End-Term Test

Production Management & Operations Research (11072)

July 20, 2012

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

Examination: Production Management & Operations Research   SS 2012

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 four production orders (A, B, C, D) should be manufactured on five production stages (#1, #2, #3, #4, #5). 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	#5
A	2	8	3	3	4
B	5	3	8	1	2
C	3	7	5	3	5
D	4	5	10	2	8

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. Further assume that orders may pass each other!

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

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

c) Determine the idle time of stage #4!

d) Determine the waiting time of order B!

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

work element i	operation time t_i [sec]	direct predecessor(s) of i
1	32	-
2	28	-
3	37	1, 2
4	30	2
5	15	1, 3
6	43	3, 4
7	48	6
8	47	5, 7

The desired output rate is 40 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 40 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 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 predecessors**.

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

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   (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 – 7!

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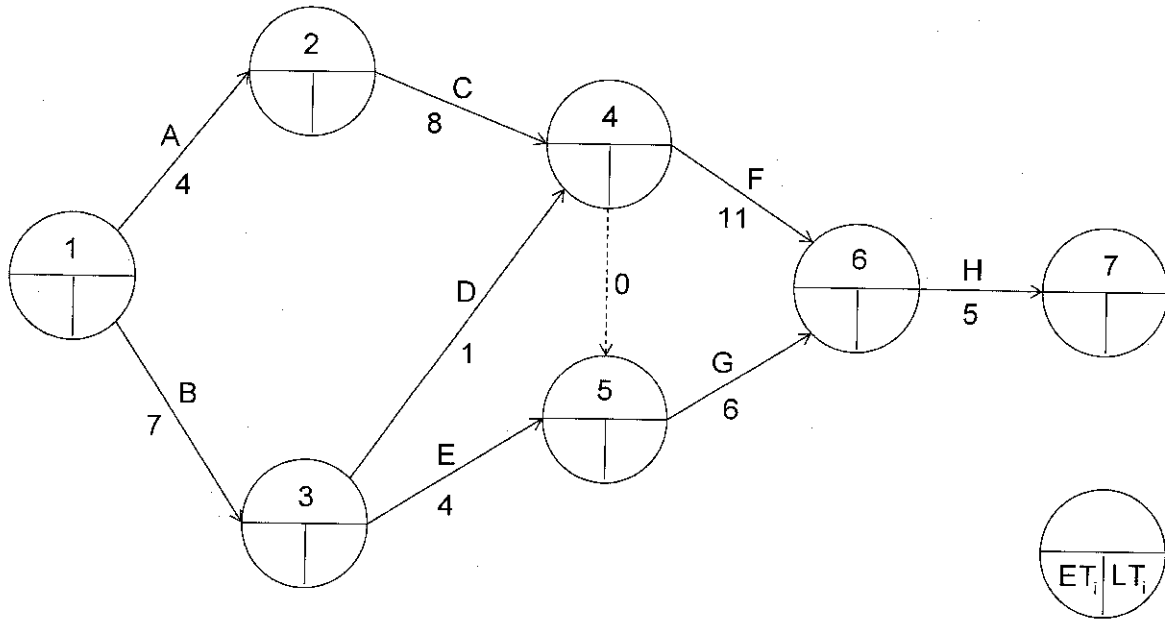
b) For each activity, determine the earliest start time (EST) and the latest start time (LST), the earliest finishing time (EFT) and the latest finishing time (LFT), and the total slack (TS), the free slack (FS) and the independent slack (IS)!

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	4							
F	11							
G	6							
H	5							

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