Course Name: Network Optimization
Course Code: DS413

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: First (Fall) Semester
Course pre-requisite(s): 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: September 2014

II. Overall Aims of Course

In this course we present the salient concepts associated with network flows and optimization. Emphasis is placed on algorithm development concepts and proofs of complexity. Problems and application provide a grounding context for the network flow algorithms. In addition, stress is placed on implementation issues and how they affect performance. Key network optimization concepts covered:

- Shortest path algorithms
- Maxflow algorithms
- Mincost algorithms
- Network transformations
- Duality
- Mathematical programs that can be viewed as network problems
- Scheduling using network flow approaches

III. Program ILOs covered by course

Program Intended Learning Outcomes (By Code)			
Knowledge & Understanding	Intellectual Skills	Professional Skills	General Skills
K16,K17,K20	I11,I12,I13,I14	P3,P10,P12,P15	G2,G4,G9

IV. Intended Learning Outcomes of Course (ILOs)

a. Knowledge and Understanding

On completing the course, students should be able to:

K.1 Explain the relationship between classical network optimization problems and linear programming.

K.2 Appreciate how understating the structure of the problem can be exploited to realize more efficient algorithms.

K.3 Illustrate the data structure and implementation issues associated with the main network optimization algorithms.

b. Intellectual/Cognitive Skills

On completing the course, students should be able to:

I.1 Identify a network problem even though it is not originally cast as such.

I.2 Detect flaws and weakness in proofs.

I.3 Assess the reason about why one approach is better than the other for a given problem.

I.4 Solve network problems using the appropriate models.

c. Practical/Professional Skills

On completing the course, students should be able to:

P.1 Understand the merits of algorithmic complexity.

P.2 Devise algorithms to solve network problems.

P.3 Apply network optimization on wide range of problems.

P.4 Demonstrate technical knowledge of Java or Python programming.

d. General and Transferable Skills

On completing the course, students should be able to:

G.1 Demonstrate Report writing abilities.

G.2 Work in teams.

G.3 Acquire problem solving skills.

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-	Network Optimization motivation and historical background	1	K1,K2,K3			
2-	Network terminology and graph theoretic background	1	K1,K2,K3			
3-	Data structures for network representation	2		I1	All	
4-	Shortest path algorithms	3		I1,I2,I3	P1,P2,P3	G1,G2
5-	Max Flow Algorithms	3		I1,I2,I3		G1,G2
6-	Min Cost Algorithms	3		I1,I2,I3		All
	Net Teaching Weeks	**13**				

VI. Course Weekly Detailed Topics / hours / ILOs

Week No.	Sub-Topics	Total Hours	Contact Hours	
			Theoretical Hours	Practical Hours*
1	Network Optimization motivation and historical background	2.5	2.5	
2	Network terminology and graph theoretic background	4	2.5	1.5
3	Data structures for network representation	4	2.5	1.5
4	Data structures for network representation	4	2.5	1.5
5	Shortest path algorithms	4	2.5	1.5
6	Shortest path algorithms	4	2.5	1.5
7	**Midterm Exam**			
8	Shortest path algorithms	4	2.5	1.5
9	Max Flow Algorithms	4	2.5	1.5
10	Max Flow Algorithms	4	2.5	1.5
11	Max Flow Algorithms	4	2.5	1.5
12	Min Cost Algorithms	4	2.5	1.5
13	Min Cost Algorithms	4	2.5	1.5
14	Min Cost Algorithms	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	√	K1,K2,K3	I1,I2,I3		All
Tutorials					
Computer lab Sessions					
Practical lab Work					
Reading Materials	√	K1,K 2,K3			
Web-site Searches	√				All
Research & Reporting					
Problem Solving / Problem-based Learning	√		I1,I2,I3	All	
Projects					
Independent Work					
Group Work	√			All	G2
Case Studies					
Presentations					
Simulation Analysis	√			All	G1
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	√	K1,K2,K3				20%	7
Final Exam	√	K1,K2,K3	I1,I2,I3		All	60%	15
Quizzes							
Course Work	√		I1,I2,I3	All	All	20%	12
Report Writing							
Case Study Analysis							
Oral Presentations							
Practical							
Group Project							
Individual Project							
Others (Specify):							

IX. List of References

Essential Text Books	• Ahuja, Magnanti, and Orlin. Network Flows: Theory, Algorithms and Applications. Prentice-Hall 1993.
Course notes	• Powerpoint slides
Recommended books	• D. P. Bertsekas, Network Optimization: Continuous and Discrete Models. Athena Scientific, 1998.
Periodicals, Web sites, etc …	• http://groups.yahoo.com/group/CUNetFlow

X. Facilities required for teaching and learning

List the facilities required
- Computer projector

Course coordinator: Ass. Prof. Mohammed El-Beltagy

Head of Department: Prof. Mohamed Mostafa Saleh

Date: September 2014