

## NON LINEAR AND DYNAMIC PROGRAMMING DS 312

### I – Basic Course Information

<u>Programme(s)</u> on which the course is given:	Bachelors in Decision Support
Major or minor element of programmes:	Major
<u>Department(s) offering the programme(s)</u> :	Decision Support Department
<u>Department offering the course</u> :	Decision Support Department
<u>Academic level</u> :	300 Level
<u>Semester in which course is offered</u> :	Second (Spring) Semester
<u>Course pre-requisite(s)</u> :	[Linear and Integer Programming ]
<u>Credit Hours</u> :	3
Contact Hours Through:	
	• Lecture: 3.0
	• Tutorial: 0.0
	• Practical: 1.5
	• Total: 4.5

Authorization date of course specification:

### II – Professional Information

#### 1. Overall Aims of Course

- 1- Introduce the topological properties of convex sets, separation and support of convex sets, polyhedral sets, extreme points and extreme directions , properties of convex functions and minima "maxima" over a convex set.
- 2- Presents algorithms for solving both unconstrained and constrained NonLinear programming problems and the issue of convergence is discussed.
- 3- Discuss penalty and barrier function method for solving NonLinear programming in which the problem is solved as a sequence of unconstrained problems.
- 4- The method of feasible directions and the methods proposed by Zoutendijk are introduced.
- 5- An introduction to multi-stage optimization through Dynamic Programming.
- 6- Treating some mathematical programming problems via Dynamic technique (Linear, Non-Linear, Transportation...).

#### 2. Intended Learning Outcomes of Course (ILOs)

##### a. Knowledge and Understanding

On completing the course students will know and understand

- a1- The methods and theories needed to solve Non-Linear Programming problems.
- a2- The difference between methodologies used to solve Non-Linear programming problems.
- a3- The usage of Dynamic programming to solve Non-Linear programming problems
- a4-

a5-

**b. Intellectual/Cognitive Skills**

The most important intellectual skills developed in the course are

**b1-** To Relate between different theories studied to solve Non-Linear programming problems.

**b2-** To Analyze the theories presented and recognizing its relation with the methods used.

**b3-** To Comprehend and communicate data presented graphically and/or mathematically.

**b4-**

**b5-**

**c. Subject-Specific Practical Skills**

The most useful practical skills, techniques and capabilities developed are

**c1-** To Apply the techniques and theorems in real applications.

**c2-** To Analyze specific data and information to build the mathematical model.

**c3-** To Apply the tools studied concerning Non-linear and Dynamic to solve a real problem (case study).

**c4-**

**c5-**

**d. General and Transferable Skills**

The most important ways a student will learn are

**d1-** To gather data from various sources, including the electronic media, such as internet.

**d2-** To choose a case study from the real world and apply the techniques studied.

**d3-** To be fully responsible for the preparation of the case study and manage the presentation schedule of his/her work.

**d4-** To exercise research skills, such as data collection, tabulation, analysis, report presentation and class discussions.

**d5-**

**3. Course Contents**

	<b>Topic</b>	<b>No. of hours</b>
1-	Convex sets and functions	3
2-	Kuhn-Tucker optimality conditions	3
3-	Lagrangian duality and saddle point optimality conditions	3
4-	The concept of an algorithm	3
5-	Unconstrained optimization	6
6-	Penalty and Barrier functions	3
7-	Method of Zoutendijk and its convergence analysis	3
8-	Dynamic programming: Principle of Optimality, Concepts of state and stage	3
9-	Solution of Discrete Problems through Backward Dynamic Programming	6
10-	Continuous and Multi-stage Dynamic programming	3

	problems.	
11-		
12-		

#### 4. Teaching and Learning Methods

Select method by checking in the box in front of the method, and type the ILOs' codes in the field opposite the method.

Teaching/Learning Method	To teach/learn the following ILO's
<input checked="" type="checkbox"/> Lectures & Seminars	a1,a2,a3,b1,b2,b3,d4
<input type="checkbox"/> Tutorials	
<input type="checkbox"/> Computer-lab Sessions	
<input checked="" type="checkbox"/> Practical lab work	a1,a2,a3,b1,b2,b3
<input type="checkbox"/> Reading Materials	
<input type="checkbox"/> Web-site Searches	
<input type="checkbox"/> Independent Work	
<input type="checkbox"/> Group Work	
<input checked="" type="checkbox"/> Case Studies	c1,c2,c3,d1,d2,d3,d4
<input type="checkbox"/> Presentations	
<input type="checkbox"/> Simulation Analysis	
<input type="checkbox"/> Problem-based Learning	
<input type="checkbox"/> Others (Specify):	

#### 5. Assessment Methods

Select method by checking in the box in front of the method, and type the ILOs' codes in the field opposite the method.

Assessment Method	To assess the following ILO's	Assessment Weight
<input checked="" type="checkbox"/> Unseen Exams	a1,a2,a3,b1,b2,b3,d4	80 %
<input type="checkbox"/> Open book Exam		
<input type="checkbox"/> Take home Exam		
<input checked="" type="checkbox"/> Quizzes	a1,a2,a3,b1,b2,b3,d4	5 %
<input type="checkbox"/> Course Work		
<input type="checkbox"/> Report Writing		
<input type="checkbox"/> Case Study Analysis		
<input type="checkbox"/> Oral Presentations		
<input checked="" type="checkbox"/> Practical	a1,a2,a3,b1,b2,b3	5 %
<input type="checkbox"/> Group Project		
<input type="checkbox"/> Individual Project		
<input checked="" type="checkbox"/> Others (Specify):	Applications. c1,c2,c3,d1,d2,d3,d4	10 %

#### 6. List of References

6.1- Essential books (text books)

1- D. Bertsekas, Dynamic Programming and Optimal Control, Vols. 1 & 2, 2nd ed. Athena Scientific. 2000.

2-D. Bertsekas , Nonlinear Programming: 2nd Edition. Athena Scientific. 1999

3-David M.Himelblan, Applied Non-Linear Programming, Mc GrawHill, 1972

- 4- Mokhtar S. Bazaraa, Non-Linear Programming Theory and Algorithms , JohnWiley & Sons Inc., 1993

6.2- Course notes:

6.3- Recommended books

- 1-Adda, Jerome, and Cooper, Russell, Dynamic Economics. MIT Press, 2003.
- 2-Richard Bellman, Dynamic Programming, Princeton University Press. Dover 2003
- 3-Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, 2nd ed. McGraw-Hill. 2001.
- 4-Nancy Stokey, and Robert E. Lucas, with Edward Prescott, Recursive Methods in Economic Dynamics. Harvard Univ. Press.1989.
- 5-Avriel, Mordecai , Nonlinear Programming: Analysis and Methods. Dover Publishing. 2003
- 6-Nocedal, Jorge and Wright, Stephen J., Numerical Optimization. Springer. 1999

6.4- Periodicals, Web sites, etc ...

- <http://www.stanford.edu/~boyd/cvxbook.html>
- [http://en.wikipedia.org/wiki/Dynamic\\_programming](http://en.wikipedia.org/wiki/Dynamic_programming)
- <http://mat.gsia.cmu.edu/classes/dynamic/dynamic.html>
- <http://plus.maths.org/issue3/dynamic/>
- [http://en.wikipedia.org/wiki/Nonlinear\\_programming](http://en.wikipedia.org/wiki/Nonlinear_programming)
- <http://www-unix.mcs.anl.gov/otc/Guide/faq/nonlinear-programming-faq.html>

## **7- Facilities required for teaching and learning**

Appropriate teaching accomodation , teaching aids, materials, calculator, computer labs, computers

**Course coordinator: Dr. Mohamed Bayoumi**

**Head of Department: Dr. Assem Tharwat**

**Date: August, 2007**