Nuclear Engineering Qualifying Exam – Spring 2017

Briefing for Students
October 26, 2016
10:30-11:30
NUCL137
Overview

10:30-11:00
- Purpose of qualifying exam.
- Components of the exam.
- Schedule.
- How the exam will be graded.
- Passed only part of the exam? Now what?
- Questions.

11:00-11:30
- Q & A with QE writers.
Purpose of Qualifying Exam.

To determine whether the student has the knowledge, skills, and ability to conduct independent thinking and creative research.
Components of the Exam

- General knowledge - Written exam.
  1. Nuclear Engineering Fundamentals and Reactor Physics,
  2. Fluids, Heat Transfer, and Reactor Safety,
  3. Nuclear Materials, including Fuel Cycle and Waste Management,

- Specialization area – Written research assessment paper with oral presentation of the paper followed by questions related to both the paper and basic knowledge in the specialization area.
  1. Materials,
  2. Reactor Physics,
  3. Nuclear Structure and Radiation Interaction,
  4. Thermal-Hydraulics and Reactor Safety,
  5. Fusion.
Written Exam

- **90 minutes-exams.**
  - Nuclear Engineering Fundamentals and Reactor Physics.
  - Nuclear materials including fuel cycle and waste management.
  - Fluids, heat transfer, and reactor safety.
  - Nuclear radiation detection and protection.

- **2 exams per day, 2 days exams.**

- Students will have **90 minutes** for each exam (exam collected at end of each exam).

- If students are interested, they can review written exams used last year during the month of November. Please contact Kellie.
Written Exam - 2

- Closed book – No notes.
- Each student will be given an ID number. That number, not the student’s name, will be used on the exam.
- The ID number will only be known to the Graduate Chair and in some cases by only the Head.
- A list of concepts that may be covered on each written exam will be available to students by the middle of Fall Semester (Around week of Oct. 3).
# QE Committee

## 2017 Q.E. Exam Committees

### Committee Chairs

<table>
<thead>
<tr>
<th>Materials</th>
<th>Reactor Physics</th>
<th>Radiation Detection &amp; Protection</th>
<th>Thermal Hydraulics</th>
<th>Fusion*</th>
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</thead>
<tbody>
<tr>
<td>Prof. Hassanein</td>
<td>Prof. Yang</td>
<td>Prof. Hassanein</td>
<td>Prof. Ishii</td>
<td>Prof. Choi</td>
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### Committee Members

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<td>Prof. Miloshevsky Prof. Sizyuk</td>
<td>Prof. Abdel-Khalik Prof. Bean</td>
<td>Prof. Garner Prof. Taleyarkhan</td>
<td>Prof. Revankar Prof. Bertodano</td>
<td>Prof. Hassanein Prof. Tsoukalas</td>
</tr>
</tbody>
</table>

*) Research Assessment Paper and Oral Examination Only

Faculty indicated by red color: Grader for written exam.

Committee chairs are responsible to submit camera-ready exams and solution manual with rubric and journal papers for assessment to Kellie by November 18, 2016. Please note that (i) no email submission of exams is allowed and (ii) no typeset service by Graduate Chair and Kellie is available.

Note: Please see the following rule indicated on page 3 in QE Handbook 2016

- If the thesis advisor of any student who is planning to do the research assessment paper and oral examination in a specialty area is not on the Area Committee that will administer the student’s exam, the Head will appoint the advisor to that Area Committee as a full member – Fall 2016, week 13.
List of Concepts (Nuclear Engineering Fundamentals and Reactor Physics)

Topics taken from NUCL 300, 310, 510 (501)

- Neutron transport and diffusion equations
- Slowing down theory and flux separation of space and energy
- Neutron spectrum in different types of reactors
- Two-group diffusion equation and its application
- Resonance absorption and escape probability
- Effect of temperature on resonances (Doppler effects and MTC)
- Reactivity balances for design and operation
- Physics of delayed neutrons and its importance in reactor control
- Point kinetics equations and approximate solution methods
- Reactivity feedbacks and transient behaviors
- Fuel depletion and nuclide transmutation
- Xenon oscillation
- In-core fuel management
- Fuel cycle analysis
List of Concepts (Fluids, Heat Transfer, and Reactor Safety)

Topics taken from NUCL350, 351, 355, 402, 551

1. Introduction to Nuclear Thermal-hydraulics Systems
2. General Balance Equation
4. Non-dimensional Analysis and Scaling Parameters
5. Heat Conduction in Solid
6. Viscous Stress and Laminar & Turbulent Flow Velocity Profile
7. Transient Diffusion Problem for Momentum and Energy and Penetration Depth Concept
8. Turbulent Flow Formulation and Reynolds Stress
9. Viscous and Turbulent Stress Distribution in Pipe Flow
10. Prandtl Mixing Length Model and Universal Velocity Profile for Turbulent Flow
11. Prandtl Number Effect on Temperature Profile in Turbulent Flow
12. One Dimensional Formulation and Closure Relations
13. Forced Convection Transient Flow Analysis using Integral Momentum Equation
14. Natural Circulation Flow Analysis using Integral Momentum Equation
15. Control Volume Analysis for Nuclear Reactor System and Application to Various Accident Analyses
16. Two-phase Flow Regimes and Boiling Flow Regimes in Terms of Heat Transfer
17. Local Instant Formulation of Two-phase Flow Based on Single-Phase Flow Formulation and Jump Conditions
18. Basic Concept and Parameters in Two-phase Flow such as Void Fraction, Flow/Static/Equilibrium Quality
19. Derivation of Two-phase Flow Equations Based on Averaging
20. Closure Relations and Correlations for Two-phase Flow
21. Two-phase flow instabilities (density wave, excursive) in reactor systems inclusive of reactivity feedback
22. Boiling heat transfer (pool, forced convective, and post-dryout) concepts including related CCFL, and CHF/DNB and PDO phenomena.
23. Sub-channel analysis including mixing and void-drift effects basic concepts
24. Two-fluid modeling basic concepts
25. Containment phenomena such as steam condensation and NCG effects, and engineered safety systems thermal-hydraulics
26. Off-site radionuclide plume transport and safety assessments including building wake effects and radiological dose evaluation.
List of Concepts (Nuclear Materials)

Topics taken from NUCL320, 420, 501, 520
1. Thermal Properties of Solids
2. Microscopic and Macroscopic Diffusion
3. Basic Radiation-Matter Interactions
4. Binary Elastic Collisions Theory
5. Inter-atomic Potentials and Cohesive Energy
6. Cross Sections
7. Particle Energy Loss
8. Electronic Stopping Power
9. Ion Range
10. Displacement Cascade
11. Channeling & Focusing
12. Ion and Neutron Damage
13. Sputtering & Blistering
14. Point Defects Clustering, Diffusion, and Kinetics
15. Swelling
16. Creep
17. Radiation Hardening
18. Embrittlement

Note that the review part of NUCL420 will be topics from NUCL520.
List of Concepts (Nuclear Radiation Detection and Protection)

Topics taken from NUCL200, 300 (205, 305, 504, 501)

1. Atomic structure, Bohr's atomic model
2. Nuclear structure and estimate of nuclear radii
3. Binding energy for atoms and nuclei, mass defect
4. Uncertainty and exclusion principles
5. Radioactive decay, decay rate, activity - concepts and calculations
6. Energies of emitted radiation during decay
7. Neutron interaction with matter
8. Charged particle interaction with matter
9. Photon interaction with matter
10. Biological effects of radiation
11. Shielding, build-up factor
12. Radiation detection principles and technology
13. Counting statistics and error propagation
14. Radiation protection
Specialization Exam

- 2 parts
  - Written research assessment paper.
  - Oral presentation of the paper followed by questions related to both the paper and basic knowledge in the specialization area.
Research Assessment Paper

- A journal article will be assigned in each specialization area.
- Article will be selected by the Area Committee.
- Article will not be directly related to any student’s research.
- Students are expected to work independently.
Research Assessment Paper - 2

- A general outline of the paper will be provided
  - Summary.
  - Critique and placing the paper in historical perspective.
  - Extension.
- 15-20 pages long.
- Double spaced.
Oral Portion of Specialization Exam

- 2 hours will be scheduled for the exam.
- Area Committee will conduct the exam.
- Advisor will be on the Area Committee.
- 30-minute presentation on the research assessment paper.
- Area Committee will first ask questions related to the research assessment paper.
- Area Committee will then ask questions related to the basic knowledge in specialization area.
Schedule for Qualifying Exam

- **Oct. 26, 2016** – Briefing for students.
- **Nov. 4, 2016** – Students planning to take the exam must notify Grad Chair (cc to Tiffany Stergar) in writing with official registration form.
- **Dec. 16, 2016** – Research assessment paper assigned.
- **Feb. 1 (Wed) and 2 (Thu), 2017** – Written exam given.
- **Feb. 13-17, 2017** – Oral exams to be held.
- **Week of Mar. 3, 2017** – Results to be provided.
QE Location & Time (tentative)

- Written Exam Schedule
  - Feb 1, 13:00 to 14:30
    Nuclear Engineering Fundamentals and Reactor Physics.
  - Feb 1, 14:45-16:15
    Nuclear materials including fuel cycle and waste management.
  - Feb 2, 13:00 to 14:30
    Fluids, heat transfer, and reactor safety.
  - Feb 2, 14:45-16:15
    Nuclear radiation detection and protection.
- Location: NUCL137 (Students Lounge)
Registration for QE

- Students planning to take the exam must notify Grad Chair in writing with official registration form.
  - CC tsterga@purdue.edu; Tiffany Stergar, Student Services
  - Deadline: Nov. 4, 2016
- A test email will be sent on Nov. 7, 2016 to registered students
  - If you do not receive an email on Nov. 7 – contact Tiffany Stergar as soon as possible
    - CC Dr. Hibiki (hibiki@purdue.edu)
How the Exam Will Be Graded

- Written exam
  - Each of the 4 exams are graded separately.
  - Each exam scored by the faculty members that prepared the exam.
  - Entire faculty will meet to discuss scores and determine “pass” and “fail” and recommend to the Head.
  - Students will be known by ID numbers only.
  - Students who fail the Qualifying Examination will have an opportunity to receive some advices from the Graduate Committee Chair to improve his or her preparedness for next Qualifying Examination by the end of 2017 March.
How the Exam Will Be Graded

- Specialization exam (written research assessment paper & oral presentation and questions)
  - Grades on the written research assessment paper and the oral portion will be determined using the rubrics in the Qualifying Examination Procedure manual.
  - The combined votes on the written research assessment paper & oral presentation and questions will be used to determine whether a student passes or fails. A student must receive a minimum of 60 percent “pass” votes in order to pass the examination.
If You Pass Part of the Exam

- **Written Exam**
  - Fail one part – take it again.
    - When given the **next spring**.
    - May petition to take it in the **fall** but not guaranteed.
  - Fail more than one part – take failed parts the **next spring**.

- **Specialization Exam**
  - If this exam is failed, it must be taken the **next spring**.
How Many Attempts?

- A student must pass all 5 parts (4 written & 1 oral exams) of the exam to continue in the Ph.D. program.
- A student may take each part only twice.
Questions?

- QE writers give you Q & A session in this QE briefing.
- If QE writers can not be present in this QE briefing, students are allowed to visit QE writers to ask about QE by November 4.