Otto-von-Guericke-University Magdeburg
Faculty of Economics and Management
- Management Science -
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Test
Production Management & Operations Research (11072)
January 30, 2013

Last name: ..... **First name: .....** **Matriculation No.: .....**

Examination: Production Management & Operations Research WS 2012/2013
Examiner: Prof. Dr. G. Wäscher

General remarks:

1. Write your name and matriculation number on this cover sheet and on every other sheet that has been issued to you.
2. Leave a minimum of 4 cm as correction space on the outside margin of each page.
3. Make sure that you have a complete copy of the test. The test consists of **7 assignments**, all of which have to be dealt with. It is not permitted to remove the retaining clip; doing so will be treated as fraudulent behaviour.
4. Please write legibly and number the pages which have been used. For each assignment, put down your answers on a separate sheet. Only pens with permanent ink may be used, while correction pens or ink erasers are not permitted. Make sure that you don't write in red.
5. Always make clear how you have determined your solution (solution path). Isolated solutions without traceable origin will not be accepted.
6. The following aids may be used: writing utensils, non-programmable pocket calculators without communicating and/or data processing functions, dictionaries (without any added remarks only).

Assignment 1 (10 points)

Short Questions (questions 1-5): Answer the questions in short! You do not need to write complete sentences – keywords are sufficient. (**Two** points for each completed question.)

1) Let the following simplex tableau be given, which represents an optimal solution for the following objective function: $x_0 = 5x_p + 4x_c$.

   Carry out a sensitivity analysis for the objective function coefficient of x_p!

x_0	x_p	x_c	s_1	s_2	s_3	s_4	s_5	RHS
0	1	0	0	$-\frac{1}{2}$	0	$\frac{5}{3}$	0	1200
0	0	0	1	$\frac{1}{2}$	0	$-\frac{5}{3}$	0	400
0	0	0	0	$-\frac{1}{2}$	1	$-\frac{2}{3}$	0	200
0	0	1	0	1	0	0	0	900
0	0	0	0	$-\frac{3}{20}$	0	$-\frac{1}{3}$	1	240

2) Give a definition of "primary demand" and "secondary demand" as they are used in the Gozinto-Graph-based determination of total demands!

3) The classic EOQ model is based on several assumptions. Name six of these assumptions!

4) Give a definition of the shadow price of a constraint!

5) Give a definition of the opportunity costs of a constraint!

Assignment 2 (14 points)

A company buys a particular component from a supplier. The corresponding demand for the forthcoming six months (planning period) has been predicted as follows:

month [t]	1	2	3	4	5	6
demand [n_t]	50	40	100	80	50	60

The retailer wants to determine the number of items he has to order from the manufacturer in each month. The ordering costs per order (ordering cost rate) amount to 800 monetary units (MU). The holding costs per stored item unit and month (holding cost rate) have been determined as 4 MU.

The following assumptions can be considered appropriate:

- Ordered items are received at the beginning of each month and can be processed without delays. Likewise, stored items can only be retrieved from the warehouse at the beginning of each month.
- Inventory at the beginning of the total planning period is zero. Inventory at the end of the total planning period is required to be zero. No other inventory constraints apply.

a) Give a general formulation of the cut-off criterion of the Silver-Meal heuristic!

b) Determine an ordering policy by means of the Silver-Meal heuristic!

c) For this policy, also give the corresponding holding, ordering and total costs of the planning period!

Assignment 3 (18 points)

A company produces and sells four products P1, P2, P3, and P4. The time capacity of the factory is limited to 500 time units in total per planning period. All other relevant facts are included in the following table:

	product			
	P1	P2	P3	P4
sales price [€ / product unit]	8	5	10	8
variable costs [€ / product unit]	7	6	9	4
processing time per unit [time units / product unit]	2	1	2	1
minimum sales quantity [product units / period]	30	40	20	0
maximum sales quantity [product units / period]	100	100	100	80

The company wants to determine a product mix that maximises the profit for this period.

a) Develop a model from which an optimal product mix can be determined! Do not forget to define the symbols used!

b) Develop at least two optimal solutions of the above problem and determine the corresponding profit contribution! (Hint: Do **not** use linear programming!)

Assignment 4 (20 points)

A production manager is about to plan the sequence according to which five production orders (A, B, C, D, E) should be manufactured on four production stages (#1, #2, #3, #4). The following table represents the corresponding operation times on each production stage (all data given in time units):

production order	operation time at production stage			
	#1	#2	#3	#4
A	4	6	6	2
B	3	9	5	1
C	3	7	5	4
D	2	10	4	3
E	4	6	8	3

The sequence of the production stages in which the orders are to be processed is identical for all orders. Splitting of orders is not permitted. All orders are available from the start. Overtaking of orders is not possible due to technical reasons!

a) Determine an order sequence by application of Johnson's Algorithm! Give the sequence and the corresponding cycle time!

b) Give general definitions of the terms "cycle time" and "capacity utilization"! Also determine the corresponding value for each of them!

c) Determine the waiting time for order A!

d) What can be said about the optimality of the obtained solution? Explain your answer!

Assignment 5 (18 points)

The following table lists the work elements that have to be performed on an assembly line in order to provide a final product. Furthermore, the corresponding operation times (in seconds) and the immediate predecessors of each work element have been given.

work element i	operation time t_i [sec]	direct predecessor(s)
1	32	-
2	48	-
3	40	2
4	27	1, 2
5	13	1, 3
6	43	3
7	49	5, 4
8	48	6, 7

The desired output rate is 30 units per hour and the goal is to minimize the number of work stations needed.

a) What is the maximal cycle time, which cannot be exceeded if 30 units are to be produced per hour?

b) Give a lower bound on the number of work stations for the desired output rate?

c) Plot the corresponding precedence diagram for the precedence relationships given in the above table!

d) Assign the work elements to stations according to the method of Helgeson and Birnie!

e) How many work stations are necessary? Also determine the total idle time and the capacity utilization of this solution!

f) What can be said about the optimality of the obtained solution? Explain your answer!

Assignment 6 (6 points)

The following list of activities gives the structure of a project. The first column lists the activities and the second column denotes the corresponding **direct predecessors**.

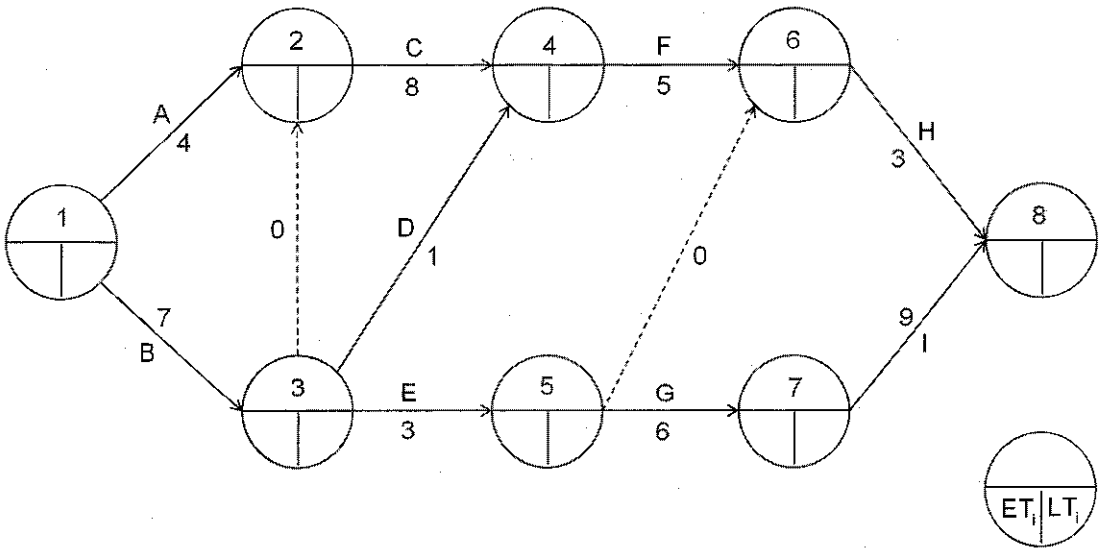
activity	direct predecessors
A	-
B	A
C	A
D	B
E	B, C
F	B
G	C
H	E, G
I	G
J	D
K	F, J

Draw an activity-on-arc network that represents the project structure! Minimize the number of dummy activities and the number of arc intersections!

Assignment 7 (14 points)

The following activity-on-arc network represents a project. Names and durations of the activities are depicted on the arcs.

a) Determine the earliest time of occurrence (ET_i) and the latest time of occurrence (LT_i) for each of the events 1 – 8!
Use the network given below in order to present your results!



b) For each activity, determine the earliest start time (EST) and the latest start time (LST), the earliest finishing time (EFT) and the latest finishing time (LFT), and the total slack (TS), the free slack (FS) and the independent slack (IS)!
Use the tableau given below in order to present your results!

	duration	EST	EFT	LST	LFT	TS	FS	IS
A	4							
B	7							
C	8							
D	1							
E	3							
F	5							
G	6							
H	3							
I	9							

c) Identify the critical path(s)! Why is it important to know the critical path(s) of a project?