

#### Form ENG-PSE125

**(September 2014)**

**Postgraduate Scheme in Engineering**

**Synopsis**

**Dissertation Proposal for MSc in \_\_\_\_Electrical Engineering\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

This form should be typewritten. All sections should be completed in full. Sections 1-3 are to be completed by the student. In signing this form the Award Committee confirms that the student is registered on dissertation, the proposal is of an acceptable academic standard and that the university resources necessary for the dissertation will be made available. The completed form should be sent to the Award Committee for approval no later than the last day of a semester.

**Section 1 : Student Details**

Student’s name : WU Huihuan PolyU ID No. : 15092499G

Tel No. : 5372 0577 Fax No. :

Subjects taken so far (include title, grade, and academic year for all subjects for which a grade has been obtained)

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| --- | --- | --- | --- | --- |
| 2015,16 Semester 1 | 05002-EE | | MSc ELECTRICAL ENGINEERING | |
| **Code** | **Title** | **Credit** | **Grade** | **Remark Code** |
| EE501 | ALTERNATIVE ENERGY TECHNOLOGIES | 3.00 |  |  |
| EE502 | MODERN PROTECTION METHOD | 3.00 |  |  |
| EE512 | ELECTRIC VEHICLES | 3.00 |  |  |
| EE525 | ENERGY POLICY AND RESTRUCTURING OF ELECTRICITY SUPPLY INDUSTRY | 3.00 |  |  |
| ISE5001 | POWER SYSTEM ANALYSIS AND DYNAMICS | 3.00 |  |  |

GPA: Sem GPA:

**Section 2 : Supervisor Details**

Academic Supervisor’s Name, Qualifications and Department :

Weinong Fu, Associate Professor, EE Dept.

Professional Supervisor’s Name, Qualifications, Position, and Affiliation (appointment of which is optional) :

Professional Supervisor’s Address :

Tel. No. : Fax No. :

**Section 3 : Details of Dissertation Topic**

Dissertation title:

Automatic evolutionary multi-objective optimizer of interior permanent magnet motor design using finite element analysis.

Signature of student : Date :

**Section 4 : Comments of Academic Supervisor**

It is an interesting research topic and I believe the student can finish the project. I support taking this topic for the MSc Dissertation.

Signature : Date :

**Section 5 : Comments of Professional Supervisor, if any**

Signature : Date :

**Section 6 : Decision of Award Committee**

Approved~~/Referred back for improvement/Rejected~~

Signature : Date :

Chairman, Award Committee

**Form ENG-PSE125**

**Objectives of the Project**

1. Design a parameterized model for IPM motor.

2. Analysis the model parameters including energy efficiency, core loss, torque and etc. by using FEA.

3. Find solutions of optimization of a set of conflicting goals.

4. Assess the optimized parameters of proposed IPM motor.

**Content**

(Innovative features, challenge, academic value and applicability of the project)

Interior permanent magnet motor

Permanent magnets (PMs) have fascinated and inspired many researchers as PMs can produce magnetic field and magnetic force without external excitations nor energy consumption. PM motors are increasingly being used by virtue of their high efficiency and simple structures. With these in mind, magnetic gear is a possible application of the PMs.

Due to rising concern of low torque transmission of the conventional mechanical gears, magnet gears were introduced actively in recently years. Compared to mechanical gears, magnetic gears have very competitive torque transmission capability and efficiency. In addition, the magnetic gears have smooth torque transmission, low vibration, virtually no mechanical wear nor fatigue and hence have maintenance free operations, when compared to their traditional mechanical counterparts. Yet, there is a challenge of widely using of magnetic gears as their torque density is not high enough to satisfy the demand of the industry.

Nevertheless, there is no specific design and analysis of magnetic gears which have a comparatively large torque upon now. The efficiency and reliability of a magnetic gear shall be further explored in different applications (e.g. vehicle drive or wind power).

Hence, in this project, it will be focus on the

1. Magnetic gears and motors,
2. The analysis of their performance and
3. Optimization of their design parameters

The design consideration and specifications of magnetic gears and motors will be studied.

Also, the performance of different configuration of magnetic gears and motors will be evaluated. After that, novel designs of magnetic gears and motors for achieving a higher torque than conventional structures will be proposed.

**(Cont’d)**

The configurations of the novel magnetic gears and motors will be proposed in this project. In order to achieve a better performance and a larger torque density than the conventional configurations, a global optimization method is used to determine the sizes of the gear. Finite-element method (FEM) of the magnetic field and mechanical motion coupled computation is employed to evaluate the dynamic electromagnetic torque comprehensively. Computer aided simulation will be carried out to evaluate the performance of those proposed gears and motors.

**Methodology**

1. **Study the use of magnetic gears and motors in modern applications**

In this part, it aims at   
1) Define factors of consideration in design and   
2) Determine design specifications for magnetic gears and motors

3) Determine the specific improvement area of existing design for further design and modelling.

It will be done by literature review.

1. **Design novel permanent magnetic gears and motors**

In this part, modelling of the magnetic gears and motors will be proposed based on the design factors and specifications as well as improving area obtained in part A.

It will be done by designing novel permanent magnetic gears and motors.

1. **Use software to simulate different magnetic gears and motors, and compare their performance**

After modelling of the magnetic gears and motors, the performance will be evaluated.

It will be done by analysing the performance of novel permanent magnetic gears and motors numerically by using a finite-element method.

1. **Optimize the parameters of proposed magnetic gears and motors**

After establishing the models of the magnetic gears and motors, the parameter optimization of the proposed permanent magnetic gears and motors will be done by using a global optimization method.

**References**

1. P. O. Rasmussen, T. O. Andersen, F. T. Jorgensen, and O. Nielsen, “Development of a high performance magnetic gear,” *IEEE Trans. Industry Applications*, vol. 41, no. 3, May/June 2005, pp. 764 - 770.
2. K. Atallah, and D. Howe, “A novel high-performance magnetic gear,” *IEEE Trans. Magn.*, vol. 37, no. 46, Jul 2001, pp. 2844 - 2846.
3. K. Atallah, S. D. Calverley and D. Howe, “Design, analysis and realisation of a high-performance magnetic gear,” *IEE Proceedings - Electric Power Applications,* vol. 151,  no. 2,  Mar 2004, pp. 135-143.
4. Cheng-Chi Huang, Mi-Ching Tsai, D. G. Dorrell and Bor-Jeng Lin, “Development of a magnetic planetary gearbox,” *IEEE Trans. Magn.*, vol. 44, no. 3, March 2008, pp. 403-412.
5. W. N. Fu, P. Zhou, D. Lin, S. Stanton and Z. J. Cendes, “Modeling of solid conductors in two-dimensional transient finite-element analysis and its application to electric machines,” *IEEE Trans. Magn.*, vol. 40, no. 2, March 2004, pp. 426-434.
6. K. T. Chau, C. C. Chan, and C. Liu, “Overview of permanent-magnet brushless drives for electric and hybrid electric vehicles,” *IEEE Trans.Ind. Electron.*, vol. 55, no. 6, pp. 2246–2257, Jun. 2008.
7. K. T. Chau, D. Zhang, J. Z. Jiang, C. Liu, and Y. Zhang, “Design of a magnetic-geared outer-rotor permanent-magnet brushless motor for electric vehicles,” *IEEE Trans. Magn*, vol. 43, no. 6, pp. 2504 - 2506,Jun 2007.
8. M. Muramatsu, M. Yamamoto, and K. Hirata, “Proposal of an axial gap magnetic harmonic gear,” *SEAD 21st*, 22A1-2, pp. 535-540 (2009) (in Japanese).

**Scheduled programme of work**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **2015** | | | **2016** | | | | |
| **Tasks** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** |
| **Study of design consideration and specification of magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Literature review of present configurations** |  |  |  |  |  |  |  |  |
| **Evaluate performance of different configurations of magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Determine modeling method** |  |  |  |  |  |  |  |  |
| **Determine parameters of magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Model magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Propose novel magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Evaluate the performance of the proposed magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Compare the performances of proposed and conventional configurations** |  |  |  |  |  |  |  |  |
| **Determine the optimization parameters of the proposed magnetic gears and motors** |  |  |  |  |  |  |  |  |
| **Optimize the parameters of proposed configurations** |  |  |  |  |  |  |  |  |
| **Summarize the outcome of the entire process** |  |  |  |  |  |  |  |  |

**Description of facilities required and justification**

(Also detail any other supporting facilities obtained elsewhere)

1. Simulation software for modelling electromagnetic devices using FEA
2. Software for optimal design of electromagnetic devices

**Expected completion date : 2015/2016 Summer Semester**

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**Student’s Signature**