. The system enables users to visualize transient response characteristics through MATLAB, which displays overshoot percentage, settling time, and natural frequency data. The experimental validation process demonstrated successful differentiation of damping states while the modular design proved effective for educational demonstrations. The prototype functions as an effective educational resource that connects theoretical second-order system dynamics with hands-on mechatronics experiments while providing the Swiss German University's Mechatronics program access to a cost-effective modular laboratory resource.

Keywords: Spring-Mass-Damper System, Spring Stiffness, Damping Coefficient, Damping Ratio, Second-Order Differential Dynamics, Transient Response, Mechatronics Education.



DEDICATION

To my parents, especially my mother, your support and dedication to my education as an engineer developed into my foundation for success. The prototype will remain as a permanent educational and innovative resource for the Swiss German University Mechatronics Laboratory. The Control Technique Laboratory system will help the future of Swiss German University mechatronics students who will study there to connect theoretical knowledge with practical experience while they investigate dynamic systems through their research.



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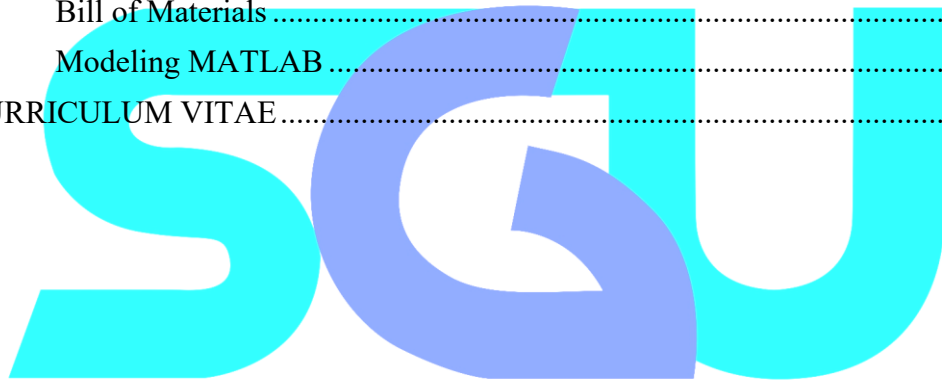
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