Tshwane University of Technology

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Department of Computer Systems Engineering
EL2116D/ELC211B – Electronics II
20 NOV 2021 Formative Assessment

Total Marks: 51
Full Marks: 45
Time: 2 Hours
Examiner: Mr. T Matshiba
Mr. A. Mpiana
Moderator: Mrs Z Mahlobogwane

MEMO

Surname, initials:	Student number:
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Instructions:

- All exam rules stated by the Tshwane University of Technology applies.
- This is a **closed-book test**. You are not allowed to use any notes or text books to assist you to answer the questions.
- **Write your answer in the space provided on the question paper. Show all calculations.** Do all calculations on the counter clear page of the questionnaire if extra space is needed. Handwriting should be neat and readable. Untidy work will not be marked.
- Programmable calculators are not allowed.
- If needed, state all necessary assumptions clearly.

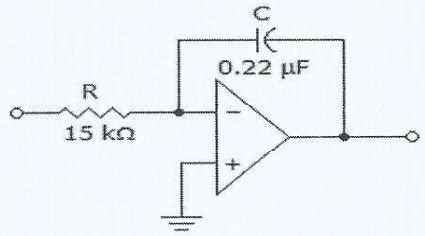
Question1 – Multiple Choice (10)

Each multiple choice question will count 2 mark. Choose the best suitable answer and mark with an "x" in the given table.

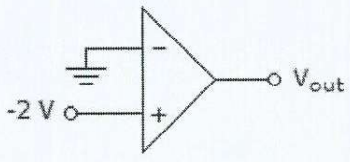
Multiple Choice Answer Sheet

	A	B	C	D
1				X
2			X	
3				X
4		X		
5	X			
6			X	
7				X
8		X		
9		X		
10				X

1. In a(n) _____, when the input voltage exceeds a specified reference voltage, the output changes state.
   A. Integrator
   B. Differentiator
   C. Summing amplifier
   (D.) Comparator
2. The given circuit is known as

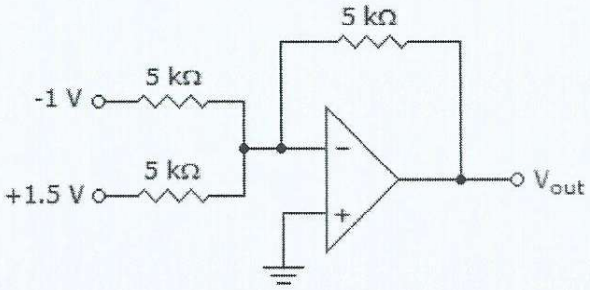


   A. A noninverting amplifier.
   B. A differentiator.
   (C.) An Integrator.
   D. A summing amplifier.
3. Refer to the given circuit. What is the output voltage?



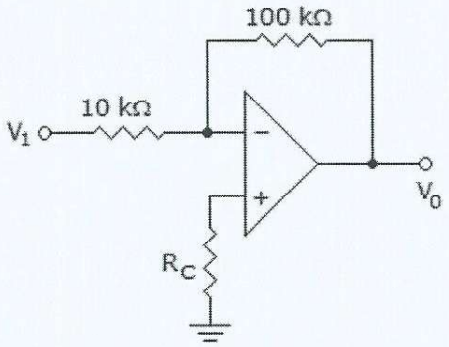
   A. 2V
   B. -2V
   C. +Vsat
   (D.) –Vsat

4. Refer to the given circuit. What is the ouput voltage



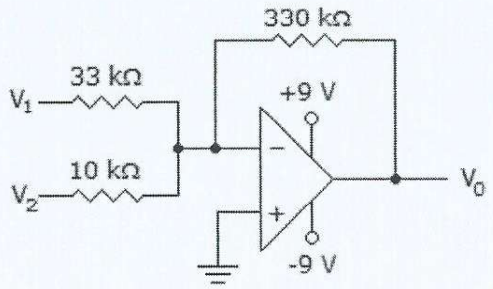
A. 0.5V
B. -0.5V
C. 2V
D. -2V

5. Calculate the input voltage for this circuit if $V_0 = -11V$.



A. 1.1V
B. -1.1V
C. -1V
D. 1V

6. Calculate the output voltage if $V_1 = 33mV$ and $V_2 = 2mV$.



A. 0V
B. -6.6V
C. -0.4V
D. 2V

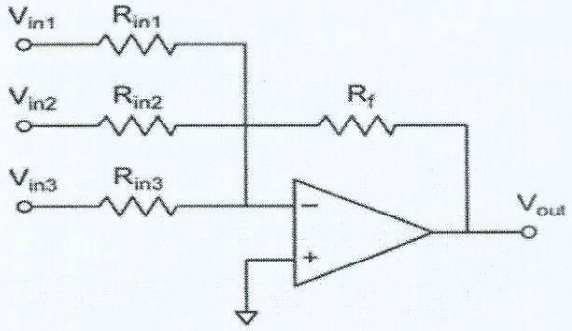
7. How many op-amps are required to implement this equation?
   $V_0 = V_1$

   A. 4
   B. 3
   C. 2
   D. 1

8. The gain of a noninverting amplifier can be given as

   A. $1 - R_f/R_1$
   B. $1 + R_f/R_1$
   C. $1 - R_1/R_f$
   D. $1 + R_1/R_f$

9. The design of the circuit below represents .....?



   A. an integrator amplifier
   B. a summing amplifier
   C. inverting amplifier
   D. non- inverting amplifier

10. A certain noninverting amplifier has R_i of 1 kΩ and R_f of 100 kΩ. What is the closed-loop voltage gain .....?

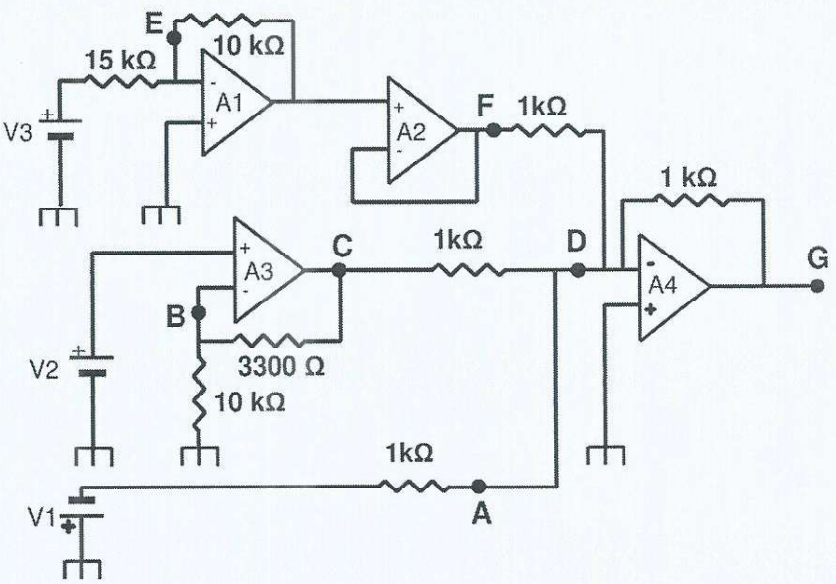
   A. 100,000
   B. 1000
   C. 100
   D. 101

QUESTION 2 [7]

V1 = 1 Volt DC
V2 = 2 Volt DC
V3= 3 Volt DC

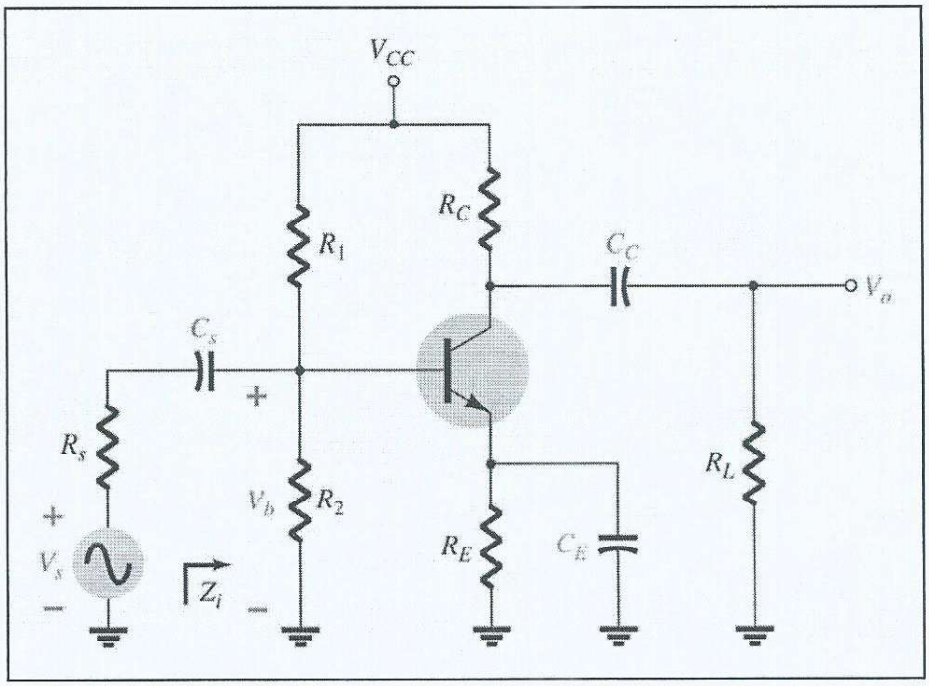
The operational amplifiers are supplied with a split supply of +15V and -15 V

Fill in:
(Indicate polarities)



	ANSWER
The voltage at point A	0V OR Virtual Ground
The voltage at point B	+2V
The voltage at point C	+2,66V
The voltage at point D	0V
The voltage at point E	0V OR Virtual Ground
The voltage at point F	-2V
The voltage at point G	0,34V

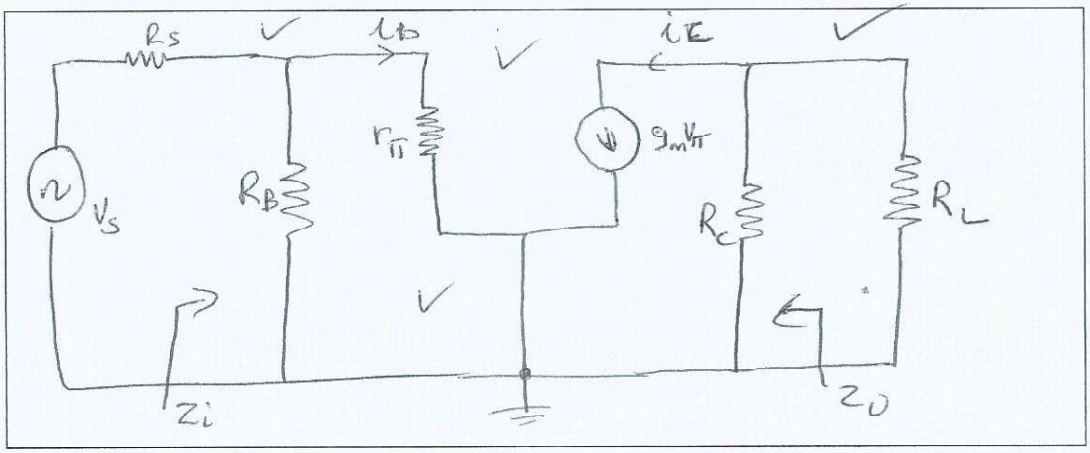
QUESTION 3 (14)



An npn transistor is used to design a common emitter amplifier such as in the figure above. The β value of the transistor is specified β = 100

V_{CC} = 12 V; R_S = 100 Ω; R_L = 10 kΩ; R_C = 1.5 kΩ; R_E = 2 kΩ; R_1 =33 kΩ; R_2 = 22 kΩ

a) DRAW the ac small-signal equivalent circuit (π-parameters) **or** (h-parameters). (4)



b) Calculate the value of Z_i (6)

c) Calculate the Voltage Gain $A_{V(NL)}$ with **R_L** disconnected (open circuit) (2)

d) Calculate the Voltage Gain A_V with **R_L** connected. (2)

Show all calculations

b) $Z_i = ?$

① $V_{R_2} = 12 \times \frac{22K}{33K+22K}$ ✓

$= 4,8V$

② $V_{RE} = V_{R2} - V_{BE}$

$= 4,8 - 0,7$

$= 4,1V$

③ $R_B = R_1 // R_2$ ✓

$= 33K // 22K$

$= 13,2K.$

④ $I_E = \frac{V_{BB} - V_{BE}}{R_E + \frac{R_B}{\beta+1}}$

$= \frac{4,8-0,7}{2K + \frac{13,2K}{100+1}}$

$= \frac{4,1}{2,13K}$ ✓

$= 1,925\,mA$

⑤ $I_C \approx I_E = 1,925$

⑥ $r_\pi = \frac{V_T \beta}{I_C}$

$= \frac{25m \times 100}{1,925m}$ ✓

$= 1298,7\,\Omega$

⑦ $Z_{in} = R_B // r_\pi$ ✓

$= 13200 // 1298,7$

$= 1182,37\,\Omega$

$= 1,182K\Omega$ ✓

ⓒ $A_{V_{ML}} = -g_m R_C$ ✓

but $g_m = \frac{I_C}{V_T} = \frac{1,925m}{25m}$

$= 0,077$

$\therefore A_{V_{ML}} = -0,077 \times 1,5K$

$= -115,5$ ✓

ⓓ $A_{V_L} = -g_m R_L'$ ✓

$= -g_m (R_C // R_L)$

$= -0,077 \times (1304)$

$= -100,41$ ✓

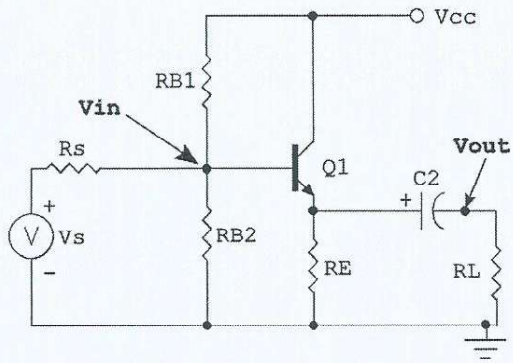
OR

$A_{V_L} = A_{VL} \frac{R_L}{R_C + R_L}$

$= -115,5 \frac{10K}{1,5K+10K}$

$= 100,4$

QUESTION 4 [12]



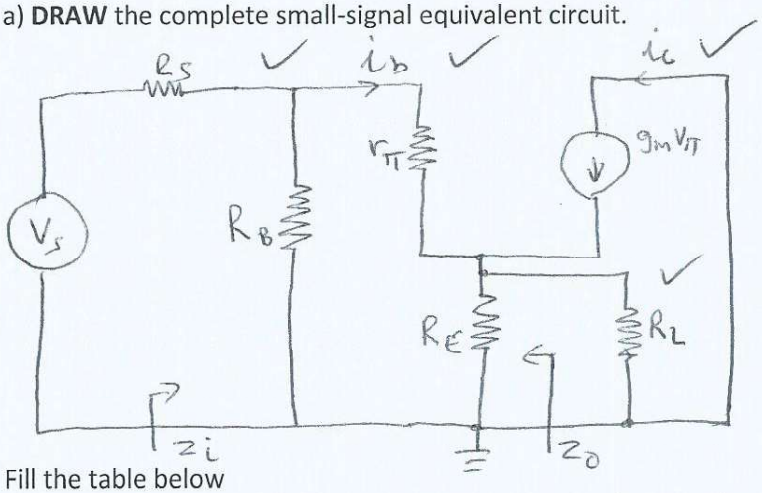
Given: r 'e = 25mV ÷ I_E ; r_π = β x r 'e ;

I_E = 1,914 mA

RB1 = 27 k Ω; RB2 = 15 kΩ; Rs = 2 kΩ;
RL = 500 Ω; RE = 1.5kΩ
Vcc = +10 V; β = 280

Assuming all capacitors and the DC power supply (Vcc) represent a zero ohm reactance at the ac signal,

a) **DRAW** the complete small-signal equivalent circuit. (4)



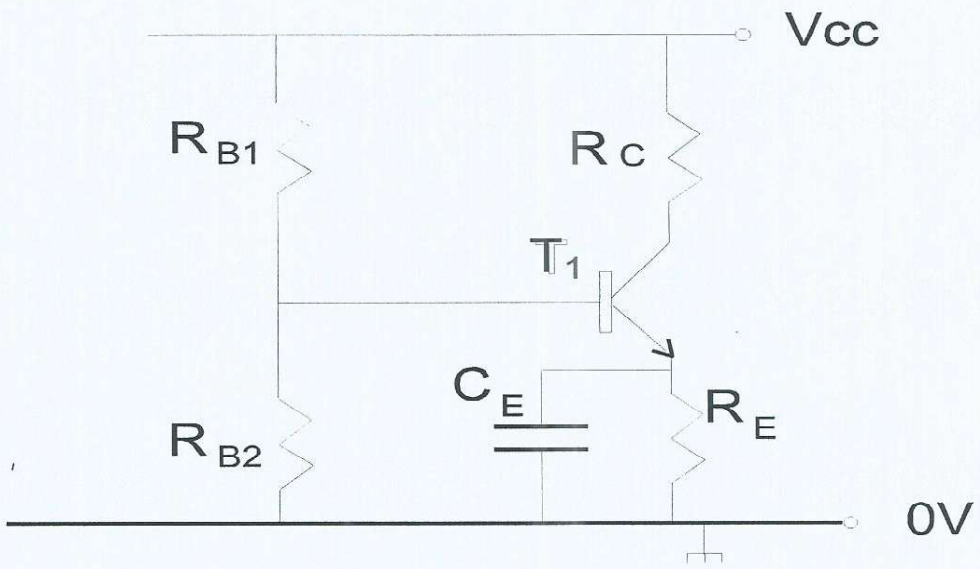
Fill the table below

r_π = 3657 Ω 3,657 kΩ		In what amplifier configuration is the circuit connected? common collector	
Zi (include loading of RL) = 8859 Ω 8,859 kΩ		**Zo (exclude RL) =** 45,88 Ω	
Voltage gain between Vo and Vi:	0,966	Voltage gain between Vo and Vs:	0,788
Voltage gain in dB between Vo and Vs: Given: dB = 20 log Vo / Vs			-2,069 dB
If Vs = 100 mV RMS, what is the magnitude of Vo (in RMS)?			78,8 mV

QUESTION 5 [8]

Perform only the DC (steady state) analysis in the following circuit:

V_{BE} = 0,7 V, R_{B1} = 24kΩ, R_{B2} = 5k6, R_E = 1k5, R_C = 3k3, V_{CC} = 15V, β = 250



The average voltage across R_{B2} (V_{RB2})	2,838 V
The average voltage across R_E(V_{RE})	2,138 V
The average current through R_E (I_E)	1,425 mA
The average voltage across R_{B1} (V_{RB1})	12,162 V
The average voltage across T_1 (V_{CE})	8,179 V
The average voltage at the collector V_C	10,317 V.
The average voltage across R_C (V_{RC})	4,683 V
The average current through collector (I_C)	1,419 mA