Student Name:

Q4: Single Electron Transistor (SET) is a discrete charge device using a conductive nanodot as central island and three other electrodes as source, drain and gate. There is a thin tunneling oxide surrounding the central island. Choose the correct properties of this device among the following.

1. Under the effect of Coulomb blockade, the output characteristics, I_d-V_d, of a SET transistor are periodic, with a period equal to e/C_g.
2. The SET transistor has threshold voltages in both I_d-V_g and I_d-V_d characteristics, which is different from a MOSFET.
3. In principle, a SET based on metallic islands and linear dielectrics, is a symmetrical device that can be operated by interchanging the source and drain or by changing the sign of the applied voltages.
4. The theoretical C-SET (C=capacitive) device, exploiting a stronger electrical potential coupling of the gate to the island, is expected to be more sensitive to background charge effect than a R-SET (R=resistive).
5. It is demonstrated that for a SET with metallic islands and SiO2 (ε_r~3.9) as dielectric, to show Coulomb blockade (CB) effective at room temperature (T=300K), the diameter of central island should be smaller than 1nm. If the surrounding dielectric is changed into a high-k dielectric with ε_r~25, then, an effective CB at 300K is obtained for larger than 1nm diameters of the central island.
6. SETMOS is hybrid equivalent device, made out of a SET and MOSFET achieving periodic Id-Vg transfer characteristics, with the Vg period dictated exclusively by the SET gate capacitance.
7. If the central island of a SET is made of a semiconductor like silicon with a diameter close to 1nm, one should consider quantum kinetic energy calculation corrections on top of the charging Coulomb energy for accurate calculation of Coulomb gap.
8. The frequency operation of a SET in applications can be higher than GHz independent of the metal interconnects and their capacitance to ground.
9. SETs are used in quantum computing as extremely sensitive charge sensors, not as logic transistors.
10. To operate a SET under orthodox theory conditions it is assumed that on the central island of the SET, only one single electron can stay at a given moment of time.

Comments Q4	

Student Name:

Q5: Micro and Nano-Electro-Mechanical switches and resonators form a special class of devices combining mechanical and electrical counterparts and calculations principles to provide a unique equivalent electrical function (digital, RF or analog). Among the following properties, choose the correct ones.

1. The pull-in voltage of a capacitive switch depends on environment in which the switch operates (air or liquid).
2. The pull-out voltage of a two- or three-terminal mechanical relays is systematically lower in absolute value than pull-in voltage.
3. A MEMS relay with in-series airgap between the conductive parts has a leakage current (I_{off}) in the OFF state of the operation independent of temperature and ionizing radiation effects.
4. The leakage power of a MEMS relay is higher than the one of a tunnel FET.
5. Increased adhesion (or van der Waals) forces between the movable and the fixed contacts could result in permanent stiction of the two contacts if the mechanical restoring force is not high enough.
6. A NEMS relay is a very good steep slope switch but has the main disadvantage that is not simultaneously scalable as size and voltage.
7. A DC voltage can be applied on a MEMS resonator across the airgap in order to increase the quality factor.
8. In a NEMS resonator used as mass nanobalance for measuring the concentration of pollution particles in air, we exploit the resonance frequency shift with the mass accretion on the resonator body; in a mixture of pollution particles of various dimensions, this principle can be used to distinguish between particles of different size.
9. The motional resistance of a MEMS resonator is influenced by both the size and the placement of the suspension arms.
10. An active resonator exploits the modulation of the inversion charge in a suspended nanowire at resonance to amplify the signal of the resonator. If a passive resonator and an amplifier circuits at his output are used, we can obtain a similar amplification. The main advantage of the vibrating or resonant body transistor is related to the fact it offers a more compact and less power-hungry implementation.

Comments Q5	