بسمه تعالی،

... و له‌الأسماء الحسنی.

گروه شبیه‌سازی و کنترل

دانشکده مهندسی شیمی و نفت – دانشگاه صنعتی شریف

روش‌های بهینه‌یابی در مهندسی شیمی و نفت

بخش سوم – بهینه‌یابی دینامیکی

سید محمودرضا پیشوایی،

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Lecturer: Mahmoud Reza Pishvaie

Status (in the study program):

Optional course in graduate study; Compulsory for Process Eng. Group students.

Aims/Scope/Objectives: The students are acquainted with engineering judgment and formulation of optimization problems in chemical processes and related issues. The basic aim is to familiarize student with three key components of an optimization problem, namely, the objective function, the process model, and constraints. The students learn the approach how to attack the optimization problems through the convenient formulation and suitable method of solution. The graduates of this study are equipped with theoretical and practical knowledge of both static and dynamic optimizations. This is especially the case when they are encountered with Chem. Eng.-oriented problems.

Syllabus:
- Introduction to optimization formulation.
- Mathematical backgrounds.
- Unconstrained static optimization methods.
- Constrained static optimization methods.
- Dynamic optimization, Variational approach.
- Application and case studies.
- Advanced topics.

References:

[1]. Rao, S.S., "Optimization, Theory & Applications", 3d Ed. Wiley Eastern Ltd., (1984).
[2]. Edgar, T.F. and D.M. Himmelblau, "Optimization of Chemical Processes", McGraw-Hill Int., (1984).
[3]. Denn, M.M., "Optimization by Variational Methods", McGraw-Hill, NY, (1969).
[4]. Pontryagin, L.S., et al, "The Mathematical Theory of Optimal Processes", Wiley & Sons, NY (1962).
[5]. Pike, R.W., "Optimization for Engineering Systems", Van Nostrand Reinhold Co. Inc., (1986).

Teaching Method: Lectures, Seminar.
Prerequisites: Mathematics, (preferably) MATLAB.

Personal work required: Project and Seminar presentation.

Examination method: Project-based.

Hints:

More References:

Linear / Nonlinear Programming

- Avriel, M., *Nonlinear Programming: Analysis and Methods*, Prentice-Hall, 1976.
- Bertsekas, D., *Nonlinear Programming*, Athena Scientific, 1995.
- Biegler, L.T., I.E. Grossman, and A.W. Westerberg, *Systematic Methods of Chemical Process Design*, Prentice-Hall, 1997.
- Chvatal, V., *Linear Programming*, W.H. Freeman, 1983.
- Conn, A.R., N.I.M. Gould, P.L. Toint, *Trust-Region Methods*, SIAM, 2000.
- Dantzig, G.B., and M.N. Thapa, *Linear Programming 1: Introduction*, Springer, 1997.
- Dennis, J.E., Jr. and R.B. Schnabel, *Numerical Methods for Unconstrained Optimization and Nonlinear Equations*, SIAM, 1996. (reprint)
- Fiacco, A.V., and G.P. McCormick, *Nonlinear Programming: Sequential Unconstrained Minimization Techniques*, SIAM, 1990. (Reprint).
- Fletcher, R., *Practical Methods of Optimization*, Wiley, 1987.
- Gill, P.E. W. Murray, and M.H. Wright, *Practical Optimization*, Academic Press, 1981.
- Mangasarian, 01, *Nonlinear Programming,* SIAM, 1994. (Reprint).
- More, J.J, and S.J. Wright, *Optimization Software Guide,* SIAM, 1993.
- Nash, S.G., and A. Sofer, *Linear and Nonlinear Programming,* McGraw-Hill, New York, 1996.
- Nocedal, J., and S.J. Wright, *Numerical Optimization,* Springer, New York, 1999.
- Press, W.H., S.A. Teukolsky, W.T. Vetterling and B.P. Flannery, *Numerical Recipes in C: The art of Scientific Computing,* Cambridge University Press, 1992.

Interior Point Methods & Convex Programming

- Ben-Tal, A., and A. Nemirovskii, *Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications,* SIAM, 2001.
- El Ghaoui, L., and S.-I. Niculescu, (eds.), *Advances in Linear Matrix Inequality Methods in Control,* SIAM, 2000.
- Nesterov, Y., and A. Nemirovskii, *Interior-Point Polynomial Algorithms in Convex Programming,* SIAM, 1994.
- Renegar, J., A *Mathematical View of Interior-Point Methods in Convex Optimization*, SIAM, 2001.
- Terlaky, T., (ed.), *Interior Point Methods of Mathematical Programming*, Kluwer, 1996.
- Wolkowicz, H., R. Saigal, and L. Vandenberghe, (eds.), *Handbook of Semidefinite Programming: Theory, Algorithms, and Applications,* Kluwer, 2000.
- Wright, S.J., *Primal-Dual Interior-Point Methods,* SIAM, 1997.

Dynamic Optimization

- Bertsekas, D.P., *Dynamic Programming and Optimal Control* Vols. 1& 2, 2nd Ed., Athena Scientific, 1995.
- Betts, J.T., *Practical Methods for Optimal control Using Nonlinear Programming*, SIAM, 2001.
- Bryson, A.E., *Dynamic Optimization*, Addison-Wesley, 1999.
- Clarke, F.H., *Methods of Dynamic and Nonsmooth Optimization*, SIAM, 1989.
- Delfour, M.C., and J.-P. Zolesio, *Shapes and Geometries: Analysis, Differential Calculus, and Optimization*, SIAM, 2001.
- Helmke, U., and J.B. Moore, *Optimization and Dynamical Systems,* Springer, 1994.
- Polak, E., *Optimization: Algorithms and Consistent Approximations,* Springer, 1997.
- Smith, D.R., *Variational Methods in Optimization,* Dover, 1998.
- Troutman, J.L, *Variational Calculus and Optimal Control,* $2^{"}$ Ed., Springer, 1996.

Analysis

- Aubin, J.-P., *Optima and Equilibria: An Introduction to Nonlinear Analysis,* 2nd Ed., Springer, 1998.
- Aubin, J.-P., and H. Frankowska, *Set- Valued Analysis,* Birkhauser, 1990.
- Bonnans, J.F., and A. Shapiro, *Perturbation Analysis of Optimization Problems,* Springer, 2000.
- Borwein, J.M., and A.S. Lewis, *Convex Analysis and Nonlinear optimization: Theory and Examples*, Springer, 2000.
- Ekeland, I., and R. Temam, *Convex Analysis and Variational Problems,* SIAM, 1999.
- Clarke, F.H., *Optimization and Nonsmooth Analysis,* SIAM, 1989.
- Fiacco, A.V., *Introduction to Sensitivity and Stability Analysis in Nonlinear Programming,* Academic Press, 1983.
- Gal, *T., Postoptimal Analysis, Parameteric Programming and Related Topics,* McGraw-Hill, 1979.
- Rockafellar, R.T., *Conjugate Duality and Optimization,* SIAM, 1974.
- Rockafellar, R.T., and J-B. Wets, *Variational Analysis*, Springer, 1998.

Selected Reference Journals:

- Applied Mathematics and Optimization

- Computers & Operations Research

- Computers and Chemical Engineering

- Journal of Optimization Theory and Applications

- Mathematical Methods of Operations Research

- Mathematical Programming

- Mathematical Programming Studies

- Optimization and Engineering

- Structural and Multidisciplinary Optimization

- SIAM Journal on Control and Optimization

- SIAM Journal of Numerical Analysis

- SIAM Journal of Optimization

Some Web Sites

AMPL	www.ampl.com
Excel Solver Add-Ins	www.frontsys.com
GAMS	www.gams.com
na-net Newsletter	www.netlib.org/na-net
NetLib	www.netlib.org
Numerical Recipes home page	www.nr.com
Optimization Technology Center	www.ece.nwu.edu/OTC/
Optimization Software Guide	www-fp.mcs.anl.gov/otc/Guide/SoftwareGuide/index.html
SIAG/OPT home page	www.siam.org/siags/siagop/siagop.htm