

DTEK1057

Fall 2018

Energy efficient Embedded Electronics/UTU

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Final Exam

21.12.2018

This final exam consists of 5 questions (each giving max 6 points) and one extra bonus question (giving 3 extra points), total maximum 30 points (+3). You have 3 hours exam time. Please provide short and accurate answers for each question. No course material is allowed in the exam.

1. (a) Explain power consumption sources in CMOS 2-input NOR gate when the NOR gate is changing its logic state at the output. What effects contribute to the power consumption at the input and at the output of the gate? How a 4-input NOR gate will differ from 2-input gate in standby situation (when the output is not changing its logic value)?

(b) Explain how active and standby power consumption contributions have changed during technology scaling from yesterday's 180 nm technology to today's 16 nm CMOS technology. What technology innovations have been used by the industry to reduce the power consumption in CMOS logic when we have moved to today's 16 nm CMOS production technology?

2. Explain what power optimization techniques for energy efficiency have been used at logic block level such as multipliers and adders and how the different techniques are scaling in effectiveness when the technology is scaling from 90 nm towards 16 nm.

3. Explain the key techniques for power reduction techniques at chip level at standby (when the chip is not doing any processing) for nanoscale CMOS technology. How the standby leakages can be controlled at system level.

4. Explain dynamic voltage and frequency scaling technique for power reduction. What are the key design challenges for power and clock distribution networks in implementing DVFS technique?

5. You are the design team leader in a SmartWorld Corporation, responsible on the next generation active and intelligent smart active sensor and tag (IoT) solutions for packaging and logistics industry. The targeted class of devices are communicating with RF links to cloud based serviced via distributed access points, the system as a whole is supposed to do processing of data from sensors, data collecting, and data analytics (data mining) , and finally the system is controlling the intelligent sensors for measurements by activating them from the system. The devices need to be extremely low power and have very long battery life time or no battery at all, due to fact is preferably embedded to e.g. packages of food products, or to objects itself to be traced and monitored. As the team leader you are requested to give a short presentation on system solutions and design ideas to a group of investors and to the company top management, especially how you need to partition different functionalities among the system components (cloud-access point and sensor node) for the best energy efficiency. Explain shortly what you are going to present as your approach for implementation and design of system architecture, its portioning for required functionalities, and sensor node You have been in allocated 10 minute time slot for your presentation in the meeting between risk capital investors and top management of your company.

6. Extra bonus question. What was the most difficult part to learn from the course? How you would the course to be improved for the following year? What material or content you would like to see added to the course? What you gained from the course?

GOOD LUCK!