NEW GRADUATE CONCENTRATION PROPOSALS
ARIZONA STATE UNIVERSITY
GRADUATE COLLEGE

This form should be used for academic units wishing to propose a new concentration for existing graduate degrees.

A concentration is a subspecialty within a degree and major which reflects that the student has fulfilled a designated, specialized course of study which qualifies the student as having distinctive skills and training in one highly concentrated area of the major. Concentrations are formally-recognized educational designations (including the assignment of a university plan code for reporting/record-keeping purposes and appearance on the ASU transcript). Concentrations are to be distinguished from not formally recognized academic distinctions frequently referred to as “emphases,” “tracks,” “foci,” “options,” etc.

Submit the completed and signed (chairs, unit deans) proposal to the Office of Graduate Academic Programs. Mail code 1003 and electronic copies to ozel@asu.edu or Denise.Campbell@asu.edu

Please type.

Contact Name: Lynn Cozort
Contact Phone: 5-4979
College/School/Division Name: Ira A. Fulton School of Engineering
Academic Unit Name: (or proposing faculty group for interdisciplinary proposals) Department of Mechanical and Aerospace Engineering (MAE)
Existing Graduate Degree and Major under which this concentration will be established: Doctor of Philosophy – Mechanical Engineering
Proposed Concentration Name: Engineering Education

Do Not Fill in this information: Office Use Only
Plan Code:
CIP Code:

1. Overview

A. Provide a brief description of the new concentration (including the specific focus of the new concentration, relationship to other concentrations in this degree program, etc).

Students pursuing the Doctor of Philosophy degree in Mechanical Engineering are eligible to apply for the Engineering Education concentration. The Engineering Education concentration is interdisciplinary and will combine research in engineering with research in education. The doctoral Engineering Education concentration will prepare students to become scholars, researchers or practitioners in academia. The proposed concentration provides students with an opportunity to explore pedagogy, methodology, and curriculum and instruction and apply it to engineering.

Students enrolled in the Engineering Education concentration under the PhD degree in Mechanical Engineering will complete 18 credit hours of graduate-level engineering coursework with a specific research focus and 15 hours of graduate-level education coursework. The program is directed toward original research. The students will be required to write and defend a dissertation that describes an original contribution within the chosen engineering discipline that integrates an education component (i.e., research on engineering pre-university programs, undergraduate engineering curriculum and instruction, etc.). The research results should be suitable for publication in a reputable journal. Students will be required to satisfy all MAE qualifying and comprehensive requirements and to abide by all policies set forth by the School of Engineering.

There are currently no doctoral concentrations available in Mechanical Engineering.
2. Impact Assessment

A. Explain the unit’s need for the new concentration (e.g., market demand, research base, direction of the discipline, and interdisciplinary considerations). How will the new concentration complement the existing degree program, including enrollment, national ranking, etc?

Current trends in engineering are foreboding: the number of engineering graduates across the country is not sufficient to make up for losses in the workforce as the current generation of engineers prepares to retire. It is estimated that 70,000 engineers will be needed by 2010. Yet, more than 85% of students today are not considering engineering as a career. Improving science, technology, engineering and mathematics (STEM) education, whether at the K-12 level, community college level or university level is a dominant focus for the nation, thus engineering and education can no longer be viewed as separate entities. The National Academy of Engineering recognizes the emerging field of engineering education and established the [Center for the Advancement of Scholarship on Engineering Education](http://www.cae.org) in 1999, a center that is “dedicated to achieving excellence in engineering education.”

The interdisciplinary Engineering Education concentration will provide an opportunity for doctoral engineering students to formally study pedagogy and educational research methods, preparing them to more effectively design K-12 outreach programs, oversee outreach programs, pursue funding for engineering education, conduct research informed by curriculum and instruction related to mechanical engineering, and/or utilize their acquired education skills as they pursue an academic position at any level.

Several Mechanical Engineering doctoral students have expressed a desire to pursue an engineering education concentration. To our knowledge, there are only five doctoral engineering education programs in the United States: Purdue University established a graduate engineering education program, Virginia Tech has an Engineering Education doctoral program, Tufts University has a Doctor of Philosophy in Mathematics, Science, Technology, and Engineering Education program, Utah State University has a PhD in Engineering Education program, and Clemson University has an Engineering and Science Education Certificate available for graduate students. With a doctoral Engineering Education concentration, ASU will be among the top schools leading efforts to produce experts in a specialized area to address the growing concerns associated with engineering education. Because only a few graduate-level engineering education programs exist in the nation, there is a large pool of prospective students available for recruitment. Additionally, a PhD Engineering Education concentration will provide an opportunity to increase the programs’ national ranking.

B. Please identify other related ASU programs and outline how the new concentration will complement these existing ASU programs? (If applicable, statements of support from potentially-affected academic unit administrators need to be included with this proposal submission.)

There are currently no engineering education concentrations available at ASU.

C. Is this an interdisciplinary concentration? If yes, please address the relationship of the proposed concentration to other existing degree programs and any parallel or similar concentrations in these degree programs.

A doctoral Engineering Education concentration is also being developed within the Mary Lou Fulton College of Education at ASU. The parallel concentrations in Engineering and in Education will be implemented simultaneously creating collaborative interdisciplinary programs that will capitalize on the strengths of each unit. Students pursuing the PhD in Mechanical Engineering with an Engineering Education Concentration will likely pursue engineering education careers at a university level; students pursuing the PhD in Curriculum and Instruction with an Engineering Education Concentration will likely pursue engineering education careers at a K-12 level.
### 3. Academic Requirements and Curriculum

A. What are the total minimum hours required for the major and degree under which the proposed concentration will be established?

Eighty four (84) credit hours are required for the PhD in Mechanical Engineering degree with an Engineering Education concentration as follows:

Eighteen (18) hours will be taken in the major engineering research area;
Nine (9) hours of appropriate mathematics courses;
Twelve (12) hours of dissertation;
Fifteen (15) hours of appropriate education courses in methodology, curriculum, and instruction; research hours will be taken as required;
Thirty (30) credit hours of appropriate coursework may be accepted from a previously earned engineering Master’s degree,

Students admitted without a previously earned master’s degree (i.e., directly from a bachelor’s degree), will be required to take 30 credit hours of a combination of coursework and research related to the student’s dissertation research as deemed necessary by the student’s dissertation supervisory committee.

B. Please provide the admissions criteria for the proposed concentration. If they are identical to the admission criteria for the existing major and degree program under which this concentration will be established, you may attach a copy of these criteria as they appear in the Graduate Catalog, departmental website, or other source (please indicate source).

A minimum grade point average of 3.0 (on a 4.0 scale) is required for graduates of accredited United States institutions. ASU’s Graduate College is responsible for international grade point average interpretation. All applicants are required to take the general Graduate Record Examination (GRE); a subject-specific GRE is not required. Students who do not have English as their primary language are required to achieve minimum competencies as specified by the Graduate College. Three letters of recommendation are required, using the format specified by the unit. All applicants are required to submit a statement of academic and career objectives and address the desire to pursue an engineering education concentration in PhD in Mechanical Engineering (Statement of Purpose).

C. If the proposed concentration is part of a larger, interdisciplinary agenda, please provide additional admission information related to students who may enter with various academic backgrounds, including expected entry-level competencies.

Students applying to the Engineering Education concentration in the Mechanical Engineering PhD program must have an earned Bachelor’s or Master’s degree in an engineering field.

D. What knowledge, competencies, and skills (learning outcomes) should students have when they graduate from this proposed concentration program? Examples of program learning outcomes can be found at [http://www.asu.edu/oue/assessment.html](http://www.asu.edu/oue/assessment.html).

Students in the Engineering Education concentration will be able to:

3.D.2. -- Conduct research and communicate research results publishable in a reputable journal.
3.D.3. -- Develop and evaluate research designs in engineering education, including (but not limited to) K-12 outreach programs, and university undergraduate engineering programs.
3.D.4. -- Effectively design and evaluate engineering courses at all levels.
3.D.5. -- Effectively teach university and college engineering courses as well as K-12 STEM subjects.
3.D.6. – Apply their expertise to address critical issues related to engineering education.

E. How will students be assessed and evaluated in achieving the knowledge, competencies, and skills outlined in 3.D. above? Examples of assessment methods can be found at [http://www.asu.edu/oue/assessment.html](http://www.asu.edu/oue/assessment.html).

Students in the Engineering Education concentration will be assessed and evaluated by:

3.E.1. – Student successfully completed and defended dissertation.
3.E.2. – Submit at least one article for publication in a reputable journal prior to graduation.
3.E.3. – Student designed an engineering research plan for a K-12 outreach program or other research-based program related to engineering education, separate from student’s dissertation.
3.E.4. – Student successfully completed graduate-level coursework specific to curriculum as it relates to engineering.
3.E.5. – Student successfully completed graduate-level coursework specific to instruction as it relates to engineering.

F. Please provide the curricular structure for the proposed concentration.

- Additionally, please ensure that all new required course proposals have been submitted to the Provost's office through the ACRES online course proposal submission system for approval before this concentration is put on the University Graduate Council and CAPC agendas.

**NOTE** that the courses listed below represent a sample of a curriculum with an engineering focus of fluid mechanics; all course numbers will vary depending on the specific research area; yet, all will require 18 core engineering credit hours; 9 hours of mathematics; 12 hours of MAE 799 dissertation hours and the 15 hours of engineering education core courses listed below; remaining hours to reach a total of 84 will be MAE 792 research.

<table>
<thead>
<tr>
<th>Required Core Courses for the Degree</th>
<th>Credit Hours (18cr hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Prefix &amp; Number)</td>
<td>(New Course?) Yes or No?</td>
</tr>
<tr>
<td>MAE 571 (Engr)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 561 (Engr)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 575 (Engr)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 566 (Engr)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 504 (Engr)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 589 (Engr)</td>
<td>No</td>
</tr>
<tr>
<td>Mathematics requirements:</td>
<td>Credit hours (9cr hrs)</td>
</tr>
<tr>
<td>MAE 501 (Math)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 502 (Math)</td>
<td>No</td>
</tr>
<tr>
<td>MAE 505 (Math)</td>
<td>No</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Required Concentration Courses</th>
<th>Credit Hours (15cr hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Prefix &amp; Number)</td>
<td>(New Course?) Yes or No?</td>
</tr>
<tr>
<td>ENE 701 (Theories of Learning and Curriculum Issues; Foundations of Engineering Education)*</td>
<td>Yes</td>
</tr>
<tr>
<td>Course</td>
<td>Required</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>ENE 702 (Science and Design of Assessment and Evaluation in Engineering Education)*</td>
<td>Yes</td>
</tr>
<tr>
<td>ENE 703 (Research Methods in Engineering Education)*</td>
<td>Yes</td>
</tr>
<tr>
<td>ENE 704 (Adv Research Methods in Engineering Education including a capstone research project)*</td>
<td>Yes</td>
</tr>
<tr>
<td>ENE 780 (Engineering Education Practicum: Applied Project)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Elective Courses and/or research credits as deemed necessary by student's dissertation committee — (Prefix & Number)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCI 701 (Curriculum Theory and Practice)</td>
<td>3</td>
</tr>
<tr>
<td>ENE 591 (Engineering Design as a Teaching Tool)</td>
<td>3</td>
</tr>
<tr>
<td>ENE 691 (Connecting Engineering to Science, Technology, and Mathematics)</td>
<td>3</td>
</tr>
<tr>
<td>ENE 791 (Engineering and Society)</td>
<td>3</td>
</tr>
<tr>
<td>ENE 791 (Curriculum and Pedagogy in Engineering Education)</td>
<td>3</td>
</tr>
<tr>
<td>ENE 791 (Design of Studio Courses for Engineering Education)</td>
<td>3</td>
</tr>
<tr>
<td>DCI 791 (How People Learn)</td>
<td>3</td>
</tr>
<tr>
<td>DCI 791 (Cognition and Instruction)</td>
<td>3</td>
</tr>
<tr>
<td>COE 503 (Introduction to Qualitative Research in Education)</td>
<td>3</td>
</tr>
<tr>
<td>EDP 651 (Methods and Practices of Qualitative Research)</td>
<td>3</td>
</tr>
<tr>
<td>MAE 792 Research</td>
<td>1-12</td>
</tr>
</tbody>
</table>

**Culminating Experience**

*New courses will be submitted to ACRES for approval before the launch of the program*

G. Please describe the culminating experience(s) required for completion of the existing degree and major, and the proposed concentration (e.g., thesis, dissertation, comprehensive exams, capstone course(s), practicum, applied projects, etc.).

The existing PhD degree in Mechanical Engineering requires that a dissertation be written and defended. The proposed concentration requires that a dissertation, including an education component, must be written and...
defended. The degree also requires successful passing of a written and oral comprehensive exam, as will the proposed concentration.

Please describe any other requirements for completion of the existing degree and major, and the proposed concentration (e.g., internships, foreign language skills, etc.).

Students pursuing the Engineering Education concentration in the Mechanical Engineering PhD program are required to complete ENE 780 Practicum. Students will develop, teach and assess a curriculum unit to be implemented into an introductory engineering course such as MAE 100 Introduction to Aerospace and Mechanical Engineering.

H. For interdisciplinary programs, additional sample curricular structures must be included as appendix items to this proposal relating to students with various academic backgrounds who may pursue the proposed concentration, including expected mastery of core competencies (e.g., course work, skills, and/or knowledge).

Students applying to this Engineering Education concentration must have an earned Bachelor’s or Master’s degree in an engineering field to be considered for admission.

4. Administration and Resources

A. How will the proposed concentration be administered (including recommendations for admissions, student advisement, retention etc.)? Describe the administering body in detail, especially if the proposed concentration is part of a larger interdisciplinary agenda. How will the graduate support staff for this proposed concentration program be met?

Students enrolled in the Engineering Education PhD concentration must satisfy all University and MAE admission criteria. Application materials will be reviewed by the graduate affairs committee in MAE and by members of the Engineering Education Concentration Committee drawn from Mary Lou Fulton College of Education, the Ira A. Fulton School of Engineering, and the College of Technology & Innovation: Dale Baker, James Collofello, Lynn Cozort, Tirupalavanam Ganesh, Stephen Krause, James Middleton, Chell Roberts, Finbarr Sloane, Kyle Squires. Admission recommendations will be submitted and reviewed by the Chair of MAE and by the Chair of Curriculum and Instruction in the College of Education.

Students will establish a five-person dissertation supervisory committee comprised of a program committee co-chair from MAE, a program committee co-chair from Education, two graduate faculty members from MAE and one graduate faculty member from Education.

The supervisory committee co-chairs (from MAE and from Education) will advise and mentor the students enrolled in the Engineering Education PhD concentration. Graduate support staff from MAE and from Education will work collaboratively to ensure student success.

B. How many students will be admitted immediately following final approval of the concentration? What are enrollment projections for the next three years?

It is expected that a 2-3 Mechanical Engineering doctoral students will be admitted into the Engineering Education concentration beginning fall 2009. Projected enrollment is expected to increase by 2-3 students each year for the first three years.

C. What are the resource implications for the proposed concentration, including any projected budget needs? For Doctoral students, how will the students be supported financially? Will new books, library holdings, equipment, laboratory space and/or personnel be required now or in the future? If multiple units/programs will collaborate in offering this concentration please discuss the resource contribution of each participating program. Letters of support must be included from all academic units that will commit resources to this concentration.
Doctoral students will be supported by 25% TA positions in combination with 25% TA positions in Education depending on available funding; and/or by 50% research assistantships from Engineering, Education, and/or STEM initiatives, depending on funding availability.

D. Please list the primary faculty participants with regards to the proposed concentration.

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Area(s) of Specialization as they relate to proposed concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyle Squires</td>
<td>Professor and Chair, Mechanical and Aerospace Engineering</td>
<td>Engineering including Computational Science and Engineering and Fluid Mechanics</td>
</tr>
<tr>
<td>James Collofello</td>
<td>Professor and Associate Dean of Engineering</td>
<td>Engineering including Software Engineering</td>
</tr>
<tr>
<td>Stephen Krause</td>
<td>Professor, Materials Science and Engineering</td>
<td>Engineering and Engineering Education</td>
</tr>
<tr>
<td>Lynn Cozort</td>
<td>Director of Graduate Studies and STEM Outreach, Mechanical and Aerospace Engineering</td>
<td>Engineering Education, Curriculum Studies, Learning Theory, Qualitative Research Methods</td>
</tr>
<tr>
<td>Tirupalavanam Ganesh</td>
<td>Assistant Dean, Education</td>
<td>Engineering Education, Qualitative Research Methods, Curriculum Studies, Learning Theory</td>
</tr>
<tr>
<td>Dale Baker</td>
<td>Professor, Science Education</td>
<td>Science, Gender, Equity, Assessment</td>
</tr>
<tr>
<td>James Middleton</td>
<td>Professor, Mathematics Education</td>
<td>Mathematics, Learning Psychology, Curriculum Development</td>
</tr>
<tr>
<td>Chell Roberts</td>
<td>Professor and Chair, Department of Engineering, College of Technology and Education</td>
<td>Engineering Design and Curriculum, Engineering Education, Industrial Engineering</td>
</tr>
<tr>
<td>Finbarr Sloane</td>
<td>Associate Dean for Research and Associate Professor, Mathematics Education</td>
<td>Mathematics, Research Methods in Education, Statistics</td>
</tr>
</tbody>
</table>
5. Additional Material — Please attach any additional information that you feel relates to the proposed concentration. (Please label accordingly, i.e., Appendix or Attachment A, B, etc.)

### Approvals
(if the proposal submission involves multiple units, please include letters of support from those units)

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>DEPARTMENT CHAIR</td>
<td>Kyle D. Squires</td>
<td>3/24/09</td>
</tr>
<tr>
<td>DEAN (Please print or type)</td>
<td>James Collofello, Associate Dean Academic and Student Affairs</td>
<td>3/24/09</td>
</tr>
</tbody>
</table>

The following section will be completed by the GC following the recommendations of faculty governance bodies.

### University Vice Provost and Dean of the Graduate College

<table>
<thead>
<tr>
<th>Signature</th>
<th>Date</th>
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</thead>
</table>

**Please note:** Proposals for new concentrations also require the review and recommendation of approval from the University Graduate Council, Curriculum and Academic Programs Committee (CAPC), the Academic Senate (Information item only), and the Office of the Provost before they can be put into operation.

The final approval notification will come from the Office of the Provost.

GF0908E-92
3. Additional Material — Please attach any additional information that you feel relates to the proposed concentration.
(Please label accordingly, i.e., Appendix or Attachment A, B, etc.)

DEPARTMENT CHAIR
(please print or type)
Kyle D. Squires

SIGNATURE

DATE

3/24/09

DEAN (Please print or type)
James Collofello, Associate Dean Academic and Student Affairs

SIGNATURE

DATE

3/24/09

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UNIVERSITY VICE PROVOST AND DEAN OF THE GRADUATE COLLEGE

SIGNATURE

DATE

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GF0508E-02
MEMORANDUM

To: Maria Allison, Dean, Graduate College

From: Paul C. Johnson, Executive Dean, Ira A. Fulton School of Engineering

Date: March 25, 2009

Re: Establishment of the Engineering Education Concentration as parallel concentrations in the PhD in Engineering and in the PhD in Curriculum & Instruction Degree Programs

I am writing this memo to support the establishment of the Engineering Education concentration as parallel concentration in the Ira A. Fulton School of Engineering and the Mary Lou Fulton College of Education.

The establishment of the Engineering Education concentration will require the offering of ENE courses. While the Mary Lou Fulton College of Education will schedule these courses; I wanted to note that the Engineering and Education colleges will collaboratively administer the Engineering Education concentration. An “Engineering Education” faculty group drawn from the two colleges will be established. Staff from both colleges will collaboratively support students in the Engineering Education concentration.

I give my support of this collaborative effort to establish the Engineering Education parallel concentration in the PhD programs in Mechanical Engineering, Aerospace Engineering, and Curriculum & Instruction.

Cc: George Hynd, Dean, Mary Lou Fulton College of Education
To: Maria Allison, Dean, Graduate College

From: George Hynd, Dean, Mary Lou Fulton College of Education

Date: March 25, 2009

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I give my unequivocal support of this collaborative effort to establish the Engineering Education parallel concentration in both the PhD in Engineering and Curriculum & Instruction.

Cc: Deirdre Meldrum, Dean, Ira A. Fulton School of Engineering