ENG08

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

B.ENG (HONS) ELECTRICAL & ELECTRONIC ENGINEERING

SEMESTER 2 EXAMINATION

INTRODUCTORY ANALOGUE ELECTRONICS

MODULE NO: EEE4014

Date: Thursday 16th May 2024 **Time: 10:00 – 12:00**

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions.

Answer ANY FOUR questions.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

Electronic calculators may be used provided that data and program storage memory is cleared prior to the examination.

CANDIDATES REQUIRE:

Formula Sheet (attached).

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Question 1

(a) Explain is doping in terms of semiconductors and how a n type semiconductor can be produced. **[4 marks]**

(b) Draw the pn junction featuring the depletion region. **[6 marks]**

(c) Use the ideal-diode model to analyse the circuit as shown in Fig.Q1 to decide the working status of diode D1 and D2. (Please analyse all possible situations with **proper equivalent circuit** for both two diodes).

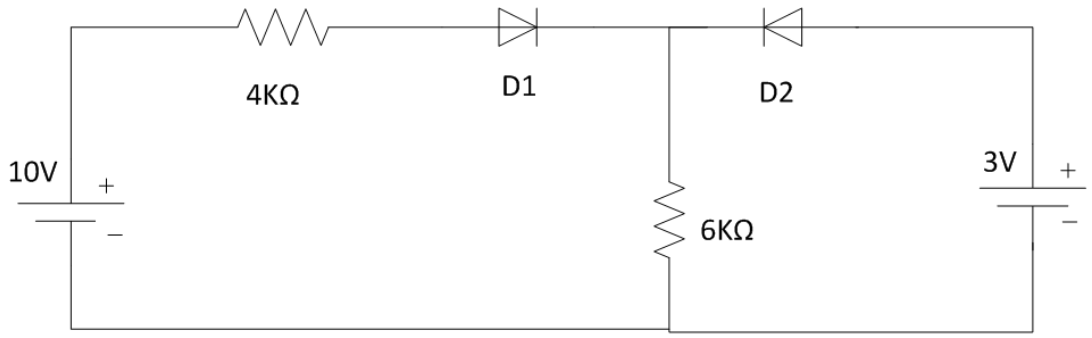

Fig.Q1 Diode circuit model

[15 marks]

Total 25 marks

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Question 2

(a) A voltage regulator circuit using Zener diode is depicted in Fig. Q2 (a). Given Vs= 50 V, Vz (Zener Voltage)= 14 V, Pz(Power rating of Zener Diode)= 5 W, Rs= 30 Ω. Calculate the allowable range of RL (load resistance) for safe operation. **[15 marks]**

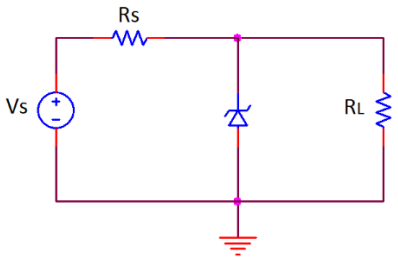

Fig.Q2(a). A voltage regulator circuit.

(b) A Zener diode has the following response curve in Fig.Q2(b). Find the following characteristics for the diode.

(i)Estimate the Zener voltage of the diode. **[2 marks]**

(ii)Determine the reverse voltage for a reverse current of -20mA. **[2 marks]**

(iii)Determine the reverse current for the reverse voltage of -5.5V. **[2 marks]**

(iii)Calculate the power dissipated when the reverse voltage is -6V. **[4 marks]**

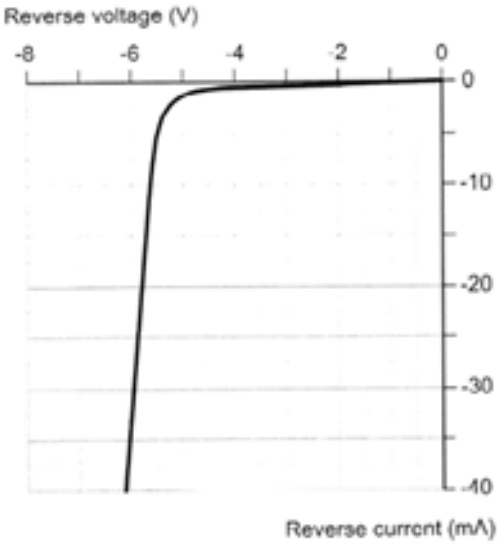

Fig.Q2(b). A Zener diode response curve. **Total 25 marks**

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Question 3

(a) An amplifier has a gain of 100, input resistance of 1kΩ and an output resistance of 10Ω. The amplifier is directly connected to a sensor that produces a voltage of 2V and has an output internal resistance of 100Ω, and also directly to a load in of 50Ω.

(i)Draw the equivalent circuit diagram. **[9 marks]**

(ii)Calculate the output voltage. **[7 marks]**

(iii)Calculate the voltage gain. **[3 marks]**

(b) An operational amplifier has high input impedance and low output impedance. Briefly explain why this is desirable.

[6 marks]

Total 25 marks

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Question 4.

(a) Calculate the bias point of the circuit as shown in Fig.Q4, find V_B (Base Voltage), V_E(Emitter Voltage), I_E(Emitter Current, I_C(Collector Current), V_C(Collector Voltage),and V_{CE} (Collector-Emitter Voltage). Assume β = 100, V_{BE} = 0.7 V.

[19 marks]

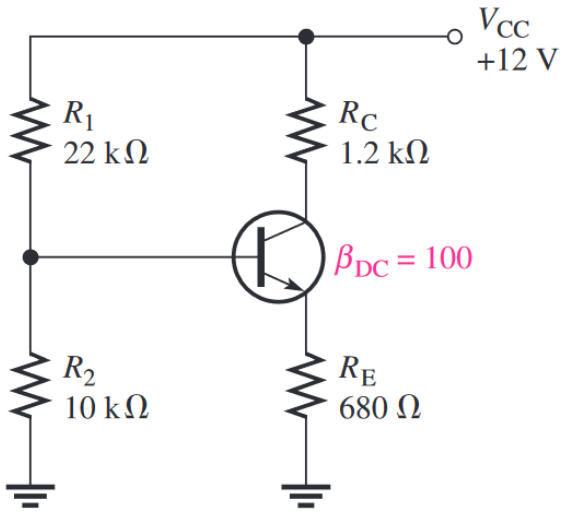

Fig.Q4: Transistor as an amplifier

(b) Draw a diagram of a npn type bipolar junction transistor. In your diagram you should label the 3 regions and 2 junctions.

[6 marks]

Total 25 marks

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Question 5.

(a) Calculate VDS(Drain-Source Voltage) and VGS(Gate-Source Voltage) in the JFET self-biased circuit in Fig.Q5 below:

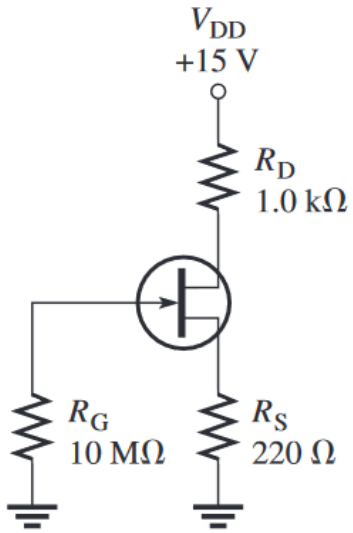

Fig.Q5

[14 marks]

(b) Name the terminals of a Field Effect Transistor.

[3 marks]

(c) Describe the operation of a n-channel enhancement MOSFET (Metal-Oxide Field Effect Transistor).

[8 marks]

Total 25 marks

END OF QUESTIONS

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EEE4014 Formula sheet

These equations are given to save short-term memorisation of details of derived equations and are given without any explanation or definition of symbols; the student is expected to know the meanings and usage.

Ohms law: $V=RI$

Power : $P= IV$

Voltage divider: $V_{Ri}=V_s(R_i/(R_i+R_s))$

Current gain: $A_i=I_o/I_i$

Power gain: $A_P=P_o/P_i=V_oI_o/V_iI_i = A_vA_i$

Bipolar Transistor:

$I_C=\beta I_B$

$r_\pi = V_T/I_B$, where $V_T=0.026V$

MOSFET:

$V_G=(R_2/(R_1+R_2)) * V_D$

$V_G= V_{GS}+R_S I_D$

$I_D=K(V_{GS}-V_t)^2$

$V_{DS}=V_{DD} - (R_D+R_S)*I_D$

Operational Amplifier:

$\frac{V_o}{V_i}=1+\frac{R_f}{R_a}$ ---------- Non-inverting

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$$V_o = -R_f\left(\frac{V_a}{R_a}+\frac{V_b}{R_b}+\frac{V_c}{R_c}\right) = -R_f\sum_{j=a}^{c}\frac{V_j}{R_j}$$ ---------- Multiple Inputs

$$\frac{V_o}{V_{in}} = \frac{-R_f}{R_a}$$ ---------- Inverting

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