



UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FIRST SEMESTER EXAMINATIONS, NOV./ DEC. 2018

COURSE NO: EL 263

COURSE NAME: LINEAR ELECTRONICS

CLASS: EL II

TIME: 3 HOURS

Name: _____ Index Number: _____

Attempt ALL questions in Section A and TWO from Section B. Answer ALL questions in the Answer Booklet

1. An ideal op-amp is characterised by
 - a. an infinite voltage gain, zero input resistance and an infinite output resistance
 - b. an infinite voltage gain, an infinite input resistance and zero output resistance
 - c. an infinite voltage gain, an infinite input resistance and an infinite output resistance
 - d. an infinite voltage gain, zero input resistance and zero output resistance.
2. In which of the following is an operational amplifier used?
 - a. instrumentation circuits
 - b. oscillators
 - c. filters
 - d. all of them
3. Frequency response of an integrator is the same as that of
 - a. high pass filter
 - b. low pass filter
 - c. band pass filter
 - d. band-stop filter
4. What is the level of the voltage between the input terminals of an op-amp?
 - a. Virtually zero
 - b. -5 V
 - c. 5 V
 - d. Infinite
5. How many op-amps are required to implement $V_o = -A \left(\frac{R_f}{R_1} V_1 + \frac{R_f}{R_2} V_2 + \frac{R_f}{R_3} V_3 \right)$?
 - a. 1
 - b. 2
 - c. 3
 - d. 4
6. A unity gain amplifier has a _____ output resistance.
 - a. very large
 - b. small
 - c. very small
 - d. zero
7. For an op-amp with a negative feedback, the output is
 - a. equal to the input
 - b. increased
 - c. fed back to the non-inverting input
 - d. fed back to the inverting input
8. Voltage follower is a special case of

- a. inverting configuration
 - b. non-inverting configuration
 - c. difference configuration
 - d. summer configuration
9. What is the scale multiplier (factor) of a basic integrator?
- a. $-1/RC$
 - b. $-RC$
 - c. $-R/C$
 - d. $-C/R$
10. An inverted output that is proportional to the rate of change of the input signal.
- a. Difference amplifier
 - b. Integrator
 - c. Differentiator
 - d. Summer
11. If ground is applied to (+) terminal of an inverting op-amp, the (–) terminal will:
- a. not need an input resistor
 - b. not invert the signal
 - c. have high reverse current
 - d. be virtual ground
12. If the gain of a closed-loop inverting amplifier is -3.9 , with an input resistor value of $1.6\text{ k}\Omega$, what value of feedback resistor is necessary?
- a. $4.08\text{ k}\Omega$
 - b. $6.2\text{ k}\Omega$
 - c. $6240\ \Omega$
 - d. $7020\ \Omega$
13. A non-inverting closed-loop op-amp circuit generally has a gain factor
- a. less than one
 - b. equal to one
 - c. more than one
 - d. of zero

14. The output voltage, V_o for Figure 1 is

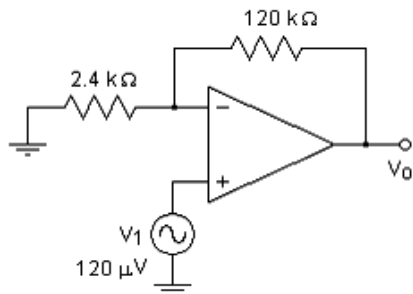


Figure 1 for Question 14

- a. -6.12 mV
 - b. -6.00 mV
 - c. 6.00 mV
 - d. 6.12 mV
15. If in a difference amplifier circuit, $R_i = 16\text{ k}\Omega$; $R_f = 20\text{ k}\Omega$; $V_1 = 2\text{ V}$ and $V_2 = 4\text{ V}$, find the value of the output voltage.
- a. -0.5 V
 - b. -2.5 V
 - c. 6.5 V
 - d. 9.0 V

Preamble 1: Use Figure 2 to answer questions 16 – 18.

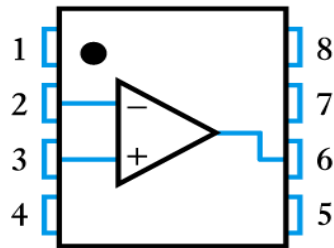


Figure 2 for Questions 16 – 18

16. What signal corresponds to pin 2 of this operational amplifier?
- inverting input
 - non-inverting input
 - inverting output
 - negative supply voltage
17. Pin 6 corresponds to
- inverting input
 - output
 - no connection
 - balance
18. What does pin 8 represent?
- Non-inverting input
 - output
 - no connection
 - balance
19. A differentiator has $R = 10\text{ k}\Omega$ and $C = 2\text{ }\mu\text{F}$. Given that $V_i = 3t^2\text{ V}$. Find the output V_o .
- $-120t\text{ mV}$
 - $-60t\text{ mV}$
 - $-50t^3\text{ V}$
 - $60t\text{ mV}$
20. If the feedback/ input resistor ratio of a feedback amplifier is 3.8. What input voltage applied to the non-inverting end will give an output of 3.6 mV?
- -0.95 mV
 - 0.75 mV
 - 0.95 mV
 - 1.8 mV
21. An open-loop differential operational amplifier has two input voltages, $2\text{ }\mu\text{V}$ and $1.5\text{ }\mu\text{V}$ applied to the non-inverting and inverting input terminals respectively. If the open-loop voltage gain is 1.8×10^6 , determine the output voltage.
- 3.6 V
 - 2.7 V
 - 0.9 V
 - -0.9
22. Which of the following will increase as a result of introduction of positive feedback?
- Noise
 - Distortion
 - Overall gain
 - All of these

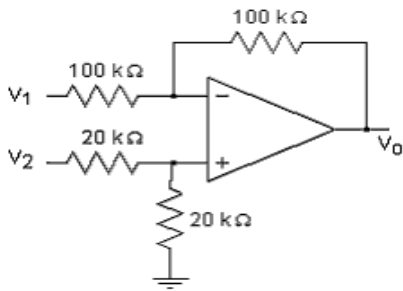


Figure 3 for Questions 23

23. Determine the output voltage when $V_1 = 2V$ and $V_2 = 1.5 V$
- a. 2 V
 - b. 1.5 V
 - c. 0.5 V
 - d. -0.5 V

Preamble 1: Use equation (1) to answer questions 24 – 28.

$$\frac{B(s)}{R(s)} = \frac{G(s)H(s)}{1 + G(s)H(s)} \quad (1)$$

24. Equation (1) represents
- a. positive feedback
 - b. primary feedback ratio
 - c. error ratio
 - d. regenerative feedback
25. The variable $G(s)$ is
- a. forward path transfer function
 - b. feedback transfer function
 - c. actuating signal
 - d. feedback signal
26. $H(s)$ is called
- a. Forward path transfer function
 - b. feedback transfer function
 - c. actuating signal
 - d. feedback signal
27. The variable $B(s)$
- a. error signal
 - b. feedback signal
 - c. feedback transfer function
 - d. reference input
28. Replacing $B(s)$ with $E(s)$ in equation (1), that is $\frac{E(s)}{R(s)}$ represents
- a. regenerative feedback
 - b. feedback ratio
 - c. error signal
 - d. error ratio
29. The first column of Routh table contains the following integers 1, -2, -4, -3, 5. The number of roots in the RHP is
- a. 2
 - b. 3
 - c. 4
 - d. 5
30. The characteristic equation of a system is $s^4 + 2s^3 + 2s^2 + 3s + 6 = 0$. The number of roots in the RHP is

- a. 4
- b. 3
- c. 2
- d. 1

31. Which of the following system(s) might be stable

- a. $-A - Bs - Cs^2 - Ds^3 = 0$
- b. $A + Bs + Cs^2 + Ds^3 = 0$
- c. $A + Cs^2 + Ds^3 = 0$
- d. Both (a.) and (b.)

Preamble 2: Use Figure 4 to answer Questions 32 – 34.

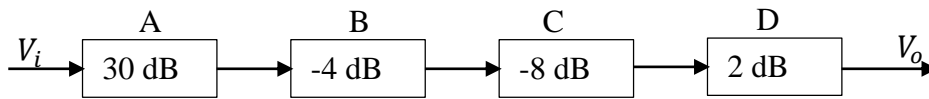


Figure 4: for Q 32 – 34

32. If P_i is 2 mV then P_o will be

- a. 2 mV
- b. 10 mV
- c. 20 mV
- d. 0.2 V

33. If B is changed to 6 dB, what will be P_o if P_i is still 2 mV?

- a. 30 mV
- b. 63.24 mV
- c. 125.68 mV
- d. 2 V

34. Determine the input power, P_i if the value of C from Figure 4 is changed to 12 dB, given the output voltage, $V_o = 400$ mV

- a. 0.04 mV
- b. 2 mV
- c. 4 mV
- d. 10 mV

35. The auxiliary polynomial for a system with characteristic equation $f(s) = s^6 + s^5 + 3s^4 + 2s^3 + 11s^2 + 9s + 9$ is

- a. $s^5 + s^3 + 9s$
- b. $s^4 + 2s^2 + 9$
- c. $s^4 + 2s^3 + 9$
- d. $4s^3 + 4s$ Answer

36. In negative feedback, error signal is.....

- a. sum of the reference input and feedback signal
- b. the difference between reference input and feedback signal
- c. product of reference input and feedback signal
- d. difference between feedback signal and reference input

37. An amplifier will generate marginally stable sinusoidal oscillations if we provide feedback such that

- a. its poles lie close to $j\omega$ -axis in the right half of s-plane
- b. its poles lie close to $j\omega$ -axis in the left half of s-plane
- c. its poles lie on the $j\omega$ -axis in the s-plane
- d. its poles lie anywhere in the s-plane

38. For an oscillator to start in a circuit the loop gain must be greater than 1 when the phase shift around the loop is
- 0°
 - 90°
 - 180°
 - 360°
39. An audio oscillator uses
- positive feedback
 - negative feedback
 - both positive and negative feedback
 - control feedback
40. An oscillator differs from an amplifier because
- it requires no dc supply
 - it requires no input signal
 - it has no gain
 - it has gain
41. The frequency of oscillation, f_o for a Clapp oscillator is
- $f_o = \frac{1}{2\pi RC}$
 - $f_o = \frac{1}{2\pi\sqrt{6RC}}$
 - $f_o = \frac{1}{2\pi LC}$
 - $f_o = \frac{1}{2\pi\sqrt{LC}}$
42. Which of the following oscillators is/are not tuned oscillators?
- Crystal
 - Armstrong
 - Hartley
 - Colpitts
43. The output of harmonic oscillators may be
- sinusoidal
 - square
 - triangular
 - sawtooth
44. In an oscillator circuit, the energy fed back to its input terminal from the output is
- 90° out of phase with the input signal
 - 180° out of phase with the input signal
 - in phase with the input signal
 - none of these
45. A harmonic oscillator is one
- which produces harmonics
 - oscillates continuously
 - which has two stable states
 - produces non-sinusoidal output
46. In a Wien Bridge oscillator, if the resistances in the positive feedback circuit are decreased, the frequency
- remains the same
 - decreases
 - increases
 - doubles
47. In a certain oscillator, $A_v = 55$. The attenuation of the feedback circuit must be
- 0.018
 - 0.055
 - 0.55
 - 55

48. When filters are cascaded, the roll-off rate
- increases
 - decreases
 - remains unchanged
 - doubles
49. A single resistor and a single capacitor can be connected to form a filter with a roll-off rate of
- 6 dB/octave
 - 20 dB/decade
 - 20 dB/octave
 - Answers (a.) and (c.)
50. Which filter has the best frequency response with respect to the phase linear characteristics?
- Butterworth
 - Bessel
 - Chebyshev
 - Schmitt trigger
51. Band-reject filter is also known as filter.
- Notch-filter
 - Band-pass
 - Low-pass
 - Stop-band
52. The critical frequency is defined as the point at which the response dropsfrom the passband.
- 40 dB
 - 20 dB
 - 6 dB
 - 3 dB
53. Which filter has maximally flat response?
- Butterworth
 - Bessel
 - Chebyshev
 - Schmitt trigger
54. A fourth-order filter will have a roll-off rate of
- 4 dB
 - 20 dB
 - 40 dB
 - 80 dB
55. Thefilter can be used to select a signal of one particular FM station.
- band-stop
 - band-pass
 - low-pass
 - high-pass

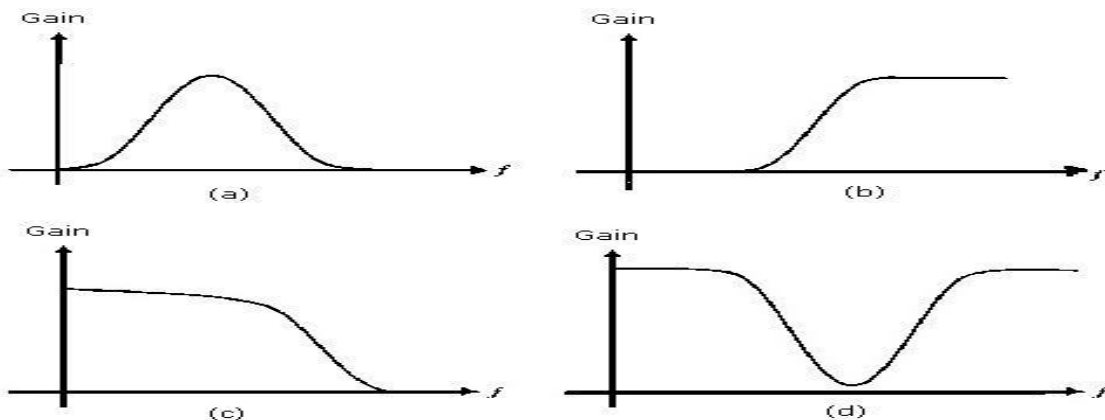


Figure 5 for Q 56

56. From Figure 5, identify the frequency response curve for a band reject filter.

- a. (a)
- b. (b)
- c. (c)
- d. (d)

57. The highest frequency passed by a low-pass filter is

- a. dependent on f_c
- b. 1 MHz
- c. 1 kHz
- d. 0 Hz

58. The circuit in Figure 6 is a

- a. low-pass filter
- b. high-pass filter
- c. band-pass filter
- d. band-stop filter

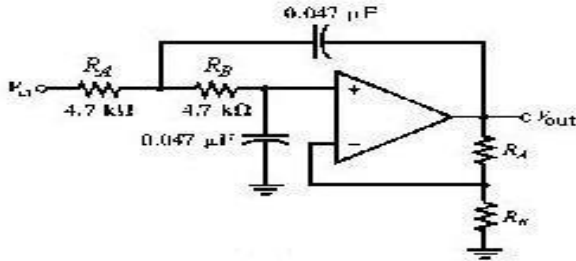


Figure 6 for Q 58

59. The cut-off frequencies of a band-pass filter with $R_1 = R_2 = 5 \text{ k}\Omega$, $C_1 = 0.05 \mu\text{F}$ and $C_2 = 0.2 \mu\text{F}$

- a. $f_{OL} = 318.3\text{Hz}$, $f_{OH} = 318.3\text{Hz}$
- b. $f_{OL} = 159.2\text{Hz}$, $f_{OH} = 636.6\text{Hz}$
- c. $f_{OL} = 318.3\text{Hz}$, $f_{OH} = 636.6\text{Hz}$
- d. $f_{OL} = 159.2\text{Hz}$, $f_{OH} = 318.3\text{Hz}$

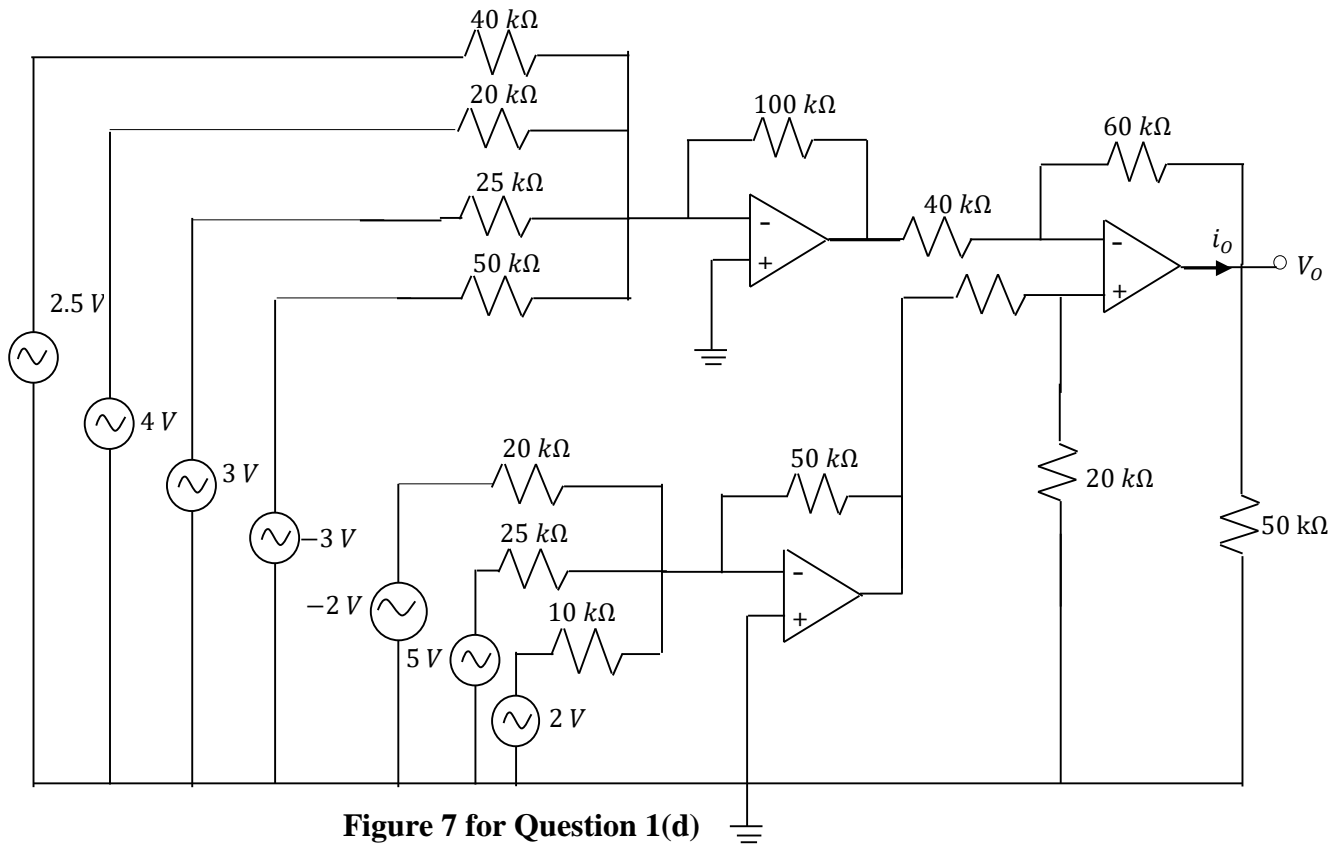
60. Determine the bandwidth of a first-order low-pass filter that has $20 \text{ k}\Omega$ resistor connected between the input and the non-inverting connection of an op-amp used as an active filter, and a 5 nF capacitor between the non-inverting connection and the ground for the circuit.

- a. 0 Hz
- b. 1591 Hz
- c. 6283 Hz
- d. 10 kHz

SECTION B

Question 1

- (a) Differentiate between regenerative and degenerative feedback **4 marks**
- (b) Explain Barkhausen criteria for oscillations **4 marks**
- (c) A certain band-pass filter has two critical frequencies of 1.4 and 1.7 kHz. Determine the bandwidth, and Q. Classify the filter as narrow-band or wide-band. **7 marks**
- (d) Find V_o and i_o in the operational amplifier in **Figure 7**. **15 marks**



Question 2

- (a) i. What is an oscillator? **2 marks**
- ii. Differentiate between a harmonic and relaxation oscillator. **6 marks**
- (b) With the aid of a labelled circuit diagram and brief explanation of procedure, derive an expression for a circuit that produces an output voltage which is proportional to the negative of the algebraic sum of its input voltages. **8 marks**
- (c) A negative feedback of $\beta = 0.02$ is applied to an amplifier of gain 1000. Calculate the change in overall gain of the feedback if the internal amplifier is subjected to a gain reduction of 15%. **9 marks**

(d) i. Identify the filter in Figure 8.

ii. For the filter, determine the capacitance values required to produce a critical frequency of 3000 Hz if all the resistors in the RC low-pass circuits are 2 k Ω .

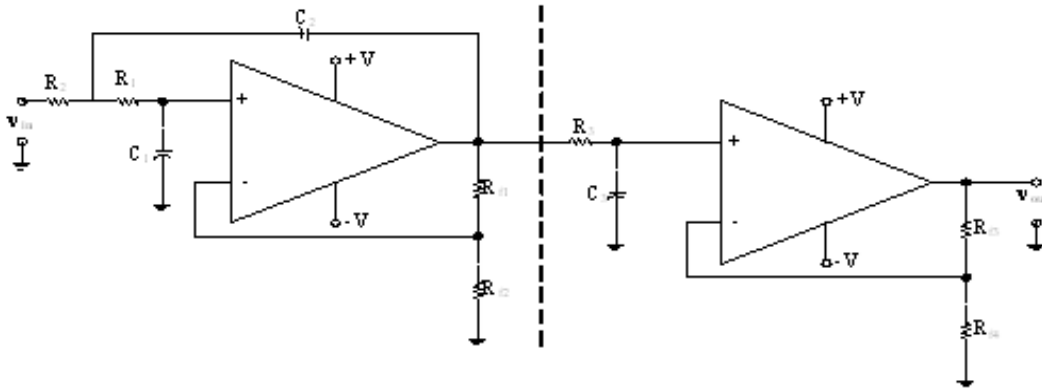


Figure 8 for Question 2(d)

Question 3

(a) What is an active filter? What are its basic parts?

4 marks

(b) i. An op-amp integrator has $R = 50 \text{ k}\Omega$ and $C = 0.04 \mu\text{F}$. Sketch its circuit diagram. If the input voltage is $v_i = 10 \sin 50t \text{ mV}$, obtain the output voltage.

ii. If the positions of R and C are interchanged, determine the output.

10 marks

(c) $P(s) = 3s^7 + 9s^6 + 6s^5 + 4s^4 + 7s^3 + 8s^2 + 2s + 6$

12 marks

(d) The resonant circuit of an LC feedback oscillator has a resonant frequency of 500 kHz and a fixed inductance of 100 μH . Calculate the capacitance.

4 marks

Examiners: S. Ofori/ F, Mumuni