Spring 2019
ME 597: Innovation and Problem Solving

INSTRUCTOR: KARTIK B. ARIYUR
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Office Hours: Flexible schedule for online/ in person meetings

COURSE TEXT: There is no textbook for the course. Some course materials can be
downloaded from http://www.opensourcetriz.com/ or used through your mobile phone.
Others will be supplied on blackboard learn (https://mycourses.purdue.edu) to supplement
online lectures. Several references will be used including

REFERENCES:
[4] The Innovator’s Dilemma: When New Technologies Cause Great Firms to Fail, C. M. Christensen,

PREREQUISITE: Linear algebra, differential equations (MATH262) and probability
(MATH250) or the consent of the instructor.

OBJECTIVES: Familiarize students with methods that are easily accessible but rigorous for
formulation and solution of hard (PSPACE or harder) design optimization problems to rapidly
create products, services, systems or solutions to specific problems whose performance is
insensitive to uncertainties in components and operating environment. Problem formulation
is based on functional modeling. This enables use of heuristics, cutting edge discoveries and
practices from a variety of disciplines organized around a core of TRIZ ideas developed by
Genrikh Altshuller. Sources for methods include mathematical problem solving, optimization
and decision theory, marketing, finance, and management research. The course will give
students a grasp of the following steps:

- Identifying the market and value proposition
- Rigorous and accessible formulation
- Solution via reducing the search space
- Eliminating tradeoffs to reduce dimension of optimization problems
- Execution through developing strategies for experiment, construction and
  monetization.

This course seeks to simulate the work environment of the modern engineer or knowledge
worker in general. It aims at familiarity with the state-of-the art results, design and analysis
tools in many disciplines, the ability to obtain relevant information to formulate and solve
problems arising in practice, and encode algorithms/procedures in software where necessary.

GRADING POLICY:
COURSE PROJECT: 50%            IN-CLASS QUIZZES: 50%

The weekly quizzes test your understanding of course material and your project updates test
your ability to apply the course material on a problem of your choice. Bonus points for in-
class questions—everyone will get a chance—2 points per correct solution and a total
maximum of 250 points. Final grading will be cluster based.

You must receive a passing grade on the project to pass the course.
**PROJECT POLICY:**
Project reporting has to be done each week. *Project updates have to be submitted via Blackboard on the following Sundays before midnight (January 29; February 3, 10, 17; March 3, 10, 24, 31; April 7, 21)*. This includes your work of the previous week and your MATLAB/SIMULINK code (clearly documented). *No late submissions will receive points.* Since projects are an integral part of the course content, they are to be an individual effort. However, study group discussion, acquiring information and code from the web and library, MATLAB/SIMULINK code sharing/reuse, and cross-checking each other’s work, are strongly encouraged. Project updates must be uploaded in the format specified, in pdf, and must NOT add more than 2 pages to the overall document. The final document must occupy 15 pages or less. You can trim/modify prior sections when you update the report on each submission.

Each project update will be worth 50 points. 10 points will be deducted for each of consistency, correctness, formatting/typographic/referencing, coding/code formatting, and spelling/grammar. Project updates will consist approximately in the following steps:

1. Problem background, motivation and formulation with references
2. Market identification: size, growth rate, predictability, competition
3. Value proposition to be constructed with all competitive factors
4. Cause effect chains and construction in SIMULINK
5. Linking cause-effect chains with functions/dynamics and finding more equilibria
6. Idealization and modification of dynamics and cause-effect chains
7. Identifying and eliminating trade-offs where possible
8. Solving the final optimization problems
9. Experiment design and product/service development strategy
10. Monetization strategies and calculations

**ONLINE QUIZ POLICY:**
Quizzes will be posted on *Monday afternoons (January 14, 21, 28; February 4, 11, 18, 24; March 4, 11, 18, 25; April 8, 15)* and are due *Sunday night*. Grading will be based on the correct answer and the correct method. Each quiz will be worth 50 points and will consist in a single question—the best 10 scores will be considered for your grade. You will receive *ZERO* points for incorrect answers or for correct answers with incorrect methods (if that happens). The questions may have multiple correct answers. The quiz will be open notes—you can use the internet or any software, class slides and required reading material. *You will have one or two hours to submit your solution in scanned pdf once you access the quiz.* *The time taken will be tracked on Blackboard Learn.*

**BONUS QUESTION POLICY:**
Bonus questions will be asked at random in any class. They will be written on the board or put on class slides. All who come up with unique and correct answers within the week of the question will get credit. The answers should be posted along with the questions on the course blog for credit.

*Grading will be performed in the week of the project update submission or quiz and scores and averages will be posted on BLACKBOARD https://mycourses.purdue.edu, so you can check on your relative performance in the class regularly.*
COMPUTER USAGE:
You will be expected to use MATLAB/SIMULINK for the course project. It is strongly advised that you go through a self-paced MATLAB tutorial such as the one at http://www.engin.umich.edu/class/ctms/ if you are not comfortable with MATLAB.

TENTATIVE COURSE OUTLINE
1. Markets and Value 2 weeks
   - Introduction
   - History of problem solving methods
   - Identifying the market
   - Methods for different market types
   - Determining competitive factors
   - Constructing a value proposition

2. Problem Formulation 3 weeks
   - Clarifying the objective
   - Codifying the constraints
   - Quantifying problem complexity.
   - Cause-effect chains or static constraints
   - Functions or dynamic constraints
   - System modeling and simulation

3. Problem Solving 6 weeks
   - Idealization or cutting the search space
     o The function
     o The physical effect
     o The implementation
   - Elimination of trade-offs
     o Finding trade-offs
     o Alternative problem paths
     o Parametrizing design variables by space, time, scale, direction, field properties
   - Optimization methods
     o Formulations
     o Numerical methods

4. Execution 3 weeks
   - Designing informative experiments and System ID
   - IP protection strategies
   - Maximizing value creation with minimal risk
     o project selection
     o research vs engineering
     o team building
   - Monetization strategies:
     o Licensing
     o Venture capital