Otto-von-Guericke-University Magdeburg
Faculty of Economics and Management
- Management Science -
Prof. Dr. Gerhard Wäscher

Test

Production Management & Operations Research (5074)

July 9, 2010

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

Examination: Production Management & Operations Research SS 2010
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 **6 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 (16 points)

Short Questions (questions 1-8): Answer the questions in short! You do not need to write complete sentences – keywords are sufficient. (**Two** points for each completed question.)

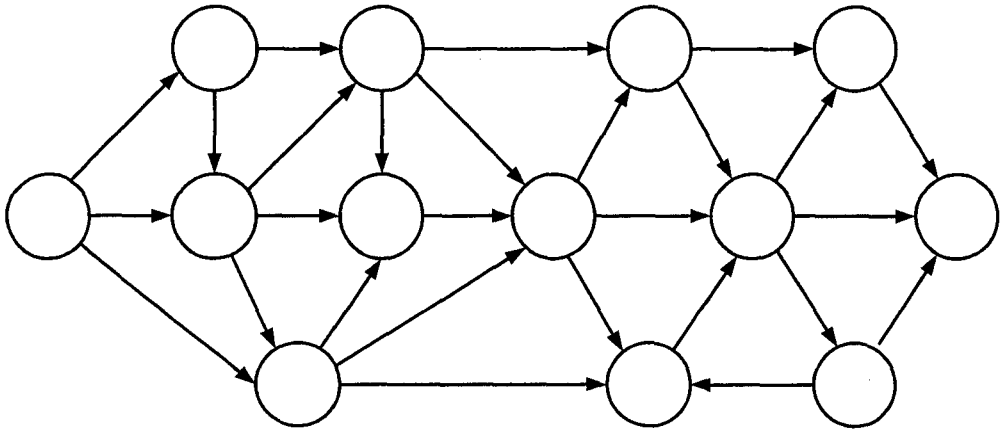
1) A competitive advantage needs certain characteristics to be called a strategic competitive advantage. Name the three attributes that make a competitive advantage a strategic one! According to Porter a competitive advantage can stem from two strategies, name these strategies!

2) Sketch the graph of the experience curve and describe the functional relationship between the independent and the dependent variable!

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

4) The classic EOQ model requires several assumptions under which the optimal lot-size can be derived. Name six assumptions!

5) If possible, number the nodes of the following graph in a topological order!



6) In general, capacity supply and demand may be balanced either by increasing the capacity supply or by reducing the capacity demand. Name three short-term means for the reduction of capacity demand!

7) Let the following simplex tableau be given, which represents an optimal solution for the following objective function: $x_0 = 200x_M + 250x_W$.
Carry out a sensitivity analysis for the objective function coefficient of x_M!

x_0	x_M	x_W	s_1	s_2	s_3	s_4	RHS
0	0	1	$\frac{1}{5}$	$-\frac{1}{15}$	0	0	440
0	1	0	$-\frac{1}{5}$	$\frac{1}{10}$	0	0	560
0	0	0	$\frac{1}{5}$	$-\frac{1}{10}$	1	0	240
0	0	0	$-\frac{1}{5}$	$\frac{1}{15}$	0	1	860

8) In order sequencing, one class of possible goals is related to capacity utilization. Name two capacity utilization-oriented goals and give the corresponding definitions! Do not forget to define all the symbols properly which you have to introduce!

Assignment 2 (17 points)

A company that produces and sells four products (P1, P2, P3, and P4) wants to determine the product mix which maximizes the profit for a particular planning period. The time capacity of this period is limited to 600 time units in total. All the other relevant facts are included in the following table:

	P1	P2	P3	P4
contribution margin [€ / product unit]	4	3	5	-1
processing time per unit [time units / product unit]	2	2	2	1
minimum sales quantity [product units / period]	0	0	50	40
maximum sales quantity [product units / period]	100	100	75	75
set-up time [time units / set-up]	30	40	70	50
(variable) set-up costs [€ / set-up]	100	150	200	40

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

b) Develop an optimal solution of the problem above and calculate the corresponding profit contribution! Demonstrate explicitly how you have derived your solution! (Hint: Do **not** use linear programming – just analyse the problem thoroughly!)

c) Determine the opportunity costs of the time capacity constraint!

Assignment 3 (16 points)

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

month [t]	1	2	3	4	5	6	7	8
demand [n_t]	50	40	100	80	50	60	40	70

The costs of placing one order (ordering cost rate) are 800 €, the holding costs amount to 4 € per month for each stored product unit (holding cost rate).

The following assumptions are feasible:

- Ordered products are received at the beginning of each month and can be processed without delays. Likewise, stored products 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 planning period is required to be zero. No other inventory restrictions apply.

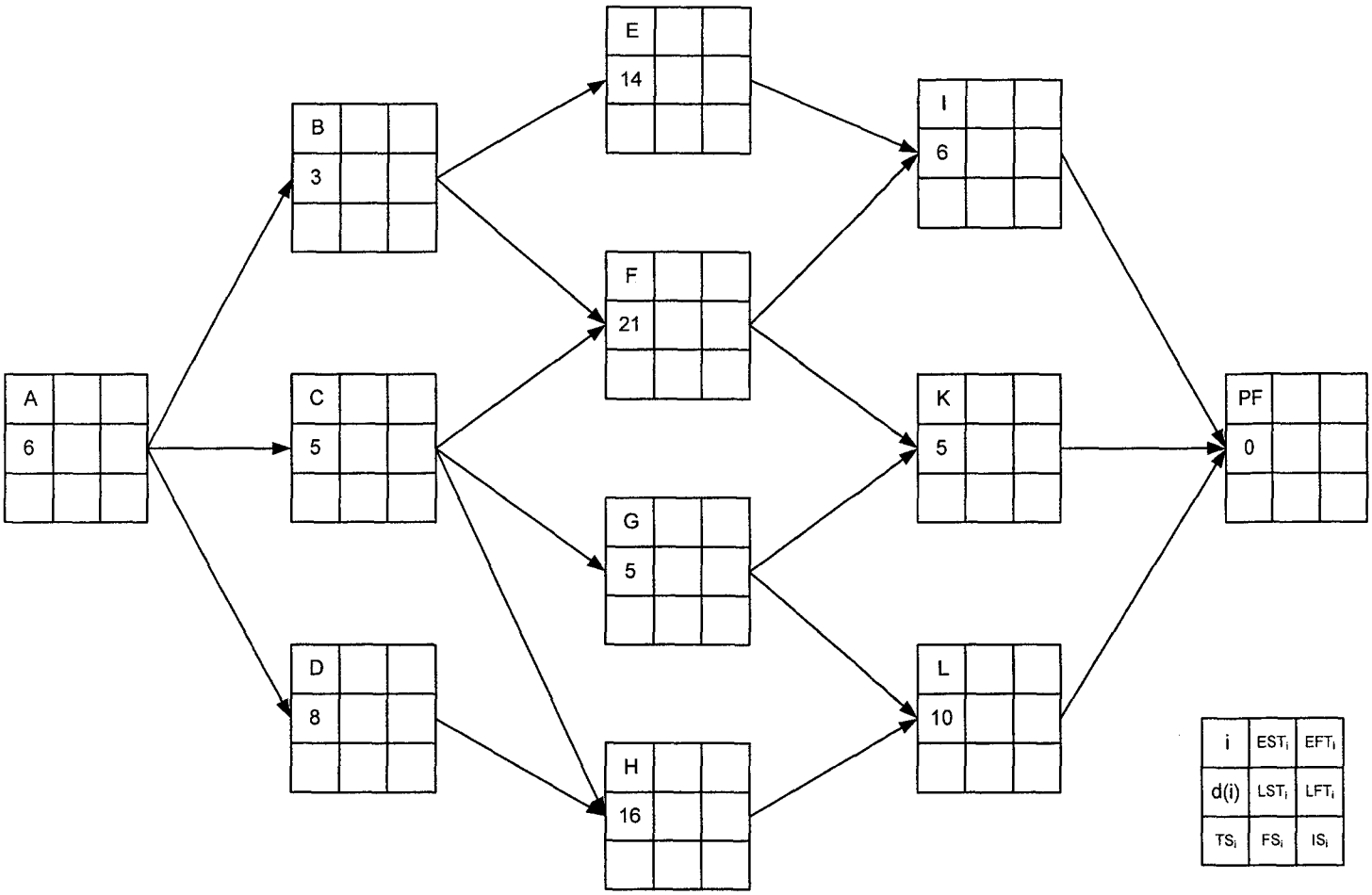
a) Give a general formulation of the cut-off criterion of the least-unit-cost-heuristic!

b) Determine an ordering policy by means of the least-unit-cost-heuristic!
For this policy, also give the corresponding holding, ordering and total costs of the planning period!

c) Give a general formulation of the cut-off criterion of the part-period heuristic!
Explain the rationale behind it! (Hint: The cut-off-criterion is derived from a property of the EOQ-model.)

Assignment 4 (14 points)

The following activity-on-node network represents a project.



a) For each activity, determine the earliest and latest start time, the earliest and latest finish time, and the total, free and independent slack!
Use the network given above to present your results!

b) Identify the critical path(s)! Why is it important to know the critical path(s)?

c) Transform the activity-on-node network given above into an activity-on-arc network! Do **not** perform the calculations again!

Assignment 5 (21 points)

A production manager is about to plan the sequence according to which four orders (A, B, C, D) should be manufactured on four production stages (1, 2, 3, 4). The following table represents the corresponding processing times (in hours):

production stage / production order	(1)	(2)	(3)	(4)
A	5	8	11	9
B	3	9	10	5
C	5	10	6	6
D	7	2	3	11

The sequence of production stages (1, 2, 3, 4) is identical for all orders. Splitting of orders is not permitted.

Assume that all orders are available when manufacturing will be started (t=0)! Further assume that orders can pass each other!

a) Determine an order sequence for the sequencing problem by means of the Shortest Operation Time-Rule (SOT)! Plot the corresponding GANTT-Chart!

b) Determine the corresponding cycle time, the average processing time, the capacity utilization, the total idle time and the waiting time of order A!

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

d) Consider the following statement:

"In order sequencing, for a given set of orders, the minimization of the average order processing time and the minimization of the total waiting time of all orders are equivalent goals."

Give a general proof for this statement! Do not forget to define all the symbols properly which you have to introduce!

Assignment 6 (16 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 minutes) and the immediate predecessors of each work element have been listed.

work element i	operation time t_i [min]	direct predecessor(s)
1	6	-
2	8	1
3	10	1
4	3	2
5	6	3
6	7	3
7	5	5
8	5	5, 6
9	8	4, 7
10	9	8, 9

The desired output rate is 4 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 4 units are to be produced per hour?

b) What is the theoretical minimum 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!