

**University of Bologna, Academic Year 2009-2010**  
**Environmental and Quality Aspects in Electronic System Design and Manufacturing**  
**Written exam – Monday, 21<sup>st</sup> of December 2009**

Instructions

Please enter the following information:

FAMILY NAME \_\_\_\_\_

FIRST NAME \_\_\_\_\_

REGISTRATION NUMBER (IF APPLICABLE) \_\_\_\_\_

1. Before answering any question, read carefully the whole text, including the introduction. Understand each question, each sentence and each single word.
  2. Put a cross ☒ in the check box of the answer you think is the right one.
  3. For each correct answer you get +3 points.
  4. For each wrong answer you get -1 point.
  5. For no answer you get 0 point.
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Introduction

*Congratulations!*

Recently you have been appointed as Quality Manager at *Wafer Manufacturing*, one of the most famous companies active in the microelectronics industry. You are an experienced quality manager coming from the car industry.

The company has 120 employees. Competitors have always been very aggressive. However, *Wafer Manufacturing* shows yearly positive benefits.

In spite of its good position on the market, this is the first time that a quality manager position has been created at *Wafer Manufacturing*. Up to now the single production line managers were responsible for the quality of the produced items.

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Question 1

Why senior management has decided to create this new position of Quality Manager?

- a)  The company would like to get the ISO certification in 2010.
  - b)  The company has decided to achieve its goals efficiently in compliance with the requirements of the Society, to improve its activities based on learning and innovation and to develop a methodology to obtain reliable and reproducible results.
  - c)  The major competitors have already created a similar position many years ago and they use this as a selling argument against the *Wafer Manufacturing* products.
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Question 2

Last week you have started your new job at *Wafer Manufacturing*. You did a tour in the different departments and met the managers.

As quality manager what will you do first?

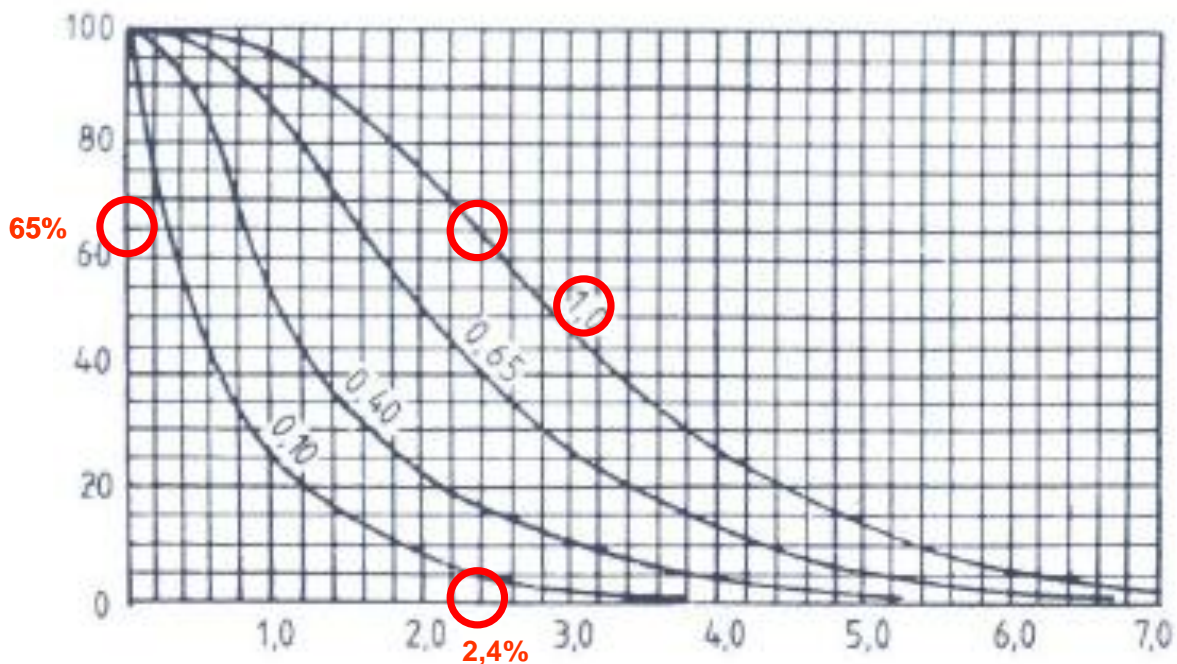
- a)  You describe all the existing processes in order to understand the company's activities.
- b)  You contact an external specialist for quality issues.
- c)  You try to discover who is doing mistakes and where.

Question 3

You should inspect a production lot of 2'000 wafers. The method used by the production managers is the lot-by-lot acceptance sampling by attributes.

The Acceptance Quality Level is set at 1% nonconforming. Tables from the adequate standard ISO 2859-1:2006 tell you that 125 wafers must be drawn at random from each lot and controlled. The same table gives also that the acceptance number is 3, the rejection number is 4. You find 3 nonconforming wafers among 125, which corresponds to 2.4% of nonconforming wafers among 125.

Operative curves



You check the operating curves for this plan: you read on the curve 1% that the percentage nonconforming of 2.4% (x-axis) corresponds to a value of 65% (y-axis).

What does it mean?

- a)  65% of the wafers are nonconforming, i.e., 1'300 wafers are nonconforming.
- b)  There is 65% of probability to accept the batch of 2'000 wafers with 20 or less nonconforming wafers.
- c)  There is 65% of probability to reject the batch of 2'000 wafers with 20 or less nonconforming wafers.

Question 4

Business Excellence could be defined as the relentless\* pursuit of continuous improvement in both an organisation's results and the way in which they are achieved. Senior management decides to use a Business Excellence model to manage the company. A project is launched and you are the project manager.

After the project kick-off, what are the first two actions on your plan?

- a)  • You send the production managers to quality-control training.
  - You increase the quality-control levels in order to improve the production quality as requested by the Plan-Do-Check-Act approach.
- b)  • You decide alone which key performance results must be measured.
  - You describe and analyze the core processes as requested by the Plan-Do-Check-Act approach.
- c)  • A team, that you have selected, agreed by senior management and led by yourself, decides which key performance results should be measured.
  - The team describes and analyzes the core processes in order to improve them in accordance with the Plan-Do-Check-Act approach.

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\* "*relentless*" means "*never ending*"

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Question 5

On the way towards Business Excellence the company could easily get the ISO 9001:2008 certification. Why?

- a)  Because the quality of the wafers has been assured.
  - b)  Because all the processes are known, the process analysis has been carried out, the business is fully understood, the key performance indicators are regularly measured and the opportunities for improvement have been identified.
  - c)  Because the objectives have been established and the necessary processes to deliver results in accordance with the expected outputs are in place.
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Question 6

*Wafer Manufacturing* is not ISO 14001:2004 certified yet. What are the main benefits of an environmental management system (EMS) meeting the requirements of the ISO 14001:2004 standards?

- a)  The company controls the environmental impact of its activities, is able to improve its environmental performance continually and achieves the set environmental objectives and targets.
  - b)  No benefit because waste management is very expensive.
  - c)  The only main benefit is that the company is compliant with the restriction of the use of certain hazardous substances in electronic equipments.
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Question 7

One of the Quality Manager's tasks is to coach project managers and to monitor the quality of projects. In the middle of the third phase of a project, which consists of five phases, a major problem occurred that may delay by several months the progress of the project.

What is your recommendation to the project manager?

- a)  The team must work on possible solutions and alternatives to the occurred problem. If necessary, the steering committee takes a decision about the possible solutions and alternatives. The project manager informs the interested parties (the stakeholders) on the event, the alternatives and the consequences for the project.
  - b)  The project manager informs immediately all the interested parties (the stakeholders) on the occurred problem. He submits then the problem to the steering committee and asks for solutions to the occurred problem.
  - c)  The project manager stops the project. He analyses the problem, assesses again the risks and submits the situation to an external consultant.
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Question 8

The senior management of *Wafer Manufacturing* must appoint a new project manager to run a strategic project. The candidates went through a written test on their skills and an interview of 30 minutes. You, as a member of the committee who should select the project manager, have to take a decision about the competences of the various candidates. Your opinion is critical and valuable because of your experience and your role of Quality Manager.

Which competences, skills and experience should you take into consideration to make up your decisive opinion?

- a)  High level of specialization in microelectronics design and manufacturing, together with an multiannual experience in electronics manufacturing and logistics.
  - b)  PhD in engineering sciences, some experience in design and manufacturing, knowledge of three languages (English is a must).
  - c)  Balance of skills between project management, organisation and teamwork, problem resolution, time management and communication, technology education is of advantage.
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Question 9

The conductivity of pure (intrinsic) silicon (Si) is low: the material is a semiconductor. It is a material which belongs to the fourth column of the periodic table of elements. The addition of a small amount of a material that belongs to the fifth column, like phosphorus (P), arsenic (As), or antimony (Sb) increases the local concentration of free electrons. The added materials are called dopants or impurities, of donor type.

Why is a dopant material added to silicon?

- a)  The inclusion of dopants makes the conductivity of silicon to decrease. In fact, the conductivity of pure silicon would be too high for the typical applications of the integrated circuits.
- b)  The presence of dopants is necessary to keep the temperature at the melting point during the production of the silicon ingots.

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- c)  The inclusion of dopants makes it possible to externally control the electrical conductivity. In addition, in a doped semiconductor the conductivity becomes independent of temperature at least in a range of temperatures.
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Question 10

Maintenance aims at keeping the functionality of the equipments and plant, to obtain products and services required by the customers. One of the possible types of maintenance is called “corrective”.

What is it meant by “corrective maintenance”?

- a)  The corrective maintenance is the one that is carried out after a failure, in order to restore the equipment’s functionality.
- b)  The corrective maintenance is the one that is carried out to the purpose of introducing changes that improve the equipment or the fabrication plant.
- c)  The corrective maintenance is the one that is carried out at specific time intervals or at the onset of specific conditions.
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Question 11

The design of a new generation of integrated circuits is typically obtained by shrinking the device size with respect to the old generation. The methods by which this goal is achieved are termed “scaling rules”. The “constant-field scaling rules” are those that leave the electric field unaltered after shrinking.

Which of the following is *not* a consequence of the application of the constant-field scaling rules?

- a)  The switching time of an inverter decreases.
- b)  The power dissipated by the individual device decreases.
- c)  The number and complicity of the lines connecting the devices of a chip decrease.
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