The Preliminary Examination for Prospective Doctoral Students in Mechanical Engineering

TO: MECHANICAL ENGINEERING GRADUATE STUDENTS

TAKING THE PRELIMINARY EXAMINATION IN

January, 2016

Prof. David Steigmann
Chair, Preliminary Examination Committee

Attached is a copy of the information sheets pertaining to the Doctoral Preliminary Examination. Please read carefully for answers to questions you may have concerning the examination.

SCHEDULE FOR THE JANUARY 2016 PRELIMINARY EXAMINATIONS

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<tr>
<td>MATERIALS</td>
<td>Kyriakos Komvopoulos</td>
<td>January 12</td>
<td>10:00 A.M.</td>
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<td>DYNAMICS</td>
<td>Fai Ma</td>
<td>January 12</td>
<td>2:00 P.M.</td>
<td>3107 E.H.</td>
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<td>DESIGN</td>
<td>Alice Agogino</td>
<td>January 13</td>
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<td>Solid MECHANICS</td>
<td>James Casey</td>
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<td>CONTROLS</td>
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<td>Fluid MECHANICS</td>
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<td>HEAT TRANSFER</td>
<td>Costas Grigoropoulos</td>
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<td>THERMODYNAMICS</td>
<td>Michael Frenklach</td>
<td>January 15</td>
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Other Important Dates and Procedures:

Sign-up for the Preliminary Examination must be completed online by 12/09/15 at noon.

After you sign-up for the exam, you will be assigned an identification number which you will use to identify your examination paper. REMEMBER IT! Students are responsible for obtaining information regarding the date, time, and location of the exams.

EXCEPTIONS TO PRELIMINARY EXAMINATION POLICIES

Petitions for exceptions should be addressed to the Chair of the Preliminary Examination Committee, Professor David Steigmann, and delivered to:

Mr. Yawo D. Akpawu in 6189 Etcheverry Hall no later than Friday, December 4, 2015 by noon.
Petitions are considered only in cases of serious extenuating circumstances that are beyond the student’s control and are decided on a case-by-case basis. The committee reserves the right to impose any requirements that it deems necessary. Supporting evidence should be submitted with the petition.

**INSPECTION OF EXAMS AND RE-GRADING**

Students may inspect their exams and the exam solutions. Such inspection will be done in the office of the chair of the exam area for which inspection is desired. Neither the exam nor the solution may be removed from the office, nor may copies be made.

Requests for re-grading should be directed to the Preliminary Examination Committee member in charge of the area for which re-grading is requested. Re-grading will only apply to grading mistakes, such as numerical errors in grading, and not reinterpretations of student’s answers.

**MOST COMMONLY ASKED QUESTIONS ABOUT THE PRELIMINARY EXAMINATION:**

1. **Why must I take the Preliminary Examination?**
   
   You must take and pass the Preliminary Examination to be considered eligible for the Ph.D. program.

2. **Can I take courses S/U prior to taking the Preliminary Examination?**
   
   Yes. At least two-third of the units (excluding courses with S/U grading option only such as ME 298, 299, 301) or two courses per semester must be taken for a letter grade prior to taking the Preliminary Examination. We note that 5 courses in the major field and 2 in each of the minor fields must eventually be taken for a letter grade to meet our doctoral degree requirements.

3. **What would it mean if I miss my deadline to sign up and take the Preliminary Examination?**
   
   Missing the deadline to take the Preliminary Examination means that you will no longer be eligible for the Ph.D. program.

4. **When is the earliest I may take the Preliminary Examination?**
   
   If you are coming into the ME program with either a Bachelor of Science Degree or a Master’s of Science, the earliest you may take the Preliminary Examination will be after one registered semester of graduate course work completed at the University of California at Berkeley.

5. **When is the latest I must take the Preliminary Examination to be eligible for the Ph.D. Program?**
   
   **M.S. students:** Must take the Preliminary Examination upon completion of one registered of completed course work within the Mechanical Engineering department.

   **B.S. students:** Must take the Preliminary Examination upon completion of two registered semesters within the Mechanical Engineering department. Exception can be made,
upon approval of a petition, to give an extra semester to students whose undergraduate degree program was not in Mechanical Engineering.

6. **Is there a minimum GPA requirement to take the Preliminary Examination?**

   Yes, all students must have a minimum graduate GPA of **3.3** overall and **3.5** in their major field from courses taken at UC Berkeley to take the Preliminary Examination.

7. **How do I pass the Preliminary Examination?**

   You pass the Preliminary Examination when you have passed three area examinations, one of which must be in your declared area of study. If your major field is represented in a preliminary examination area, you must choose this area as your declared area of study. If your major field is not represented in the preliminary examination areas, you must select, in consultation with your major field advisor, one the preliminary examination areas as your declared area of study. Your declared area must be indicated on your application form. If you do not sign up for your declared area of study, you will be ineligible to take the prelims.

8. **What happens if I don’t pass the Preliminary Examination the first time?**

   The Preliminary Examination Committee will decide, based upon your performance on the examinations, whether you will be allowed to retake the Preliminary Examination. If you do not pass the first time, and are permitted a retake, you may retake any part of the Preliminary Examination you wish, but **you must retake the Preliminary Examination the very next time it is scheduled**.

   For example:

   a. If you sign up for the three required area exams, pass your major and one other area, you may take the one area exam you did not pass or take any other area that you haven’t already passed.
   b. If you sign up for more than three exams, pass three but fail your major, you are still required to sign up and pass your major.

9. **Is there a limit to the number of area examinations I can sign up for?**

   No, there is no limit. You may sign up for as many as you wish.

10. **Can I simply show up for the exam?**

    No, you must register for the exam ahead of time.

11. **How many area examinations must I take?**

    **First sitting:** For your first sitting you must sign up and take at least three area exams. Failure to do so will make you ineligible to take the Preliminary Examinations and you will be considered only for the M.S. program. Remember that one examination must be in your major strength area.
**Second sitting:** If a second sitting is necessary, you may sign up and take as many area examinations as you wish to pass the Preliminary Examination.

12. **Once I have signed up for the Preliminary Examination, what is the latest date I may add or drop an area of examinations?**

   You may add or drop an area examination up to the date of the examination as long as you take at least three examinations (first sitting).

   If you drop an area examination and fall below the prescribed three area examinations, you may take the one or two exams you signed up for but you will be considered as having failed all three, regardless of your grade in the exams (first sitting).

13. **Once I have registered for the Preliminary Examination, may I change my major strength area before I pass the Examination?**

   No, the committee expects you to commit to one major strength area from the time you register to the time you complete the Preliminary Examination.

14. **What if there are extenuating circumstances that have forced me out of compliance with the Preliminary Examination rules?**

   Students may petition for an exception to the rules. However, the committee cannot guarantee hearing the petition unless submitted by the deadline.

15. **How do I find out how I did on the exams?**

   Results will be emailed to you individually within two weeks after the last exam taken.

16. **With whom do I discuss my Preliminary Examination scores?**

   You must contact the Area Chair for each exam you wish to review. The Area Exam Chair will verify that the scores are numerically correct and discuss your performance on the exam. The Area Chair will not re-interpret your answers, which must stand on their own merits. It is the student’s responsibility to present clearly his or her answers on the exam.

17. **How long are the Preliminary Examination results valid?**

   The Preliminary Examination results are valid for five (5) years.

18. **May I use a calculator during the exam?**

   Yes, however, you may only use a calculator as outlined at the following website, [http://www.ncees.org/Exams/Exam-day_policies/Calculator_policy.php](http://www.ncees.org/Exams/Exam-day_policies/Calculator_policy.php)

**THE HIGHEST LEVEL OF UNDERGRADUATE COURSES TO BE COVERED IN THE PRELIMINARY EXAMINATION FOR PROSPECTIVE DOCTORAL STUDENTS IN MECHANICAL ENGINEERING**

<table>
<thead>
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<th>1. CONTROLS</th>
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A. OBJECTIVE

The objective of the Preliminary Examination is the early assessment of a student's potential for satisfactory completion of the doctoral degree. The exams are entirely closed books and notes.

All students admitted to the Ph.D. program on entry are required to take the examination. Students who enter with a declared M.S. degree goal and who wish to petition for a change in degree goal to Ph.D. or D. Eng must pass the examination before such petitions can be approved. Change of Degree goal petitions must be filed before completion of the M.S. degree requirements and must be approved if a student is to register beyond the Master’s degree.

B. DATE OF THE EXAMINATION

The examination will be given twice a year, in January and August. The examination must be taken following two semesters of registration for those students entering with Bachelor’s degree. Those entering with a Master’s degree will take the examination at the beginning of the second semester of registration. Some flexibility is allowed for students who do not have undergraduate degrees in Mechanical Engineering or closely related areas. These students may petition the Preliminary Examination Committee to take the examination at a later than normal time.

C. GRADE POINT REQUIREMENT

To qualify to take the Preliminary Examinations, students must maintain a GPA of 3.5 or better in the Major Field*, and an overall GPA of 3.3.

D. RESULTS

The Preliminary Examination Committee will meet approximately one week after the last exam is given. The results will then be emailed to the students. The results of the examination will be one of the following:

1. Pass: Continue in the doctoral program (for change of degree goal candidates, admit to doctoral program). Such students then prepare for the Ph.D. Oral Qualifying Examination.

*Major Field is defined to be a field for which a preliminary examination exists.
2. **Not Pass:** The Examination Committee decides whether or not such students may take the examination a second time. The examination may not be taken more than twice.

**E. GRADING**

There are nine (8) core examination areas. In each area the two grades are: “PASS” and “NOT PASS”. The student must pass in three areas, one of which **must** be in the proposed doctoral major. Students may attempt the examination in as many areas as they please at one offering. Students may review their solutions along with a set of recommended solutions to the problems.

**F. AREAS, FORMAT, TOPICS**

A student must attempt no fewer than three areas at the first offering.

**Area 1: CONTROLS**

Questions will be drawn from the following list of topics:

- Linear control system analysis and design in the frequency and time domain.
- Derivation of state equation and transfer functions for mechanical and mechatronic systems.
- Derivation of the characteristic equation and Root locus and Routh-Hurwitz stability conditions.
- Nyquist and Bode frequency response plots and Nyquist stability theorem.
- Compensator design using time domain and frequency response techniques.

**Area 2: DESIGN**

Questions will be drawn from the following list of topics:

- Product design (customer-driven design and design for assembly, manufacture, and environment).
- Machine design (design applications of dynamics, force, mass, displacement, velocity, acceleration, energy, momentum, the kinematics of place motion; mechanics of materials; static failure; fatigues failures.)

**Area 3: DYNAMICS**

Questions will be drawn from the following list of topics:

- Planar and 3-D kinematics of systems of particles and rigid bodies.
- Stationary and moving reference frames, coordinate transformations, linear and angular momentum, energy methods, impulsive motion (linear and angular).
- Single degree of freedom vibrations.

**Area 4: FLUID MECHANICS**

Questions will be drawn from the following list of topics:

- Boundary conditions on fluid motion.
• Control volume formulation of problems involving mass, momentum and energy balances.
• Laminar and turbulent flows in ducts, pipes, channels and about immersed bodies.
• Boundary layers
• Similitude.
• Shock.
• Dimensional analysis
• Bernoulli.
• Potential flow, sources and sinks, points vortices.
• Steady and unsteady motion of compressible fluids.
• Waves.

Area 5: HEAT TRANSFER

Questions will be drawn from the following list of topics:

• Steady and transient conduction.
• Lumped analysis.
• Principles of convection, thermal boundary layer, control volume analysis, free, forced, laminar, and turbulent convections.
• Thermal radiation, shape factors, diffuse surface radiation transfer.
• Heat exchangers.

Area 6: MATERIALS

Questions will be drawn from the following list of topics:

• Mechanics of materials.
• Transformation of stress and strain.
• Mechanical behavior materials.
• Mechanical properties of materials.
• Thermal processing of metals.
• Materials selection static failure theories.
• Fatigue failure: effects of load, size surface, stress concentration, mean stress, combined loading.
• Stress intensity factors, introductory fracture mechanics.

Area 7: SOLID MECHANICS

Questions will be drawn from the following list of topics:

• Continuum Mechanics: kinematics of deformation, balance laws, constitutive relations, invariance requirements for constitutive equations, fundamental equations of elasticity, elementary boundary value problems.
• Mechanics of Materials: beams and rods under axial loading, bending and torsion, statically indeterminate structure, buckling.

Area 8: THERMODYNAMICS

Questions will be drawn from the following list of topics:
• Interrelationship of heat, work energy, enthalpy, entropy, Gibbs and Helmholtz functions, heat capacity.
• Non-ideal gas behavior, first and second law.
• Reversible processes.
• Gas mixtures and gas-water vapor mixtures.
• Phase and thermodynamics system analysis.
• Cycle analysis.

G. DEPTH OF EACH AREA EXAMINATION

The questions can be expected to be thought provoking and probing but requiring only a clear understanding of the foundations of each technical area. Material is generally at the level of the core undergraduate Mechanical Engineering Curriculum. The reference list is not meant to be exhaustive but is to provide some approximation of the scope of the exam.

H. AVAILABILITY OF OLD EXAMINATIONS

We make available old examinations online at: http://www.me.berkeley.edu/prelims/prelims.php?ticket=ST-25642-gZdF6AeapcH5YorvsAXf-cas-p1

I. REFERENCE LIST

Area 1: CONTROLS

Gene Franklin, J.d. Powell and Abbas Emami-naeini “Feedback Control of Dynamics System”, Prentice Hall, 6th or earlier edition

Nise, N.S., “Control System Engineering”, Wiley, 5th or earlier edition

Ogata, K. “Modern Control Engineering”, Prentice Hall, 5th or earlier edition


Area 2: DESIGN

Product Design:


Machine Design:

Compiled text (chapters on design of machine components), Mechanical Engineering Design (custom), McGraw Hill. Sold at ASUC book store

Area 3: DYNAMICS


Area 4: FLUID MECHANICS


Area 5: HEAT TRANSFER


Area 6: MATERIALS


Area 7: SOLID MECHANICS

The references are listed in order of relevance to the Preliminary Examination:

P. M. Naghdi, ME 185 Class Notes. These notes are available online at: http://me.berkeley.edu/csml/PMNnotes/ME185Naghdi.pdf


Popov., E., “Introduction to Mechanics of Solids”, Prentice Hall, Chapters 5-8, 10-12

Area 8: THERMODYNAMICS

Classical thermodynamics; no compressible flow.


The Preliminary Examination Committee will periodically review the content and format of the Preliminary Examination.