PROPOSAL SCC ~~#00-01~~ 01-02-103 ~~#05~~ Stochastic

CURRICULUM PROPOSAL FORM 2000-2001

NON-GENERAL EDUCATION PROCESS A

***DEADLINES: Deadline dates for 2000/2001 submissions: Regular proposals: October 20, 2000 to be implemented in Fall 2001; Short-Term proposals: December 8, 2000 to be implemented in Fall, 2001; Regular proposals February 16, 2001 to be implemented in Spring, 2002; March 23, 2000 for short-term courses to be implemented in Spring 2002.**

PROPOSAL TITLE: Stochastic Models in Operations Research

SPONSOR(S): Dr. Christopher Lacke

DEPARTMENT: Mathematics

COLLEGE: College of Liberal Arts & Sciences

IF LAS CHECK ONE: ___ **History/Humanities** X **Math/Sciences** ___ **Social/Behavioral Sciences**

Check one: X **Undergraduate** ___ **Graduate**

THE ATTACHED ***NON-GEN-ED*** PROPOSAL IS BEST DESCRIBED BY THE ITEM(S) CHECKED.

X New non-gen-ed course

___ Short-term non-gen-ed course

___ Minor curricular changes (fewer than three) to:

___ existing non-gen-ed course

___ non-gen-ed degree requirements

___ major

___ minor, specialization, concentration, track, certificate program

DEPARTMENT
(Signature indicates approval)

Dept. Curriculum Chair / Date Abera Abay 5/15/01

Dept. Chairperson / Date Ronald J. Gorka 5/15/01

ACADEMIC DEAN

Approved ✓ Not Approved ___ Comments:

Dean's Signature/Date [signature] 10/26/01

COLLEGE CURRICULUM COMMITTEE

Date of open hearing (if necessary) 12-5-01 Approved ✓ Not Approved _____
Comments:

Signature of College Chair/Date: [signature] 1-17-02

UNIVERSITY CURRICULUM COMMITTEE

Date Received/Processed _____
Comments:
please see attached letter from sponsor & me

Curriculum Chair Signature [signature] Date Announced At Senate 1/29/02

EXECUTIVE VICE PRESIDENT/PROVOST

Approved ✓ Not Approved _____ If no, reasons are as follows:

Student Credit Hours _____ Faculty Load Hours _____ Equalized Credit Hours _____

Official Copy & Approval Sheet Filed (Date): _____ Executive VP/Provost Signature/Date [signature] 2/22/02

REGISTRAR

Date Approved Course Description Received _____ Hegis Taxonomy & Course Number Assigned 1703-412

Registrar Signature/Date [signature] 2/27/02

NOTIFICATION FORWARD

✓ Senate Curriculum Committee Chairperson ✓ Academic Dean(s) Department 3/6/02

✓ Department Chairpersons ✓ Registrar _____ Sponsor(s)

Rowan University
Department of Mathematics

Course Proposal

Stochastic Models in Operations Research

I. Details

a) **Course Title:** Stochastic Models in Operations Research

b) **Sponsor:** Dr. Chris Lacke, Department of Mathematics

c) **Credit Hours:** 3 credit hours

d) **Course Level:** Senior

e) **Curricular Effect:** Elective course for students majoring in Mathematics, Engineering and Computer Science.

f) **Prerequisites:** 1702.360 Introduction to Probability and Statistics I

and

1) 1703.4xx Deterministic Models in Operations Research

or

2) 1701.230 Calculus III and 1701.210 Linear Algebra

or

3) 1701.235 Math for Engineering Analysis I

or

4) Permission of the instructor

g) **Suggested Time, Implementation:** This course will be offered once every other spring.

h) **Resources:** Faculty, equipment and library resources are adequate.

II. Rationale

The development of mathematical applications in business, government and the military during the 20th century has been phenomenal. It is no longer sufficient to find a solution to a problem, but rather to develop a methodology to provide the optimal solution to a problem. In its early days, operations research was used by the British military to find the best way to move all of its forces and equipment across the English Channel. Modern applications include portfolio theory, environmental and communication systems development, hospital staffing, and production planning. Operations researchers use their strong mathematical background to find a best solution to a problem, given a specific set of limitations, or constraints. A vast mathematical background is required, as operations researchers are required to build mathematical models that can involve virtually any type of mathematical function. Moreover, operations researchers need to be able to convert everyday phenomena to mathematical expressions. The extensive growth of the Institute for Operations Research and the Management Sciences (INFORMS) during the 1980's and 1990's has been, in large part, to the demand for qualified students in this field.

While extensive study in Operations Research is usually done on the graduate level, many undergraduate institutions now offer introductory courses in Operations Research. The growth in this area is due to the increased demand for undergraduates with some training in Operations Research, as well as providing exposure to a subject that used to be dominated by engineers doing graduate study. Students taking the Operations Research and Probability and Statistics sequences will greatly enhance their career options, as well as the number of fields that they can pursue in graduate school.

This is the second member of a two-course sequence designed to provide a strong introduction in Operations Research, regardless of the student's industrial or academic future pursuits. A graduate version of this course, 1703.5XX, Operations Research II, will be offered concurrently. Details of the extra expectations placed on the graduate students are described in the accompanying proposal. It is not necessary for the student to have taken Deterministic Models in Operations Research to succeed in this course.

III. Essence of the Course

a) Objectives in Relation to Student Outcomes

Students in this course will become familiar with the process of Operations Research: learning how to create and validate a mathematical model, as well as the processes and optimization/sub-optimization. They will be able to create and solve Markovian and general queuing models. They will also learn how to use decision trees to determine optimal policies in the face of uncertainty. They will learn how to determine optimal inventory policies under the assumption of variable demand. They will complete this process for a variety of model types; however, all of the types of modeling covered in this course will be stochastic, that is, including uncertainty. Reliance on the tools in the Calculus, Linear Algebra and Probability will be substantial, but we will also examine the reasons why these tools provide us with an optimal solution in each scenario. In addition, we will examine how multiple modeling procedures can be used to arrive at the same result, as well as the benefits and pitfalls of the different techniques. Furthermore, students will learn a procedure called *sensitivity analysis*, which is used to determine what types of changes are necessary for our optimal solution to become sub-optimal. Use of some of the leading software in the field, which is included in the text, will be required.

b) Topical Outline

1. Markov Chains

   Stochastic Processes
   Discrete Time Markov Chains
   Chapman-Kolmogorov Equations
   Transition Matrices
   Steady-State Behavior
   Passage Times
   Absorbing and Transient States
   Continuous Time Markov Chains (Markov Processes)

2. Queuing Theory

   Exponential Distribution
   Birth-Death Processes
   Single Server Queues
   Finite, Multiple Server Queues
   Little's Law
   Finite and Infinite Capacity Queues

3. Decision Trees

4. Stochastic Inventory Theory

   Continuous Review Models
   Periodic Review Models
   Models Involving Perishables

5. Stochastic Dynamic Programming and Markov Decision Processes

6. Reliability Theory

   Parallel Systems
   Series Systems
   Mixed Systems

c) **Evaluation and Grading**

Students will be evaluated by traditional methods of homework, which will include analytic and computer-based problems, and written exams. Students will also prepare solutions to class projects and be required to make a brief presentation at the end of the semester. Additional methods, such as journal reviews, may also be used.

d) **Course Evaluation**

The course will be evaluated through customary student evaluations as well as regular departmental review.

VII) Consultation

The content and nature of this course was discussed with:

1. Dr. T. R. Chandrupatla , Department of Mechanical Engineering
2. Dr. Ralph Dusseau, Department of Civil and Environmental Engineering
3. Dr. Jennifer S. Kay, Department of Computer Science
4. Dr. Jooh Lee, Department of Management and M.I.S.

VIII) This proposal has been reviewed by the Department of Mathematics' Curriculum Committee.

IX) Catalogue Description

1703.412 Stochastic Models in Operations Research

(Prerequisites: 1702.360 Introduction to Probability and Statistics I **and one of the following:** 1703.4xx Deterministic Models in Operations Research **or** 1701.230 Calculus III and 1701.210 Linear Algebra **or** 1701.235 Math for Engineering Analysis I **or** Permission of the instructor.

This course is an introduction to mathematical modeling, analysis, and solution procedures applicable to decision-making problems in an uncertain (stochastic) environment. Methodologies covered include dynamic programming, Markov chains, queuing theory, decision trees, system reliability and inventory theory. Solutions will be obtained using theoretical methods and software packages.

ROWAN UNIVERSITY

Mechanical Engineering Department

October 12, 2000

TO: Dr. Chris Lacke, Assistant Professor of Mathematics

FROM: Dr. T.R. Chandrupatla, Professor and Chair, Mechanical Engineering

Re: Consultation for course proposals in Operations Research (OR)

I have reviewed the course proposals for the following courses that you put forward.

1703.4xx	Deterministic Models in OR
1703.4xx	Stochastic Models in OR
1703.5xx	OR I
1703.5xx	OR II

The two course sequence in OR is a good proposition. Having the 5xx course and its companion 4xx undergraduate elective provides better structure to the course. The work must be planned to differentiate between the graduate and undergraduate students. Parts of Deterministic Models in OR and OR I overlap with our course on Optimization but this overlap is acceptable to me. In our course, we approach with an engineering design approach, while the proposed course dwells more on the mathematical aspects.

I expect that our Mechanical Engineering students will have an option of taking either of the two 4xx courses as Science and Math Elective. The graduate courses may be acceptable for our MS in Engineering program. This needs further discussion before a final decision is made.

In the Deterministic Models in OR and OR I, the Big-M Method is given as a part of Transportation and Assignment Problems (Topic 4). Big-M Method may have to be placed in Topic 3 on Linear Programming, where it is used with certain type of constraints.

I strongly support the offering of these courses.

From: "Ralph A. Dusseau" <Dusseau@rowan.edu>
To: <lacke@rowan.edu>
Date: 10/20/00 11:10AM
Subject: Consultation

Dear Chris:

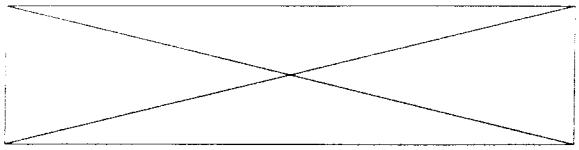
Attached is our consultation for your operations research courses.
If you have any questions, please feel free to contact me.

Thank you very much for your efforts in creating these new courses.

Ralph Alan Dusseau, Ph.D., P.E.
DRBA Professor and Chair
Civil and Environmental Engineering
College of Engineering
Rowan Hall
Rowan University
201 Mullica Hill Road
Glassboro, New Jersey 08028-1701
Telephone: (856) 256-5322
Fax: (856) 256-5242
E-mail: dusseau@rowan.edu

Department of Civil and Environmental Engineering

To: Chris Lacke, Assistant Professor of Mathematics.



From: Ralph Alan Dusseau, Professor and Chair

Date: October 20, 2000

Re: Consultation

The Civil and Environmental Engineering faculty have reviewed your proposals for the following four courses:

1703.4xx	Deterministic Models in Operations Research
1703.4xx	Stochastic Models in Operations Research
1703.5xx	Operations Research I
1703.5xx	Operations Research II

We strongly support these course proposals. We endorse the two undergraduate courses in Operations Research as possible Technical Elective courses for our undergraduate Civil and Environmental students. In addition, we also endorse the Operations I and II courses as Math Elective courses for both the Civil Engineering Specialization and the Environmental Engineering Specialization within the Master of Science in Engineering Program.

If you have any questions concerning this consultation, please feel free to contact me.

201 Mullica Hill Road • Glassboro, New Jersey • 08028-1701 • Phone: (856) 256-5320 • Fax: (856) 256-5242

Department of Computer Science

MEMORANDUM

To: Dr. Chris Lacke, Mathematics

From: Dr. Jennifer Kay, Chair Computer Science Curriculum Committee

Date: April 2nd, 2001

Subject: Course proposal for Stochastic Models in Operations Research

The Computer Science Department has reviewed the course proposal for Stochastic Models in Operations Research. The CS Department supports this proposal.

201 Mullica Hill Road • Glassboro, New Jersey 08028 • T:856-256-4805 F:856-256-4741

From: Jooh Lee
To: Lacke, Christopher J.
Date: 4/2/01 3:15PM
Subject: Re: course proposals

Dear Professor Chris Lacke

In reference to two new course proposals (Stochastic Models in Operations Research and Deterministic Models in Operations Research), please accept my comments on it. Overall, both courses would be very interesting and informative to the students in Math and Engineering fields. But I would like to provide the following comments with respect to OR subject.

First, there may be some key subject to be covered in OR field : (1) Network Model and Project Scheduling (PERT/CPM) and (3) Decision Making in both Determistic and in Stochastic approach in addition to Decision Trees. Second, if it is not targeted for the graduate level, it may be more feasible to offer one solid OR course (rather than two split courses (which is designed to focus on the fundamental concepts and techniques of OR. For example, inventory must be covered in a continuous format regardless of two different possible perspectives particularly because it is one unique subject. Fourth, some key contents should be added to topical outline: for example, Problem formulation in L.P. and Poisson Distribution in Queuing Theory. Fifth, more computer application to each modules should be emphasized. Sixth, the students may be expected to have more strong statistical knowledge to handle advanced OR tools. Finally, I would like to suggest a comprehensive but general approach to OR subject to attract more various group of students including business majors.

Thanks for your sincere consideration in tuning up this course proposal.

Dr. Jooh Lee
Professor and Chairman
Department of Management and MIS
College of Business, Rowan University
Glassboro, NJ 08028

Phone : 856-256-4035
Fax : 856-256-4439
Hand : 856-371-2020 (Emergency only)
Email : LEE@ROWAN.EDU

>>> Christopher J. Lacke 03/14/01 02:44PM >>>
Dear Jooh:

Here are the course proposals for Operations Research. Thanks for taking a look at them.

Chris

Christopher Jay Lacke
Mathematics Department
Rowan University
Glassboro, NJ 08028
(856) 256-4500 x3897
(856) 256-4816 (fax)
http://www.rowan.edu/mars/depts/math/lacke/lacke1.html

"I hit the ground so hard, even my cape hurts" - Super Grover

---

ROWAN UNIVERSITY

Mathematics Department

February 7, 2002

To: Dr. Lauretta Reeves, Chair – University Curriculum Committee

From: Dr. Christopher Lacke, Department of Mathematics

Re: Operations Research course proposals

Included with my course proposals in Operations Research was a letter from Dr. Jooh Lee in which he expressed some concerns regarding the course proposals. Before I make my comments regarding some of his more specific statements, I should note that the College of Business offers 0507.430 Principles of Management Science. I submitted a consultation request to Dr. Lee because Operations Research and Management Science are related subjects, and I wanted to show him that I was not trying to create a set of courses to replace his course, as he often teaches Management Science.

The greatest difference between the two fields is based on the coverage of mathematics in the courses. Management Science, especially on the undergraduate level, concentrates on setting up problems and using computer software to solve the problems. Much of the mathematics is left out. In Operations Research, we study the modeling aspect, but we also study the mathematical algorithms used to solve the problems, how they work and why they work. We can also take advantage of a number of the software tools to solve larger problems. Because of this difference, students need to have the mathematical background to study the algorithms at the level that is expected in Operations Research.

With regard to Dr. Lee's comments, I have the following responses:

1. The comment regarding PERT/CPM and Decision Making is unclear. The topics are listed in the syllabi.
2. I am familiar with institutions that attempt to teach both deterministic and stochastic Operations Research in one semester. In order to cover the topics, all of the mathematical rigor must be removed, which results in a management science course.
3. Problem formulation is a general topic in Operations Research and is included under item 2 in the topical outline. It is absolutely necessary in every component of the course, but rather than list it ten times, I included it early in the list, with the knowledge that it has to be covered in every situation.
4. The Poisson distribution is covered in great detail in 1702.360 Introduction to Probability and Statistics I, which is a prerequisite for the courses that involve queuing theory.
5. We are looking at computer applications, but this is a math course. To substantially increase the time dedicated to computer applications would again reduce the mathematical rigor, again making this a management science course.

201 Mullica Hill Road • Glassboro, New Jersey 08028-1701 • Phone 856-256-4844 • Fax 856-256-4816

ROWAN UNIVERSITY
Mathematics Department

6. Business majors who have the requisite mathematical background are more than welcome to take the Operations Research courses. We have had some business majors minor in mathematics. The core requirement for the minor contains the prerequisites for the deterministic OR course, where as Introduction to Probability and Statistics I, which is the third requirement for the stochastic OR course, would count as an elective for the minor. The OR courses would fulfill the remainder of the minor requirements.

If you have any further questions or concerns, please feel free to contact me. Thanks for your help in this matter.

cc: Czochor, R.

201 Mullica Hill Road • Glassboro, New Jersey 08028-1701 • Phone 856-256-4844 • Fax 856-256-4816