ABET Course Syllabi for IND E 412: Integer and Dynamic Programming

1. **Course number and name:** IND E 412: Integer and Dynamic Programming

2. **Credits and contact hours:** 4 credit hours, 5 hours per week (3 hrs lecture, 2 hrs lab)

3. **Instructor’s names:** Archis Ghate, Zelda B. Zabinsky

4. **Text book, title, author, and year**

5. **Specific course information**
   5a. **Brief description of the content of the course** (catalog description):
       Modeling and optimization of problems and dynamic programming approach to optimization. Topics include: integer programming formulation techniques, linear and Lagrangian relaxation, branch-and-bound and cutting-plane methods, integer programming applications, and dynamic programming.
   5b. **Prerequisites or co-requisites:**
       IND E 411
   5c. **Required, elective, or selected elective (as per Table 5-1) course in the program:**
       Elective for A (Operations Research)

6. **Specific goals for the course**
   The goals of the course are to expose students to OR models of optimization with integer variables and to general dynamic programming models. When time permits, the students may be exposed to nonlinear optimization models and game theory.

6a. **Specific outcomes of instruction**
   - Students will be able to formulate a simple IP (set up decision variables, constraints and objective functions).
   - Students will be able to interpret results (feasible/infeasible, optimal).
   - Students will develop an understanding about the difference between an LP and an IP, and modeling and computational implications.
   - Students will be able to formulate a simple DP using states and a DP recursion.
   - Students will develop an understanding about the difference between DP, IP and LP, and modeling and computational implications.
   - Additional topics, including nonlinear programming and game theory, will be addressed if time permits.

6b. **explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**
   (a) an ability to apply knowledge of mathematics, science and engineering
   (b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(e) an ability to identify, formulate, and solve engineering problems
(i) a recognition of the need for, and ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) an understanding of the integrated nature of the discipline

7. Brief list of topics to be covered:

- Integer Programming (IP):
  - Introductory examples
  - Formulation and modeling techniques
  - LP relaxations
  - Lagrangian relaxation
  - Branch and bound methods
  - Cutting plane methods
  - Applications to industrial and other branches of engineering

- Dynamic Programming (DP):
  - Introductory examples
  - DP concepts including stages, decisions, states, policy, value function, optimal policy etc.
  - Important formulation techniques such as equipment replacement, distribution of effort, capacity expansion, resource allocation etc.

- Nonlinear Programming (NLP):
  - Introductory examples
  - Multi-variable models for unconstrained and constrained formulations
  - Lagrangian multipliers and KKT approaches
  - Gradient search and Newton's method

- Game Theory
  - Two-person, zero-sum games
  - Solution of simple games
  - Mixed strategies
  - Graphical solution procedure
  - Solution by linear programming