

Name:

Id#

**COE 360, Principles of VLSI Design, Term 991
Quiz# 1**

Date: Saturday, Sep. 25

Indicate whether the following is true or false, and if it is false explain why:

- (1) **(True, False)** In an intrinsic semiconductor, electrons and holes have equal densities and contribute equivalent current.
- (2) **(True, False)** If an intrinsic semiconductor material is doped with p-type impurities, the number of free holes increases while the number of free electrons remains the same.
- (3) **(True, False)** The product of the free electron and hole concentrations in a semiconductor material is a constant independent of temperature.
- (4) **(True, False)** To maintain the electric neutrality of the crystal, the number of free electrons $n = p + N_D - N_A$.
- (5) **(True, False)** The concentration of free holes in an n-type semiconductor, $p = n = n_i^2$.
- (6) **(True, False)** Mobility increases with temperature because more carriers are present and these carriers are more energetic at higher temperatures.
- (7) **(True, False)** In a pn junction, free electrons diffuse from the n-side to the p-side leaving behind negative donor ions.
- (8) **(True, False)** Further diffusion of majority carriers across a pn junction is stopped due to the balance of concentration of majority carriers across the junction.
- (9) **(True, False)** In general, higher doping concentrations result in higher depletion region width and lower transition capacitance.
- (10) **(True, False)** The width of the depletion region in a forward-biased pn junction is narrower than that of a reverse-biased pn junction.

- (11) **(True, False)** The higher the doping concentrations of the pn junction are, the higher the magnitude of the built-in electric field and the higher the breakdown voltages.
- (12) **(True, False)** In an nMOS inverter, V_{IL} is less than the nmos transistor threshold voltage V_t , while V_{IH} is greater than V_t .
- (13) **(True, False)** V_{OL} is the output voltage produced when the input voltage is greater than or equal to V_{IH} .
- (14) **(True, False)** A piece of semiconductor material which is doped with equal donor and acceptor impurity concentrations has higher conductivity compared to the intrinsic semiconductor since it has higher electron and hole concentrations.
- (15) **(True, False)** The width of the depletion region into the lightly doped side of a pn junction is larger than the width of the depletion region into the heavily doped side.
- (16) **(True, False)** It is desirable to have V_{IH} as large as possible and V_{IL} as small as possible to increase the noise margins.
- (17) **(True, False)** The fanout of a gate with $V_{IL}=1.2V$, $V_{IH}=3V$, $V_{OH}=4.5V$, $V_{OL}=0.2$, $I_{IH}=50\mu A$, $I_{IL}=2.5mA$, $I_{OH}=600\mu A$, and $I_{OL}=25mA$ is 12.
- (18) **(True, False)** The resistivity of an n-type silicon semiconductor material increases with the increase of the doping concentration of pentavalent impurities.
- (19) **(True, False)** At room temperature in an extrinsic semiconductor, a small number of the impurity atoms gets ionized.

(20) **(True, False)** A broken covalent bond in an intrinsic semiconductor generates an electron and a hole in the conduction band.