MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF

BACHELOR OF SCIENCE
IN
MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: ECE 363

COURSE TITLE: BASIC ELECTRONICS

DATE: THURSDAY, APRIL, 21ST, 2022.   **TIME:** 12:00 – 2:00 PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 printed Pages. Please Turn Over.

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Question One (30 Marks)

(a) With the aid of diagrams, briefly explain the reverse-bias operation of a diode **[3 marks]**

(b) (i) Name two types of junction field effect transistors and draw their symbols. **[2 marks]**

(ii) State the junction field effect transistor that has a greater channel conductivity and explain why. **[2 marks]**

(c) State and explain the three regions of operation of a bipolar junction transistor. **[3 marks]**

(d) The circuit diagram of a bipolar junction transistor, which is made of silicon, is shown below. Given that $V_{BB} = 5.7\,V, R_B = 50k\Omega, V_{CC} = 10V, R_C = 970\,\Omega$ and $\beta = 100$,
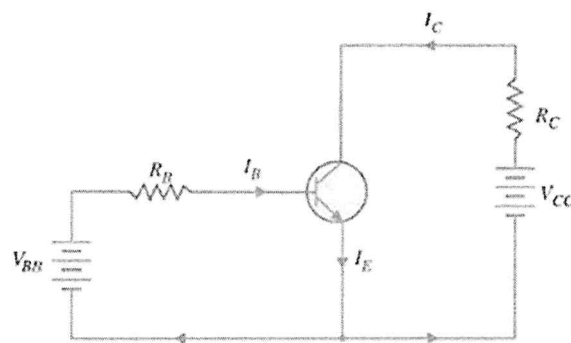
Find the collector emitter voltage, V_{CE}. **[4 marks]**

(e) Draw the circuit diagram of a common-emitter NPN transistor and write the equation for emitter current. **[3 marks]**

(f) A D-MOSFET has a shorted-gate drain current, I_{DSS} of 10 mA and the gate-source cut off voltage, $V_{GS(off)}$ is $-8V$. Using the information given:

(i) state whether this is an n-channel or p-channel and explain why.
(ii) calculate I_D at $V_{GS} = -3\,V$
(ii) calculate I_D at $V_{GS} = +3\,V$. **[4 marks]**

(g) (i) Sketch the circuit diagram of a full-wave bridge rectifier with smoothing capacitor. **[4 marks]**
(ii) Indicate the direction of current flow for one-half cycle around the circuit. **[1 mark]**
(iii) State the function of the smoothing capacitor. **[1 mark]**
(iv) Draw the output waveforms of a full-bridge rectifier with a smoothing capacitor and without the capacitor. **[3 marks]**

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Question Two (20 marks)

a) Define the following terminologies:
   (i) Junction field effect transistor
   (ii) Pinch-off voltage
   (iii) Shorted-gate drain current.
   (iv) Gate-source cut off voltage   **[4 marks]**
b) Mention two characteristics of a good transimpedance amplifier.   **[2 marks]**
c) Draw and explain the working of an N-channel junction field effect transistor. **[6 marks]**
d) Explain why the gate voltage of an N-channel JFET should never be positive. **[2 marks]**
e) A JFET has a drain current of 5 mA. If the shorted-gate drain current, I_{DSS} is 10 mA and the gate-source cut off voltage, $V_{GS(OFF)}$ is $-6V$, find the value of:

   (i) gate-source voltage, V_{GS},
   (ii) pinch-off voltage, V_P.
   (iii) Using the information above, draw the I-V characteristic of this JFET. Clearly label all the points on the graph and show all the operating regions.   **[6 marks]**

Question Three (20 marks)

(a) (i) Draw the static I-V characteristics of a diode. Name and indicate on the graph the two operating regions.   **[3 marks]**
   (ii) Explain how the p-type and n-type materials are arranged in a circuit for the mentioned operating regions.   **[2 marks]**
(b) In the circuit diagram below, the silicon diodes have a forward resistance of zero ohms.
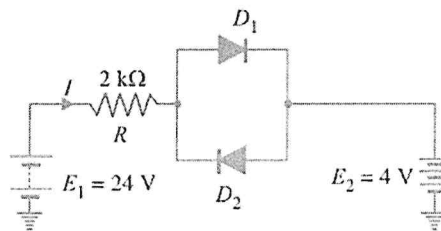
   Determine the current, I, flowing through the circuit.   **[2 marks]**

(c) Define the following terminologies:

   (i) Insulator   **[1 mark]**
   (ii) Semiconductor   **[1 mark]**
   (iii) Conductor   **[1 mark]**

(d) Define a rectifier and name two types of rectifiers. [2 marks]

(e) The circuit shown below has four silicon diodes and the forward resistance of each diode is 1Ω.
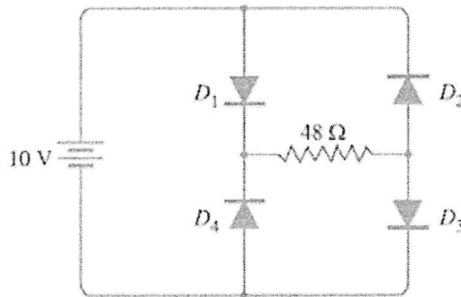
Calculate the current through the 48 Ω resistor. [3 marks]

(f) There are two types of diodes used in solar panels.
    (i) Name the two types of diodes. [1 mark]
    (ii) With the help of a diagram, explain how and why they are used. [4 marks]

Question Four (20 marks)

(a) Explain what Darlington transistors are and why they are used. Write its formula for current gain. [3 marks]

(b) State two characteristics of the common-emitter configuration of a transistor. [2 marks]

(c) A transistor can operate as an amplifier or as a switch. Elaborate how this is achieved. [5 marks]

(d) A common base PNP transistor amplifier has an input resistance of 20Ω and the collector load is 1000Ω. A signal of 500mV is applied between the emitter and base. Draw the circuit diagram representing this information and calculate the voltage amplification, A_v. Assume that $\alpha = 1$ and neglect the voltage drop due to the diode. [6 marks]

(e) Sketch the output characteristics curves of an NPN bipolar transistor, label the graph in detail and show the Q-point. [4 marks]

Question Five (20 marks)

(a) Name six classes of integrated circuits. [3 marks]

(b) (i) Define the term MOSFET. Give three similarities and one difference between MOSFETs and JFETs. [5 marks]

(ii) Mention and briefly explain the two types of MOSFETs. [4 marks]

(iii) Draw the symbols of the aforementioned MOSFETs for both the N-channel and P-channel types. [2 marks]

(c) Write the Boolean expression, draw the truth table and the transistor-transistor logic circuit diagram of each the following:

(i) transistor AND gate,
(ii) transistor NOR gate. [6 marks]