MEMORANDUM

TO: Dr. Jeannine Blackwell
    Graduate Council

FROM: Dr. Donn Hancher, Associate Dean

Below is an item for consideration by the Graduate Council. The corresponding proposal can be viewed at:

http://www.engr.uky.edu/proposed_changes/pending/

Graduate Certificate in
  Computational Fluid Dynamics

<table>
<thead>
<tr>
<th>Type</th>
<th>Effective Date</th>
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<tr>
<td>New</td>
<td>Spring 2007</td>
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We appreciate your consideration of this request.
January 23, 2006

TO: Rosa Hicks, Engineering Student Records

FROM: Dr. Eric Gruke, Associate Dean for Research and Graduate Studies

SUBJECT: Graduate Certificate in Computational Fluid Dynamics

Attached is a proposal submitted by Dr. James McDonough, mechanical engineering, to create a Graduate Certificate in Computational Fluid Dynamics in the College of Engineering. The program will be available to all graduate students in Engineering and the Mathematical, Physical and Biological Sciences at the University of Kentucky.

The proposed certificate program will be a minimum of 12 credit hours in length and represents a collaborative effort between the Department of Mechanical Engineering and various other departments within the College of Engineering and the College of Arts and Sciences at UK.

Dr. McDonough will be the Director of this graduate certificate. Associates will be drawn from numerous departments reflecting the interdisciplinary nature of this endeavor. Additional details on the certificate can be found on the attached.

This proposal has been reviewed by the College of Engineering’s Graduate Studies Team and was approved unanimously. I concur with their decision and ask that you approve this request.

[Signature]
Dean of College

[Date]
Date of notice to faculty
UNIVERSITY OF KENTUCKY
Department of Mechanical Engineering
Proposal for Graduate Certificate in Computational Fluid Dynamics

Purpose. This proposal is for the establishment of a Graduate Certificate in Computational Fluid Dynamics (CFD) available, in principle, to all graduate students in Engineering and the Mathematical, Physical and Biological Sciences at the University of Kentucky. It will be a minimum of 12 units in length and represents a collaborative effort between the Department of Mechanical Engineering and various other departments within the College of Engineering and the College of Arts and Sciences at UK.

Background. Computational fluid dynamics is by now a generally recognized subdiscipline of fluid dynamics, complementing (and now often supplanting) use of theory and experimentation in the analysis of fluid behavior from sub-micro scales to intergalactic cosmological scales. CFD is highly interdisciplinary, as hinted by the accompanying figure, and due to this it can be approached for study from a number of different directions; correspondingly, its potential applications are essentially unlimited. Examples that are currently of very high interest include biological flows (e.g., air in respiratory systems and blood in circulatory systems of animals), flows in porous media (e.g., remediation of contaminated ground water, extraction of oil from marginal deposits), and combusting flows (e.g., higher energy conversion efficiencies, lower pollutant production). Thus, competency in the use of CFD is becoming critical to the advance of science and technology in the 21st Century.

It is of interest to further note that the term “computational fluid dynamics” actually originated at the University of Kentucky, appearing in the title of a book written by a visiting researcher in Mechanical Engineering, P. Roache, in 1971, and which now is considered a classic reference. Yet, to this day, UK has no formal program in this very important field. This proposed Graduate Certificate represents an attempt to at least minimally address this shortcoming.

Director. The Director of the Graduate Certificate in CFD will be Professor J. M. McDonough of the Department of Mechanical Engineering, who also holds a secondary appointment in the Department of Mathematics. Dr. McDonough has performed analyses via CFD since the mid 1970s, initially in an industrial setting, and has been teaching CFD and related courses since 1980—first at UCLA and then, beginning in 1990, at UK. He is well qualified to make decisions regarding qualifications of applicants for the CFD Graduate Certificate and to advise them on appropriate courses of study.

Associates. Associates will be drawn from numerous departments reflecting the interdisciplinary nature of this endeavor. At a minimum, the list of Associates will be comprised of: Prof. Tate Tsang (Chemical and Materials Engineering), Prof. Scott Yost (Civil Engineering), Prof. Craig Douglas (Computer Science, with secondary appointment in Mechanical Engineering), Prof. Zhongwei Shen and Prof. Qianguo Ye (Mathematics), Prof. George Huang and Prof. Raymond LeBeau (Mechanical Engineering), and Prof. Isaac Shlosman (Physics and Astronomy). While this list of associates must not be viewed as permanent,
it should be clear that the ability to present a broad spectrum of interdisciplinary CFD-related courses is easily attainable.

**Admission Requirements.** Admission to eligibility for a Graduate Certificate in CFD follows the same minimum requirements as apply to admission to the Graduate School of UK. In particular, any student currently accepted, or enrolled, in the Graduate School in graduate student, post-baccalaureate, or university scholar status will be considered for admission.

**Graduate Certificate Requirements (General).** As required by the Graduate School, a student must maintain a minimum GPA of 3.0 in the set of courses required for completion of the Graduate Certificate. In addition, a grade of C will be permitted only in fewer than one half of the total units a student wishes to apply toward the certificate, and no more than one half of the certificate units may be satisfied with 4XXG and/or 500-level courses.

**Course Requirements.** Course work applied to satisfy the minimum 12 unit requirement will be selected from three categories: i) basic mathematics/numerical analysis, ii) specific CFD and CFD-related courses and iii) independent studies and “Topics” courses in closely related fields. A minimum of one course must be selected from category i), and a minimum of two courses must come from the second category. One course will be permitted from category iii) but is not required. Lists of courses in each of these categories follow.

<table>
<thead>
<tr>
<th>Math/Numerical Analysis</th>
<th>CFD/CFD-Related</th>
<th>Topics/Indep. Studies</th>
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<tbody>
<tr>
<td>MA/CS/EGR 537</td>
<td>ME 691</td>
<td>ME 599</td>
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<td>MA 625</td>
<td>ME 692</td>
<td>ME 699</td>
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<tr>
<td>ME 690</td>
<td>ME 69X*</td>
<td>ME 780</td>
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<td></td>
<td>ME 530</td>
<td>Analogous courses from other departments</td>
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<td>MA 471G</td>
<td>ME 531</td>
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<td>MA 481G</td>
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<td>MA 633</td>
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* We note that the course ME69X is a more fundamental incompressible CFD course appropriate mainly for doctoral students with superior mathematics backgrounds. This has previously been taught as a ME 699 Topics course but will be submitted for regular course status with the course number and title ME 693, Mathematical & Algorithmic Foundations of Incompressible CFD.

Courses shown above the dashed line in the table are to be viewed as the core courses of the CFD Graduate Certificate curriculum, and most students, especially those from Mechanical Engineering, would be expected to construct their course sequence mainly from these with the help of their graduate advisor and the CFD Certificate Director. On the other hand, because of the interdisciplinary nature of CFD, students from outside of Engineering may wish to apply a somewhat different curriculum toward receiving a certificate. For example, a student from Mathematics might find it worthwhile to take ME 531, a basic fluid dynamics course emphasizing analysis of viscous incompressible flows, before taking either ME 691
or ME 693, the corresponding CFD courses. Similarly, a student from astrophysics might benefit by taking ME 530 (gas dynamics) before enrolling in the compressible CFD course ME 692.

Finally, we note that the purpose of the individual study and topics courses is to address two main issues. First, there are specific recognized deficiencies in our current CFD curriculum. Specific examples of this are lack of courses in which so-called "grid generation" is taught (although a minimal amount of this is covered in ME 690), and similarly no courses in which use of commercial CFD codes, as widely employed world wide in industry, is specifically taught. But at present, we believe these subjects can be handled in independent studies and topics courses.

**Award of Certificate.** When a student enrolled in the UK Graduate School has successfully completed the last required course for the CFD Graduate Certificate and has satisfied the above-stated GPA requirements, the Director shall send a completed, signed Graduate Certificate Completion Form to the Dean of the Graduate School verifying that the student has fulfilled all requirements for the certificate and requesting award thereof. The Graduate School shall then issue the student’s certificate and officially notify the University Registrar of award of the certificate for posting to the student’s permanent transcript.