FNU FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

**School of Electrical & Electronics Engineering**

**Trade Diploma in Electronics Engineering**

**EEE552 – Analog Electronics II**

**FINAL EXAMINATION (Supplementary)**

**Trimester 2, 2017**

**Date: As per Exam Time Table**

**Time: As per Exam Time Table (3 hours)**

**Venue: As per Exam Timetable**

**Instructions to Students**

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Attempt ALL questions in this examination booklet
3. Write your answers in the answer booklet provided.
4. Write your Student ID number on each page used.
5. Begin each Section on a fresh page and use both sides of the answer sheet.
6. You may use calculators provided they are non-programmable.
7. Clearly number the questions in your answer paper in their correct sequence and write legibly. Show all working.
8. Attach any extra sheets used to your answer booklet securely with the string provided.

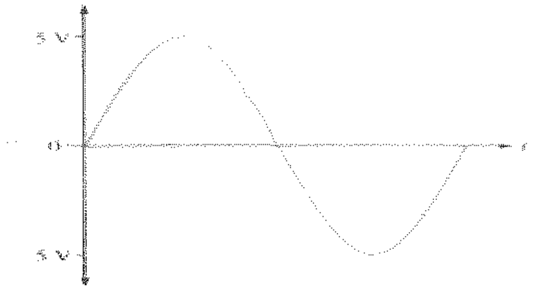
************************************************************************************************

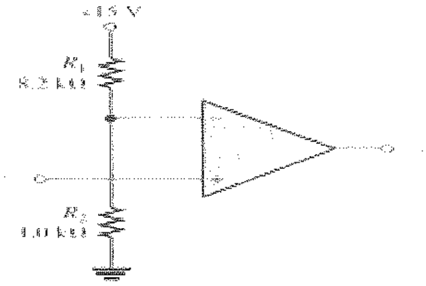
## Final Examination (Supplementary)

**Question 1:** **(Operational Amplifier/Op-Amp)** ***(15 marks)***

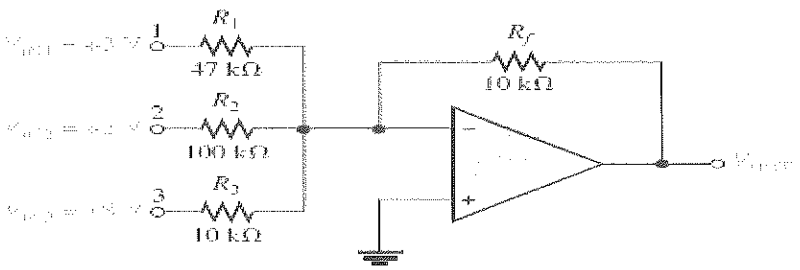
a) i. Draw the circuit of non-inverting amplifier and select the value of resistors to provide a close loop gain of 374. ***(4 marks)***
ii. Outline the properties of practical op-amp. ***(2 marks)***

b) The input signal in Figure below is applied to the comparator circuit. Draw the output showing its proper relationship to the input signal. Assume the maximum output levels of the comparator is ±14V. ***(4 marks)***

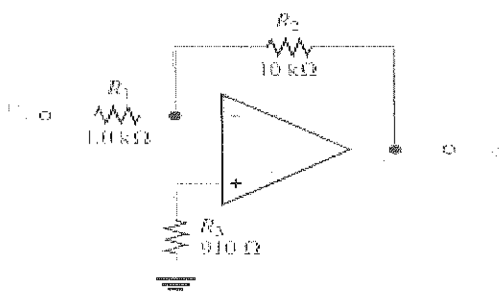





c) Determine the output voltage $V_{out}$ in Figure below. ***(2.5 marks)***




d) Determine the effect on the output of the circuit in Figure below if the following changes are made:
i) R1 is removed and left open ***(1 mark)***
ii) R2 and R3 are swapped ***(1.5 mark)***

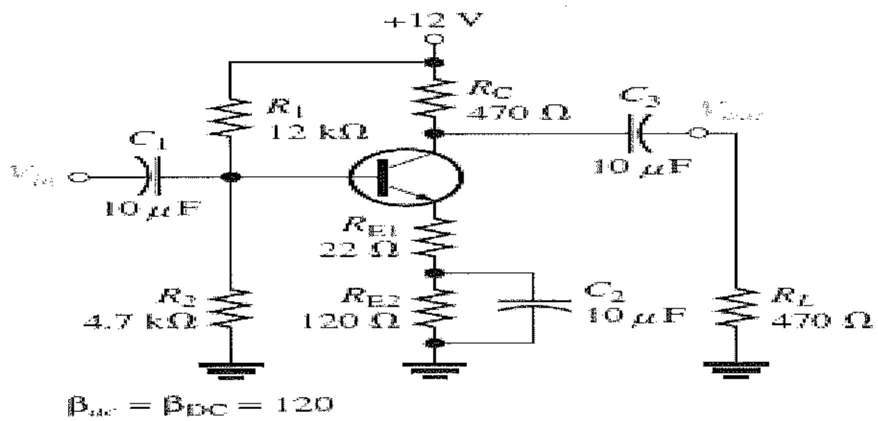



*Please Turn Over*

**Question 2: (Power Amplifiers / Distortion) (20 marks)**

a) Explain how cross over distortion is caused in class B power amplifiers. ***(2 marks)***

b) For the amplifier circuit given below:
   i) Determine the dc collector voltage. ***(4 marks)***
   ii) Determine the voltage gain ($A_v$). ***(3 marks)***




c) A class C amplifier is driven by a 200 kHz signal. The transistor is on for 3μs, and the amplifier is operating over 100 percent of its load line. If $I_c(sat)$ = 200 mA and $V_{ce}$ $(sat)$ = 0.25 V, what is the average power dissipation of the transistor. ***(2 marks)***

d) Sketch the circuit diagram of class AB power amplifier operating with a single power supply and outline its characteristics. ***(4 marks)***

e) Define amplifier distortion. ***(2 mark)***

f) Describe the use and importance of fins in heat sink. ***(1 mark)***

g) What are the factors need to be considered while designing heat sinks ***(2 marks)***

*Please Turn Over*

## Final Examination (Supplementary)

**Question 3: (Oscillators) (20 marks)**

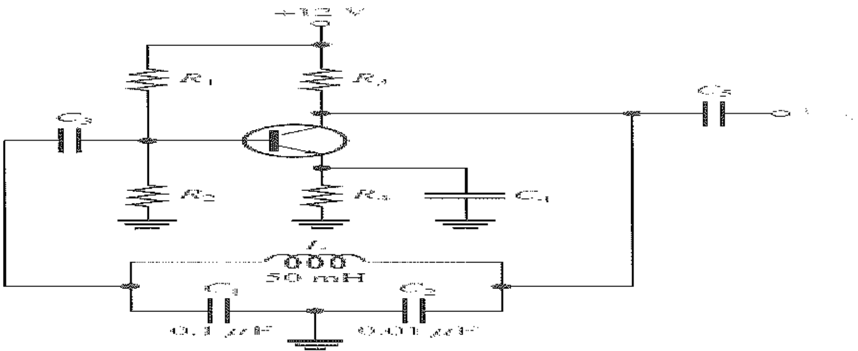
a) i) Draw the circuit diagram of a wien-bridge oscillator with amplitude stabilization circuit to achieve sustained oscillation (use back to back zener diode arrangement sustain oscillations) ***(3 marks)***

ii) To obtain an output frequency of 125kHz, compute the appropriate parameters in the circuit. ***(2 marks)***

iii) Explain how output voltage is stabilized in wein-bridge oscillator using a back to back zener diode arrangement. ***(2 marks)***

b) i) Determine the frequency for the oscillator in Figure below. Assume there is negligible loading on the feedback circuit and that its Q is greater than 10. ***(3 marks)***

ii) Find the frequency, if the oscillator is loaded to a point where the Q drops to 8. ***(1 mark)***

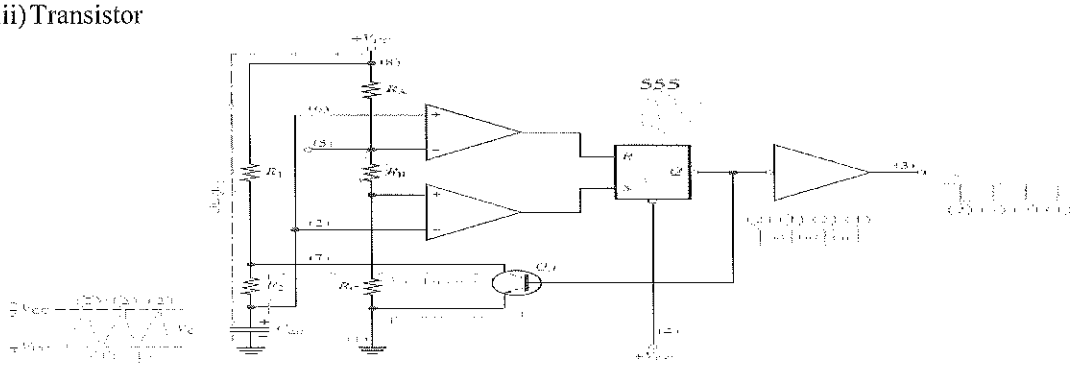



c) i) Sketch the circuit diagram of a triangular wave generator (hint: stage 1 will be comparator and stage 2 will be integrator). ***(3 marks)***

ii) Select the appropriate values of resistors and capacitors in the circuit of part (i) to obtain output frequency of 1.6kHz. ***(2 marks)***

d) A 555 timer connected to operate in the astable mode as a free-running relaxation oscillator (astable multivibrator) is shown in Figure below. Explain the purpose of the following: ***(4 marks)***

i) Flipflop
ii) Resistive voltage divider
iii) Transistor



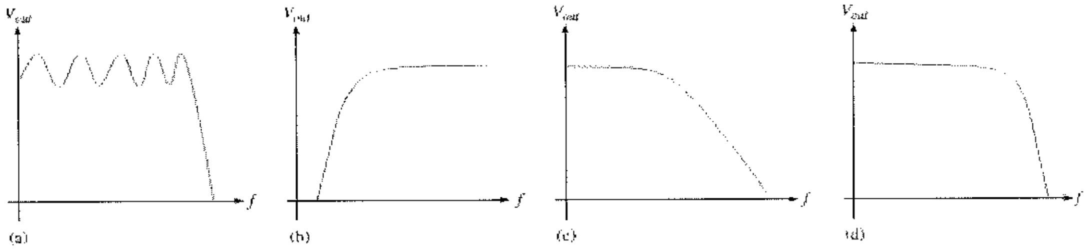

*Please Turn Over*

## Final Examination (Supplementary)

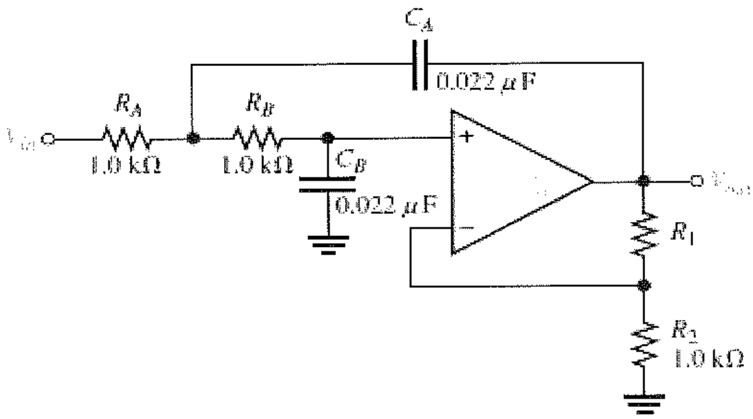
**Question 4: (Tuned Amplifiers) (15 marks)**

a) Name 4 types of active filters and describe each with frequency-response curves and explanation. ***(4 marks)***

b) Response curve for second-order filters are shown below. Identify each as Butterworth, Chebyshev or Bessel. ***(2 marks)***




c) Determine the critical frequency of the Sallen-key low-pass filter in Figure below and set the value of R1 for an approximate Butterworth response. ***(4 marks)***




d) Design a four-pole low pass RC filter with critical frequency of 2500 Hz, consider all resistors in the RC low-pass circuit as 1.8k ohm and set the feedback resistors to obtain Butterworth response. ***(5 marks)***

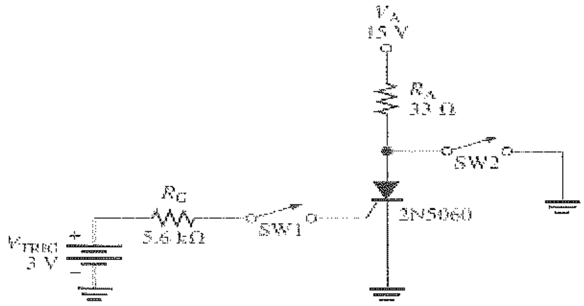
*Please Turn Over*

**Question 5: (Optoelectronics) (8 marks)**

a) Define Optoelectronics. ***(2 marks)***
b) List three LED performance measures. ***(3 marks)***
c) Describe operation of Photo Detector. ***(3 marks)***

**Question 6: (Thyristors / CRTs and CROs) (22 marks)**

a) Draw the SCR characteristics curve and describe its operation. ***(5 marks)***
b) Outline the two methods to turn off a thyristor. ***(4 marks)***
c) Determine the gate trigger current and the anode current when the switch, SW1, is momentarily closed in Figure below. Assume $V_{AK}$ =0.2V, $V_{GK}$ =0.7V and $I_H$=5mA. ***(5 marks)***




d) i) Outline the operation of CRTs. ***(3 marks)***
ii) List the important functions of CROs. ***(3 marks)***

*THE END*

***ALL THE BEST FOR THE EXAMINATION***

Formulas

$A_{cl(NI)} = 1 + \frac{R_f}{R_i}$ Voltage gain (noninverting)

$A_{cl(VF)} = 1$ Voltage gain (voltage-follower)

$A_{cl(I)} = -\frac{R_f}{R_i}$ Voltage gain (inverting)

$I_E = I_C + I_B$ Transistor currents

$\beta_{DC} = \frac{I_C}{I_B}$ DC current gain

$r_e' \cong \frac{25\text{ mV}}{I_E}$ Internal ac emitter resistance

**Common-Emitter**

$R_{in(base)} = R_1 \parallel R_2 \parallel R_{in(base)}$ Total amplifier input resistance, voltage-divider bias

$R_{in(base)} = \beta_{ac} r_e'$ Input resistance at base

$A_v = \frac{R_C}{r_e'}$ Voltage gain, base-to-collector, unloaded

$A_v = \frac{R_C}{r_e' + R_E}$ Voltage gain without bypass capacitor

$A_v = \frac{R_c}{r_e'}$ Voltage gain, base-to-collector, loaded, bypassed $R_E$

**Power Amplifier**

$A_p = \frac{P_L}{P_{in}}$ Power gain

$A_p = A_v^2\left(\frac{R_{in}}{R_L}\right)$ Power gain in terms of voltage gain

Class C Amplifier

$P_{D(avg)} = \left(\frac{t_{on}}{T}\right)P_{D(on)} = \left(\frac{t_{on}}{T}\right)I_{c(sat)}V_{ce(sat)}$

Oscillator

$$\frac{V_{out}}{V_{in}} = \frac{1}{3}$$ Wien-bridge positive feedback attenuation

$$f_r = \frac{1}{2\pi RC}$$ Wien-bridge resonant frequency

$$B = \frac{1}{29}$$ Phase-shift feedback attenuation

$$f_r = \frac{1}{2\pi\sqrt{6}RC}$$ Phase-shift oscillator frequency

$$f_r = \frac{1}{4R_1C}\left(\frac{R_2}{R_3}\right)$$ Triangular-wave oscillator frequency

$$V_{UTP} = +V_{max}\left(\frac{R_3}{R_2}\right)$$
$$V_{LTP} = -V_{max}\left(\frac{R_3}{R_2}\right)$$ UTP and LTP for Triangular wave oscillator

$$f_r \cong \frac{1}{2\pi\sqrt{LC_T}}$$ Colpitts, Clapp, and Hartley approximate resonant frequency

$$f_r = \frac{1}{2\pi\sqrt{LC_T}}\sqrt{\frac{Q^2}{Q^2+1}}$$ Colpitts resonant frequency

$$f_r = \frac{1.44}{(R_1 + 2R_2)C_{ext}}$$ 555 astable frequency

$$\text{Duty cycle} = \left(\frac{R_1 + R_2}{R_1 + 2R_2}\right)100\%$$ 555 astable

Filter

$$BW = f_c$$ Low-pass bandwidth

$$BW = f_{c2} - f_{c1}$$ Filter bandwidth of a band-pass filter

$$f_0 = \sqrt{f_{c1}f_{c2}}$$ Center frequency of a band-pass filter

$$Q = \frac{f_0}{BW}$$ Quality factor of a band-pass filter

$$DF = 2 - \frac{R_1}{R_2}$$ Damping factor

$$A_{cl(NI)} = \frac{R_1}{R_2} + 1$$ Closed-loop voltage gain

$$f_c = \frac{1}{2\pi\sqrt{R_AR_BC_AC_B}}$$ Critical frequency for a second-order Sallen-Key filter

if $R_A = R_B = R$ and $C_A = C_B = C$, $\quad f_c = \frac{1}{2\pi RC}$

Butterworth response.

| ORDER | ROLL-OFF dB/DECADE | 1ST STAGE POLES | 1ST STAGE DF | 1ST STAGE $R_1/R_2$ | 2ND STAGE POLES | 2ND STAGE DF | 2ND STAGE $R_3/R_4$ | 3RD STAGE POLES | 3RD STAGE DF | 3RD STAGE $R_5/R_6$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | −20 | 1 | Optional | | | | | | | |
| 2 | −40 | 2 | 1.414 | 0.586 | | | | | | |
| 3 | −60 | 2 | 1.00 | 1 | 1 | 1.00 | 1 | | | |
| 4 | −80 | 2 | 1.848 | 0.152 | 2 | 0.765 | 1.235 | | | |
| 5 | −100 | 2 | 1.00 | 1 | 2 | 1.618 | 0.382 | 1 | 0.618 | 1.382 |
| 6 | −120 | 2 | 1.932 | 0.068 | 2 | 1.414 | 0.586 | 2 | 0.518 | 1.482 |