Course Name: Multiobjective Programming
Course Code: DS414

I. Basic Course Information

Major or minor element of program: Major
Department offering the course: Operations Research and Decision Support Department

Academic level: 400 Level
Semester in which course is offered: Second (spring) Semester
Course pre-requisite(s): Linear & Integer Programming (DS311)
And Nonlinear & Dynamic Programming (DS312)

Credit Hours: 3
Contact Hours Through:

Lecture	Tutorial*	Practical*	Total
2.5	1.5	0.0	4.0

* 1.5 hours for **either** Tutorial or Practical

Approval date of course specification: January 2015

II. Overall Aims of Course

The course aims to introduce sufficient theortical background to allow the derivation of the featured methods for both theoretically and practically oriented, the algorithms are described in a consistent manner with some implementational remarks and software information. Also, the optimality conditions for differentiable and nondifferentiable multiobjective optimization problems are introduced the topics of sensitivity analysis, stability and duality must be covered.

III. Program ILOs covered by course

Program Intended Learning Outcomes (By Code)			
Knowledge & Understanding	Intellectual Skills	Professional Skills	General Skills
K16,K17,K23	I12,I13,I14	P9,P12,P16	G1,G2,G5,G6

IV. Intended Learning Outcomes of Course (ILOs)

a. Knowledge and Understanding

On completing the course students will know and understand

K.1 Explain the methods and theories needed to solve Multiobjective Programming (MOP) problems.

K.2 Learn the difference between methodologies used to solve MOP problems.

K.3 Illustrate the usage of MOP solving methods to solve Multiobjective programming problems.

b. Intellectual/Cognitive Skills

The most important intellectual skills developed in the course are

I.1 Relate between different theories studied to solve MOP problems.

I.2 Analyze the theories presented, recognizing their relation with the methods used.

I.3 Comprehend and communicate data presented graphically and/or mathematically.

c. Practical/Professional Skills

The most useful practical skills, techniques and capabilities developed are

P.1 Apply the techniques and theorems in real applications.

P.2 Analyze specific data and information to build the mathematical model.

P.3 Apply the tools studied concerning MOP to solve a real problem (case study).

d. General and Transferable Skills

The most important ways a student will learn are

G.1 Gather data from various sources, including electronic media, such as internet.

G.2 Choose a case study from the real world and apply the techniques studied.

G.3 Be fully responsible for the preparation of the case study and manage the presentation schedule of his/her work.

G.4 Exercise research skills, such as data collection, tabulation, analysis, report presentation and class discussions.

V. Course Matrix Contents

	Main Topics / Chapters	Duration (Weeks)	Course ILOs Covered by Topic (By ILO Code)			
			K & U	I.S.	P.S.	G.S.
1-	• Principle of Multiobjective Optimization • Difference with Single Objective	1	K2	I1,I3	P3	G4
2-	• Dominance and Pareto Optimality • The Graphical method for multiple objective linear programming problems (MOLP)	1	K1,K3	I1	P1	G2
3-	Classical Methods	3	K2		P2	G1
4-	Goal Programming Methods	3	K1			G3
5-	Interactive Methods	3		I2		G3
6-	Evolutionary Algorithms	2				G1
	Net Teaching Weeks	**13**				

VI. Course Weekly Detailed Topics / hours / ILOs

Week No.	Sub-Topics	Total Hours	Contact Hours	
			Theoretical Hours	Practical Hours*
1	Principle of Multiobjective Optimization- Difference with Single Objective	2.5	2.5	
2	• Dominance and Pareto Optimality • The Graphical method for multiple objective linear programming problems (MOLP)	4	2.5	1.5
3	• The Global Criterion method • Weighted Sum Method	4	2.5	1.5
4	• The ϵ - constraint method • The hybrid method	4	2.5	1.5
5	• The proper equality constraint method • Benson's Method	4	2.5	1.5
6	• The Equal-Weighted linear Goal programming. • The Unequal-Wheighted linear goal programming. • The Preemptive linear goal programming.	4	2.5	1.5
7	**Midterm Exam**			
8	• The goal attainment method. • The modified goal attainment method • The iterative approach for linear goal programming problems	4	2.5	1.5
9	• The bounded objective function method • The Lexicographic method.	4	2.5	1.5
10	• STEP Method • Method of Geoffrion	4	2.5	1.5
11	• Reference Point Method • Nondifferentiable interactive M.O.	4	2.5	1.5
12	• Bundle-based Optimization System Approach	4	2.5	1.5
13	• Difficulties with Classical Optimization Algorithms • Evolution Strategies	4	2.5	1.5
14	• Evolutionary Programming • Genetic Programming	4	2.5	1.5
15	**Final Exam**			
Total Teaching Hours		**51**	**33**	**18**

* **No Practical/Tutorial during the first week of the semester**

VII. Teaching and Learning Methods

Teaching/Learning Method	Selected Method	Course ILOs Covered by Method (By ILO Code)			
		K & U	Intellectual Skills	Professional Skills	General Skills
Lectures & Seminars	√	All	All		G4
Tutorials	√	K1		All	G2,G4
Computer lab Sessions					
Practical lab Work					
Reading Materials	√	All	All		G1,G4
Web-site Searches	√	All	All		G1,G4
Research & Reporting					
Problem Solving / Problem-based Learning					
Projects					
Independent Work					
Group Work					
Case Studies	√			All	All
Presentations					
Simulation Analysis					
Others (Specify):					

VIII. Assessment Methods, Schedule and Grade Distribution

Assessment Method	Selected Method	Course ILOs Covered by Method (By ILO Code)				Assessment Weight / Percentage	Week No.
		K & U	I.S.	P.S.	G.S.		
Midterm Exam	√	All	All		G4	20%	7
Final Exam	√	All	All		G4	60%	15
Quizzes	√	All	All		G4	5%	5,9
Course Work	√			P1,P2	G4	10%	6, 11
Report Writing							
Case Study Analysis	√			All	All	5%	12
Oral Presentations							
Practical							
Group Project							
Individual Project							
Others (Specify):							

IX. List of References

Essential Text Books	• Berc Rustem (1998), "Algorithms for Nonlinear Programming and Multiple-Objective Decisions", John Wiley & Sons, U.S.A. • Ching-Lai Hwang & Abu Syed Md. Masud (1979), "Multiple Objective Decision Making Methods and Applications", Springer- Verlag, U.S.A. • Jared L. Cohon (1978), "Multiobjective Programming and Planning" Academic Press, U.S.A. • K. Deb, (2001), "Multi-objective Optimization using Evolutionary Algorithms", John Wiley & Sons, U.S.A
Course notes	• None
Recommended books	• Lee, S. M. (1972): Goal Programming for Decsion Analysis. Philadelphia: Auer Bach Publishers • Miettinen, I. C. (1999): Nonlinear Multiobjective Optimization, Boston: Kluwer • Milan Zeleny (1974), "Linear Multiobjective Programming", Springer-Verlag, U.S.A. • Milan Zeleny (1982), "Multiple Criteria Decision Making", McGraw-Hill Book Company, U.S.A. • Ralph E. Steur (1986), "Multiple Criteria Optimization: Theory, Computation and Application", John Wiley & Sons, Inc, U.S.A. • Vira Chankong & Yacov Y. Haimes (1983), "Multiobjective Decision Making : Theory and Methodology", Elsevier Science Publishing Co., Inc., U.S.A.
Periodicals, Web sites, etc …	• http://www.stanford.edu/~boyd/cvxbook.html • http://www.lionhrtpub.com/orms/ormssurveys.html

X. Facilities required for teaching and learning

- Appropriate teaching accommodation
- Computer lab
- Computer aided data show
- Laptop computer

Course coordinator: Ass. Prof. Tarek H. M. Abou-El-Enien

Head of Department: Prof. Mohamed Mostafa Saleh

Date: January 2015