THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND COMMUNICATIONS ENGINEERING

SECOND SEMESTER EXAMINATION (2022)

EE222 – ANALOG ELECTRONICS AND CIRCUITS

TIME ALLOWED: 3 HOURS

INFORMATION FOR STUDENTS

1. You have **TEN (10) MINUTES** to read the paper. You must not begin writing during this time.

2. All answers must be written in the **ANSWER BOOK** supplied.

3. **COMPLETE THE DETAILS REQUIRED ON THE FRONT COVER OF YOUR ANSWER BOOK - DO THIS NOW**.

4. Only drawing instruments and calculators are permitted on your desk.

5. Answer all questions.

6. Total available mark is 50

7. If you are found cheating in the Examination, the penalties specified by the University shall apply.

8. **TURN OFF** all mobile phone and place them on the floor under your sit before the start of examination.

QUESTION 1 (8 MARKS)

a. Explain how electricity conductivity is increased in intrinsic semiconductor. **(2)**

b. Explain how electricity conductivity is increased in extrinsic semiconductors. **(2)**

c. Draw the I-V characteristics of the diode and explain interms of forward and reverse bias. **(2)**

d. The figure 1 below is the Basic MOS Structure for $V_{GS} > V_{TN}$the thickness of the inversion channel layer qualitatively indicates the relative charge density, which for this case is essentially constant along the entire channel length. What Condition would be obtained if $V_{DS}$is increased as shown in figure 1, and state the condition. Draw the MOS Structure and Graph to represent this condition. **(2)**

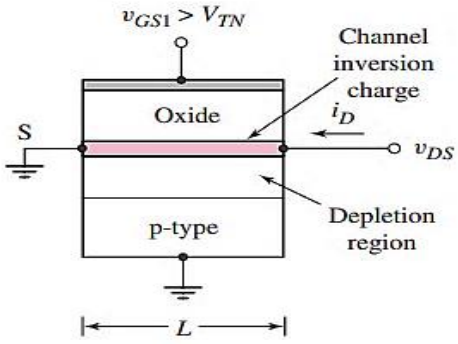

Figure 1: Basic MOS Structure

QUESTION 2 (12 MARKS)

There are three different circuits in the below.

a) For circuit Number (I), determine the current across 5k**Ω** Resistor. **(2)**

b) For circuit Number (II), determine the output voltage and the current following through the 6k**Ω** resistor. **(4)**

c) For circuit Number (III), Determine current flowing through 8k**Ω** resistor, 2k**Ω** resistor and 4k**Ω** resistor. (**6)**

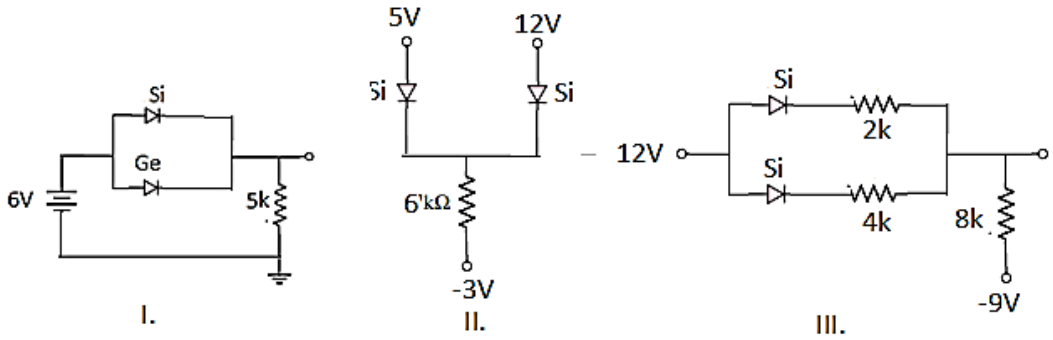

Figure 2: Analysis of Electronic diode circuits

QUESTION 3 (10 MARKS)

a. Consider the current in an n-channel enhancement-mode MOSFET with the following parameters;$V_{TN} = 0.4V$, $W = 20\mu m$, $L = 0.8\mu m$, $\mu_n = 650\, cm^2/Vs$, $t_{ox} = 200A$, $\epsilon_{ox} = (3.9)(8.85 \times 10^{-14})\, F/cm$, Determine the current when the transistor is biased in the saturation region for $V_{GS} = 0.8V$, $V_{GS} = 1.6V$. **(2)**

b. Calculate the drain current and drain-to-source voltage of a common source circuit with an n-channel enhancement-mode MOSFET. Also find the power dissipated in the transistor in figure 3. Assume that, $R_1 = 30k\Omega$, $R_2 = 20k\Omega$, $R_D = 20k\Omega$, $V_{DD} = 5V$, $V_{TN} = 1V$, $K_n = 0.1\, mA/V^2$. **(3)**

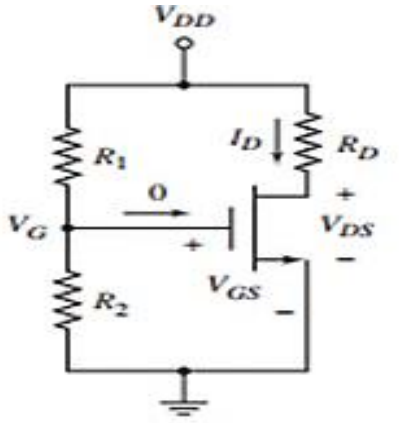

Figure 3: n-channel enhancement-mode MOSFET

c. Calculate the drain current and source-to-drain voltage of a common source circuit with a p-channel enhancement-mode MOSFET shown in figure 4. The parameters of the circuit are$R_1 = R_2 = 50k\Omega$,$V_{DD} = 5V$, $R_D = 7.5k\Omega$, $V_{TP} = -0.8V$, $K_p = 0.2\, mA/V^2$. Prove that it is in biasing in saturation region. **(5)**

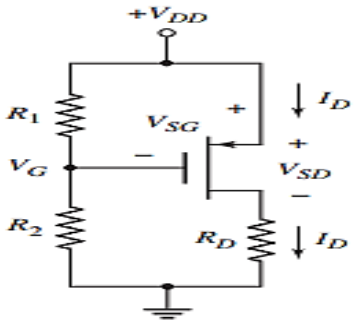

Figure 4: p-channel enhancement-mode MOSFET

QUESTION 4 (10 MARKS)

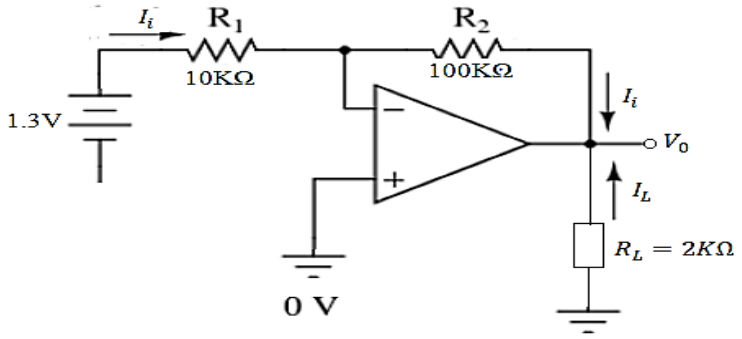

Figure 5: Operational Amplifier

a) Derive the output voltage of the operational amplifier above. (**2**)

b) Determine load current**. (2)**

c) Determine input current. **(2)**

d) Determine total current. **(2)**

e) Explain the difference between the inverting and non-inverting operational amplifier. **(2)**

QUESTION 5 (10 MARKS)

a. Calculate the base, collector, and emitter currents and the C–E voltage for a common-emitter circuit shown in figure 6. The parameters of the circuits are$V_{BB} = 4V$, $R_B = 220k\Omega$, $R_C = 2k\Omega$, $V_{CC} = 10V$, $V_{BE}(on) = 0.7V$ and $\beta = 200$ **. (3)**

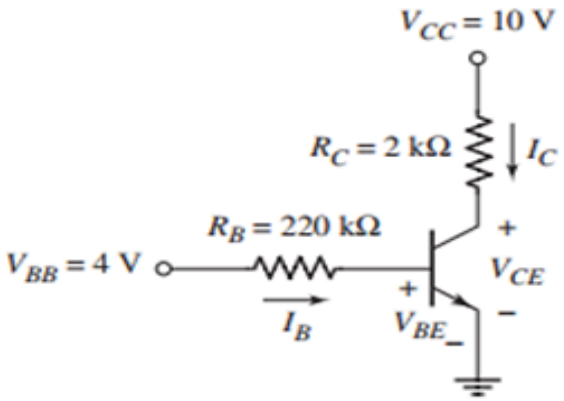

Figure 6: Bipolar Junction Transistor (BJT) Transistor

b. Assuming that the NMOS is in saturation region, analysis the circuit in figure 7 using Both DC and Ac Analysis. In this analyse use the following data,ג $= 0.005V^{-1}$, $= 0.4mA/V^2$,$V_t = 2.0V$. Make so you justify your answer with following two saturation conditions $V_{GS} > V_{TH}$ and $V_{DS} > V_{GS} - V_{TH}$. **(7)**

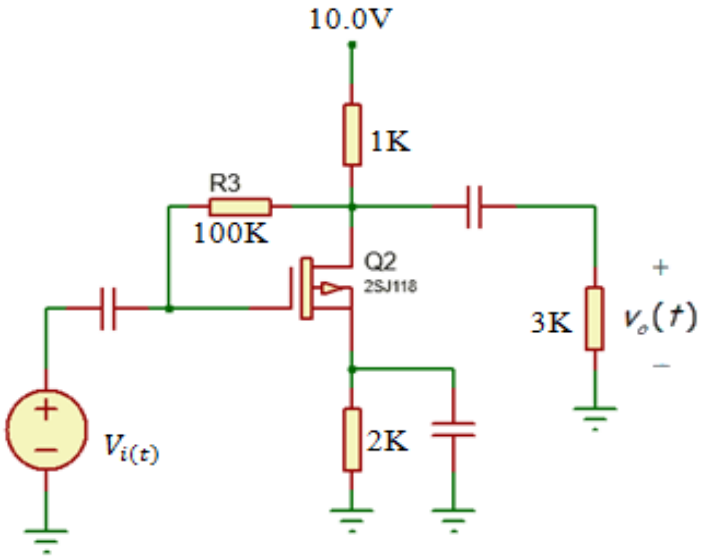

Figure 7: Direct Current (DC) and Small signal Analysis of N-Type MOSFET

_____end_____