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 2, 2015

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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Final Examination

Section A: Multiple Choices [10 marks]
Choose the letter of the BEST choice.

1. The lowest frequency passed by a band-pass filter is
(a) 1 Hz
(b) 0 Hz
(c) 10 Hz
(d) dependent on the critical frequency

2. The number of poles in a filter affects the
(a) voltage gain
(b) bandwidth
(c) center frequency
(d) roll-off rate

3. A 4-layer diode turns on when the anode-to-cathode voltage exceeds
(a) 0.7 V
(b) the gate voltage
(c) the forward-break-over voltage
(d) the forward-blocking voltage

4. An SCR differs from the 4-layer diode because
(a) it has a gate terminal
(b) it is not a thyristor
(c) it does not have four layers
(d) it cannot be turned on and off

5. The Triac is
(a) a thyristor
(b) a bilateral, two-terminal device
(c) like two parallel 4-layer diodes in reverse directions
(d) answers (a) and (c)

6. When an op-amp is operated in the single-ended differential mode,
(a) the output is grounded
(b) one input is grounded and a signal is applied to the other
(c) both inputs are connected together
(d) the output is not inverted

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7. Bias current compensation
(a) reduces gain
(b) reduces output error voltage
(c) increases bandwidth
(d) has no effect

8. The transistor in a class C amplifier conducts for
(a) more than of the input cycle
(b) one-half of the input cycle
(c) a very small percentage of the input cycle
(d) all of the input cycle

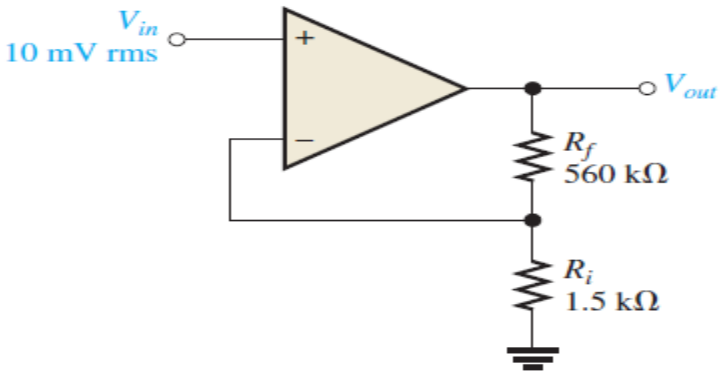
9. An oscillator differs from an amplifier because the oscillator
(a) has more gain
(b) requires no input signal
(c) requires no dc supply
(d) always has the same output

10. In a Wien-bridge oscillator, if the resistances in the positive feedback circuit are increased, the frequency
(a) decreases
(b) increases
(c) remains the same
(d) None of the above

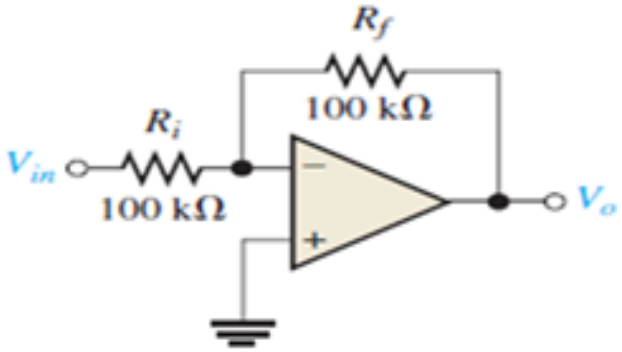
Section B: [90 marks]

Question 1: Operational Amplifier/Op-Amp [15 marks]

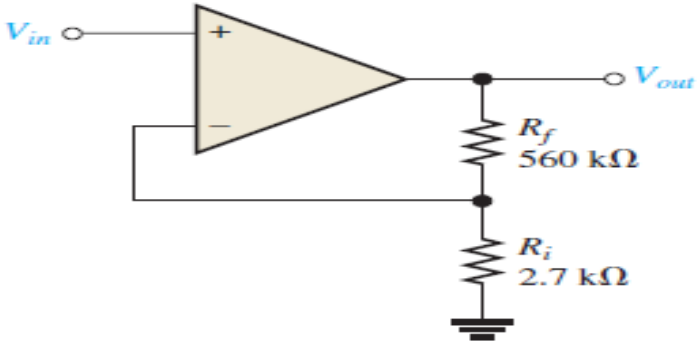
A) For the amplifier below, determine the Acl(NI), Vout and Vf. [3 marks]



B) If a voltage signal of 10 mV rms is applied to the amplifier in Figure below, what is the output voltage and what is its phase relationship with input? [2 marks]



C) Determine the compensating resistor value for the amplifier configuration in Figure below, and indicate the placement of the resistor [2 marks]



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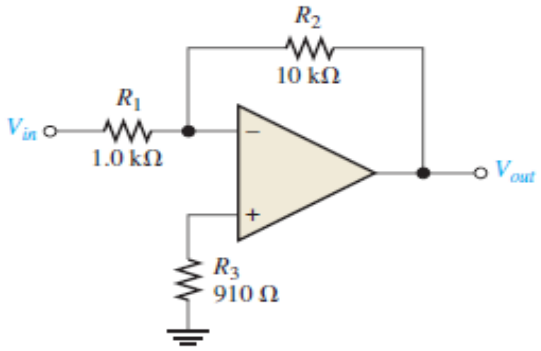
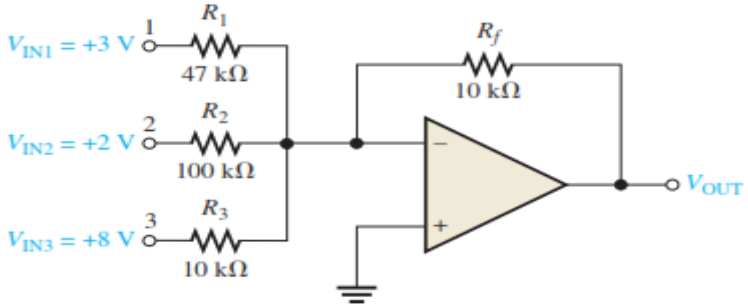
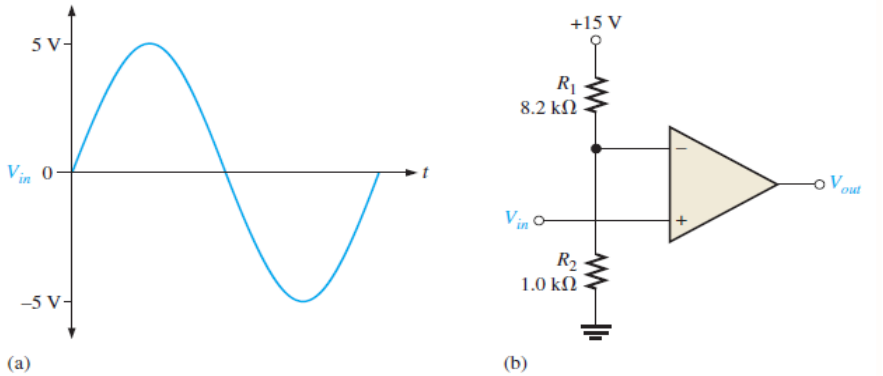
D) Determine the effect on the output of the circuit in Figure below if the following changes are made:
   i) R2 is removed and left open
   ii) R1 and R3 are swapped [3 marks]



E) Determine the weight of each input voltage for the scaling adder in Figure below and find the output voltage. [2 marks]



F) The input signal in Figure (a) below is applied to the comparator in Figure (b) below. Draw the output showing its proper relationship to the input signal. Assume the maximum output levels of the comparator are ±14 V. [2 marks]



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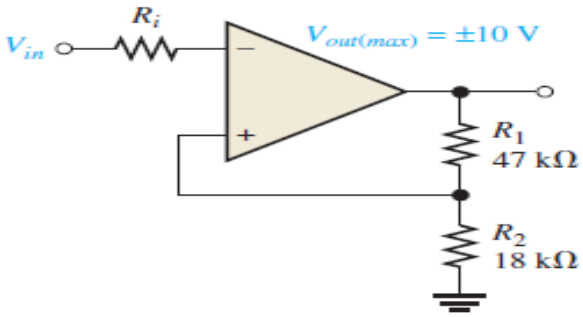
G) What is the hysteresis voltage in Figure below. [1 mark]

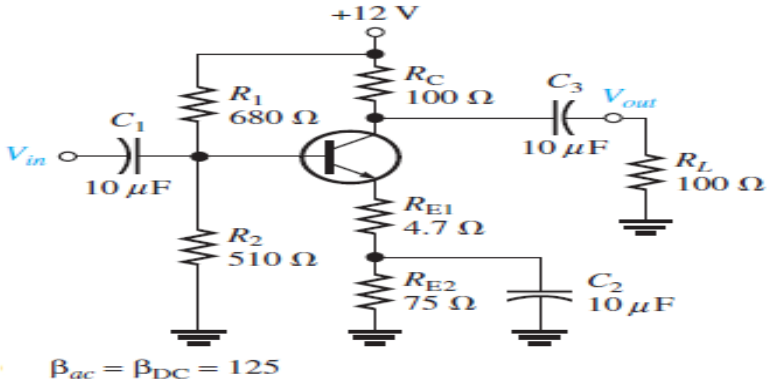


Question 2: Power Amplifiers / Distortion [15 marks]

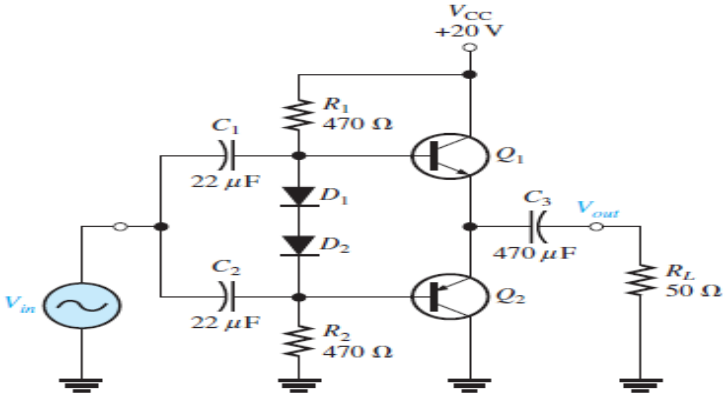
A) Explain how cross over distortion is caused in class B amplifier. [2 marks]

B) Describe the operation of class A and class C power amplifier. [2 marks]

C) Determine the DC collector voltage and AC collector voltage for the amplifier given below if Vin= 2mV. [4 marks]



D) Refer to class AB amplifier in Figure below operating with a single power supply Determine the dc parameters *V*B(*Q*1), *V*B(*Q*2), *V*E, *I*CQ, *V*CEQ(*Q*1), *V*CEQ(*Q*2).[2 marks]



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E) Describe the term biasing of amplifier and how correct biasing could overcome crossover distortion in class B power amplifiers. [2 marks]

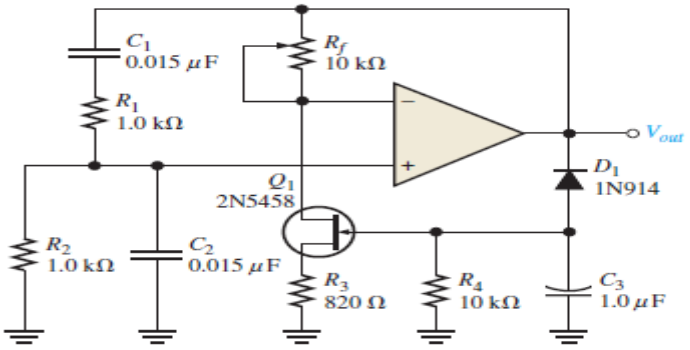
F) Describe the use and importance's of fins in heat sink. [1 mark]

G) 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 *Ic*(*sat*) = 100 mA and *Vce* (*sat*) = 0.2 V, what is the average power dissipation of the transistor? [2 marks]

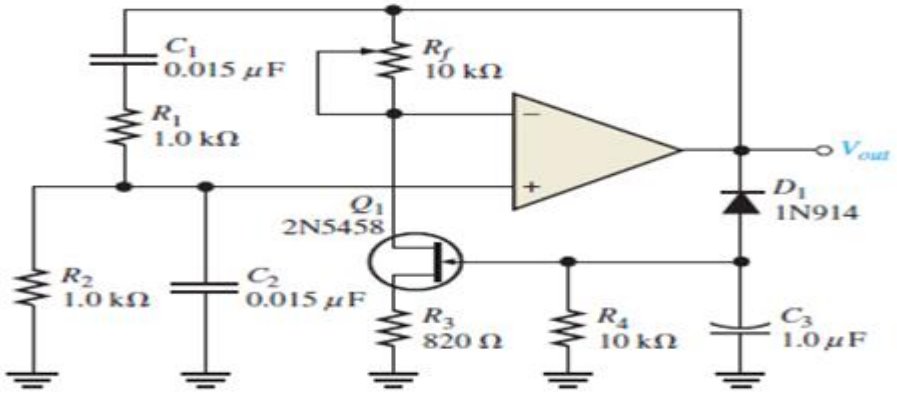
Question 3: Oscillators [15 marks]

A) There are two feedback loops in the Wien-bridge oscillator. Name each and list its purpose. [2 marks]

B) Explain the purpose of JFET in the circuit. [2 marks]



C) 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]



D) Describe Twin-T oscillator. [2 marks]

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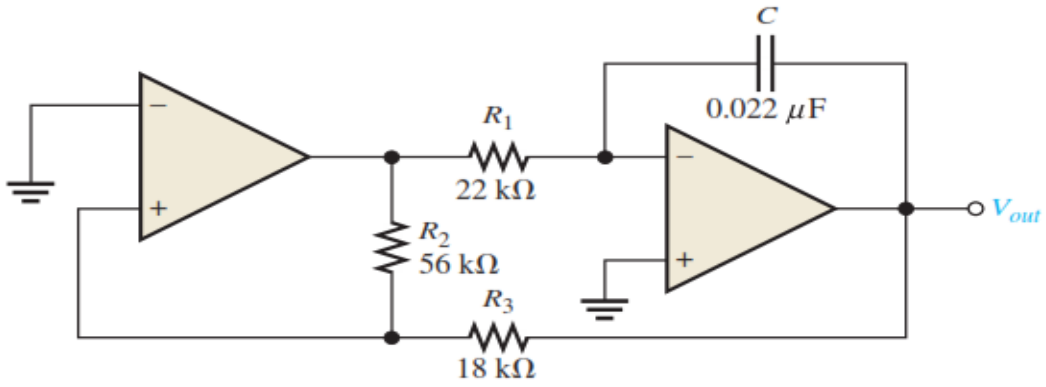
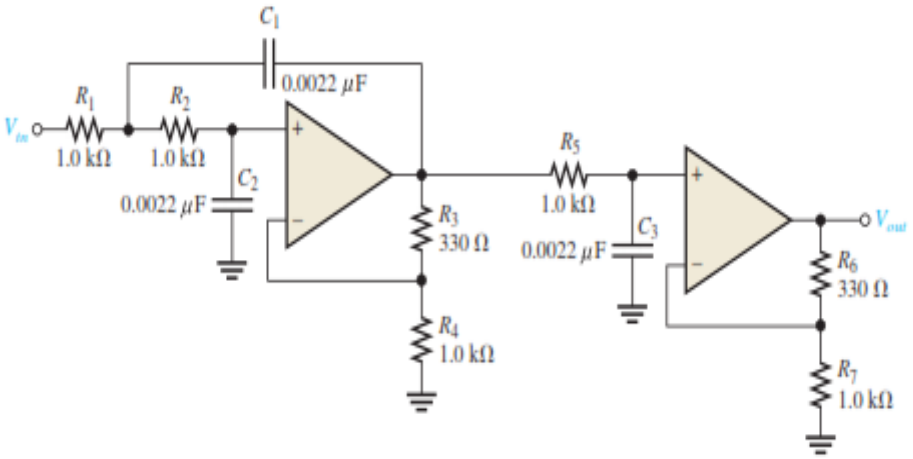
E) What type of signal does the circuit in Figure below produce at each stage? Name each of the stage? Determine the frequency of the output. [3 marks]



F) Show how to change the frequency of oscillation in Figure above to 10 kHz. [2 marks]
G) State two condition for oscillations in positive feedback. [1 mark]

Question 4: Tuned Amplifiers [17 marks]

A) Describe the characteristic of Butterworth, Chebyshev and Bessel filters with response curve and description. [3 marks]
B) Name 4 types of active filters and describe each with frequency-response curves and explanation. [4 marks]
C) Is the three-pole filter in Figure below approximately optimized for a Butterworth response? What is the roll-off rate. [2 marks]



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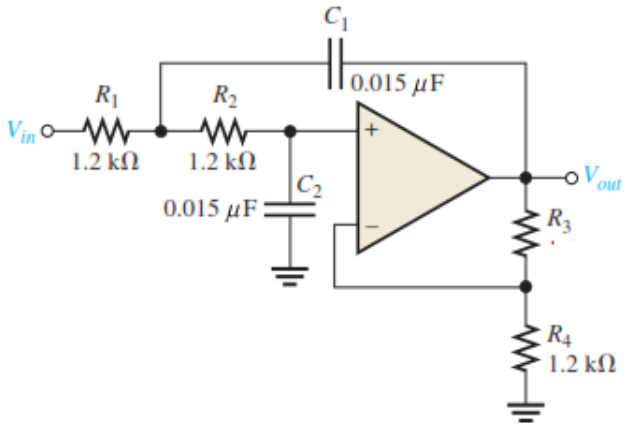
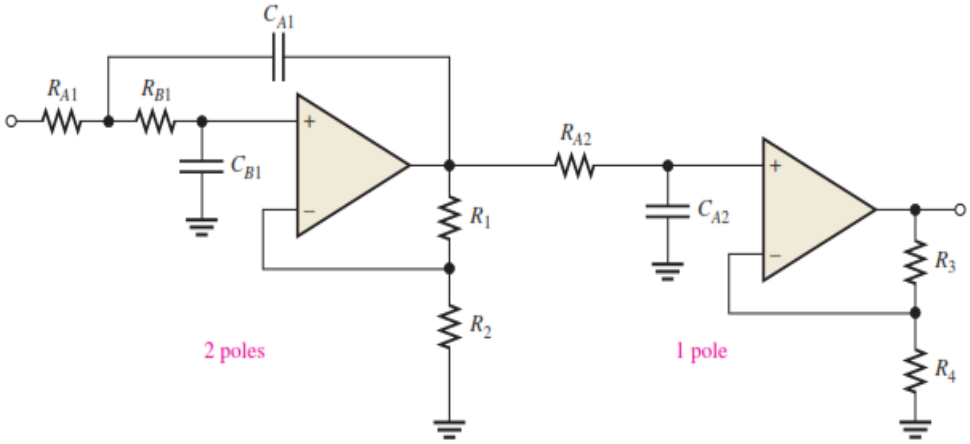
D) Determine the critical frequency of the Sallen-key low-pass filter in Figure below and set the value of R1 for an approximate Butterworth response. [3 marks]



E) For the filter in Figure below, determine the capacitances values 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. [3 marks]



F) What is the bandwidth of a band-pass filter whose critical frequencies is 3.2 kHz and 3.9 kHz. What is Q of the filter. [2 marks]

Question 5: Optoelectronics [8 marks]

A) Define Optoelectronics. [1 mark]
B) List three LED performance measure. [2 marks]
C) List advantages of optoelectronics. [2 marks]
D) Describe operation of Photo Detector. [1 mark]
E) List advantage of using LED. [2 marks]

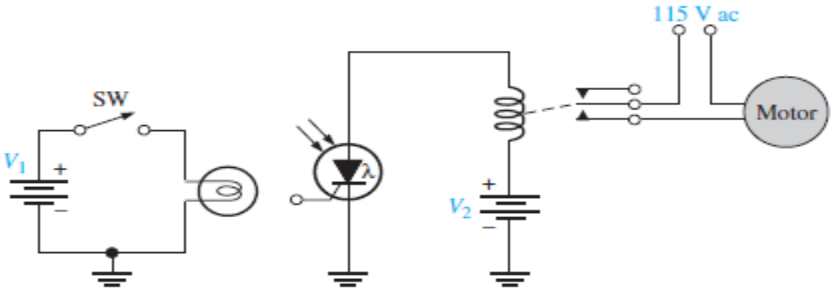
Please Turn Over

Question 6: Thyristors [14 marks]

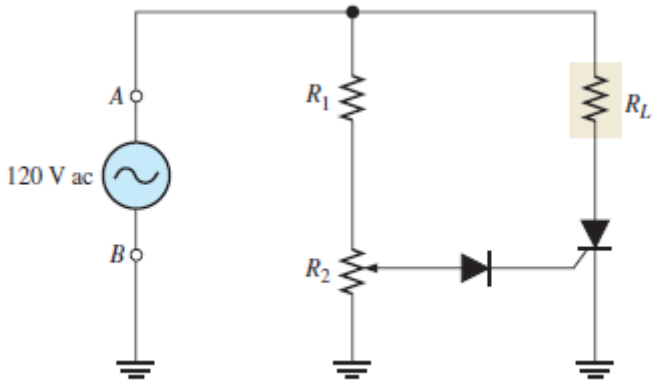
A) Describe the operation of Shockley diode. [2.5 marks]

B) How can SCR be turn on(made to conduct). [2.5 marks]

C) By examination of the circuit in Figure below, explain its purpose and basic operation. [3 marks]



D) A common application of SCRs is in the control of ac power for lamp dimmers, electric heaters, and electric motors. Using the circuit below, describe the application of SRC, as how it is used in the circuit below to control the power. [3 marks]



E) Define Triac and list 2 applications of it. [3 mark]

Question 7: CRT and CRO [6 marks]

A) Define CRT and its operation. [2 marks]

B) What are the advantages and disadvantages of CRT. [3 marks]

C) What is the use of CRO. [1 mark]

THE END

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Formulas

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

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

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

$$I_\mathrm{E} = I_\mathrm{C} + I_\mathrm{B}$$ Transistor currents

$$\beta_\mathrm{DC} = \frac{I_\mathrm{C}}{I_\mathrm{B}}$$ DC current gain

$$r'_e \cong \frac{25\ \mathrm{mV}}{I_\mathrm{E}}$$ 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

$$A_v = \frac{R_\mathrm{C}}{r'_e}$$ Voltage gain, base-to-collector, unloaded

$$A_v = \frac{R_\mathrm{C}}{r'_e + R_\mathrm{E}}$$ 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

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

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

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 $C_A = C_B = C$. $f_c = \frac{1}{2\pi RC}$

Butterworth response.

ORDER	ROLL-OFF DB/DECADE	1ST STAGE			2ND STAGE			3RD STAGE		
		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