

# ROWAN UNIVERSITY CURRICULUM PROPOSAL

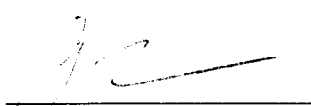
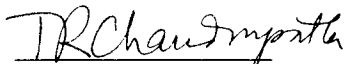
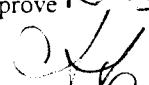
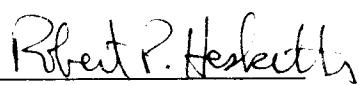
**PROPOSAL TITLE:** Introduction to Engineering Optimization

**CHECK APPROPRIATE:**  UNDERGRADUATE     GRADUATE     SEMESTER HOURS

**SPONSOR(S):** Tirupathi R. Chandrupatla and Dept. of Mechanical Engineering Curriculum Committee


**DEPARTMENT/TELEPHONE #** 4632

**CHECK ONE:**  COURSE     MINOR PROGRAM     CONCENTRATION     SPECIALIZATION  
 ACHIEVEMENT CERTIFICATE     CERTIFICATION PROGRAM     MAJOR PROGRAM

Step #1 (Department)	Step #2 (Receipt)	Step #3 (School)
<input checked="" type="checkbox"/> Approved (Date) <u>10/21/97</u> <input type="checkbox"/> Not Approved (Date)  Dept. Curriculum Chr.  <u>10/21/97</u> Reviewed (Date)   Dept. Chr.	SCC# <u>97-98-80</u>  <u>10-22-97</u> Date Received Senate  _____ Senate Curriculum Chr.	Reviewed Date: _____ <input checked="" type="checkbox"/> Recommend to Approved <input type="checkbox"/> Recommend NOT to Approve <b>RAD</b> Forward for Open Hearing:  <input checked="" type="checkbox"/> WITHOUT Reservations <input type="checkbox"/> WITH Reservations: Comments:   School Committee Chr.

**Step #4 (Academic Dean):**  Recommended     NOT Recommended     Conditionally Recommended (See Comments)

Comments:

Dean Signature/Date:  10/23/97

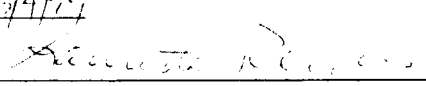
**Step #5 (Senate Curriculum Committee):** Open Hearing Date: \_\_\_\_\_ Approved by Curriculum Committee Date 2/12/97

Returned to Sponsor(s) for the following reason: pending change

change needed 1/97

**Step #6 (Senate)** Date announced/voted on at Senate 2/12/97; if voted on:  Approved     NOT Approved

Forwarded to Executive Vice President/Provost 3/4/97

Senate Curriculum Committee chair Signature/Date:  4/22/97

Step #7 (Executive Vice President/Provost): Date Received \_\_\_\_\_

Approved

NOT Approved If no, reasons are as follows:

Student Credit Hours 3

Faculty Load Hours 2

Equalized Credit Hours \_\_\_\_\_

Official Copy & Approval Sheet Filed (Date) \_\_\_\_\_

Executive Vice President/Provost Signature \_\_\_\_\_

*C. J. Motter*

**Registrar**

Date Approved Course Description Received \_\_\_\_\_

Hegis Taxonomy and Course Number Assigned       

Date/Signature of Registrar \_\_\_\_\_

*3/31/99*

**Notification Forward:**

Senate Curriculum Committee Chairperson

Department Chairpersons

Academic Dean(s)

Registrar

Sponsor(s)

*TMM 3/31/99*

## Course Proposal

### 1. Details:

- a) **Course Title:** Introduction to Engineering Optimization
- b) **Sponsor:** Dr. Tirupathi R. Chandrupatla and College of Engineering Curriculum Committee
- c) **Credit Hours:** 3 credit hours
- d) **Course Level:** Senior undergraduate (0901.402)
- e) **Curricular Effect:** Elective course for chemical, civil, electrical, and mechanical engineering senior undergraduate students
- f) **Prerequisites:** Math for Engineering Analysis II (1701.335) or equivalent
- g) **Suggested Time/  
Scale of Implementation** One section during fall semesters
- h) **Resources:** Faculty: Existing faculty can teach this course  
Library: No library acquisitions will be required  
Equipment: No laboratory equipment will be required  
Computers: Computer laboratory access will be required and additional software may be acquired.

### 2. Rationale:

The proposed course is an additional engineering elective that would supplement the Engineering Curriculum Proposal approved by the College Senate in December 1994. The proposed course is consistent with the establishment of the School of Engineering approved by the Board of Trustees in February 1995.

The course introduces students to the concept of optimization and its applications to various fields of engineering. The course covers both linear and non-linear programming. The course deals with engineering problems in design and analysis.

### 3. Essence of the Course:

#### a) Objectives:

Upon completion of the course, the students will be able to

1. Formulate optimization problems by defining the objective function and the problem constraints.
2. Make the choice of the right method for finding the optimum solution.
3. Understand and use linear, non-linear, and discrete optimization concepts.

4. Apply basic computer software to solve optimization problems.
5. Develop and extend the computer source codes for additional capabilities.

**b) Topical Outline:**

The topics to be covered are listed below. The instructor will supply the students with a syllabus during the first week of classes. The instructor will assess any technology advances in the subject matter prior to the course and make topic changes deemed to be appropriate to maintain the level and currency of instruction.

Fundamental concepts and problem formulation strategies

- Objective function for minimization
- Unconstrained problems
- Origin of the constraints
- Types of constraints
- Engineering problem formulation
- Taylor series
- Gradient and Hessian
- Convexity

One dimensional search

- Sectioning methods
- Polynomial fit methods
- Hybrid methods
- Computer experiments

Unconstrained optimization

- Gradient based methods
- Quasi-Newton methods
- Second order methods
- Applications to problems

Linear programming

- Simplex method
- Interior methods
- Duality
- Sensitivity analysis
- Problem formulation and solution

Constrained optimization

- Karush-Kuhn-Tucker conditions
- Optimality criteria methods

- Gradient projection methods
- Reduced gradient approach
- Method of feasible directions
- Exterior and interior penalty methods
- Applications to engineering problems

- Direct methods of optimization
  - Algorithms of Hooke and Jeeves, Nelder-Meade, Box
  - Conjugate directions
  - Genetic algorithms
  - Simulated annealing techniques
  - Computer implementation and engineering problems

- Multicriteria optimization
  - Engineering problems involving multiple objectives
  - Solution techniques

- Integer programming
  - Branch and bound algorithm
  - Cutting plane algorithm
  - Discrete engineering problems and their solution

- Design sensitivity analysis
  - Sensitivity in engineering problems
  - Interfacing of optimization and finite element analysis
  - Sensitivity of finite element response

**c) Evaluation and Grading Procedure of Students:**

Student grades will be determined on the basis of examinations, homework and/or projects, laboratory projects and reports. A course syllabus with stated method of arriving at the final grade, e.g., number of exams, projects homework, percentage of grade, will be distributed to the students during the first week of classes.

**d) Course Evaluation:**

The proposed course will be evaluated on the basis of student evaluations and curriculum review by appropriate faculty.

**4. Results of Consultations:**

The proposed course is an additional elective that would supplement the Engineering Curriculum Proposal approved by the Faculty Senate in December 1994. Consultations were submitted with original proposal as specified by the Curriculum Committee. The course ran under the special topics category in Fall 1997.

**Catalog Description:**

**Introduction to Engineering Optimization (0901.402)**

Prerequisites: Math for Engineering Analysis II (1701. 335) or equivalent

The formulation and modeling aspects of engineering optimization problems are presented. These steps involve setting up of the objective function to be minimized and the resource and system constraints to be satisfied. Solution techniques using gradient based methods, zero order methods, and penalty techniques are discussed. Formulation and solution of linear programming, non-linear programming, integer and discrete programming problems in engineering are covered. Algorithms are implemented in computer programs for problem solution.