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To: UCITE Nord Grant Committee

Prof. Lacks and Prof. Sankaran are developing a new course, ENGR 225B, titled “Thermodynamics, Fluid Dynamics, Heat and Mass Transfer (in Botswana)”. **ENGR 225B intertwines engineering content with regional issues specific to sub-Saharan Africa, and will be offered annually at the University of Botswana in May.**

***How will the engineering content and regional issues be intertwined?***

We describe two examples (with others also being developed):

In the fluid flow section of the course, pumping water from wells in villages in the Kalahari Desert is addressed. Water is necessary for peoples’ use and for agriculture (both livestock and crops) – how much energy is required to pump the water, what is the cost of the necessary fuel, and how does this fit in the village’s economic budget? A field trip to Botswana villages, to see the water wells and pumps, shows firsthand how fluid flow issues impact the villagers.

In the thermodynamics section of the course, energy generation processes are addressed in the context of Botswana. This is an important current issue for Botswana, which is in the midst of major energy initiatives in regard to becoming self-sufficient for energy generation (currently 70% of its energy is imported from South Africa) and providing electricity to small villages thinly spread across a large desert (only 15% of rural households have electricity). Sustainable energy solutions are being pursued, as Botswana is well suited for solar energy (most of the country is a desert) and biofuels (native plants are suitable), and these solutions do not require remote desert villages to be connected to a national energy grid. A field trip to Botswana villages will be taken to see how solar power is changing the lives of villagers.

***Why develop this course?***

ENGR 225, “Thermodynamics, Fluid Dynamics, Heat and Mass Transfer”, is a 4-credit course required for all engineering students, normally taught for 3 hours a week over a 14 week semester. Student satisfaction with ENGR 225 has been low, because it is difficult to make the material relevant to all engineering students – electrical engineers are not interested in pumping liquids, biomedical engineers are not interested in distillation, etc.. We believe that ENGR 225B can overcome this problem, in that the applications of the engineering content to issues related to sub-Saharan Africa will cross engineering disciplines.

ENGR 225B also provides a unique international experience, which is difficult for engineering students due to their many required courses. With the course offering in May, the course will not disrupt a student’s academic year or summer (students will return in time to work summer jobs). Botswana is ideal for this course because it among the wealthiest countries in Africa, with a stable democratic government and a low crime rate, and with English widely spoken.

***How will ENGR 225B be taught?***

ENGR 225B will be taught as an intensive 3-week course, consisting of 15 130-minute lectures and 15 75-minute recitations. The technical content and number of meeting hours in ENGR 225B will be identical to that of ENGR 225. Research has shown that short intensive courses taken one at a time are just as effective as semester-long courses taken in parallel;<sup>1</sup> in fact, some colleges operate entirely by short courses taken in series.<sup>2</sup> This intensive format facilitates course-related activities such as field trips, as the students have no other obligations.

<sup>1</sup> W. M. Davies, “Intensive Teaching Formats: A Review”, Issues in Educational Research, vol. 16 (2006).

<sup>2</sup> E.g., Cornell College (Iowa), Colorado College.

**What is the status of this course?**

Course development has been moving forward. We recently submitted the course action form, and have the support of the School of Engineering (specifically Associate Deans Pat Crago and Ica Manas), and Don Feke in the Provost's Office.

Our UB contacts have been enthusiastic about the program. Lacks and Sankaran visited UB in February 2010 to initiate plans, and met with numerous faculty and administrators. We have been in recent discussions with Dr. James King (Head of the Department of Physics), Dr. C. Ketlogetswe (Head of the Department of Mechanical Engineering), and Dr. Leapetswe Maletle (Director of International Education & Partnerships). Residential facilities are available for the students (dormitories and meals).

**What is the anticipated enrollment for the course?**

We estimate that approximately 20-30 students would take this course each year. The course will be viable with a minimum enrollment of 12.

**Is this course sustainable? What are the costs for CWRU to operate this course?**

This course would be self sustaining from fees paid by the participating students; *it will not involve any additional financial commitment from CWRU*. The students would pay a course fee that covers tuition, housing and activities. The students would be responsible for their own travel expenses.

**How will we assess the effectiveness and usefulness of this course offering?**

The participating students will be queried for feedback after completing the course. This feedback will be in regard to the academic component, the living arrangements, and the overall experience. The standard CWRU course evaluations will also be used. A further test of the effectiveness will be the enrollments in the course, which would likely be correlated with the experiences of previous participants.

**Are any other funds being used to support development of this course?**

Lacks and Sankaran were awarded \$25,000 in two grants from the National Science Foundation to support travel to Africa to develop academic and research programs. These grants funded our initial visit to UB in February, and a visit the University of Niamey (Niger) in June (field experiments on dust storms were also carried out in Niger). We have also been given \$2000 from the Case School of Engineering in support of our next visit to UB to develop the course.

**What is the purpose of this Nord Grant request?**

The Nord grant would provide the remaining funding needed for Lacks and Sankaran to travel to UB to develop the course (\$2000). In particular, we will meet with faculty at UB that work on sustainable energy (we have been in contact with them), and visit villages that are potential field trip sites to develop ways to teach engineering content in the context of issues relevant to sub-Saharan Africa.

Sincerely,



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Assistant Professor  
Dept. of Chemical Engineering



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**Budget:**

We request funds for Lacks and Sankaran to travel to the University of Botswana. The estimated cost is \$4000, broken down as described below:

\$3200 Flights to Gaborone, Botswana (\$1600 per person, for Lacks and Sankaran)

\$400 Cheap hotel in Gaborone for 4 nights (\$50 per person per night, for Lacks and Sankaran)

\$400 Miscellaneous expenses including meals, ground transportation

We are being given \$2000 for this trip from the Engineering Dean's Office, and thus are requesting \$2000 in this proposal.