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

End-Term Test
Production Management & Operations Research (5074)
July 17, 2009

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

Examination: Production Management & Operations Research SS 2009
Examiner: Prof. Dr. G. Wäscher

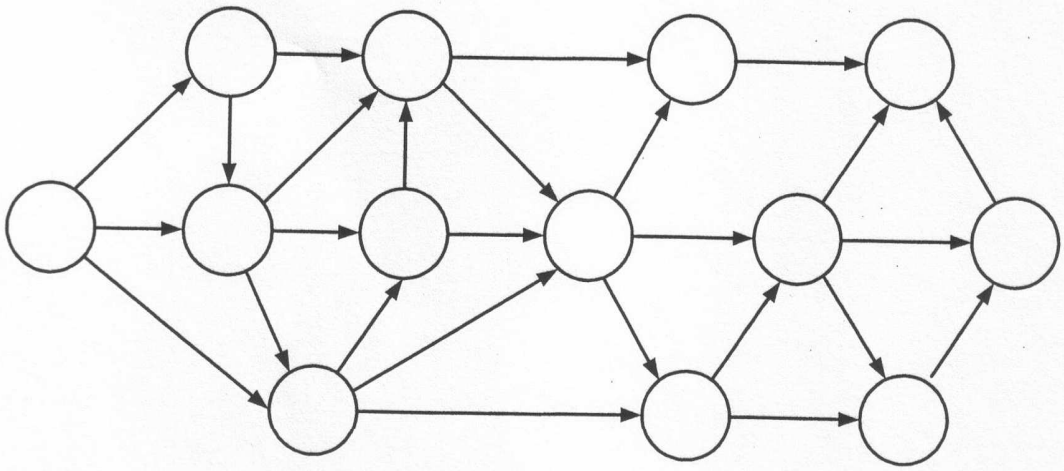
General remarks:

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 **4 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 **(8 points)**

Short Questions (questions 1-4): Answer the questions in short! You do not need to write complete sentences – keywords are sufficient. (**Two** points for each completed question.)

1) Number, if possible, the nodes of the following graph in a topological order from 1 to 13!



2) 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 by which the capacity supply can be increased!

3) One class of possible goals in order sequencing is related to due-date-oriented goals. Name two goals of this class and give the corresponding definitions! Do not forget to define all the symbols properly which you have to introduce!

4) The same machine type is needed for the production of five orders (A,B,C,D and E). How many machines of this type will you need if the orders are to be produced on time and in accordance with the following activity schedule? Explain your answer!

	EST	EFT	LST	LFT
A	0	4	6	10
B	0	7	3	10
C	0	5	5	10
D	0	6	4	10
E	0	3	7	10

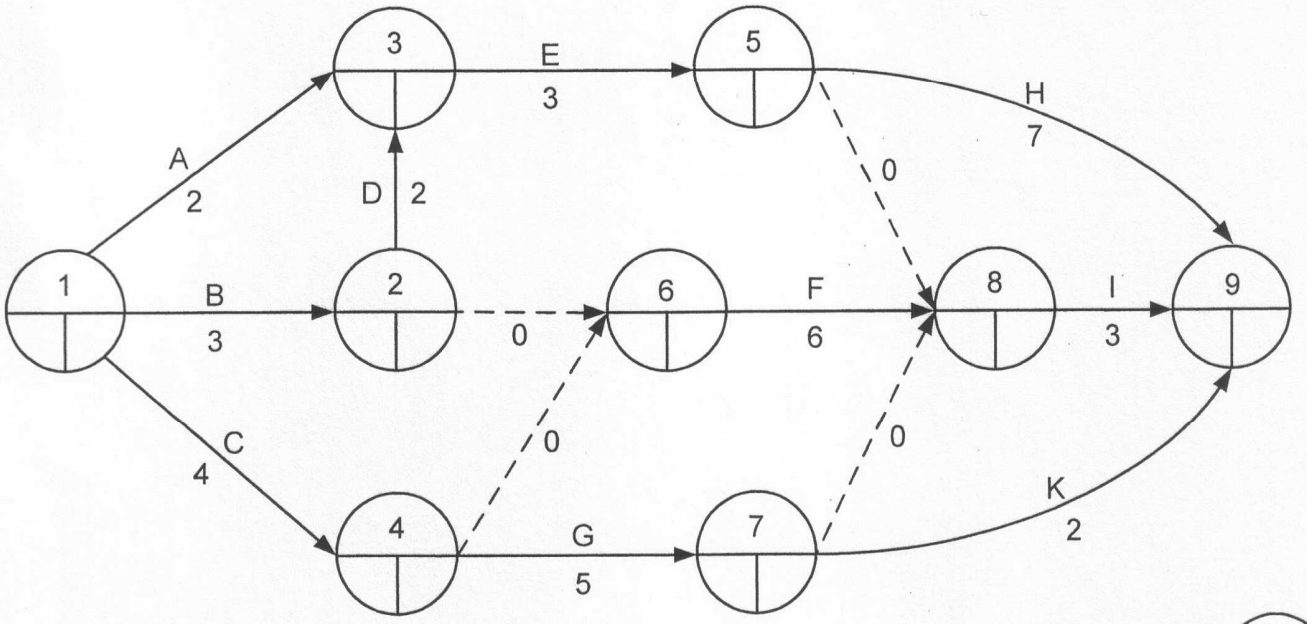
EST: earliest start time
EFT: earliest finishing time
LST: latest start time
LFT: latest finishing time

Assignment 2 (12 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 – 9!

Use the network given below in order to present your results!



b) For each activity, determine the earliest and latest start time, the earliest and latest finishing times, and the total and independent slacks!

	duration	EST	EFT	LST	LFT	TS	IS
A	2						
B	3						
C	4						
D	2						
E	3						
F	6						
G	5						
H	7						
I	3						
K	2						

Assignment 3 (10 points)

A company manufactures five types of products in a three-stage production process. The operation times of the corresponding production orders (A, B, C, D and E) on the different stages are given in the table below.

production stage / production order	(1)	(2)	(3)
A	4	1	5
B	5	2	1
C	4	3	3
D	2	2	4
E	4	2	2

The sequence of the stages, which the orders have to pass through, is identical for all orders. Overtaking of orders is not permitted due to technical reasons.

The production manager wants to know in which sequence the orders should be processed in order to minimize the cycle time.

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

b) Plot the corresponding GANTT-Chart!

c) Determine the waiting time for order A!

d) Determine the total idle time!

Assignment 4 (15 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	2	-
2	2	-
3	6	1
4	9	1
5	5	2, 4
6	7	3
7	4	4, 5, 6
8	3	5
9	5	7, 8

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?