American University of Beirut
Faculty of Engineering and Architecture
Engineering Management Program

ENMG 501 Engineering Management II

Spring 2013, CRN 20173: TTh 11:00 AM - 12:15 PM, Bechtel 210

Instructor

Dr. Bacel Maddah
Office: Bechtel 519A
E-mail: bacel.maddah@aub.edu.lb. Office phone: 01 350 000 Ext. 3551.
Webpage: `www.aub.edu.lb/~bm05/`
Office hours: Mon 2 - 5 PM

Course Description

Operations Research (OR) is a decision science concerned with optimal allocation of scarce resources. (Check out *www.informs.org* .) OR applications include production planning and scheduling in manufacturing, staffing, pricing, and capacity planning in service industries (e.g. airlines, hotels, retailing), military operations, health care management, and financial asset management, among others. Operations researchers develop mathematical models of real life systems with the objective of enhancing performance. In ENMG 500 Engineering Management I, the emphasis is on "deterministic" OR models, which assume certainty and linearity. Here, in ENMG 501 Engineering Management II, you will explore decision problems involving one or more elements of uncertainty and nonlinearity. The assumption of uncertainty is quite realistic for most problems. However, it brings with it additional complexities. The mere evaluation of the objective function and constraints for a given set of decision variables requires creative use of *probability theory*. In this course, we will explore the art and science of "modeling under uncertainty." The course will start with a thorough review of probability and then emphasis three areas of probabilistic OR applications: *Markov Chains*, *Queueing*[1] *Systems* and *Inventory Control*.

Course Learning Outcomes

- Understand the OR methodology of mathematical modeling.
- Develop probabilistic models for real problems.
- Enhance the understanding of probability theory through real applications.
- Understand the probability theory in Markov chains, queueing and inventory models.
- Identify and understand the applications of Markov chains and queueing theory.
- Master the fundamental techniques for analyzing basic Markov chains and queues.
- Understand and appreciate the importance of inventory management.
- Determine the optimal control policies for basic inventory systems.

[1] Never spell this as "Queuing" in this course.

Textbook

Taha, H. A. *Operations Research: An Introduction.* Ninth Edition. Prentice Hall, 2011.

Additional References

1. Feller, W. (1968). *An Introduction to Probability Theory and Its Applications*, Vol. 1, 3rd Edition. Wiley.
2. D. Gross and C. Harris (1998). *Fundamentals of Queueing Theory*, 3rd Edition. Wiley.
3. Hillier, F. S. and G. J. Lieberman. *Introduction to Operations Research*, 8th Edition. McGraw-Hill, 2004.
4. Ross, S. M. (2002). *Introduction to Probability Models*, 8th Edition. Academic Press.
5. Silver, E. A., D. F. Pyke, and R. Peterson (1998). *Inventory Management and Production Planning and Scheduling*, 3rd Edition. Wiley.
6. Winston, W. L. *Operations Research: Applications and Algorithms*, 4th Edition. Duxbury Press, 2003.

Tentative Schedule
Topics will be covered according to the following schedule. While the schedule may very slightly, *the midterm exam date will not be changed.*

- Week 1: Course introduction and the OR modeling approach
- Week 2: Basic probability theory, sets, probabilistic models, conditional probability, Bayes' rule, independence.
- Week 3: Random variables, discrete and continuous, mass and density functions, expectation, variance, independence.
- Week 4: Common discrete random variables: Bernoulli, Binomial, Geometric, Poisson. Properties and OR applications.
- Week 5: Common discrete random variables: Uniform, Exponential, Normal. Properties and OR applications. A stock price model: The Lognormal random variable.
- Week 6: Discrete time Markov chains, classification of states, OR applications.
- Week 7: Discrete time Markov chains, stationary solution, OR applications.
- Week 8: **Midterm on Tuesday 03/26/2013 at 7:00 PM.**
- Week 9: Continuous time Markov chains, Chapman-Kolmogorov equations, limiting probabilities, applications.
- Week 10: Continuous time Markov chains, Birth-death process, pure birth process, Poisson process.

- Week 11: Queueing models, application of birth-death analysis to Markovian queues
- Week 12: Detailed analysis of Markovian queues, single- and multi-server, finite waiting space
- Week 13: More queueing, finite population, networks of queues, general service times.
- Week 13: Introduction to inventory systems, importance and main characteristics. Deterministic economic order quantity model and variants
- Week 14: Probabilistic single period (newsvendor) model. Multi-period probabilistic inventory models.
- Week 15: **Final exam (not comprehensive)**

Grading

Midterm Exam	40%
Final Exam	40%
Homework	10%
Project	10%

Homework

Homework problems will be assigned frequently. All students are encouraged to solve the homework problems and discuss their solutions with the instructor and their colleagues. However, *every student must write his own homework assignments.* **Doing the homework is the best way to excel in this course.** Do not type the homework. But do stable it. No late submissions will be accepted.

Project

The project will involve a case study on applying Markov chains modeling to a real-life inventory control problem. It is intended to give you a taste of realistic OR applications and to enhance your writing skills. The project will be done in two phases in groups of two. You'll submit the first phase, receive feedback from the instructor, and then submit the second phase close to the final exam date. The project deadlines and group assignments will be announced later. The project should not exceed 6 pages. This is a "small" project.

Attendance Policy and Class Management

Attendance will be noted utilizing random sampling.[2] A student is allowed **two** unexcused absences at most. Each additional unexcused absence will lead to losing five points from the final grade.

Course Website

`www.aub.edu.lb/~bm05/ENMG501/`

Look for assignments and slides presented in class there.

[2] I'll call on 9 students in every session. With 35 students in the class, there is approximately 25% chance that your name is called in a given session. With around 28 sessions in the semester, there is approximately a 98.3% chance that your name will be called more than two times in the whole semester. So, the probability of missing all sessions and not getting penalized is 1.7%.