ABSTRAK

Nama	:	ANDRI MULYAWAN
Program Studi	:	Fisika
Judul	:	Rancang Bangun Sistem Pengukuran Koefisien Redaman Osilasi Pegas dalam Medium Udara, Air, dan Minyak Berbasis Sensor *Tunneling Magnetoresistance* (TMR)

Pengukuran koefisien redaman osilasi secara konvensional masih bergantung pada pengamatan visual yang rentan terhadap kesalahan paralaks dan subjektivitas. Penelitian ini merancang sistem instrumentasi digital otomatis untuk mengukur koefisien redaman dalam tiga medium (udara, air, minyak goreng) menggunakan sensor *Tunneling Magnetoresistance* (TMR) sebagai pendeteksi posisi secara *non-contact*. Perangkat keras meliputi sensor TMR, penguat diferensial, ADC 16-bit, dan Arduino Uno. Perangkat lunak Python berbasis GUI dikembangkan guna mengintegrasikan akuisisi data, pengolahan sinyal, visualisasi, dan ekspor laporan otomatis. Algoritma memproses penapisan derau, deteksi puncak berinterpolasi parabola, serta regresi linear $\ln A$ terhadap t untuk mengestimasi redaman. Pengujian pada lima variasi massa (69,83 g; 80,18 g; 89,94 g; 100,00 g; dan 110,34 g) menunjukkan bahwa viskositas medium berpengaruh signifikan terhadap konstanta redaman (b), dengan urutan $b_{\text{minyak}} \gg b_{\text{air}} \gg b_{\text{udara}}$, berturut-turut $0{,}105 \pm 0{,}003$ kg/s, $0{,}034 \pm 0{,}001$ kg/s, dan $0{,}0014 \pm 0{,}0003$ kg/s. Kestabilan nilai b pada medium cair antar-variasi massa menegaskan redaman sebagai sifat intrinsik sistem. Koefisien determinasi regresi linear (R^2) berada pada rentang 89–99% secara keseluruhan dan rata-rata di atas 96% pada medium cair (tertinggi 98,92% pada air), membuktikan keandalan sistem dalam merekonstruksi profil peluruhan osilasi.

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Kata kunci: koefisien redaman, osilasi teredam, pegas, sensor TMR, akuisisi data, viskositas

ABSTRACT

Name : ANDRI MULYAWAN

Study Program : *Physics*

Title : *Design and Development of a Spring Oscillation Damping Coefficient Measurement System in Air, Water, and Oil Media Based on Tunneling Magnetoresistance (TMR) Sensor*

Conventional measurement of oscillation damping relies on visual observation, which is susceptible to parallax errors and subjectivity. This study designed an automated digital instrumentation system to measure damping coefficients in three media (air, water, cooking oil) using a non-contact Tunneling Magnetoresistance (TMR) sensor. The hardware comprises a TMR sensor, differential amplifier, 16-bit ADC, and Arduino Uno. Python-based GUI software was developed to integrate data acquisition, signal processing, visualization, and automated reporting. The algorithm autonomously filters noise, detects peaks with parabolic interpolation, and estimates damping through linear regression of $\ln A$ *versus* t*. Tests on five mass variations (69.83 g, 80.18 g, 89.94 g, 100.00 g, and 110.34 g) revealed that medium viscosity strongly affects the damping constant (*b*), following* $b_{oil} \gg b_{water} \gg b_{air}$*, with values of* 0.105 ± 0.003 *kg/s,* 0.034 ± 0.001 *kg/s, and* 0.0014 ± 0.0003 *kg/s, respectively. The stability of* b *in liquid media across masses confirms damping as an intrinsic property of the system. The coefficient of determination (*R^2*) for the linear regression was in the range of 89–99% overall and averaged above 96% in liquid media (maximum 98.92% in water), demonstrating the system's reliability in accurately reconstructing oscillation decay profiles.*

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Keywords: *damping coefficient, damped oscillation, spring, TMR sensor, data acquisition, viscosity*