Exam preparation

Nanoelectronics

2023 – 2024

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Exam: date, hour, place

Nanoelectronics examen (Prof. Ionescu):

- Tuesday, 16.01.2024
- 15h15 to 18h15
- Room INJ218

Exam: organization and evaluation/2023-2024

- Written
- Open book: printed slides/exercies or pdf on off-line computer/tablet
- 5 Questions with 10 possible answers each - multiple answer QCM
  - Correct answer: +1 pt
  - Wrong answer: -1 pt
  - No answer: 0pt
- 1 Bonus
- Time = 3 hours

Exam example

Student Name:

Nanoelectronics

Prof. A.M. Ionescu, I. Stolichnov

Examination: Written, Open books

Date: January 30th, 2023, Duration: 3:00 hours

Select by circle:
the correct answers for each of the questions below.
Multiple correct answers are possible.

- Each good answer = +1 pt
- Each wrong answer = -1 pt
- No selection = 0 pts
- Even if not mandatory, you can explain your answer(s) under 'Comments'
- The Bonus question is optional.

Exam question example #1

Q3: The Metal-Insulator-Transition (MIT) switch is a new class of steep slope switch under the Oxide Electronics that offers unique electronic properties and functionalities. Please choose the correct properties of MIT switches from the below statements.

1. Bipolar switching in functional oxides involves structures that exploit tunneling mechanisms of both electrons and holes.
2. A thin 2-terminal VO_2 layer can be used as a gas and/or pressure multimodal sensor by exploiting the heat exchange mechanism with the gas molecules at various pressures.
3. The VO_2 switch sub-60mV/decade abrupt swing between OFF and ON conduction states below the IMT/MIT transition temperatures can be explained, at least in part, by an abrupt phase transition between states with different bandgaps.
4. VO2 can be considered an enabler technology for neuromorphic devices and circuits. One can build spiking neuron circuits that have stochastic (probabilistic) behavior due to the stochasticity of nucleation phenomena (filament formation) in functional oxides of this kind.
5. Dennard scaling rule are applicable to MIT hysteretic abrupt switches.
6. The mechanism of switching the current in a MIT switch corresponds exclusively to electron correlations, with a change of the equivalent bandgap of the MIT material.
7. Negative capacitance (ferroelectric gating) could, in principle, help to increase the electric field at surface of a 3-terminal gated MIT switch.
8. One can decrease the transition temperature of VO_2 material by doping with germanium (Ge).
9. The oxygen vacancy densities play an important role in the transport characteristics of functional oxide switches and in the obtained level of ON current.
10. VO_2 devices can be used to design and fabricate programable capacitors and inductors operating at GHz based on their ability to reversibly switch between a non-conductive and a conductive state.

Bonus question example (counts like ~1 question)

BONUS - Question:
Enumerate three (3) advantages and three (3) disadvantages of tunnel FETs compared to Negative capacitance FETs.

Advantages:

A1:

A2:

A3:

Disadvantages:

D1:

D2:

D3: