INTI International College Penang
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FINAL
Examination Paper

(COVER PAGE)

Session	:	JANUARY 2015
Programmes	:	**DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)**
Course	:	**EEE1106 : ANALOGUE ELECTRONICS**
Date of Examination	:	10 March 2015
Time	:	11.00 am – 1.00 pm Reading Time: Nil
Duration	:	2 Hours
Special Instructions	:	

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Students are not allowed to remove this question paper from the examination venue.

Materials permitted :

Non Programmable Scientific Calculator

Materials provided:

Nil

Examiner(s) : **Mr. Chan Tse Wei**

Moderator : **Dr. Khoo Bee Ee**

This paper consists of 8 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)

EEE1106 : ANALOGUE ELECTRONICS
FINAL EXAMINATION : JANUARY 2015 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks. The marks allocated to each sub-question are shown in square brackets at the right-hand margin.

Question 1

a. i. An amplifier has 5 dBm output power. Calculate its output power in Watts. [2]

ii. The input and output resistances of a voltage amplifier are given as 100kΩ and 200Ω respectively. If the power gain of the amplifier is 40 dB, calculate its voltage gain in dB. [3]

iii. The maximum voltage gain of an audio amplifier is found to be 50 dB. What is the voltage gain of the audio amplifier at its cutoff frequency? [2]

iv. A voltage amplifier frequency response has a –40 dB/dec roll off rate at the high frequency band. What does that mean? [2]

b. Figure-Q1(b) shows a AC equivalent circuit model of a voltage amplifier at low frequency band. Determine the cutoff frequency of the amplifier. [6]

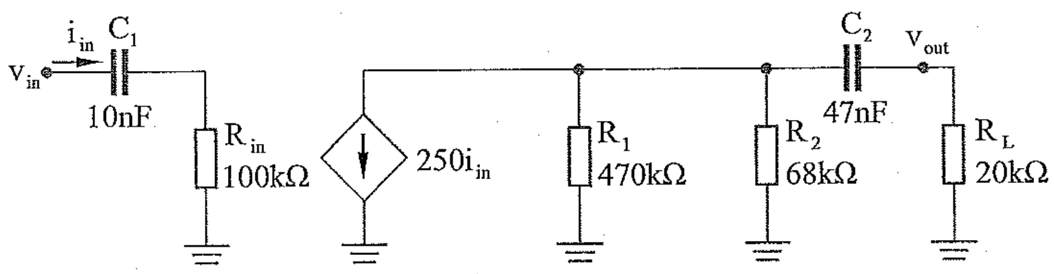

Figure-Q1(b)

c. Determine the lower cutoff frequency (in Hz) of the amplifier circuit shown in Figure-Q1(c). Transistor Q_1 has the following dynamic specifications:

Transconductance, $g_m = 8$ mS

Output resistance, $r_d = \infty\Omega$ [10]

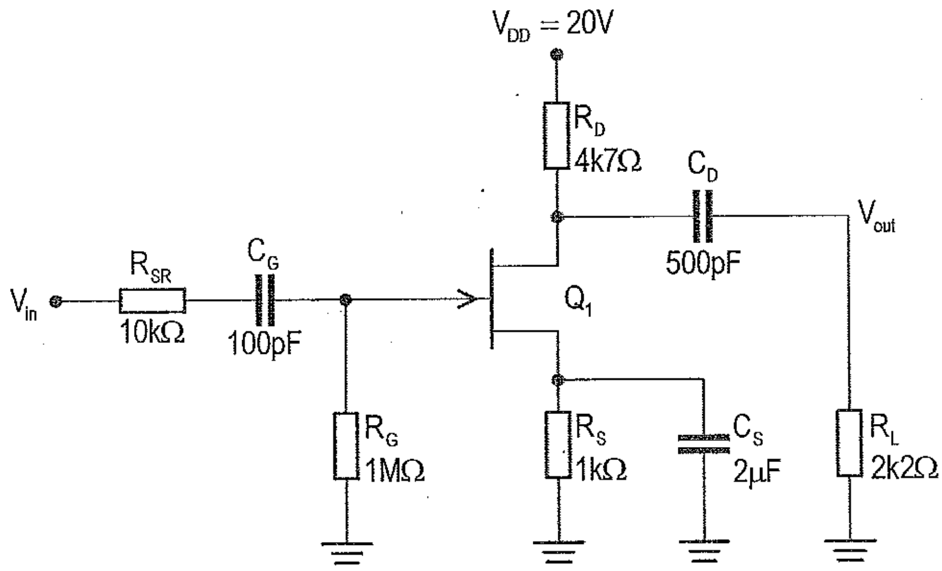

Figure-Q1(c)

Question 2

a. i. State the three main design features of a power amplifier. [3]

ii. What is crossover distortion and which type of power amplifier exhibits crossover distortion in its output? [2]

iii. State the two types of power amplifier which is biased for operation at more than 180° of the input cycle? [2]

iv. State the function of power amplifiers and explain why it is always not 100% efficient. [3]

b. A power amplifier circuit and its AC load line are shown in Figure-Q2(b)(i) and Figure-Q2(b)(ii) respectively. Also shown in Figure-Q2(b)(ii), are the amplifier's output voltage and its corresponding current swing. The wiring resistance and power dissipation of the transformer are negligible.

i. From the given AC load line, calculate the transformer turn ratio, N:1. [3]

ii. Calculate the power delivered to the 8Ω speaker. [2]

iii. Calculate the DC power drawn from the supply. [2]

iv. Calculate the efficiency of the power amplifier. [2]

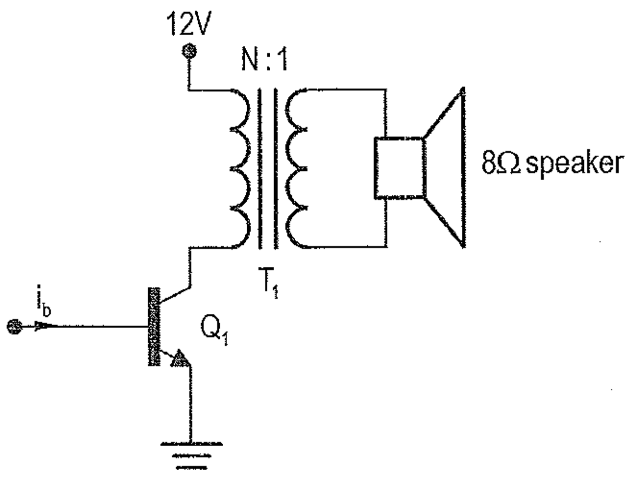

Figure-Q2(b)(i)

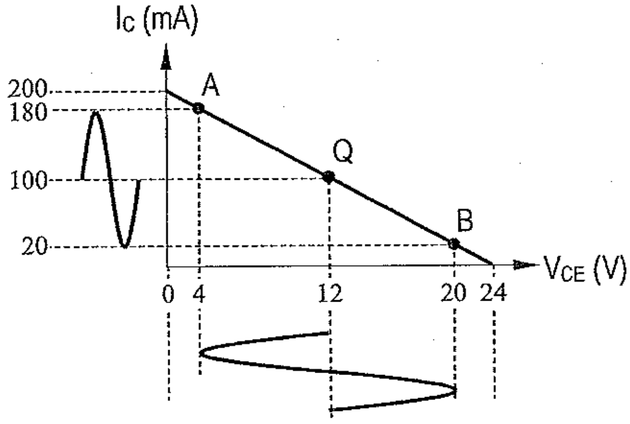

Figure-Q2(b)(ii)

c. Quantitatively show that the maximum theoretical efficiency of the power amplifier in Figure-Q2(b)(i) can be as high as 50%. [6]

Question 3

a. i. Draw the circuit diagram of an active inverting integrator. [2]

ii. One application of the inverting integrator is to convert a square wave to a triangular wave. Describe the circuit operation that fulfills this implementation. [3]

iii. State two factors that limit the operation of the inverting integrator in fulfilling its application given in part (a)(ii). Explain your answer. [3]

b. i. State the name of the circuit implemented in Figure-Q3(b). [2]

ii. Determine the resistance ratio, R_1:R_2 if the circuit's voltage transfer function is to be set at 100. [3]

iii. If the supply voltages for the op-amp is set at ±15V and its voltage transfer function is as given in part (b)(ii), determine the maximum allowable sinusoidal input voltage, V_{in} before the output voltage saturates. Assume ideal op-amp operation. [3]

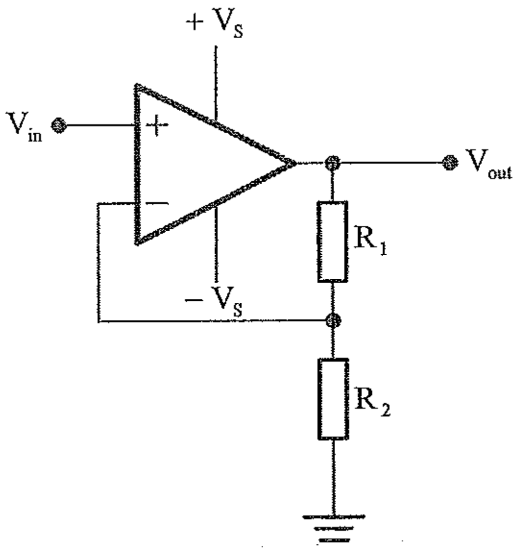

Figure-Q3(b)

c. Base on the maximum allowable sinusoidal input voltage determined in part (b)(iii) and the voltage transfer function given in part (b)(ii), modify the circuit in Figure-Q3(b), assume ideal op-amp operation, so that it can be operated in single supply mode. Justify your modification(s). [9]

Question 4

a. The circuit shown in Figure-Q4(a) is to be utilized as a filter circuit.

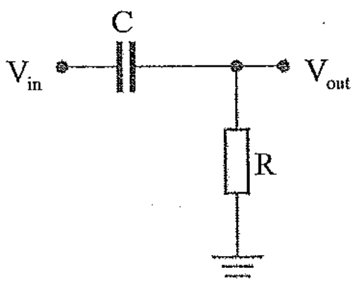

Figure-Q4(a)

i. Identify the type of filter implemented. [2]

ii. Identify the order of the filter. [2]

iii. What is the expected roll-off rate of the filter? [2]

iv. If the output terminal in Figure-Q4(a) is terminated by a resistor which is 5 times of R, how much (in percentage) will the cutoff frequency be increased or reduced? [4]

b. Modify the circuit in Figure-Q4(a), by adding extra component, so that a resistive load terminating the output terminal will not affect the cutoff frequency set by the RC pair. Justify the modification made. [5]

c. The circuit shown in Figure-Q4(c) is a multiple-feedback active filter circuit. The op-amp is assumed ideal.

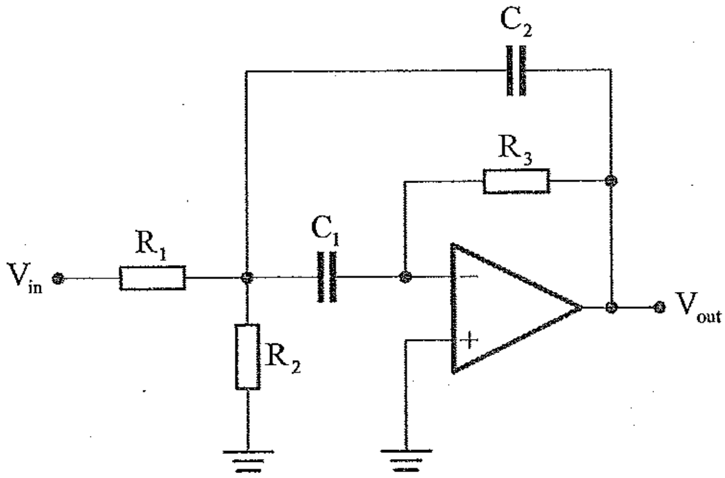

Figure-Q4(c)

i. Derive the circuit's voltage transfer function. [5]

ii. Hence, identify the type of filter implemented. [1]

iii. If $C_1 = C_2$, show that the maximum magnitude of the voltage transfer function is,

$$\left|\frac{V_{out}}{V_{in}}\right|_{max} = \frac{R_3}{2R_1}$$ [4]

Question 5

a. i. Draw the block diagram of a RC feedback harmonic oscillator. [2]

ii. State the Barkhausen criteria of oscillation used in RC feedback harmonic oscillator, clearly explain all the symbols used. [2]

iii. State the condition where the oscillating waveform produced by a RC feedback harmonic oscillator shows signs of saturation, assuming that all components in the circuit are in working condition. [2]

iv. State the condition where a RC feedback harmonic oscillator fails to produce a sinusoidal waveform, assuming that all components in the circuit are in working condition. [2]

v. Name two examples of RC feedback harmonic oscillator. [2]

b. i. Draw a schematic diagram of a relaxation oscillator that generates both square wave and triangular wave simultaneously. [2]

ii. Briefly explain the operation of the oscillator given in part (b)(i). [3]

c. Figure-Q5(c) shows FET-based oscillator circuit.

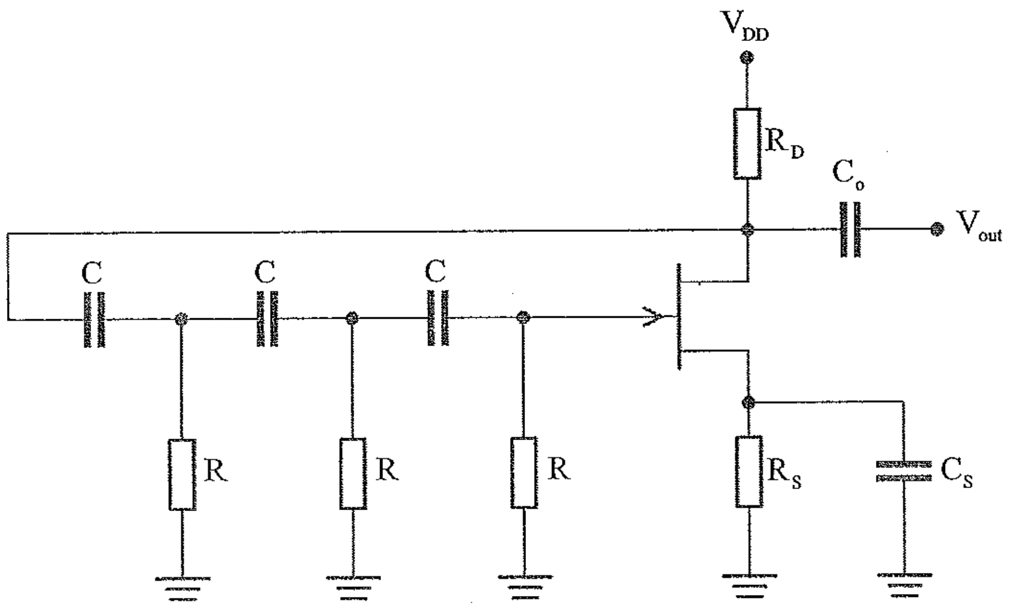

Figure-Q5(c)

i. Draw the AC equivalent circuit model of the oscillator. The output dynamic drain-source resistance (r_d) of the FET is not to be neglected. [2]

ii. Hence, show that $g_m(r_d \,//\, R_D) = 29$ when the circuit generate a sustainable sinusoidal output. Assume the feedback network draws negligible currents from the output. [8]

Question 6

a. i. Draw the schematic diagram of an inverting amplifier. [2]

ii. Suggest relevant resistance values in the inverting amplifier given in part (a)(i) that fulfills the following design specifications:

- Voltage gain, $A_v = -8$
- Input resistance, $R_{in} = 20k\Omega$ [3]

iii. If a 1V DC voltage is applied to the inverting amplifier designed in part (a)(ii) which is terminated by a $1k\Omega$ load resistor, calculate the current flowing through to the $1k\Omega$ load. [3]

b. In addition to the design specifications listed in part (a)(ii), all the resistors used in the inverting amplifier circuit must be equal-valued and less than $100k\Omega$ in order to minimize the impact of non-ideal characteristics of the op-amp used. Figure-Q6(b) shows a modified inverting amplifier that fulfills the new design requirements.

Show that the voltage gain of the amplifier is fulfilled. [7]

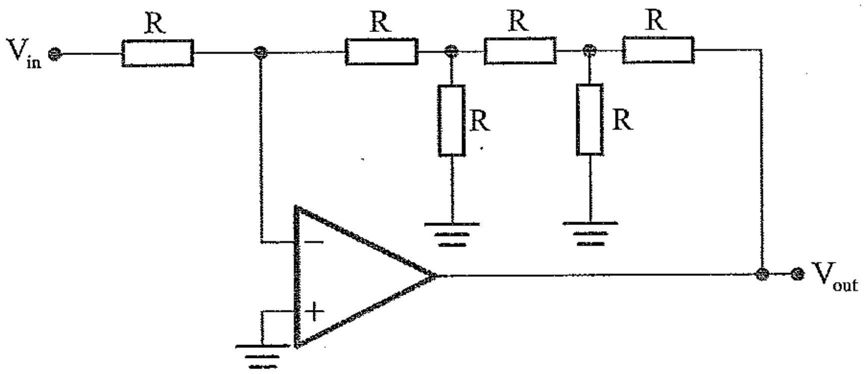

Figure-Q6(b)

c. In a practical implementation of the circuit in Figure-Q6(b), a low graded op-amp is used to reduce the product cost. The op-amp has the following specifications:

- Input resistance, $R_{in} = 100k\Omega$
- Open-loop voltage gain, $A_o = 1000$
- Output resistance, $R_{out} = 200\Omega$

Quantitatively investigate the effect of these specifications on the circuit voltage gain. [10]

– THE END –