

SOUTHWESTERN UNIVERSITY OF FINANCE AND ECONOMICS
Management Science Seminars

Undergraduate Course Syllabus • 17-Week Curriculum (51 Lecture Hours)

Course Title: Management Science Seminars
Academic Level: Undergraduate Course
Course Type: Seminar & Lecture Series

Instructor: Dr. Luping Zhang
Credits / Hours: 4 Credits (51 Lecture Hours)
Schedule Format: 17 Weeks × 3 Hours / Week

1. Course Materials and Reading References

Instruction integrates instructor lecture notes, optimization modeling scripts, and the following foundational textbooks and academic literature:

- [*] **Core Textbook:** Anderson, D. R., Sweeney, D. J., Williams, T. A., Camm, J. D., & Martin, R. K. *An Introduction to Management Science: Quantitative Approaches to Decision Making*. Cengage Learning.
- [**] **Supplementary Reading 1:** Stanford University MS&E 111 / ENGR 62: *Introduction to Optimization* (Chapter 4: Linear Programming Theory and Duality). Stanford University. Online: web.stanford.edu/~ashishg/msand e111/
- [***] **Supplementary Reading 2:** Bradley, S. P., Hax, A. C., & Magnanti, T. L. (1977). *Applied Mathematical Programming*. Addison-Wesley. Online: web.mit.edu/15.053/www/AMP.htm
- [*] **Academic Journal Literature:** Recommended seminal and contemporary articles published in leading peer-reviewed journals (*Management Science*, *Operations Research*, *INFORMS Journal on Applied Analytics*).

2. Course Objectives

This course equips undergraduate students with a solid foundational understanding of Management Science and its analytical applications in managerial decision-making. By the end of this course, students will be able to:

- **Formulate and solve quantitative models** using mathematical programming techniques, including linear programming, network optimization, and integer programming.
- **Apply Management Science principles** to systematically address real-world business challenges in production planning, inventory control, logistics distribution, and resource allocation.
- **Analyze and interpret quantitative solutions**, leveraging sensitivity analysis, shadow prices, and post-optimality diagnostics while evaluating model strengths and practical limitations.
- **Communicate problem-solving approaches effectively**, articulating model formulation, methodological logic, and actionable insights to managerial and executive audiences.
- **Develop critical thinking capabilities** to rigorously evaluate the appropriateness, assumptions, and effectiveness of quantitative methods across diverse managerial decision scenarios.

3. Course Overview and Module Summary

#	Module / Topic Area	Scope and Methodological Focus	Weeks	Hours
1	Foundations & Systems Modeling	Quantitative decision-making process, systems thinking, and model abstraction.	W1–2	6
2	LP Foundations & Sensitivity	LP formulations, graphical solution, shadow prices, and post-optimality analysis.	W3–4	6
3	Linear Programming: Applications	Practical business applications in marketing mix, corporate finance, and operations.	W5–6	6
4	LP: Advanced Applications	Constrained portfolio optimization, asset allocation, and investment strategies.	W7	3
5	Simplex Method & Duality Theory	Unified simplex algorithm (Python) and complete duality theory and proofs.	W8–12	15
6	Networks & Integer Programming	Transportation, assignment, network flows, and integer programming modeling.	W13–16	12
7	Project Presentation & Synthesis	Student team capstone project reporting, peer evaluation, and course synthesis.	W17	3
Total Curriculum Hours (17 Weeks):			51 Hours	

4. Detailed Weekly Schedule (Weeks 1–9)

The 17-week curriculum is structured into weekly 3-hour sessions. The first half focuses on management science foundations, decision-making, systems modeling, linear programming applications, the simplex method, and duality introduction:

Week	Lecture Topic & Key Syllabus Contents	Materials	Readings
Week 1	Introduction to Management Science and Decision-Making Process Overview of quantitative management science, historical development, problem definition; structured decision-making workflows, qualitative vs. quantitative analysis, and decision environments under certainty and uncertainty.	Lecture Notes	Textbook*
Week 2	Fundamentals of Systems and Modeling Concepts of organizational systems, subsystems, and feedback loops; model abstraction; classification of variables (decision, state, random); objective functions and constraints; model validation.	Lecture Notes	Textbook*
Week 3	Introduction to Mathematical Modeling and Linear Programming Approaches Formulation of linear programming (LP) problems; fundamental assumptions (proportionality, additivity, divisibility, certainty); geometry of linear programs and graphical solution method.	Lecture Notes	Textbook*
Week 4	Sensitivity Analysis and Interpretation of Solutions Managerial interpretation of optimal solutions; shadow prices (dual values) and economic meaning; reduced costs; allowable ranges of optimality for objective coefficients and right-hand sides.	Lecture Notes	Textbook*
Week 5	Linear Programming: Applications in Marketing, Finance, and Operations I Marketing applications (media selection and advertising budget allocation); operations planning (aggregate production scheduling, workforce staffing, and multi-period capacity planning).	Lecture Notes	Textbook*
Week 6	Linear Programming: Applications in Marketing, Finance, and Operations II Corporate financial applications (cash flow management, working capital planning, capital budgeting); operational decisions (make-or-buy decisions, blending, and product-mix problems).	Lecture Notes	Textbook*
Week 7	Linear Programming: Advanced Applications in Portfolios and Asset Allocation Portfolio optimization under linear constraints; asset allocation models; index tracking; transaction cost considerations; risk budgeting and diversification constraints.	Lecture Notes	Textbook*
Week 8	Solving Linear Programming Models: The Simplex Method and Implementation Algebraic foundations of the simplex algorithm; standard form conversion; basic feasible solutions and extreme points; tableau pivoting mechanics; degeneracy and cycling; Python implementation using scientific optimization libraries.	Lecture Notes & Python Code	Bradley et al. ^{***} , Stanford's ^{**}
Week 9	Introduction to Duality Theory Motivation and economic interpretation of duality; constructing the dual problem from the primal program; standard and canonical primal-dual pairs; dual variables as resource valuations.	Lecture Notes	Stanford's ^{**}

Pedagogical Note on Week 8: In alignment with modern management science curricula, algebraic mechanics and Python computational implementations of the Simplex Method are unified into a single intensive 3-hour session, establishing the computational foundation for duality.

4. Detailed Weekly Schedule (Continued: Weeks 10–17)

The second half of the course advances through formal duality theorems, network optimization, integer linear programming, and concludes with student capstone project presentations:

Week	Lecture Topic & Key Syllabus Contents	Materials	Readings
Week 10	Duality Theory Basics: Weak Duality, Strong Duality, and Hyperplane Theorems Fundamental duality properties; Weak Duality Theorem; Strong Duality Theorem; geometric interpretation via separating and supporting hyperplane theorems.	Lecture Notes	Stanford's**
Week 11	Farkas' Lemma and Strong Duality Theorem Convex polyhedra; cone theory; theorems of the alternative; Farkas' Lemma and its rigorous application to the proof of the Strong Duality Theorem.	Lecture Notes	Stanford's**
Week 12	Complementary Slackness and Duals of General Linear Programs Complementary slackness optimality conditions; economic interpretation; primal-dual relationships; duals of general linear programs with equality and unconstrained variables.	Lecture Notes	Textbook*
Week 13	Transportation Problems and Assignment Problems Network structure of transportation models; balanced vs. unbalanced problems; unimodularity property and integer solutions; Hungarian method and assignment problem formulations.	Lecture Notes	Textbook*
Week 14	Distribution and Network Models Transshipment models; shortest-path algorithms; maximum flow problems; minimum-cost network flow formulations; applications in supply chain logistics.	Lecture Notes	Textbook*
Week 15	Integer Linear Programming: Basic Theories Pure, mixed, and 0–1 (binary) integer programs; LP relaxation; graphical illustration of the integrality gap; modeling fixed costs, logical conditions, and binary choice constraints.	Lecture Notes	Textbook*
Week 16	Integer Linear Programming: Applications Facility location problems; set covering and set packing; traveling salesperson problem (TSP) formulations; modern computational integer programming solvers and workflows.	Lecture Notes	Textbook*
Week 17	Student Project Presentations and Discussions Capstone group project presentations; oral defense and peer critique; instructor feedback; comprehensive course review and methodological synthesis.	Student Slides & Reports	Textbook*

5. Evaluation System and Grading Criteria

Course evaluation combines continuous formative assessment with applied analytical deliverables:

Assessment Component	Description, Scope, and Deliverables	Weight
Final Project Report & Presentation	Comprehensive group project addressing a complex real-world managerial decision problem. Deliverables include formal mathematical model formulation, computational solver implementation, sensitivity analysis, written final report, and executive presentation.	40%
Midterm Progress Report & Presentation	Intermediate milestone report documenting the selected problem background, literature context, initial mathematical formulation, data structure, and preliminary results.	30%
Case Studies, Homework, & In-Class Discussion	Quantitative problem sets, modeling homework, hands-on case study discussions, active classroom participation, and constructive peer review during presentations.	30%
Total:		100%

6. Academic Expectations and Course Policies

- **Academic Integrity:** All submitted code, modeling formulations, and project reports must represent the original work of the enrolled students. Appropriate citations are required when referencing external literature, open-source repositories, or data sources.
- **Computational Tools:** Students are strongly encouraged to implement optimization models using Python (e.g., SciPy, PuLP, Pyomo) or commercial solvers with academic licenses (Gurobi, CPLEX).
- **Collaboration & Seminar Engagement:** Active participation during lectures, seminar critiques, and Q&A discussions is integral to both individual learning and final evaluation.