# Production and Operations Management

## Regular Period Exam

**June 15, 2022, noon – 2h30 p.m. | Wednesday**

**NAME** _____

**STUDENT NUMBER** _____

**This is a closed book exam lasting 2 hours and 30 minutes, exactly.**

**Before you start, please read carefully the instructions below and follow them.**

1. *During the examination time stated above, you are not allowed to leave the classroom, including visits to the bathroom.*
2. In the event you wish to drop the exam, you must return this set of questions to the instructor. The instructor will append the note *"dropped"*.
3. This exam is a collection of stapled A4 pages numbered on the upper right corner and printed on both sides. Please do not remove the staple.
4. Use of smart phones, headphones or laptops is prohibited. Do not share your hand calculator with your classmates.
5. Utilization of smartphone functionalities (voice, image, audio, calculator, watch, messages) is strictly prohibited.
6. The only material you are allowed to keep on your desk is this test, tables and formulae, hand calculator, pen or pencil, eraser and a valid pictured ID document.
7. Please organize your answers. Whenever deemed appropriate, use tables to show calculations and/or results. In the event you are asked to provide your advice, opinion or recommendation, please phrase it based upon quantitative values you found. Show your calculations.
8. Multiple choice questions you respond correctly will be graded the points shown in front of it; wrong answers will penalize you with the equivalent negative number of points shown in front of it. Questions left unanswered or answered with confused or multiple paragraphs selected making impossible a clear-cut identification of one single answer, will be graded with zero points.

[2]

## SECTION I

**1. (0.5 points).** The seven basic TQM tools are grouped in the following three categories:

(a) Tools for generating ideas; tools for organizing the data; tools for identifying problems.
(b) Tools for generating ideas; tools for organizing information; tools for eliminating problems.
(c) Tools to manage professional training; tools for organizing problems; tools for detecting the data.
(d) Tools for maximizing ideas; tools to map mindsets; tools for dropping problems.

**2. (0.5 points).** One of the following is not a process strategy. Circle it:

(a) Repetitive process.
(b) Product focus.
(c) Mass customization.
(d) Environment focus.

**3. (0.5 points)** Johnson's rule:

(a) Designed to schedule n/1 problems.
(b) Minimize average job lateness.
(c) Minimize total processing time.
(d) None of the above.

**4. (0.5 points)** One of the following statements is FALSE. Circle it:

(a) The simplest queuing model is made up of one waiting line and one server.
(b) The simplest queuing model is made up of 1 sever, only.
(c) Average time a customer spends in a queuing system is the sum of average waiting time and average service time.
(d) On average, 4 customers arrive at M/M/1 every 30 minutes, therefore, the average time between arrivals is 7,5 minutes.

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**SECTION II**

Consider the following online Marketplace project (time durations in days):

| **Activity** | **A** | **B** | **C** | **D** | **E** | **F** | **G** |
|---|---|---|---|---|---|---|---|
| Predecessor | - | - | A | B | B | C, D | E, C, D |
| Optimistic time | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| Most probable time | 2 | 1 | 4 | 3 | 2 | 3 | 5 |
| Pessimistic time | 3 | 1 | 6 | 4 | 3 | 5 | 9 |

1. **(1.5 points)** Draw the network and find the total slack for activity E.

2. **(1.5 points)** Find the probability the project is completed 2 or more days prior the estimated date.

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**SECTION III**

(3 points) DRONE.TECH is a Japanese company that produces drones, among them the DRONE 4DRC F11 6K, which has an annual demand of 55,200 drones. At its manufacturing plant in Osaka the company produces drones DRONE 4DRC F11 6K at a rate of 1,600 drones per week. The holding cost per drone per year is 50 euros, and the setup cost is 150 euros per production run. The company currently produces lots of 11,040 drones in each production run. Assume that the company works 250 days per year, 50 weeks.

**1.** a) Taking into account the lot size used by DRONE.TECH:

**1.1 (1 point**) **Determine the annual holding cost.**

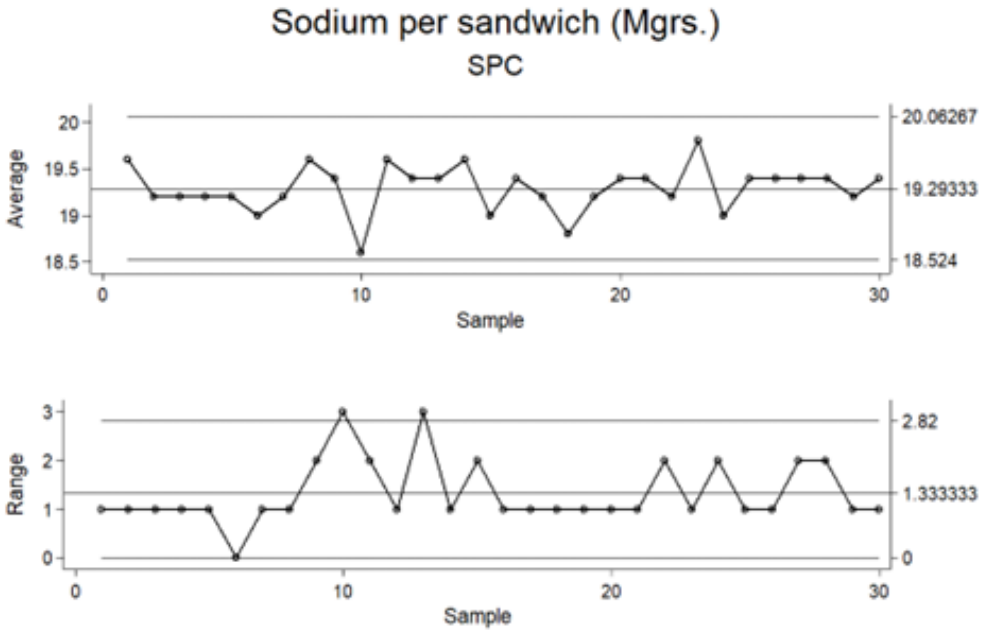
**1.2. (1 point)** What is the stock level 8 weeks after the beginning of a production run?

**2. (1 point)** In order to reduce the annual holding cost, the production manager decided to change the lot size. Knowing that the annual setup cost for the new lot size is 4,140 euros per year, what is the lot size defined by the production manager?

[5]

**SECTION IV**

1. The level of sodium in a Big Kahuna sandwich has been controlled by the quality compliance technician for the last 30 days. During this period, the technician gathered a daily sample of five sandwiches and summarized the information on sodium levels using the charts depicted below. The charts provide information for the sampled average and range of sodium levels, respectively.




**1.1. (1 point)** Identify the statistical process control charts employed by the technician and explain whether they are variable or attribute control charts.

**1.2. (1 point)** Is this process under statistical control? Carefully justify your answer.

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2. The production of 180 gr. vinyl records at the Léaud pressing plant is meticulously controlled by Mr. Doinel, its quality assurance technician. During the last 26 days, Mr. Doinel controlled a daily sample of 100 vinyl records. After examining each sampled record, he decided whether they would be approved for shipping, or rejected and recycled. The daily number of rejected records is reproduced below:

| **Day** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** | ***12*** | ***13*** | **Average** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No. Reject** | 1 | 5 | 1 | 4 | 5 | 5 | 4 | 3 | 3 | 5 | 2 | 4 | 4 | **3.538** |
| **Day** | ***14*** | ***15*** | ***16*** | ***17*** | ***18*** | ***19*** | ***20*** | ***21*** | ***22*** | ***23*** | ***24*** | ***25*** | ***26*** | **Average** |
| **No. Reject** | 3 | 5 | 5 | 4 | 2 | 5 | 4 | 5 | 4 | 5 | 0 | 5 | 4 | **3.923** |

**2.1. (1 point)** Identify the adequate control chart(s) to assess this process and calculate its upper and lower control limits (at the 3σ level). Is this process under statistical control?

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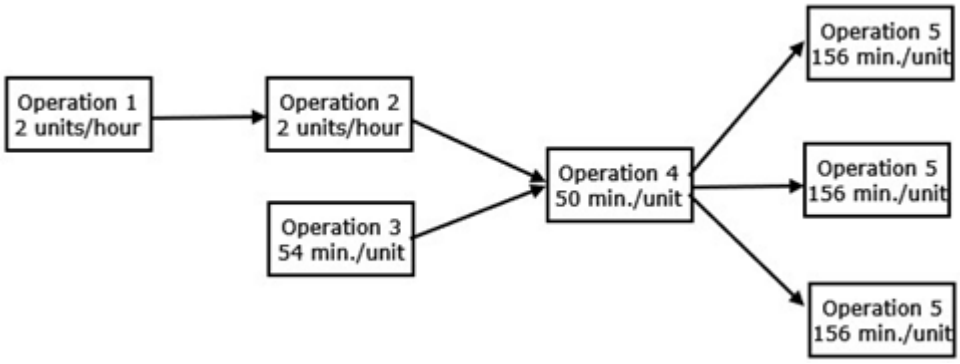
**SECTION V**

GPO-POM is a company that has the process (with 5 operations) displayed below:




The Operation 3 occurs separately from, and simultaneously with, the Operation 1 and Operation 2. The product only needs to go through one of the three final operations (Operation 5), since they are in parallel. Assume that the company works 8 hours per day, the yield in each phase is 100%, there are no stoppages, and stock cannot be accumulated between the different operations of the process.

1. **(1 point).** Which operation is the bottleneck?

2. **(1 point).** What is the throughput time (in minutes) for the overall system?

3. **(1 point).** Suppose that a second 'Operation 3' machine is added, and it takes the same time as the original 'Operation 3' machine. What is the new bottleneck time of the system and how long is it?

[8]

**SECTION VI**

The operations manager of AUTOREP, a truck repair shop, has six trucks to schedule for repair. Each truck requires body work prior to painting. The processing times to the body and paint work are as follows:

| Table 1 | | | | | | |
|---|---|---|---|---|---|---|
| | Truck 1 | Truck 2 | Truck 3 | Truck 4 | Truck 5 | Truck 6 |
| Body work (hours) | 4 | 8 | 10 | 6 | 9 | 5 |
| Paint (hours) | 12 | 16 | 4 | 8 | 6 | 10 |

Os custos de processamento e os custos de inatividade de cada secção (bate-chapa e pintura) são apresentados na tabela 2:

| Table 2 | Processing cost (euros/hora) | Idle cost (euros/hora) |
|---|---|---|
| Body work (hours) | 10 | 12 |
| Paint (hours) | 25 | 12 |

The shop works 8 hours per day (from 8 a.m. to 12 and 1 p.m. to 5 p.m.), from Monday thru Friday. The operations manager decided to start the repair of these trucks today, June 15 (Wednesday) at 8 a.m. The total cost of idle time for body work and paint is allocated to each truck proportionally to their respective total processing time.

1. **(1 point**) The processing sequence followed by the operations manager was 1-4-6-2-5-3, do you agree with this sequence? Justify your answer.

2. **(1 point**) Assuming that the sequence followed was 1-4-6-2-5-3, how many trucks are repaired on June 17 at the end of the day?

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3. **(1 point)** Determine the total cost allocated to the repair (body work and paint) of truck 3.

[10]

**SECTION VII**

1. **(1 point)** The cost (C), in euros, of a M/M/1 system is C=50+15W (W in hours). On average, 1 customer arrives every 20 minutes according to a Poisson distribution. Currently, the utilization factor is 60%. Find the system cost.

2. **(1 point)** On average, cars arrive at *CleanWash* at a rate of 6 per hour according to a Poisson distribution. The washing team spends on average 7,5 minutes to wash 1 car manually. The manager is concerned about the time customers wait to be served as well as with the number of cars waiting within the limited parking space available. She is considering purchasing a state-of-the-art automatic car wash system that washes at a constant rate of 4 minutes each car. Would you recommend purchasing the state-of-the-art automatic car wash system? Show all calculations supporting your recommendation.

**3. (1 point)** *(Work out this problem regardless of what you have recommended in the previous problem).* Consider the management is operating an automatic carwash system which washes 15 cars per hour at a constant rate. Cars arrive at a rate of 6 per hour according to a Poisson distribution. Management greets customers waiting 4 or more minutes with a free of charge wash. Find the estimated annual number of customers receiving the free of charge wash (the automatic line works 8 hours daily over 250 days per year).