RESPONSE SURFACE AND NEURO FUZZY METHODOLOGY FOR ROTATING MAGNETIC FIELD AND GMR ARRAY SENSOR FOR CRACK DETECTION IN FERROMAGNETIC PIPE

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Doctor of Philosophy

UNIVERSITI MALAYSIA PAHANG
SUPERVISOR’S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy in Electrical Engineering.

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STUDENT’S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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DAMHUJI BIN RIFAI

Thesis submitted in fulfillment of the requirements for the award of the degree of Doctor of Philosophy (Electrical Engineering)

Faculty of Engineering Technology
UNIVERSITI MALAYSIA PAHANG

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**LIST OF SYMBOLS**

$C_i$  
Centre of the Gaussian Membership Functions

$\sigma_i$  
Width of the Gaussian Membership Functions

$^\circ C$  
Degree Celsius

$\mu$  
Conducting Material Permeability

$\AA$  
Angstrom

$a$  
Tuning Parameter

$B$  
Vector of Tuning Parameters

$I$  
Current

$K$  
Kelvin

$L$  
Inductance

$R$  
Resistance

$V$  
Voltage

$X$  
Value of Design Variable

$x_i$  
Design Parameter

$Y$  
Vector of Observations

$\theta$  
Angle

$\sigma$  
Conducting Material Conductivity

$\omega$  
Angular Frequency

$B_\theta$  
Azimuth Magnetic Field

$B_r$  
Radial Magnetic Field
**LIST OF ABBREVIATIONS**

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<td>VT</td>
<td>Visual testing</td>
</tr>
<tr>
<td>AE</td>
<td>Acoustic emission</td>
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<tr>
<td>ANFIS</td>
<td>Adaptive neuro-fuzzy inference system</td>
</tr>
<tr>
<td>ANN</td>
<td>Artificial neural network</td>
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<tr>
<td>CNC</td>
<td>Computer numerical control</td>
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<tr>
<td>Cr</td>
<td>Cuprum</td>
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<tr>
<td>CTS</td>
<td>Copper tubing size</td>
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<td>DAQ</td>
<td>Data acquisition</td>
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<td>DC</td>
<td>Direct current</td>
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<td>DSECT</td>
<td>Distributed System for Eddy Current Testing</td>
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<td>ECT</td>
<td>Eddy current testing</td>
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<tr>
<td>Fe</td>
<td>Ferum</td>
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<tr>
<td>FEM</td>
<td>Finite element model</td>
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<td>GMR</td>
<td>Giant magneto resistance</td>
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<td>MBE</td>
<td>Minimum bias estimator</td>
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<tr>
<td>MFL</td>
<td>Magnetic flux leakage</td>
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<td>MRPC</td>
<td>Motorized rotating probe coil</td>
</tr>
<tr>
<td>MRPC</td>
<td>Motorized rotating probe coil</td>
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<td>MSE</td>
<td>Mean squared error</td>
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<td>Magnetic particle testing</td>
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<td>Destructive testing</td>
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<td>PVC</td>
<td>Poly vinyl chloride</td>
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<td>RPC</td>
<td>Rotating pancake coil</td>
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<td>Response surface methodology</td>
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<tr>
<td>USB</td>
<td>Universal serial bus</td>
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