ELIZADE UNIVERSITY, ILARA-MOKIN,

ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SECOND SEMESTER EXAMINATION, 2019/2020 ACADEMIC SESSION

COURSE TITLE: PHYSICAL ELECTRONICS

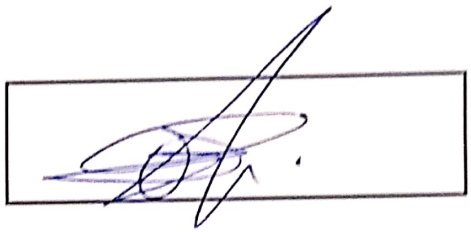
COURSE CODE: EEE 319

EXAMINATION DATE: 24th February, 2020

COURSE LECTURER: Dr. Akinwumi A. Amusan,

Dr Razaq O. Alli-Oke

TIME ALLOWED: 3 hours



HOD's SIGNATURE

INSTRUCTIONS:

1. **QUESTION 1 IS COMPULSORY**
2. **ANSWER QUESTION 1 AND ANY OTHER FOUR QUESTIONS IN TOTAL FIVE QUESTIONS**
3. **ANY INCIDENT OF MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM SHALL BE SEVERELY PUNISHED.**
4. **YOU ARE NOT ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.**
5. **ELECTRONIC DEVICES CAPABLE OF STORING AND RETRIEVING INFORMATION ARE PROHIBITED.**
6. **DO NOT TURN TO YOUR EXAMINATION QUESTION PAPER UNTIL YOU ARE TOLD**

Question #1 (20 Marks)

(a) Discuss (in detail and with relevant diagrams) the action of a forward and reverse biased pn junction (7 marks)

(b) An N-type silicon has a resistivity of 50 Ω-m at a certain temperature. Compute the electron-hole concentration, given that $n_i = 1.5 \times 10^{16}$ m^{-3}, $\mu e = 0.14$ m^2/V-s, $\mu h = 0.05$ m^2/V-s and $e = 1.6 \times 10^{-19}$ C. (3 marks)

(c) With the aid of well-labeled diagrams, briefly discuss the construction and principle of operation of a laser diode. (5 marks)

(d) Briefly discuss how the principle of operation of BJTs differs from enhancement-type n-channel MOSFETs (5 marks)

Question #2 (10 Marks)

(a) Summarize the five Bohr's atomic postulates (5 marks)

(b) Determine the value of the kinetic, potential and total energy in eV of an electron revolving in Bohr's first orbit in Sodium atom

Given: $KE = \frac{mZ^2e^4}{8n^2h^2{\varepsilon_o}^2}$ $PE = \frac{-Z^2me^4}{4n^2h^2{\varepsilon_o}^2}$

electron mass $= 9.11 \times 10^{-31}$ kg, Vacuum Permittivity $= 8.85 \times 10^{-12}$ F/m

Planck constant $= 6.626 \times 10^{-34}$ m^2 kg/s, electron charge $= 1.602 \times 10^{-19}$ C, $Z = 11$ (4 marks)

(c) What is the shape of 4f sub-orbital? (1 mark)

Question #3 (10 Marks)

(a) State five purpose of Hall-effect measurement (5 marks)

(b) The Hall coefficient of doped silicon is measured to be $3.66 \times 10^{-4}\ m^3/C$. If the resistivity of the specimen is $8.93 \times 10^{-3}\Omega - m$, determine the carrier mobility. (2 marks)

(c) The electron and hole mobilities of graphene have been reported to be in excess of $15000\ \frac{cm^2}{V.s}$. Qualitatively compare the conductivity of intrinsic silicon with that of graphene. (3 marks)

Question #4 (10 Marks)

(a) Briefly explain how energy bands are formed in solids. (5 marks)

(b) A specimen of pure germanium at 300° K has a density of charge carriers of 2.5×10^{19}/m^3. It is doped with donor impurity atoms at the rate of one impurity atom for every 10^6 atoms of germanium. All impurity atoms may be supposed to be ionized. The density of germanium atom is 4.2×10^{28} atoms/m^3. Find the resistivity of the doped germanium if electron mobility is 0.36 m^2/V-s. (3 marks)

(c) A cylindrical piece of silicon having a diameter of 1 mm is doped with $10^{20}\ m^{-3}$ atoms of phosphorous which are fully ionized. What length of this silicon would be required to give a resistance of 1 $k\Omega$ if electronic mobility in silicon is $0.1\ m^2 / V - s$?

(2 marks)

Question #5 (10 Marks)

(a) With the aid of diagrams, briefly explain the following diode specifications:
(i) reverse recovery time t_{rr}
(ii) diode capacitances (C_D and C_T). (4 marks)

(b) With the aid of diagrams, briefly discuss opto-isolators and optical fibre communication systems. Your discussion should also highlight the similarities and differences between both devices.
(6 marks)

Question #6 (10 Marks)

(a) With the aid of the aid of diagrams, briefly discuss the two breakdown mechanisms in a Zener diode.
(4 marks)

(b) With the aid of relevant circuits, explain how operation of the circuit shown in Figure Q6(b). What is the name and function of this circuit? Assume that the diodes are ideal. (6 marks)

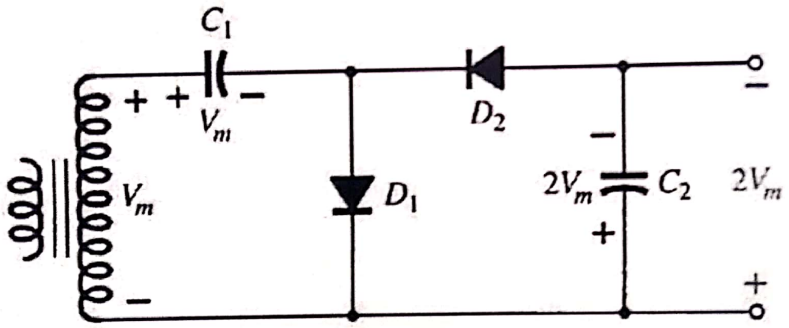


Figure Q6(b): Diode-Circuit Application

Question #7 (10 Marks)

(a) With the aid of the JFET characteristic I-V curves, briefly discuss the operation of the circuit shown in Figure Q7(a). (4 marks)

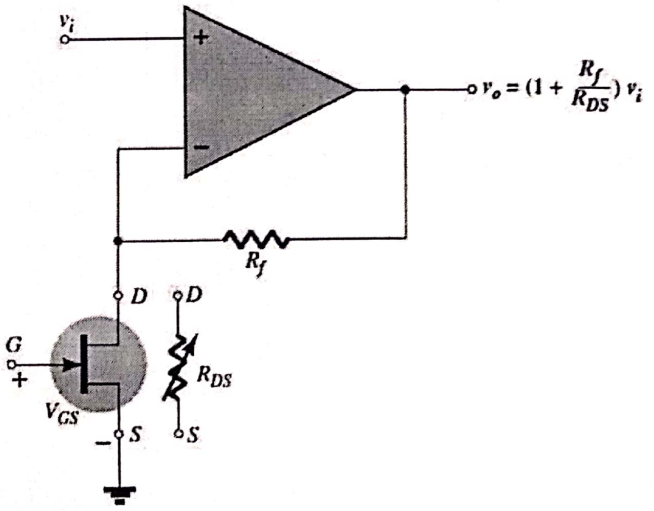


Figure Q7(a): JFET Transistor Application

(b) With the aid of relevant circuits, explain how the output waveform V_o is produced in Figure Q7(b). What is the name and function of this circuit? Assume that the diodes are ideal. (6 marks)

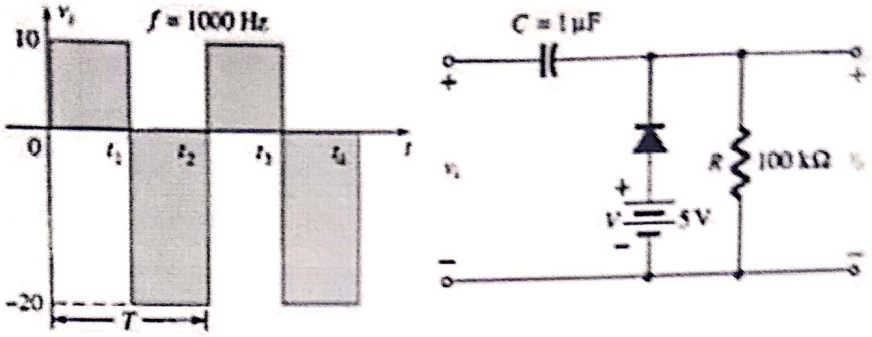


Figure Q7(b): Diode-Circuit Application

$$\frac{9.11\times10^{-31} \times 11^{2} \times 6.587\times10^{-76}}{} = 0$$