ELECTRICAL ENERGY GENERATION FROM PIEZOELECTRIC MATERIALS

LAU LEE TAK

SCHOOL OF ELECTRICAL SYSTEMS ENGINEERING

UNIVERSITY MALAYSIA PERLIS

2011

ELECTRICAL ENERGY GENERATION FROM PIEZOELECTRIC MATERIALS

by

LAU LEE TAK

Report submitted in partial fulfillment

of the requirements for the degree

of Bachelor of Engineering

MAY 2011

ACKNOWLEDGEMENT

Gratefully, at last I am able to complete this final year project (FYP) successfully in the schedule time. The completion of this project is not possible without the technical support and aid from other parties. In this short column, I would like to express my sincere gratitude to my supervisor, Prof. Madya Dr. Siti Fatimah Siraj and co-supervisor, Puan Nor Hanisah Baharudin from School of Electrical Systems Engineering for their knowledgeable advices, patience and guidance.

I want to thank to my family for their love, morale and financial support, encouragement, education and prayer. Their support has given me spiritual strength and inspiration in pursuing my ambition in life as well as to complete this project.

Finally, I would like to give my thanks to my fellow friends and laboratories assistants for their constructive idea, and technical support at the beginning stages of my project.

DECLARATION SHEET

I hereby declare that my Final Year Project Thesis is the result of my research work under supervision of Prof. Madya Dr. Siti Fatimah Siraj. All literature sources used for the writing of this thesis have been adequately referenced.

Name	**:**	**LAU LEE TAK**
Candidate number	**:**	**071090295**
Supervisor	**:**	**PROF. MADYA DR. SITI FATIMAH SIRAJ**
Title of thesis	**:**	**ELECTRICAL ENERGY GENERATION FROM PIEZOELECTRIC MATERIALS**

Candidate's signature: …… **Supervisor signature: ……...**

Date: …….. **Date: …..……**

APPROVAL AND DECLARATION SHEET

This project report titled Electrical Energy Generation from Piezoelectric Materials was prepared and submitted by Lau Lee Tak (Matrix Number: 071090295) and has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the Bachelor of Engineering (Electrical Systems Engineering) in University Malaysia Perlis (UniMAP).

Checked and Approved by

_____

(Prof. Madya Dr. Siti Fatimah Siraj)
Project Supervisor

School of Electrical System Engineering

Universiti Malaysia Perlis

May 2011

PENJANAAN TENAGA ELEKTRIK DARI BAHAN

PIEZOELEKTRIK

ABSTRAK

Tujuan dari projek ini adalah untuk menuai tenaga elektrik dari struktur yang bergetar dengan menggunakan bahan piezoelektrik. Definisi dibangunkan, model teoritis untuk memprediksi voltan yang dihasilkan dari bahan piezoelektrik bergetar menempel pada angka tahap kanti. Model ramalan diaktifkan dengan membandingkannya dengan data eksperimen. Keputusan kajian menunjukkan bahawa model Euler-Bernoulli mewakili bahan piezoelektrik. Selain itu, pengoptimuman parametrik untuk kemampuan generasi sistem angka kantilever kuasa dibahas. Alternatif voltan yang dihasilkan oleh bahan piezoelektrik diperbaiki dan kemudian disimpankan di dalam bateri nickel metal hydride. Projek ini membuktikan bahawa kuasa yang kecil dihasil dari bahan piezoelectric adalah wujud dan ini memberikan alternatif baru di loji tenaga elektrik.

ELECTRICAL ENERGY GENERATION FROM PIEZOELECTRIC MATERIALS

ABTRACT

The goal of this project is to harvest electrical energy from vibrating structures by using the piezoelectric materials. Definitive is developed, theoretical models to predict the output voltage which is generated from vibrating piezoelectric materials attached to a cantilever beam. The predictive models are validated by comparing them to experimental data. The results show that the Euler-Bernoulli model must appropriately represent the piezoelectric material. Besides, parametric optimization for the cantilever beam system's power generation capability is discussed. The alternating voltage generated by the piezoelectric material is rectified and then stored in a nickel metal hydride battery. The project proves that small power harvesting from piezoelectric materials is possible and this provides a new alternative in electrical energy generation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

ε	Mechanical Strain
σ	Mechanical Stress
E	Electrical Field
D	Electric Density
s	Elastic Compliance
d	Piezoelectric Strain Coefficient
ε_a	PZT strain
σ_a	PZT stress
F	Force
I_b	Moment area of inertia of the beam
g_{31}	PZT voltage constant
$\emptyset$	Phi
M	Moment of the beam
b	Width of PZT
t_a	PZT thickness
t_b	Beam thickness
E_a	PZT young modulus
E_b	Beam young modulus

k	Curvature of the beam
ρ	Destiny of the aluminum beam
A	Cross-sectional area
ω	Driving frequency