[ENG 03]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

B.ENG (HONS) ELECTRICAL & ELECTRONIC ENGINEERING

SEMESTER TWO EXAMINATION 2021/22

INTRODUCTORY ANALOGUE ELECTRONICS

MODULE NO: EEE4014

Date: Thursday 19th May 2022 **Time: 10:00 – 12:00**

INSTRUCTIONS TO CANDIDATES:

There are SIX 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).

Question 1

(a)

What is the graphical Volt-ampere characteristic plot of the normal silicon diode and ideal- diode model?

[10 marks]

(b)

Use the ideal-diode model to analyse the circuit as shown in Fig.1(b) to decide the working status of diode D1 and D2. (Please analyse all possible situations with **proper equivalent circuit** for both two diodes).

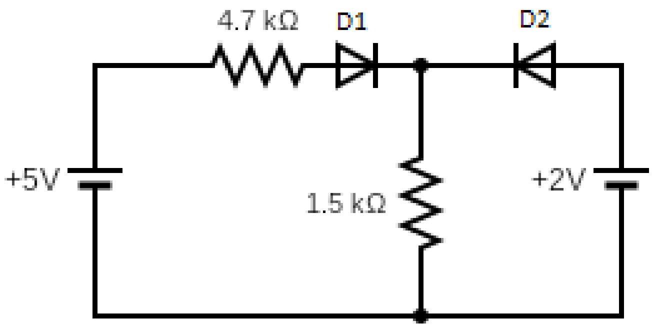

Fig.1(b) Diode circuit model

[15 marks]

Total 25 marks

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Question 2

(a) A voltage regulator circuit using Zener diode is depicted in Fig. 2 (a). Given Vs= 15V, Vz= 4V, Pz= 3W, Rs= 10Ω. Calculate the allowable range of RL (load resistance) for safe operation.

[15 marks]

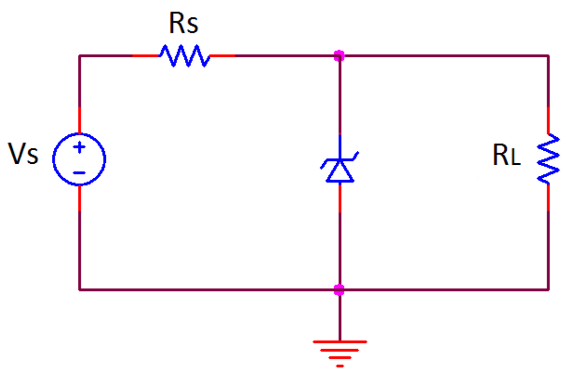

Fig.2(a). A voltage regulator circuit.

(b) Draw the output waveform of following circuits in Fig. 2 (b) if an AC sine wave Vs= 10sin(90t) is applied. Use the non-ideal diode models.

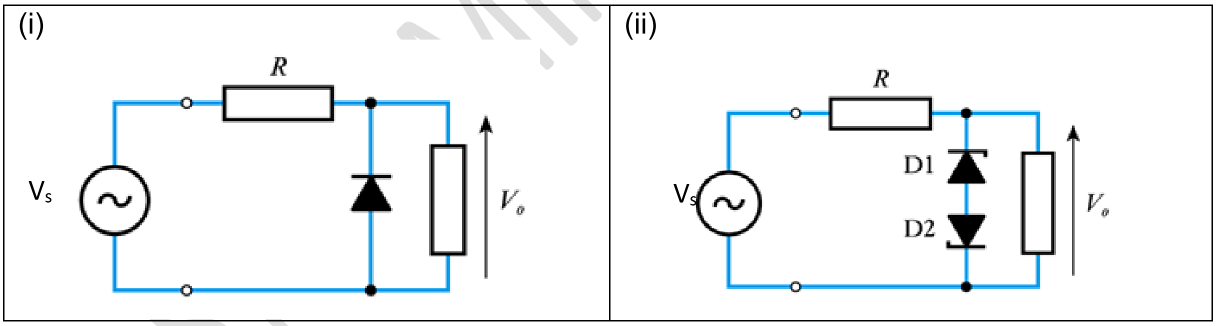

Fig.2(b). Diode circuits.

[5 marks for each question, total 10 marks for (b)]

Total 25 marks

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Question 3

(a) Explain the difference between DEMOSFETS and Enhancement MOSFET

[7 marks]

(b) Sketch the transfer characteristic for an n-channel depletion type MOSFET with I_{DSS} = 10mA and VP = -4V

[18 marks]

Total 25 marks

Question 4

(a) Draw a table to compare the operation regions, i.e. Cutoff, Saturation, Active linear and Break-down of a transistor in term of I_B or V_{CE} characteristics, BC and BE junctions and operating mode.

[12 marks]

(b) Calculate the base, collector, and emitter currents in the circuit in Fig. Q4 (b). Also calculate the transistor power dissipation. Given that Gain β =200, assume the circuit in the active region where V=0.7V.

[13 marks]

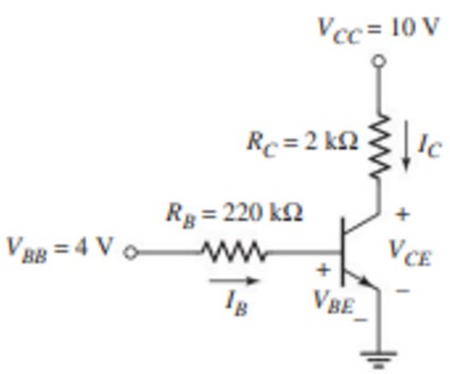

Fig.Q4(b): Transistor as an amplifier

Total 25 marks

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Question 5

(a) An amplifier has a gain of 100, input resistance of 1kΩ and an output resistance of 10Ω. The amplifier is connected to a sensor that produces a voltage of 2V and has an output resistance of 100Ω, and also to a load 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 6

(a) Explain, with the use of examples, the difference between active and passive amplifiers.

[6 marks]

(b) Fig.6b is a diagram of a summing inverting negative feedback operational amplifier circuit with two inputs V1 and V2 and an output Vo. What is the value of Vo if V1=5V and V2 = 8V

[4 marks]

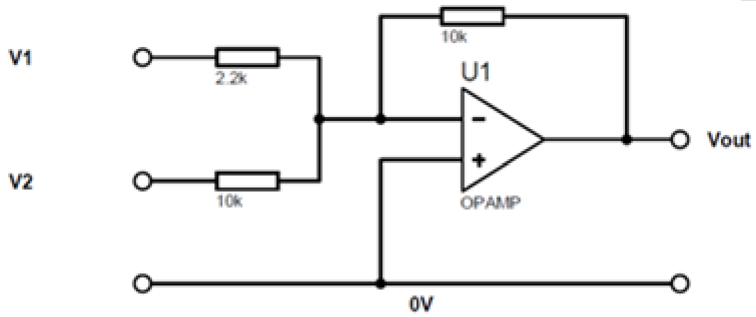

Fig.6b: Summing amplifier

(c) Briefly define the term common mode rejection ratio. An amplifier has a CMRR of 42dB. Restate this CMRR as an arithmetic ratio e.g. *x*:1, where *x* is a numerical value.

[7 marks]

(d) An op-amp has a differential gain G_d = 4000 and a CMRR ratio of 100. Determine the output voltage given input voltages of V_+= 150μV and V_-=140 μV

[8 marks]

Total 25 marks

END OF QUESTIONS

Formula Sheet follows on the next page..

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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:

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

$V_G= V_{GS}+R_S\ I_D$

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

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

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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

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

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