

***“Computer Modeling and Burnup Analysis in  
Light Water Nuclear Reactors”***

*Presented by*

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to  
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**Physics Department  
Faculty of Science  
Cairo University**

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# **"نمذجة بالحاسب الآلي و تحليل اختراق الوقت في مفاعلات الماء الخفيفة"**

إعداد

**بسمه محمود محمد فؤاد**

رسالة مقدمة

إلى

**كلية العلوم**

كجزء من متطلبات الحصول على درجة

الماجستير

( الفيزياء النووية )

قسم الفيزياء

كلية العلوم

جامعة القاهرة

( 2010 )

## المستخلص

أسم الطالب: بسمة محمود محمد فؤاد

عنوان الرسالة : "نمذجة بلع الحاسب الآلي و تحليل احتراق الوقود في مفاعلات الماء الخفيف"  
الخبيرة

الدرجة : ماجستير في الفيزياء

الغرض من هذه الرسالة هي دراسة سلوك وقود الثوريوم/يورانيوم المتباين في مفاعلات الماء الخفيف المضغوط. تهدف هذه الرسالة الى دراسة التحليلات النيوترونية و الاحتراق لوقود الثوريوم/يورانيوم باستخدام برنامجي الحاسب الآلي WIMS-D5 , MCNPX . يعتمد تصميم المفاعل على نموذج يسمى بالوحدات المتكاملة للبذرة و الغطاء بحيث تشغل وحدات البذرة المحتوية على وقود اليورانيوم و وحدات الغطاء المحتوية على وقود الثوريوم/يورانيوم الحجم الكلي لقلب مفاعلات الماء الخفيف المضغوط و المصممة على شكل لوحة شطرنج. وقد وجدت تطابقات مرضية بين نتائج النموذج الحالي و نتائج حالات قياسية متماثلة.

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## **Appendix A**

### **The Multiplication Factor ( $K_{\text{eff}}$ )**

The ratio of the number of fission neutrons in one generation divided by the number of fission neutrons in the preceding generation.

### **Burnup**

The total energy released in fission by a given amount of nuclear fuel released per unit mass of the fuel and is measured in megawatt days per kilogram.

### **Thermal energy group**

The neutrons whose energies are smaller than 0.625 eV.

### **Epithermal group (Resonance group)**

The neutrons which have energies between 0.625 eV to 5.53 KeV.

### **Fast group**

The neutrons which have energies between 5.53 KeV to 20 MeV.

### **Reflective Boundary**

It is an imaginary surface; where any particle hitting this reflecting surface is specularly (mirror) reflected. Reflective surfaces are valuable because they can simplify a geometry setup (and also tracking) in most problems.

# CHAPTER 1

## INTRODUCTION

# CHAPTER 2

## METHODOLOGY

## CHAPTER 3

# RESULTS AND DISCUSSION

# CHAPTER 4

## CONCLUSIONS



## REFERENCES

# APPENDIX

# ABSTRACT

Student Name: **Basma Mahmoud Mohammed Fouad**

Title of the thesis: **Computer Modeling and Burnup Analysis in  
Light Water Nuclear Reactors**

Degree: **Master of Science**

*The purpose of this thesis is to study the feasibility of the Thorium/Uranium fuel cycle in heterogeneous Pressurized Water Reactors (PWR) core design. This thesis focuses on the neutronic and burnup analysis of the Thorium/Uranium fuel using the computer codes MCNPX and WIMS-D5. The design is based on the Whole Assembly Seed and Blanket (WASB) concept, in which the individual seed (Uranium) and blanket (Thorium-Uranium) units occupy one full-size PWR assembly in a checkerboard core configuration. The results of the present models are compared with the solution of the benchmark problems. Satisfactory agreement is obtained.*

Keywords: Thorium Fuel cycle, Whole Assembly Seed and Blanket, Neutronic calculations

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- 1- **Prof. Dr. Hesham Mohammed Mansour**
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## **APPROVAL SHEET FOR SUBMISSION**

Thesis Title: **Computer Modeling and Burnup Analysis in  
Light Water Nuclear Reactors**

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### **To WHOM IT MAY CONCERN**

**This is to certify that: Basma Mahmoud Mohamed Foad**

**Has attended and passed successfully the following postgraduate Courses as a partial  
Fulfillment of the requirements of the degree of Master of Science:**

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- 2. Group Theory,**
- 3. Quantum Field Theory,**
- 4. Theories of Nuclear interactions,**
- 5. Molecular Spectroscopy,**
- 6. Statistical and electrodynamics**

**This certificate is issued at his own request.**

**Date of birth: 15/10/1981**

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**Controller**

*9 G.M. Nashed 2010*  
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