IST, Technical University of Lisbon
Department of Chemical and Biological Engineering

"Athens" Spring course 14.th March, 2008

OPERATIONAL RESEARCH

Exam (simulated)

Duration: 02 hours 30 minutes. *Type:* "open book" exam with computer.
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Instructions
(1) Present your answers in an Excel file or other, as needed. In the end: if you have not used any paper, at least leave a **sheet with your name** on it; and **send your file(s)** to ***mcasquilho@ist.utl.pt*** and to the course e-mail account at ***athenslisbon@yahoo.co.uk***, for security (empty message with your name as subject). You may go to Yahoo to send the messages. **(2)** Below, references may be made to the ***c***ourse ***w***eb***p***age (CWP), which is at *http://web.ist.utl.pt/mcasquilho/acad/or/*. **(3)** If other entities' Internet pages or sources are used, cite them.

1) *(Short answers)*

a) How can an LP program work with free sign variables ?

b) Who discovered the simplex method for LP ?

c) "In the Monte Carlo 'inversion' method, the only function (of the random variable to be simulated) that is needed is the density." True or false ?

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3) A company, with maximum profit as its objective, can manufacture certain products, with known *unit profits*, in *quantities* to be determined, respectively, P and X, both with elements $i = 1..4$. It is assumed that $P = (5, 5, 5, 5)$. The technological or other conditions to be met are: 1) for safety, the total of 1 and 2 cannot exceed the total of 3 and 4; 2) for fiscal reasons, the total of 3 and 4 has to be at least 80 % of the whole production; 3) the market absorbs no more than 300 units of the total of products 3 and 4.

a) Formulate the problem.

b) Solve the problem with the Excel Solver.

c) Put the problem in the standard form and use a convenient program to solve it.

d) Consider now that the profit of product 3 decreases (becoming its negative). What happens ?

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4) Cylindrical cans are filled with exactly 1 L (1 000 cm^3) of a liquid. Their diameter, d, varies randomly with a triangular density in the interval 9.0 ± 0.3 cm. Find the probability that the height of the liquid is below 15.2 cm in the following steps.

a) Simulate the filling of 100 cans.

b) Classify the values of d in 7 classes. Determine their accumulated values. With the classified values, make a histogram. From the accumulated values, find the probability as mentioned.

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5) A queue, working with one server, shows an average length of $L_q = 8.4$ and causes an average wait of $W_q = 12$ min.

a) Calculate its parameters.

b) For the same arrival rate, calculate the service rate that reduces W_q to half the previous value.

c) Determine the minimum service rate for the same arrival rate.

d) Compare the cost of the system with *one* and *two* servers for costs of C_s = 66 € / server / day, with 1 day = 12 h, and C_w = 8 € / hour.

e) Calculate L_q for a new number of two servers.

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Marks:	**1)**	1,5	(3 × 0,5)	7,5 %
	2)	3	(1+1+1)	15 %
	3)	5	(1+2+1+1)	25 %
	4)	5,5	(2,5+3)	27,5
	5)	5	(1+1+1+1+1)	25 %
	Total	***20***		***100*** %

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