[ENG86]

UNIVERSITY OF GREATER MANCHESTER

SCHOOL OF ENGINEERING

B.Eng. (Hons) ELECTRICAL AND ELECTRONIC ENGINEERING

SEMESTER 2 EXAMINATIONS 2024/2025

INTRODUCTORY ANALOGUE ELECTRONICS

MODULE NO: EEE4014

Date: Thursday 15 MAY 2025 **Time: 14:00 -16:00**

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) Given V_S=45V, V_Z=11V (voltage across the Zener diode), R_S=50Ω, R_L=360Ω.Find or estimate the maximum acceptable power rating for the Zener diode given in the circuit shown in Fig Q1(a). **[10 marks]**

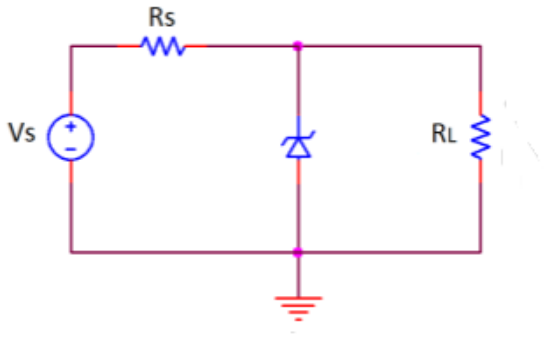

Fig.Q1(a).

(b) Draw the complete circuit of a full-wave rectifier circuit including the smoothing capacitor and a load resistor **[4 Marks].** Sketch the unsmoothed and smoothed waveforms on the same axis. Label the unsmoothed and smoothed waveforms

[4 Marks]

(c) Explain the doping in terms of semiconductors and how a p-type semiconductor can be produced. **[4 Marks]**

(d) For the practical diode circuit, Fig Q1(d), calculate V_D, I_R, and V_R if V_S=9V and R=100Ω. **[3 Marks]**

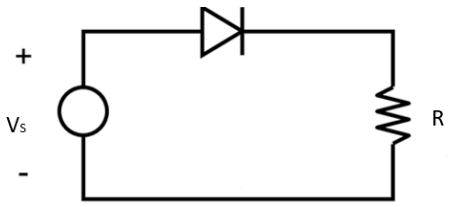

Fig.Q2(d).

Total 25 marks

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Question 2

(a) For the voltage-divider bias circuit shown in Fig Q2(a) below, calculate the following. Assume β = 200, VBE = 0.7 V.

I. I_{BQ} **[7 marks]**

II. I_{CQ} **[3 marks]**

III. V_{CEQ} **[4 marks]**

IV. V_C **[4 marks]**

V. V_E **[4 marks]**

VI. V_B **[3 marks]**

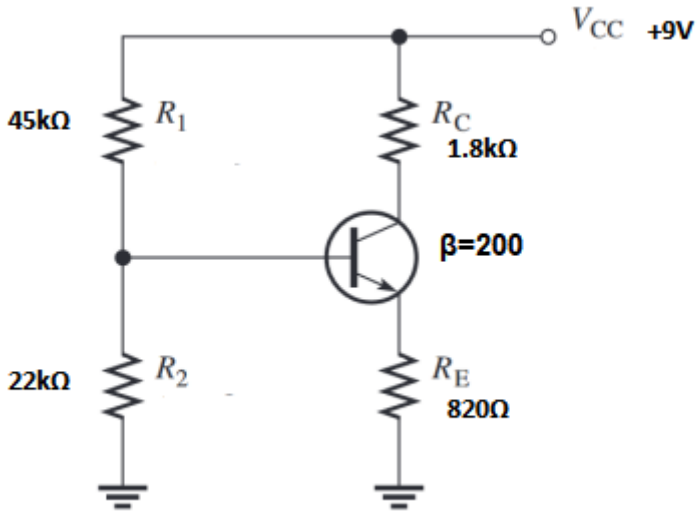

Fig.Q2(a).

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Question 3

(a) Sketch output characteristics of a bipolar junction transistor in the Common Emitter Configuration and label the regions of operation. **[10 marks]**

(b) Determine the small-signal behaviour of the following circuit and calculate gain of the amplifier. **[15 marks]**

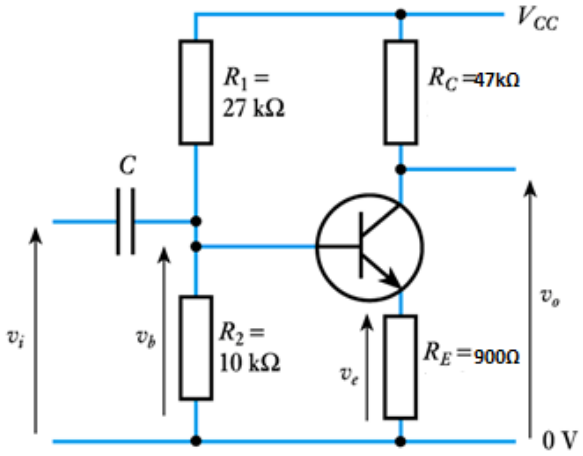

Fig.Q3 (b).

Total 25 marks

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Question 4

(a) Given that V_{GS}=-1.15V, solve for the following for Fig.Q4a:

i. V_G **[5 marks]**

ii. V_S **[3 marks]**

iii. I_D **[3 marks]**

iv. V_D **[5 marks]**

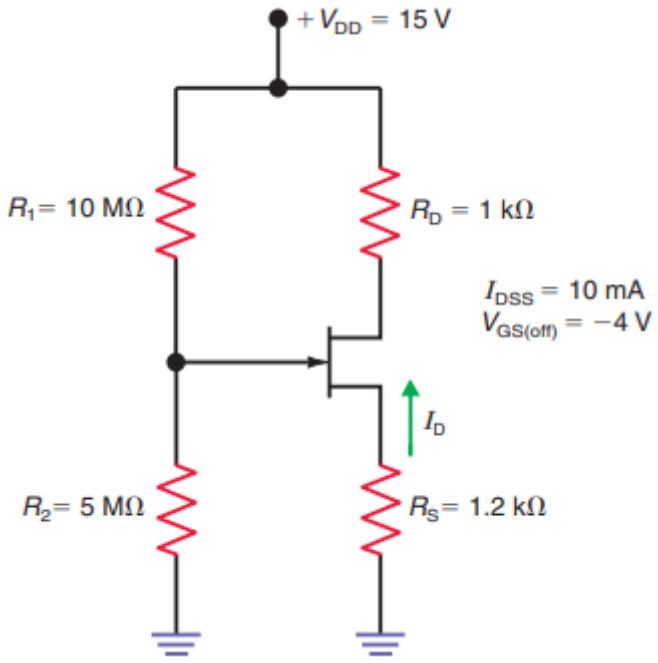

Fig.Q4a

(b) Calculate V_{DS} for Fig.Q4a and confirm if it is in active (saturation) mode or ohmic mode.

[9 marks]

Total 25 marks

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Question 5.

(a) What is the purpose of a voltage follower as shown in Fig.Q5a below:

[8 marks]

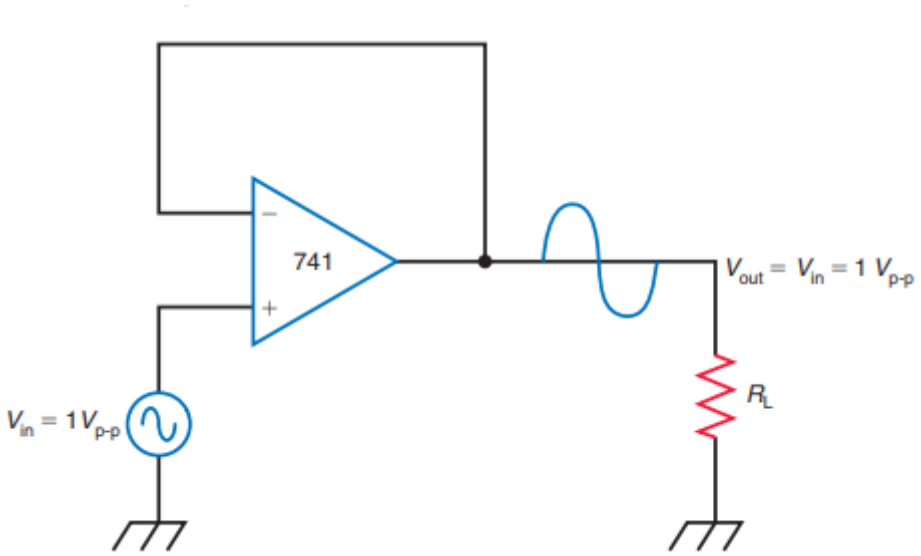

Fig.Q5a

(b) In Fig.Q5a, given that $R_{in} = 2\ \text{M}\Omega$, $Z_{\text{out(CL)}} = 75\ \Omega$, and $A_{\text{vOL}} = 100{,}000$. Calculate $Z_{\text{in(CL)}}$ and $Z_{\text{out(CL)}}$.

[9 marks]

Question 5 continues next page…

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(c) In Fig. Q5c, calculate the value of R_D that will provide a total current (I_{total}) of 10mA for each of the following values of V_{DD}: **[8 marks]**

a. $V_{DD} = 12\,V$.

b. $V_{DD} = 18\,V$.

c. $V_{DD} = 24\,V$.

d. $V_{DD} = 36\,V$.

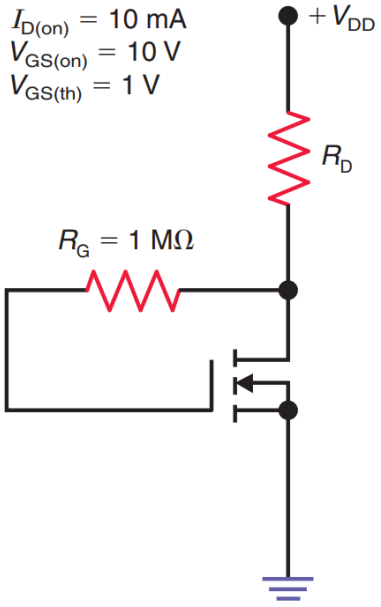

Fig.Q5c

Total 25 marks

End of questions.

Please turn the page for the Formula Sheet.

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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:

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

$V_G= V_{GS}+R_S I_D$

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

$$K = \frac{KP}{2}\left(\frac{W}{L}\right)$$

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

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Operational Amplifier:

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

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

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

$$Z_{in(CL)} = R_{in}(1 + A_{VOL}\beta)$$

$$Z_{out(CL)} = \frac{Z_{out(OL)}}{1 + A_{VOL}\beta}$$

End of Exam