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

End-Term Test
Production Management & Operations Research (11072)
July 15, 2011

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

Examination: Production Management & Operations Research SS 2011
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 (14 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	3	6	2	6
B	5	4	8	2
C	4	6	5	2
D	2	5	5	3
E	6	3	4	4

The sequence of the production stages according to which the orders are to be processed, namely #1, #2, #3, #4, is identical for all orders. Splitting of orders is not permitted.

Assume that the orders A, B and C are available when manufacturing will be started at t = 0! The orders D and E will become available at t = 5! 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)!

b) Determine the corresponding cycle time, the average processing time and the waiting times of the orders C and E!

c) Determine the capacity utilization and the idle time of stage #4!

Assignment 2 (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 minutes) and the immediate predecessors of each work element have been listed.

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

The desired output rate is 5 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 5 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!

g) As known from the mathematical formulation of the assembly line balancing problem, every feasible solution has to fulfill the cycle time restrictions. Formulate the cycle time restrictions for the work stations 2 and 3 in an explicit way! Demonstrate that the obtained solution from d) complies with these restrictions!

Assignment 3 (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 successors**.

activity	direct successors
A	D, E
B	C, F
C	E
D	G
E	G, H
F	-
G	-
H	-

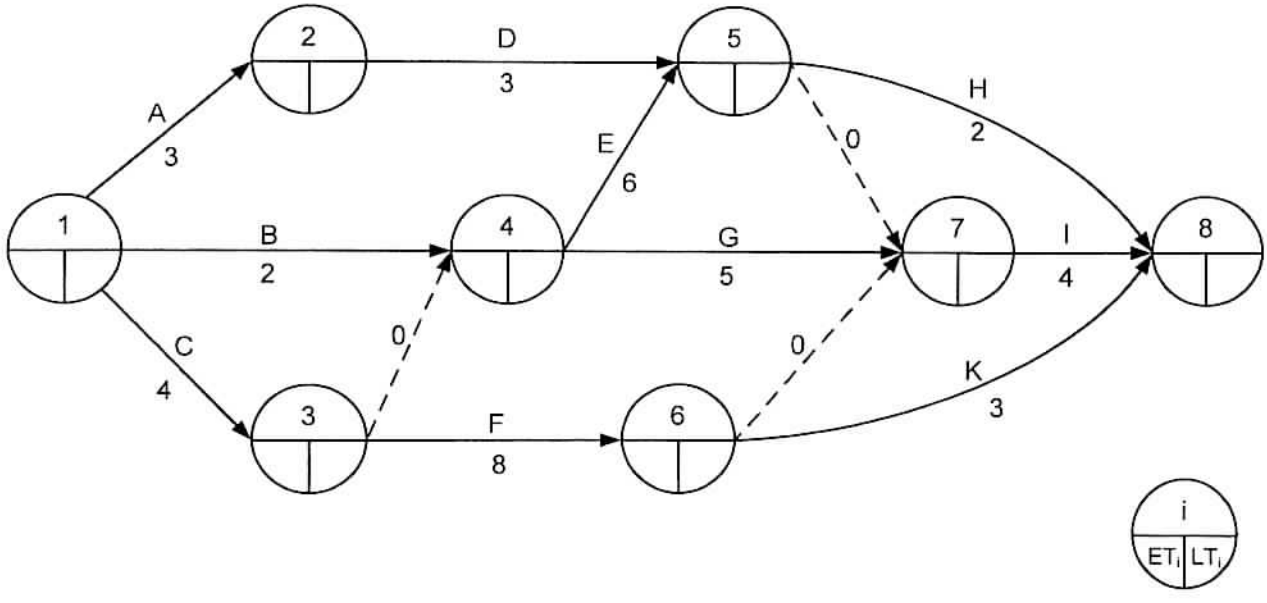
Draw an activity-on-arc network that represents the project structure! Minimize the number of dummy activities and the number of arc intersections!

Assignment 4 (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 – 8!

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	3						
B	2						
C	4						
D	3						
E	6						
F	8						
G	5						
H	2						
I	4						
K	3						

c) Identify the critical path(s)!