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Kaferelsheikh University
Faculty of Engineering
Electrical Engineering Dept.
Final Exam 2016-2017.
date: 2/1/2017

Subject: Electronic devices
Time allowed: 180 min.
Full Mark: 100 degree
Year: 3rd comm.
Exam in 2 pages

[1] Question One[15Marks]:

A) Explain, how to Measure the Effective Mass.

B) Derivation an expression of hole Concentration in the valence band*(sketch the E.B. diagram).*

C) 1-Under equilibrium condition, what is the probability of an electron state being occupied if it is located at the Fermi level?
2-If E_F is positioned at E_c, determine the probability of finding electrons in states at $E_c + kT$. (A numerical answer is required.)
3- The probability of a state being filled at $E_c + kT$ is equal to the probability of a state being empty at $E_c + 3\,kT$. Where is the Fermi level located?

[2] Question Two[15 Marks]:

A)What are the Carrier Scattering Mechanisms?(without explain)
B) Explain, Einstein Relationship.
C) Define briefly, Radiative recombination.

D) An N-type silicon sample has a uniform density $N_d = 10^{17}\text{cm}^{-3}$ of arsenic, and a P-type sample has $N_a = 10^{15}\text{cm}^{-3}$.
(a) Find the equilibrium minority carrier concentrations at 300 K in each sample.
(b) Find the conductivity of each sample at 300 K.
(c) Find the Fermi level in each material at 300 K with respect to either the conduction band edge (E_c) or the valence band edge (E_v).

[3] Question Three[20 Marks]

A)Explain the physical structure of MOS capacitor then sketch all operation regime, what are the model that covers all the regimes of operation, explain.

B) Calculate the oxide capacitance, the flatband capacitance and the high frequency capacitance in inversion of a silicon nMOS capacitor with a substrate doping $Na = 10^{17}$ cm^{-3}, a 20 nm thick oxide ($\varepsilon_{ox} = 3.9\ \varepsilon_0$) and an aluminum gate ($\Phi_M = 4.1$ V).

C)High frequency instruments and switching power supply, what can be used and why a Schottky diode or pn junction diode.

D) What is the parasitic diode in power MOSFET, can be used in low frequency, why? what can be used in high frequency applications? (Explain with sketch)

With best wishes

Dr. noha abd al-salam-

[4] Question Four[20 Marks]

A) Draw the band diagram in forward bias. Of the current transport mechanisms we discussed in course (drift, diffusion, thermionic emission, and tunnelling) which are dominant in a forward biased Schottky diode. Which are dominant in a reverse biased diode? Why?

B) Usually the thermionic emission current in a pn-junction is ignored because it is small. How would it be calculated?

C) The capacitance of a Au-n-GaAs Schottky diode is given by the relation 1/C2 = $1.57 \times 10^{15} - 2.12 \times 10^{15}$ V, where C is expressed in F and V is in Volts. Taking the diode area to be 0.1 cm^2, calculate the barrier height and the dopant concentration^3.

D) Find current densities j at room temperature for a Schottky diode Pt-n-GaAs at V = +0.5 and −5 V if ρ = 50cm. $\mu_n = 8800\ cm^2\ V^{-1}\ s^{-1}$, $m_n/m_0 = 0.063$, work function of Pt is 5.65 eV, $\chi_{GaAs} = 4.07$ eV, $N_c = 8.63 \times 1013 \times T^{3/2}\ cm^{-3}$. Apply thermionic-emission theory.

[5] Question Five[15 Marks]

A) Design two circuits used FET as a Shunt Switch and a Series switch.

B) Find the threshold voltage and body factor γ for an n-channel transistor with an n^+ silicon gate if t_{ox} =200A° , $N_A = 3x10^{16}\ cm^{-3}$, gate doping, $N_D = 4x10^{19}\ cm^{-3}$, and if the positively-charged ions at the oxide-silicon interface per area is $10^{10}\ cm^{-2}$.

C) Drive an expression for i_D of the complete Large Signal MOS Transistor Model.

D) Define the channel length modulation parameter, λ.

[6] Question Six[15 Marks]

A) Compare with sketch only the output characteristics of Enhancement NMOS transistor for $V_{GS}=2V_T$ and for $V_{DS}=2V_T$.

B)Sketch each of the following(with define each parameter):
1- Complete small signal model of MOSFET.
2- Circuit model for velocity saturation.

C)Drive an expression for i_D for short channel MOSFET Model.

With best wishes

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