OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
FAKULTÄT FÜR WIRTSCHAFTSWISSENSCHAFT

LEHRSTUHL FÜR
BETRIEBSWIRTSCHAFTSLEHRE, INSBES.
MANAGEMENT SCIENCE

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End-Term Exam

Production Management & Operations Research (11072)

July 19, 2013

Name:..... Matriculation No:.....

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** (7 pages), 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 (12 Points)

Answer the following questions in short! You do not need to write complete sentences – keywords are sufficient. Insert your answers into the provided spaces and diagrams!

a) Let a dynamic lot sizing problem with six sub-periods, an ordering cost rate (cost per order) of 100 €, and a holding cost rate (cost per product unit and sub-period) of 5 € be given. The following table represents the demand in each sub-period and a solution to this problem:

sub-period	1	2	3	4	5	6
demand	50	20	10	70	45	30
order quantity	80	0	0	70	75	0

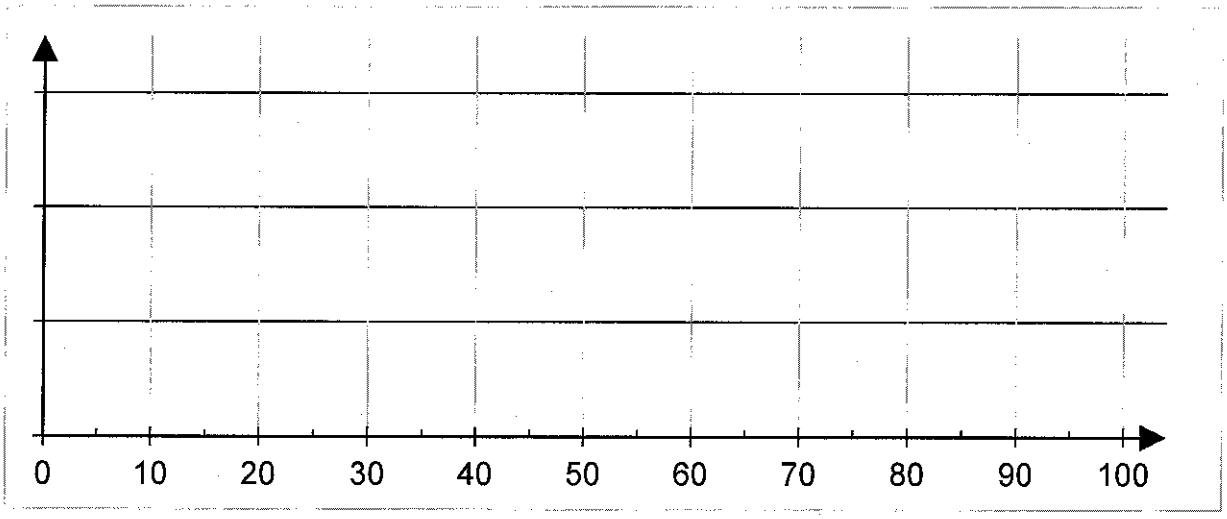
Determine the total ordering costs and the total holding costs for this solution!

b) Name three types of goals which can be distinguished in production order sequencing!

c) Let an order sequencing problem with three orders (A, B, C) and three production stages be given. The sequence according to which these orders are to be processed on each stage is B – C – A. The operation times are given in the following table:

production stage / production order	(1)	(2)	(3)
A	40	5	25
B	10	20	20
C	15	30	10

Plot the corresponding GANTT-Chart and indicate the cycle time!



d) What is the critical path of a project? Give a definition!

e) The following table lists the work elements that have to be performed on an assembly line and the immediate predecessors of each work element:

work element	direct predecessor(s)
1	-
2	1
3	1
4	2, 3
5	2, 3
6	4, 5

The objective is to assign work elements to work stations such that the number of work stations is minimized. Determine the number of variables (without the objective function value) and the number of constraints (without binary constraints) which are needed in order to formulate this problem as a mathematical model! Use 3 work stations as an upper bound on the number of work stations.

Assignment 2 (10 Points)

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

production stage / production order	(1)	(2)
A	40	10
B	25	20
C	25	15
D	10	15
E	25	30
F	5	20

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 the order sequence which minimizes the cycle time.

a) Determine an order sequence by application of Johnson's Algorithm!
b) Determine the corresponding cycle time, the total idle time, and the capacity utilization!
c) What can be said about the optimality of the obtained solution? Explain your answer!

Assignment 3 (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 listed.

work element	operations time [seconds]	direct predecessor(s)
1	60	-
2	20	1
3	70	1
4	10	2
5	20	2
6	30	2, 3
7	20	4, 5, 6

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

a) What is the maximal cycle time, which cannot be exceeded if 30 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 graph for the precedence relationships given in the above table!
d) Assign the work elements to stations according to the method of Helgeson and Birnie! How many work stations are necessary? Also determine the total idle time and the capacity utilization of this solution!
e) What can be said about the optimality of the obtained solution? Explain your answer!
f) As known from the mathematical formulation of the assembly line balancing problem, every feasible solution has to fulfill the sequencing constraints. Formulate the sequencing constraints for the relationship between work element 6 and its direct predecessors in an explicit way! Demonstrate that the obtained solution from d) complies with these constraints!

Assignment 4 (10 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	F, H
C	E, F
D	-
E	I, K
F	G
G	I, K
H	-
I	-
K	-

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

b) What is the independent slack of an activity? Give a definition!