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FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2018**
Programmes	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE1106: Analogue Electronics**
Date of Examination	:	6 December 2018 (Thursday)
Time	:	11:00am – 1:00pm
Duration	:	2 Hours Reading Time **Nil**
Special Instructions	:	

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

IMPORTANT NOTE : THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL BY THE STUDENTS.

Materials Permitted :

Non-programmable Calculator (e.g. Model fx570 Series)

Materials Provided :

1. **Linear graph paper** (× **1**)
2. **Appendix-1**

Examiner(s)	:	**Chan Tse Wei**
Moderator	:	Assoc. Prof. Dr. Khoo Bee Ee

*This paper consists of **9** printed pages, including the cover page.*

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DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE1106: ANALOGUE ELECTRONICS
FINAL EXAMINATIONS: AUGUST 2018 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. Present your answers neatly and clearly. The assessor reserves the rights to ignore your answers if they are ambiguous.

Question 1

a. Figure-Q1(a)(i) shows a common emitter amplifier circuit with an input coupling capacitor. Figure-Q1(a)(ii) shows the component model for transistor T_1 needed to analyze the amplifier circuit.

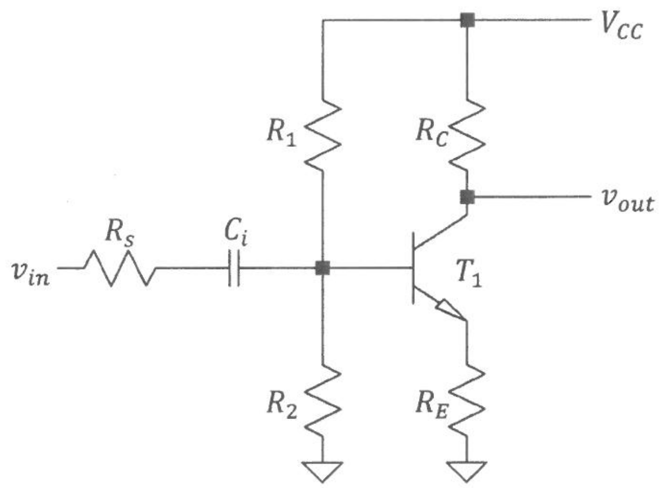

Figure-Q1(a)(i)

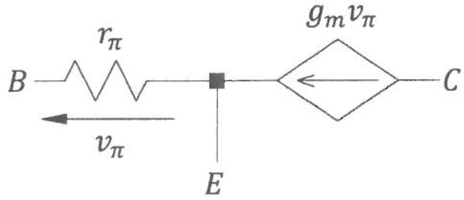

Figure-Q1(a)(ii)

i. Draw the low frequency small-signal equivalent circuit for the amplifier circuit in Figure-Q1(a)(i), utilizing the transistor model as shown in Figure-Q1(a)(ii). [3]

ii. Derive the expression of the resistance looking into the base terminal of the small-signal equivalent circuit drawn in in part (a)(i). [4]

iii. Derive the expression of the lower cutoff frequency of the amplifier circuit in Figure-Q1(a)(i). [3]

b. Figure-Q1(b) shows an incomplete design of an inverting amplifier. The signal source, $v_{signal} = 0.1\sin(\omega t)$, is capable to supply a maximum current of 5 μA. The frequency of the signal source, ω is sufficiently low such that the frequency effects on the op-amp operation can be neglected. The op-amp has a minimum voltage supply requirement of $\pm 3\ V$ and maximum at $\pm 18\ V$.

Complete the design of the amplifier such that its voltage gain, A_v is -5. [10]

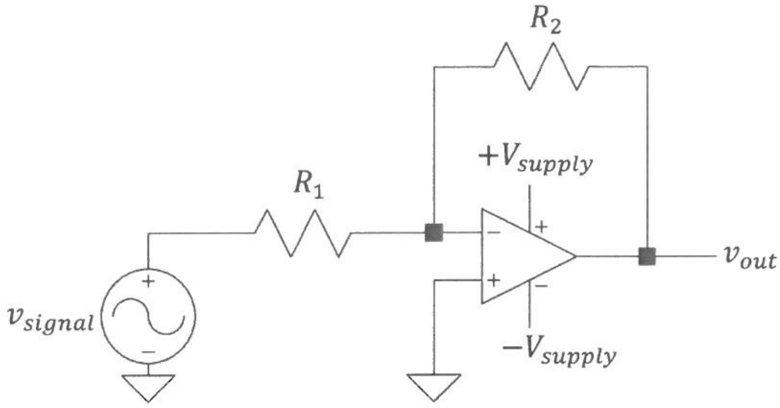

Figure-Q1(b)

c. Explain the function of a harmonic oscillator and give two application examples. [5]

Question 2

a. Explain the selection criteria for the choice of a Class-A power amplifier in an application design. [5]

b. The voltage transfer function of an active filter is given by,

$$\frac{V_{out}(s)}{V_{in}(s)} = \frac{19.739 \times 10^9}{s^2 + (88.86 \times 10^3)s + (20 \times 10^3 \times \pi)^2}$$

Calculate the filter's cutoff frequency in Hz, bandwidth in Hz and the maximum gain in dB. [10]

c. Figure-Q2(c) shows a phase-shift oscillator circuit.

i. Analyze the circuit to quantitatively formulate the oscillation frequency expression. [7]

ii. Explain the approach to easily obtain higher oscillation frequencies from the circuit. [3]

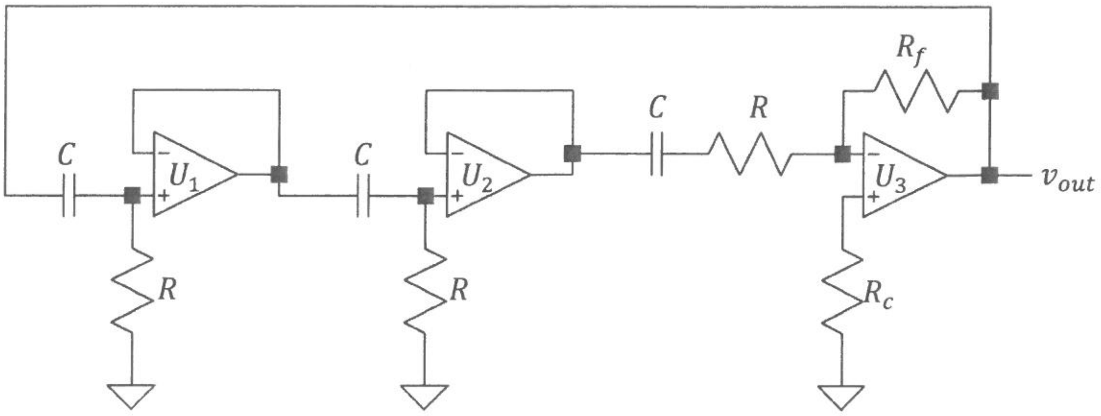

Figure-Q2(c)

Question 3

a. Figure-Q3(a) shows a transformer-coupled emitter-follower amplifier delivering a specified power signal to R_{load} which is an 8 Ω, 5 W load. The peak emitter current, $i_{e(peak)} = 0.9I_{CQ}$ and the peak emitter voltage, $v_{e(peak)} = 0.9V_{CC}$. Calculate,

i. the peak output voltage, $v_{out(peak)}$. [2]

ii. the peak output current, $i_{out(peak)}$. [2]

iii. the required transformer turn ratio, N. [2]

iv. the quiescent collector current, I_{CQ}. [2]

v. the maximum power dissipation in the transistor, P_Q. [2]

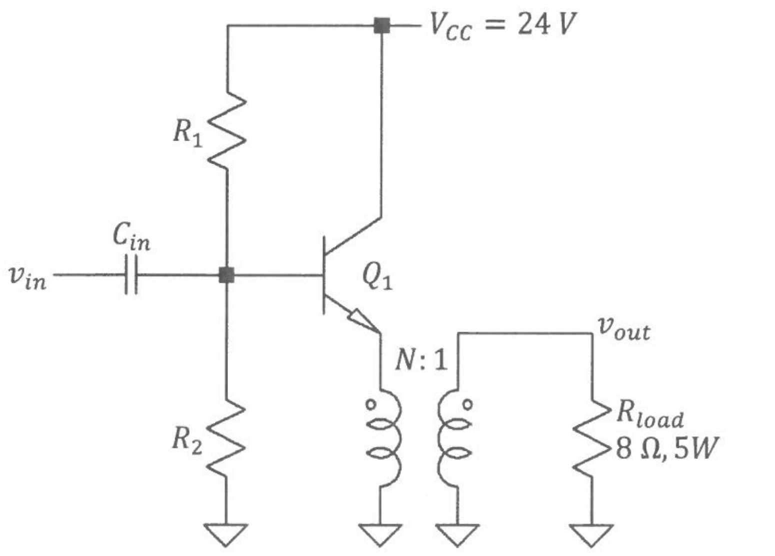

Figure-Q3(a)

b. State the two families of analogue filter and give two major differences between these two filter families. [5]

c. Figure-Q3(c) shows a relaxation oscillator implemented using a 555 timer. Sketch the synchronized timing diagrams of the voltages across capacitor C_1 and V_{out}. Clearly label the sketches with timings and voltage levels. [10]

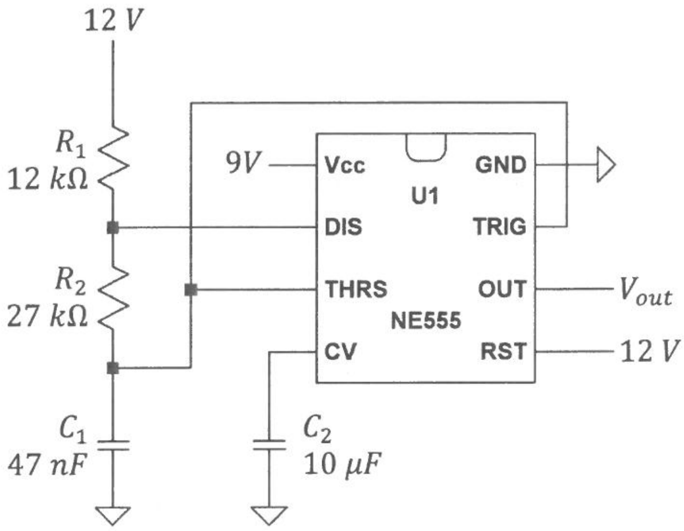

Figure-Q3(c)

Question 4

a. Explain the three guidelines that are adopted when analyzing any op-amp circuit which establishes negative feedback. [5]

b. Figure-Q4(b) shows a basic complementary pair push-pull power amplifier.

Table-Q4(b) shows the experiment results when the power amplifier is being evaluated.

$v_{out(p)}$ in Table-Q4(b) is the peak output voltage measured across the 8 Ω load resistor, R_{load}.using an oscilloscope.

I_{DC} is the average current flowing from the power supply unit that delivers the $+24V$ supply. The magnitude of the average current flowing into the $-24V$ supply is assumed the same as that from the positive supply channel.

i. Assume that both Q_1 and Q_2 transistors are identical and ideal, plot a best fit graph of one transistor dissipation (P_Q) against $v_{out(p)}$ on the provided linear graph paper. [8]

ii. From the plotted graph in part (a)(i), estimate the output voltage that causes the transistor to radiate the most heat. [2]

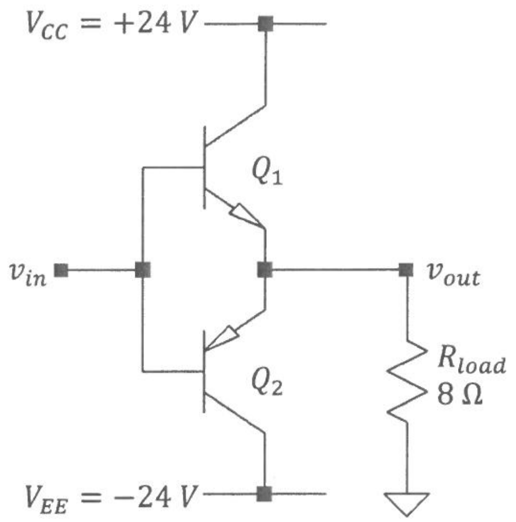

Figure-Q4(b)

Table-Q4(b)

$v_{out(p)}\ (V)$	0	2	4	6	8	10	12	14	16	18	20	22
$I_{DC}\ (A)$	0.00	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.88

c. Figure-Q4(c) shows an audio amplifier circuit model. Analyze the amplifier circuit model to identify its lower and upper cutoff frequencies. [10]

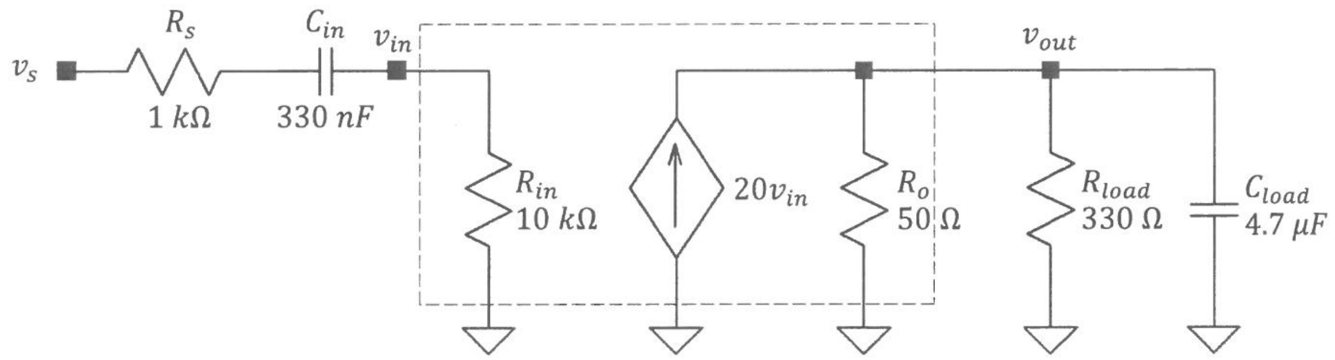

Figure-Q4(c)

Question 5

a. Explain the function of capacitor C_E and resistor R_E of the amplifier in Figure-Q5(a) [5]

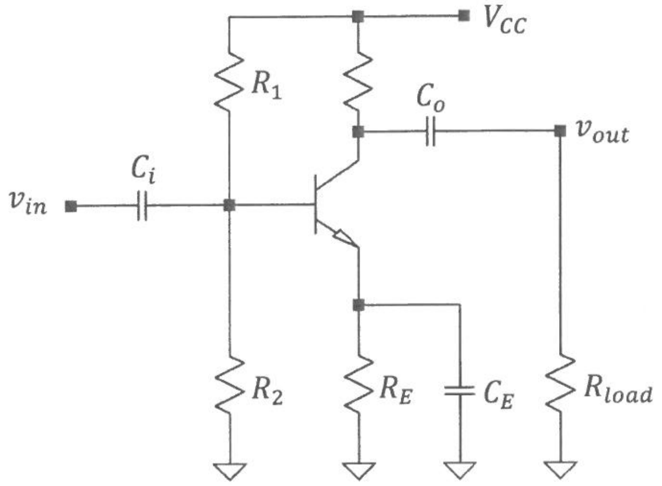

Figure-Q5(a)

b. Figure-Q5(b) shows an inverting summing amplifier.

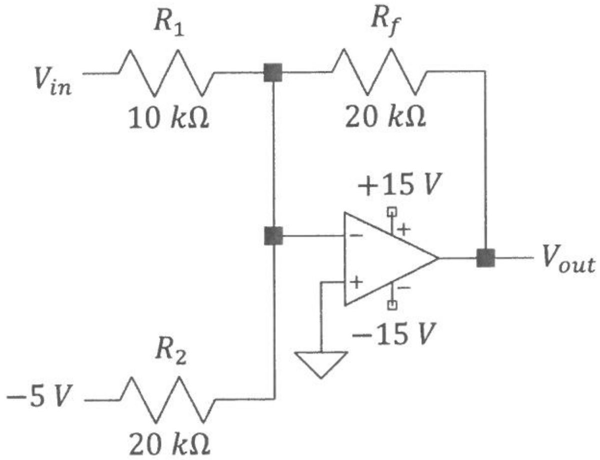

Figure-Q5(b)

i. Derive the expression of V_{out} in terms of V_{in}. [5]

ii. If the input voltage, V_{in} is a triangular wave swinging between ± 1 V at 50% duty cycle, sketch the voltage transfer curve of the amplifier. [5]

c. Figure-Q5(c) shows a Sallen-Key high pass filter. Identify its lower cutoff frequency in Hz. [10]

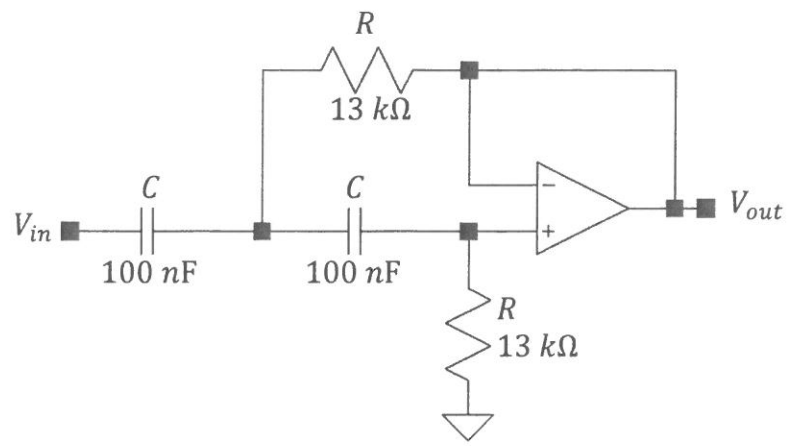

Figure-Q5(c)

Question 6

a. Figure-Q6(a) shows a circuit to be used as a simple audio amplifier. The biasing components in the amplifier causes the n-channel JFET to exhibit a transconductance, $g_m = 1.2\ mS$.

i. Analyze the circuit's mid band voltage transfer function. [5]

ii. Identify the value of C_o so that the amplifier's lower cutoff frequency is 20 Hz. [5]

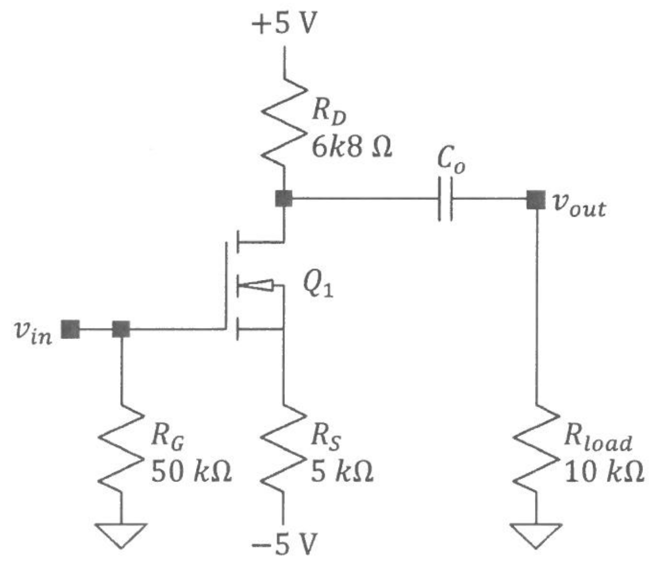

Figure-Q6(a)

b. The non-inverting amplifier in Figure-Q6(b) draws no current from its voltage source v_{in}. Calculate the RMS current drawn from the op-amp output terminal if v_{in} is a sinusoidal signal having a peak-to-peak voltage of 1 V. [5]

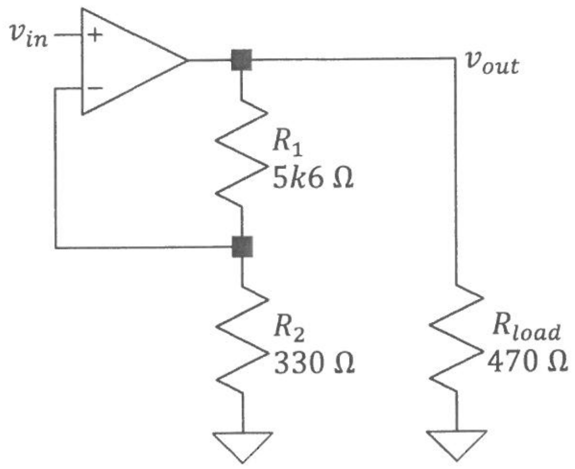

Figure-Q6(b)

c. Appendix-1 shows datasheet extracts of op-amp TL081.

Examine if the op-amp TL081 in Figure-Q6(c) is suitable to buffer the applied sinusoidal signal to the low resistive load. Quantitatively justify your answer. [10]

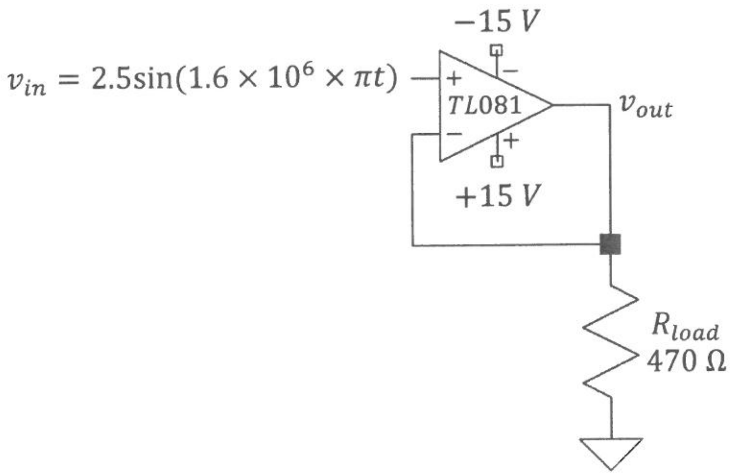

Figure-Q6(c)

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