MAKERERE UNIVERSITY

College of Engineering, Design, Art and Technology
School of engineering
Department of electrical and computer engineering

CMP 1101: ELECTRONICS 1

DATE: Friday, December 8th, 2017

TIME: 9:00 AM – 12:00 PM

INSTRUCTIONS:

1. *Each question carries equal total marks as assigned.*
2. *Attempt any four (4) of the five (5) questions in this paper.*

QUESTION 1: TRUE OR FALSE **(*25 marks*)**

For each of the following statements, answer TRUE or FALSE. Each question carries 1.25 marks.

1) P-N junctions are constructed by joining individual semiconductor materials that are appropriately doped with either holes or electrons.
2) The magnitude of current that flows in the forward bias of a semiconductor is equivalent to that which flows in the reverse bias for the same magnitude of bias voltage.
3) The construction and operation of FETs is not any different from that of BJTs except in the biasing requirements.
4) The atomic number of any element in the periodic table is a prediction of the conductivity of the element.
5) The high leakage currents in eMOS have significantly contributed to the popularity of MOSFETs in electronics.
6) Transistors find wide application in digital electronics because they provide the capability to switch and/or amplify signals as required.
7) Metals and integrated circuits are examples of conductors with positive temperature coefficient.
8) At equilibrium, the electrons and holes in either the p-type or n-type semiconductor materials of a p-n junction are uniformly distributed.
9) The input impedance of a MOSFET is usually higher than that of a BJT.
10) The typical i-v characteristics of diodes depict a linear relationship between the current and voltage from the point where the bulk voltage is superseded.
11) Tunnel diodes are very similar in operation to the varactors and are thus substitutes.
12) Since all transistors are current controlled devices, it is necessary to ensure that they only receive current signals at their inputs.
13) Due to the added insight derived from the use of load lines in the graphical diode analysis method, the subsequently determined values of currents and voltages are accurate.

14) The size of the P-N junction area in any diode is only useful for aesthetic purposes.

15) Depletion MOSFETs are constructed such that they are always in the "ON" state until an appropriate voltage is applied to change their state to "OFF".

16) Small signal diodes are generally not operated in the breakdown region because the amounts of current experienced in this region have no use in electronics.

17) Tunnel diodes are very similar in operation to the varactors and are thus considered substitutes.

18) When the SOURCE-GATE voltage of an nMOS is higher than that of the bulk, the threshold voltage quickly falls resulting into a fast saturation-region operation of the device.

19) With the appropriate voltage, diodes effectively conduct in one direction and block the flow of current in the opposite direction. It thus follows that all diodes are p-n junctions.

20) Uncontrolled rectifiers are those rectifiers that can only be operated in conjunction with an external switch to determine when the rectifier diodes process the input signal.

QUESTION 2: **(*25 marks*)**

Semiconductor devices are widely used in electronic circuits today. One of the basic derivatives of semiconductor devices is the p-n junction.

a) Discuss, with appropriate language and illustrations, the functionality of p-n junctions in the presence or absence of a connected voltage source. (9)

b) What is a p-n junction diode and how does its functionality in electric circuits compare with that of passive electrical elements. (5)

c) In analyzing the operation of diodes circuits, 2 methods find wide application. Name and contrast each of the diode analysis methods. (6)

d) For your choice of diode analysis method, determine the current and voltage experienced in a half-wave rectifier circuit. (5)

QUESTION 3: **(*25 marks*)**

a) With appropriate illustrations and equations, describe the MOSFET regions of operation highlighting the applications of each of the regions. (10)

b) In what ways does the construction and operation of the BJTs differ from that of the depletion MOSFETs. (8)

c) Moore's law is widely quoted in electronics to project the advancements in semiconductor technology. VLSI design employs CMOS technology to implement integrated circuits.

   i) State Moore's law and explain what CMOS technology represents. (3)

   ii) What is the range of the number of transistors that make VLSI? (1)

   iii) Name three (3) operations that employ VLSI designs. (3)

QUESTION 4: **(*25 marks*)**

Transistors find wide application in electronics today and have been credited for the accelerated growth in the provision of low cost communication to many parts of the world.

a) List two broad classifications of transistors and discuss their two main differences. (4)

b) For any of the MOSFETs, explain with appropriate illustrations, its principle of operation highlighting how the switching and amplification functions are achieved (10)

c) Figure 1 represents a comparison between the different BJT configurations with their associated electrical characteristics. Based on the input and output impedance and current gain, explain with supporting reasons and justifications which of the configurations presents itself as the ideal candidate for switching and amplification applications? (7)

d) Compare and contrast TTL logic with CMOS logic. (4)

Figure 1: **Electrical characteristics of the different BJT configurations.**

Characteristic	Common Base	Common Emitter	Common Collector
Input Impedance	Low	Medium	High
Output Impedance	Very High	High	Low
Phase Angle	0^o	180^o	0^o
Voltage Gain	High	Medium	Low
Current Gain	Low	Medium	High
Power Gain	Low	Very High	Medium

QUESTION 5: **(*25 marks*)**

a) Define a logic gate and explain its importance in electronics. (3)

b) Name 4 logic gates and discuss their operational capabilities highlighting their effect on the different signal combinations that they process. (8)

c) Implement the NAND gate using diodes and explain how all combinations of the input signals are processed through the gate. (6)

d) Compare and contrast the implementation and operation of the CMOS NAND gate with that discussed in (c) above. (6)

e) List two shortcomings associated with the use of diodes in implementing logic gates. (2)