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

Trimester 1, 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.

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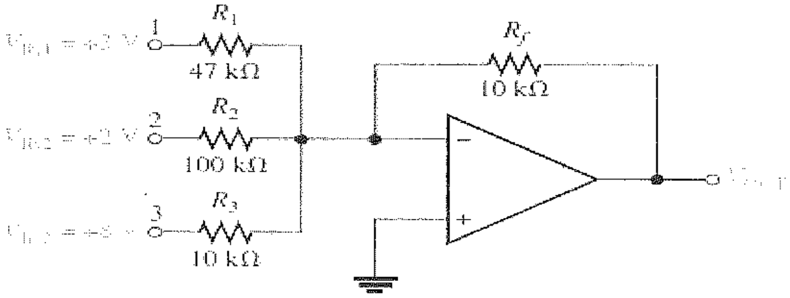
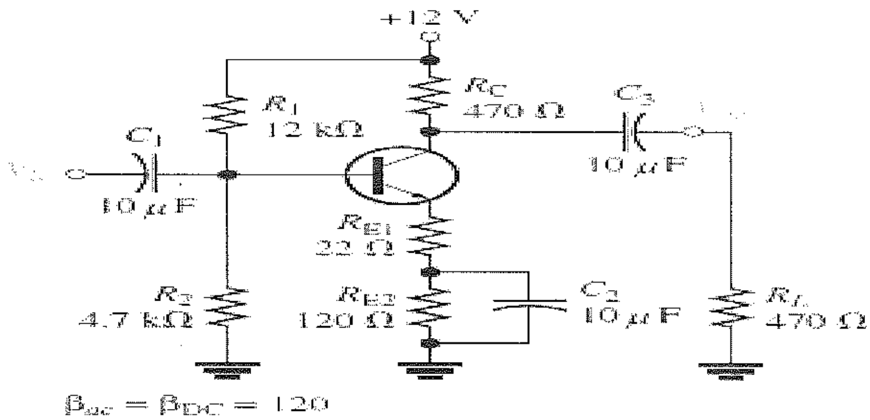
f) Determine the weight of each input voltage for the scaling adder in Figure below and find the output voltage. *(3 marks)*



Question 2: (Power Amplifiers / Distortion) (21 marks)

a) Describe the operation of class A or class C power amplifiers. *(3 marks)*
b) Explain how cross over distortion is caused in class B amplifier. *(2 marks)*
c) For the amplifier circuit given below:
   i) Determine the dc Q point. *(3 marks)*
   ii) Determine the voltage gain and power gain. *(3 marks)*



d) A class C amplifier is driven by a 100 kHz signal. The transistor is on for 2 ms, and the amplifier is operating over 100 percent of its load line. If $I_c(sat)$ = 100 mA and $V_{ce}\,(sat)$ = 0.2 V, what is the average power dissipation of the transistor. *(2 marks)*
e) Refer to class AB amplifier in Figure below operating with a single power supply. Determine the dc parameters $V_{B(Q1)}$, $V_{B(Q2)}$, V_E, I_{CQ}, $V_{CEQ(Q1)}$ and $V_{CEQ(Q2)}$. *(3 marks)*

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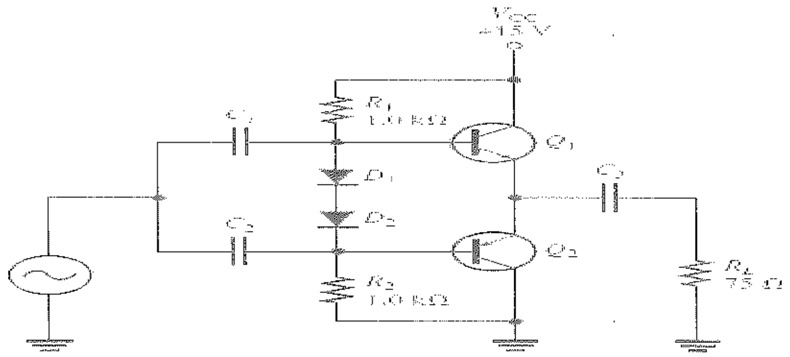
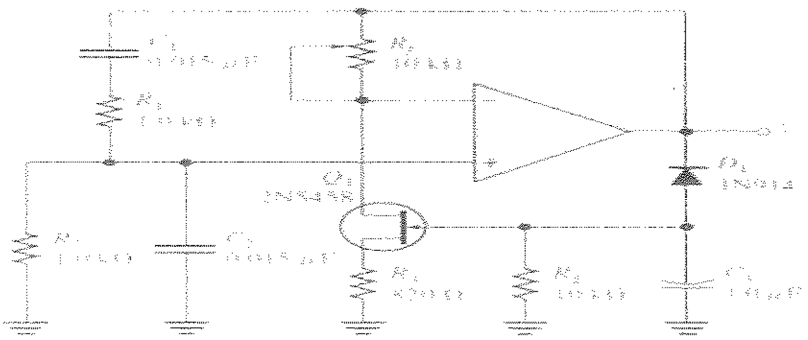


f) Define the term attenuation. *(1 mark)*
g) Define amplifier distortion. *(1 mark)*
h) Describe the use and importance of fins in heat sink. *(1 mark)*
i) Define convection. *(1 mark)*
j) What are the factors need to be considered while designing heat sinks *(1 mark)*

Question 3: (Oscillators) (20 marks)

a) There are two feedback loops in the Wien-bridge oscillator. With the aid of a diagram, describe the purpose of each. *(3 marks)*
b) For the Wien-bridge oscillator in Figure below, setting R_f= 5k ohm, what should be the internal drain-source resistance, r'_{ds} of the JFET when oscillations are stable. *(3 marks)*



c) Name the circuit in Figure below and find the value of R_f required and also find f_r. *(2 marks)*

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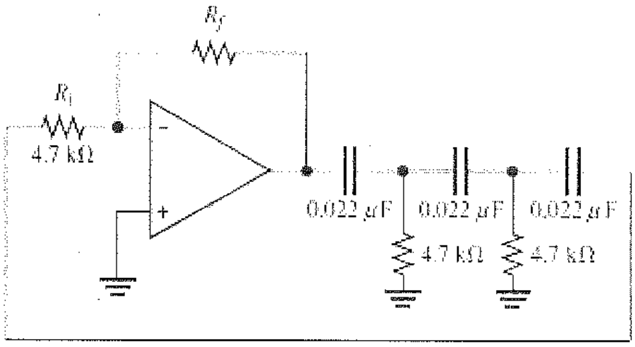
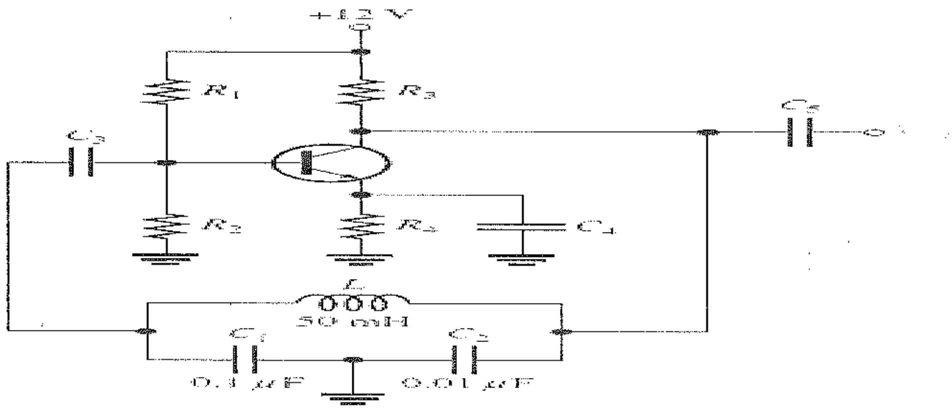


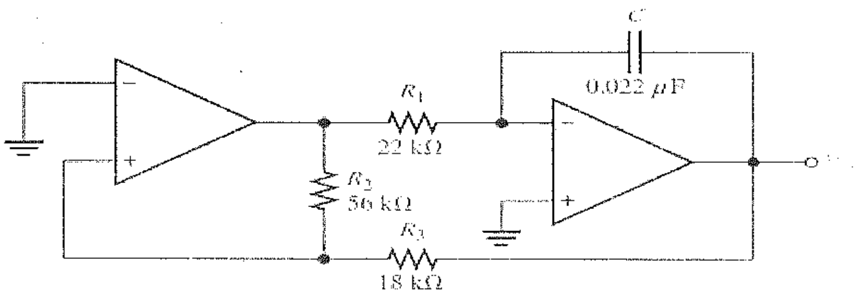
d)

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. *(2 marks)*

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



e) What type of signal does the circuit in Figure below produce at each stage. Name each of the stage and determine the frequency of the output. *(3 marks)*



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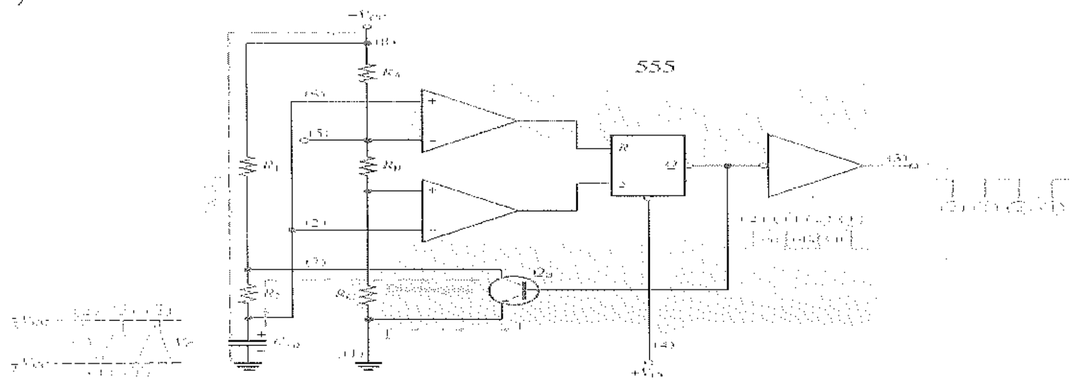
Final Examination

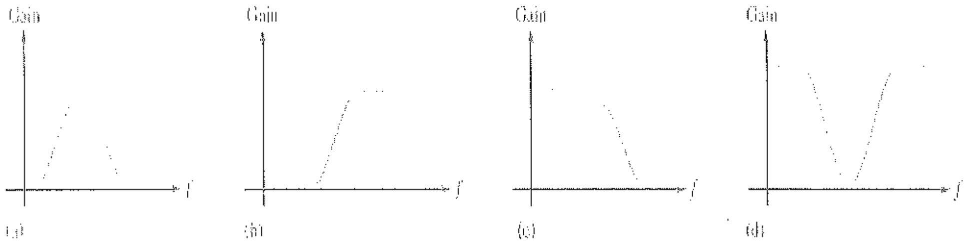
f) A 555 timer connected to operate in the astable mode as a free-running relaxation oscillator (astable multivibrator) is shown in Figure below. Explain the purpose of the following: *(4 marks)*
   i) Flipflop
   ii) Resistive voltage divider
   iii) Transistor



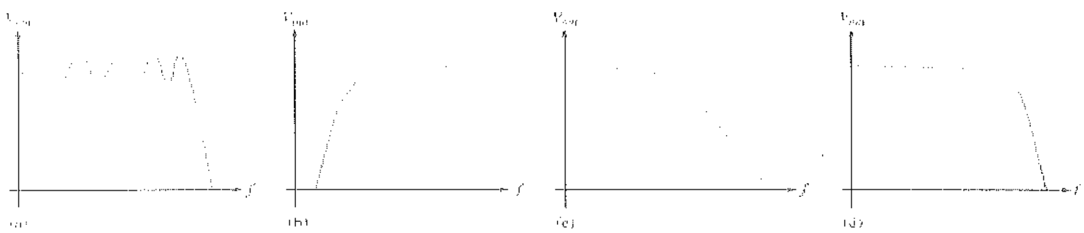
g) Explain how a 555 timer can be set to operate as a voltage-controlled oscillator. *(2 marks)*

Question 4: (Tuned Amplifiers) (15 marks)

a) Identify each type of filter response in the Figure below. *(2 marks)*



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



c) A single-pole high-pass filter has a frequency-selective circuit with R = 2.2k ohm and C = 0.0015 μF. What is the critical frequency. Can you determine the bandwidth from the available information. *(3 marks)*

d) What is the roll-off rate of the filter described in C above. *(1 mark)*

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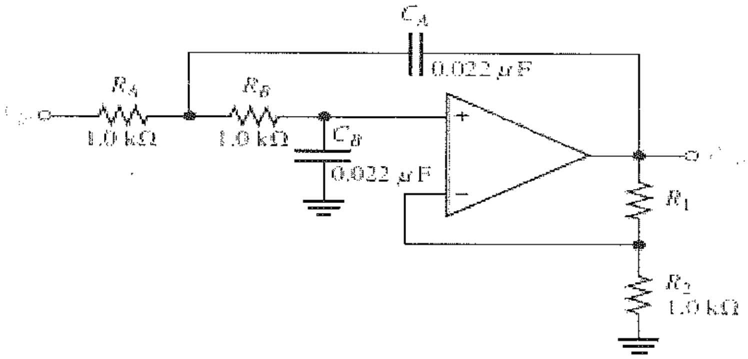
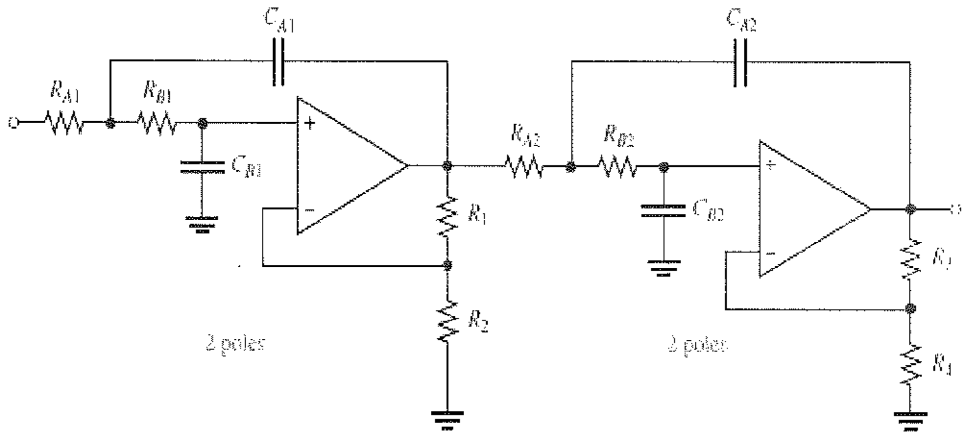
e) Determine the critical frequency of the Sallen-key low-pass filter in Figure below and set the value of R1 for an approximate Butterworth response. *(3 marks)*



f) For the four pole filter in Figure below, determine the capacitances value required to produce a critical frequency of 2500 Hz, if all resistors in the RC low-pass circuit are 1.8k ohm. Also choose R2 = R4 = 1.8k ohm and select the values of feedback resistors R1 and R3 to get a Butterworth response. *(4 marks)*



Question 5: (Optoelectronics) (8 marks)

a) List three LED performance measures. (3 marks)
b) List advantages of optoelectronics. (2 marks)
c) Describe operation of Photo Detector. (3 marks)

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

a) Determine the value of anode current in Figure below when the device is on. $V_{BR}(F)$ =10 V. Assume the forward voltage drop is 0.9 V. *(2 marks)*

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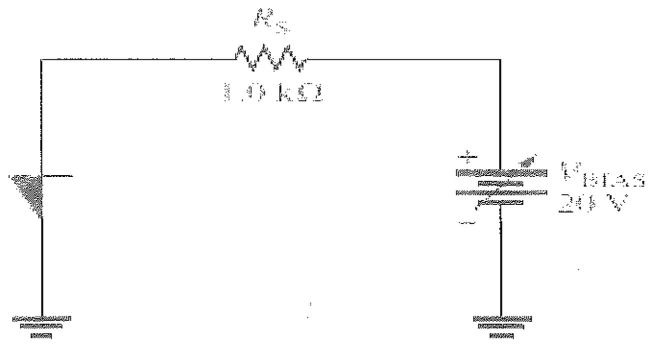
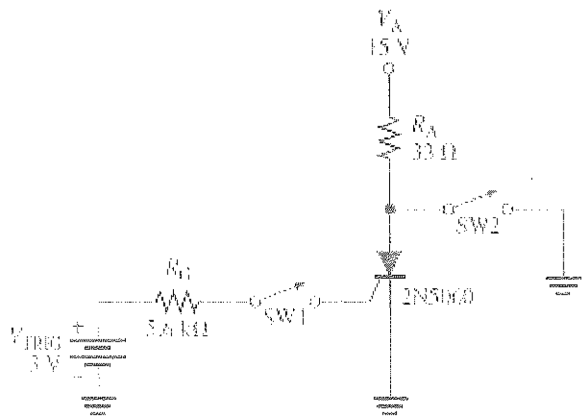
Final Examination



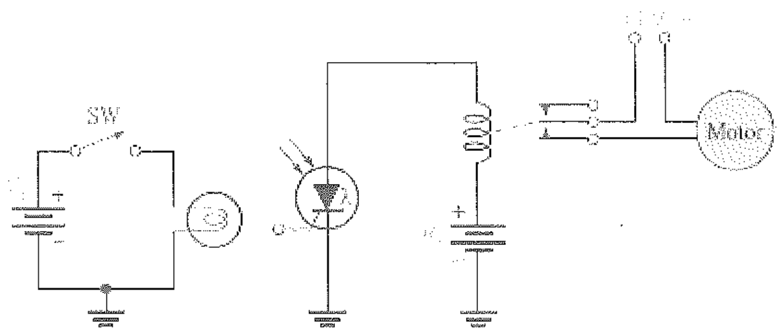
b) Draw the SCR characteristics curve and describe its operation. *(4 marks)*

c) Outline the two methods to turn off a thyristor. *(4 marks)*

d) 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. *(3 marks)*



e) By examination of the circuit in Figure below, explain its purpose and basic operation. (5 marks)



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f) i) Define CRTs and its operation. ***(2 marks)***
ii) Describe the function of CROs. ***(2 marks)***

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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

$R_{in(tot)} = R_1 \parallel R_2 \parallel R_{in(base)}$ 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

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

Final Examination

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
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.

		1ST STAGE			2ND STAGE			3RD STAGE		
ORDER	ROLL-OFF DB/DECADE	POLES	DF	R_1/R_2	POLES	DF	R_3/R_4	POLES	DF	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