[ENG26]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

B.ENG (HONS) ELECTRICAL & ELECTRONIC ENGINEERING

SEMESTER TWO EXAMINATION 2022-23

INTRODUCTORY ANALOGUE ELECTRONICS

MODULE NO: EEE4014

Date: Thursday 11th May 2023 **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).

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

Question 1

(a)

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

[10 marks]

(b)

Using the approximate characteristics of a diode, calculate the V_D, I_D and V_R for the circuit below.

Fig.1(b) Diode circuit

[6 marks]

Question 1 continues on the next page…

Please turn the page

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

…Question 1 continued

(c)

Using the approximate characteristics of a diode, calculate the current I in the circuit below

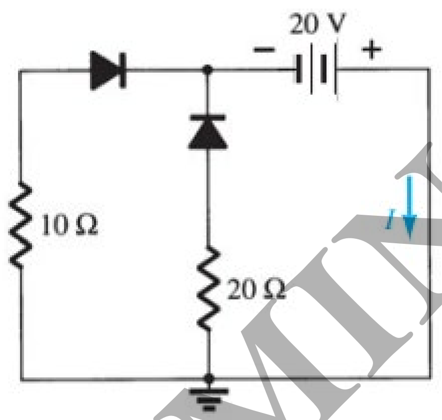

Fig.1(c) Diode circuit

[9 marks]

Total 25 marks

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

Question 2

(a) A voltage regulator circuit using Zener diode is depicted in Fig. 2 (a). Given Vs= 30 V, Vz= 8 V, Pz= 5 W, Rs= 10 Ω. Calculate the allowable range of RL (load resistance) for safe operation.

[15 marks]

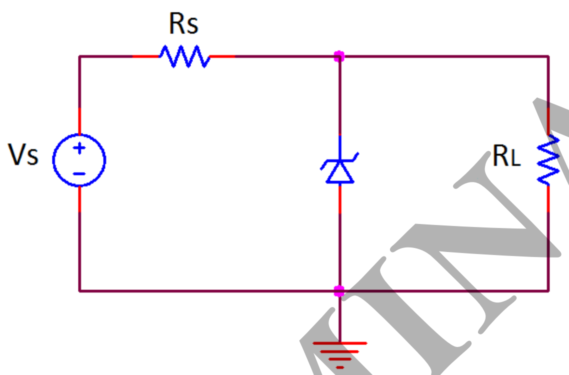

Fig.2(a). A voltage regulator circuit.

(b) Draw the output waveform of following circuits if an AC sine wave Vs= 22sin(900t) is applied. Use the non-ideal diode models in Fig. 2(b).

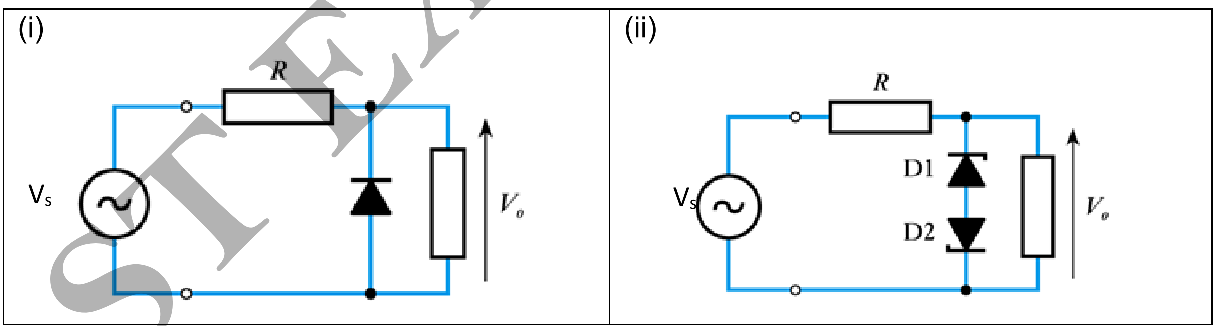

Fig.2(b). Diode circuits.

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

Total 25 marks

Please turn the page

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

Question 3

a) A source with an internal voltage of V_s= 10 mV rms and an internal resistance of R_s= 200 Ω is connected to the input terminals of an amplifier having an open-circuit voltage gain of A_{voc}=1000, an input resistance of R_i= 2kΩ, and an output resistance of R_o= 1kΩ. The load resistance of R_L= 5kΩ. See Fig 3(a)

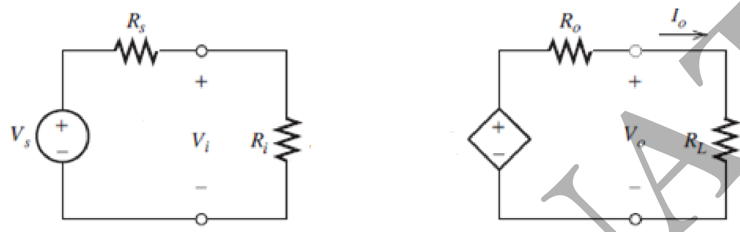

Fig.3(a): a source, amplifier and load circuits

(i) Find the voltage gains, A_{vs}= V_o/V_s and A_V= V_o/V_i

[12 marks]

(ii) Find the current gain and power gain.

[4 marks]

b) Find the overall simplified model for the cascade connection of Fig.3(b).

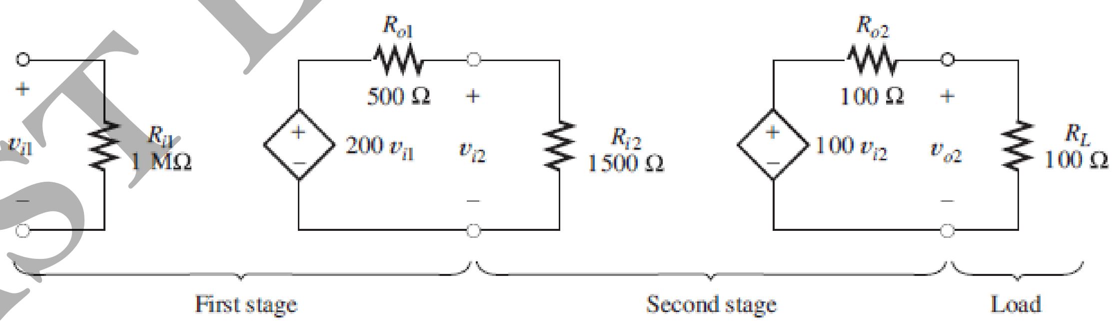

Fig.3(b): A cascaded amplifier circuit

[9 marks]

Total 25 marks

Please turn the page

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

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) A BJT circuit used to as a switch is shown in Fig. Q4. Given that Gain β =200, assume the circuit in the active region where VBE=0.7V. Confirm whether the following circuit is operating in active region.

[13 marks]

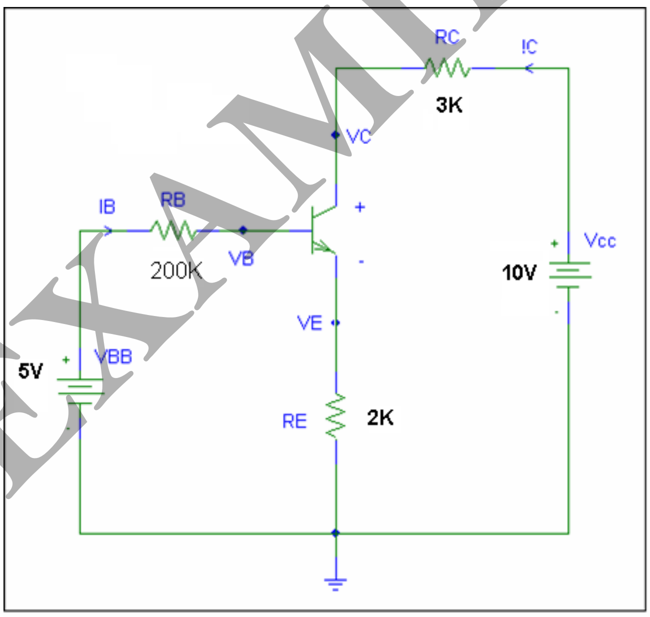

Fig.Q4: Transistor as an amplifier

Total 25 marks

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

Question 5

For the voltage-divider bias circuit (Fig Q5) below, calculate the following:

(a) I_{BQ} **[7 marks]**
(b) I_{CQ} **[3 marks]**
(c) V_{CEQ} **[4 marks]**
(d) V_C **[4 marks]**
(e) V_E **[4 marks]**
(f) V_B **[3 marks]**

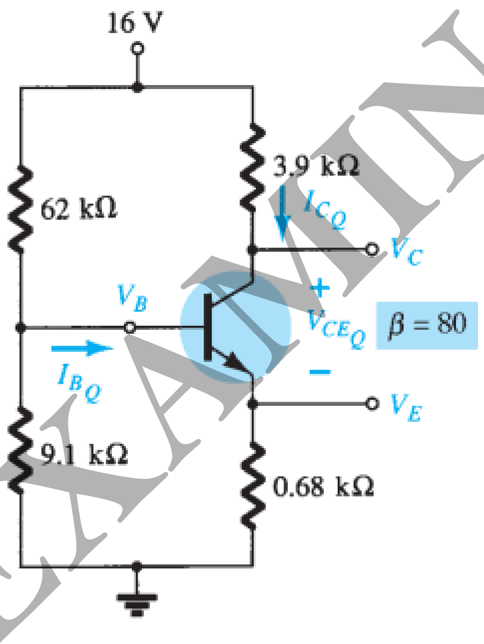

Fig.Q5: Voltage Divider Circuit

Total 25 marks

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

Question 6

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

[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=2.5V and V2 = 5V

[4 marks]

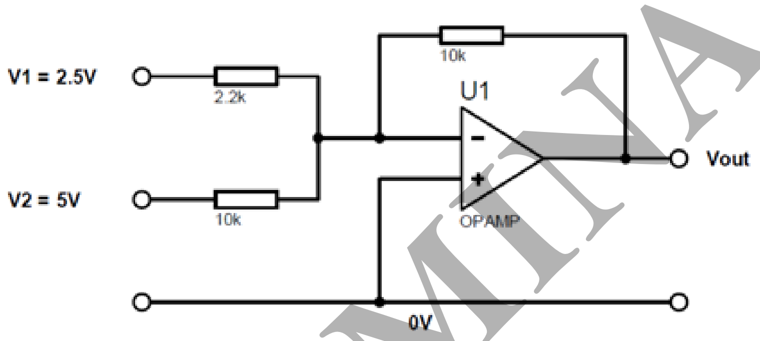

Fig.6b: Summing amplifier

c) Determine the input voltage (V_{in1}) from a cascaded operational amplifier circuit as shown in Fig.Q6c. 401 **[7 marks]**

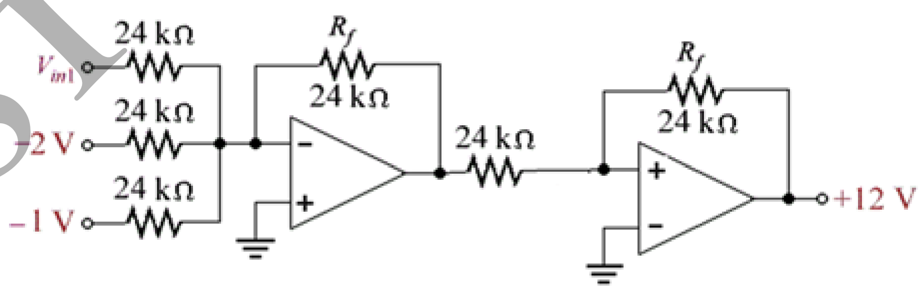

Fig.Q6c: A cascaded operational amplifier circuit.

Question 6 continues on the next page…

Please turn the page

…Question 6 continued

d) Briefly define the term common mode rejection ratio. An amplifier has a CMRR of 82 dB. Restate this CMRR as an arithmetic ratio e.g. *x*:1, where *x* is a numerical value.

[8 marks]

Total 25 marks

End of Questions

Formula sheet follows over the page

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

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:

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

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

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

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

Please turn the page

School of Engineering
B.Eng (Hons) Electrical and Electronic Engineering
Semester Two Examination – 2022/23
Introductory Analogue Electronics
Module No. EEE4014

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

End of formulae sheet

END OF PAPER