Tshwane University
of Technology
We empower people

Tshwane University of Technology
2024 SEMESTER 2 TEST 1

SUBJECT: ELECTRONICS II
SUBJECT CODE: EL2F06D/EL2116D

PAPER NO.: PAPER 1
PAPER DESCRIPTION: CLOSED BOOK
DURATION: 2 HOUR

SPECIAL REQUIREMENTS:	(✔)
None	
Non-programmable pocket calculators	
Scientific calculators	✔
Drawing instruments	
Other	

INSTRUCTIONS TO CANDIDATES:
Answer all questions. All calculations must be shown. Write answers in the spaces provided on the question paper. Use opposite pages for calculations. Do not do calculations inside blocks intended for answers. All answers must be given in correct units. All silicon junction voltages are 0,7 V in forward bias. Answers must be accurate to the first three significant figures.

NUMBER OF PAGES: 6 (Including this page)
ANNEXURES: NONE

QUALIFICATION(S):

N DIP: COMPUTER SYSTEMS ENG.	

EXAMINER: MR TD MATSHIBA
MODERATOR: MR TC TSHIPOTA
TOTAL MARKS: 49 FULL MARKS: 45

Initials:	Surname: MEMO	Student No: 000000000

Q1

1) $Z_0 = ?$

$$V_{R_L} = V_{S1} \frac{R_L}{R_L + Z_0}$$

$$400m = 750m \frac{100}{100+Z_0}$$

$$100+Z_0 = \frac{750}{400} \cdot 100$$

$$Z_0 = 187{,}5 - 100$$

$$= 87{,}5\,\Omega$$

2) $$A_{V_{NL}} = \frac{V_o}{V_i} = \frac{750m}{50m}$$

$$= 15$$

3) $$A_{V_L} = \frac{V_o}{V_i} = \frac{400m}{50m}$$

4) $$V_{Z_i} = V_{S2} \frac{Z_i}{Z_i + R_S}$$

$$50m = 75m \frac{Z_i}{Z_i + 1000}$$

$$Z_i + 1000 = \frac{75m}{50m} Z_i$$

$$1000 = 1{,}5Z_i - Z_i$$

$$1000 = 0{,}5Z_i$$

$$Z_i = 2000\,\Omega$$

5) $$A_I = \frac{V_o/R_L}{V_i/Z_i} = \frac{V_o Z_i}{V_i R_L}$$

$$= 8 \frac{2000}{100}$$

$$= 160$$

6) $$I = \frac{V_{RL}}{R_L} = \frac{400m}{100}$$

$$= 4mA$$

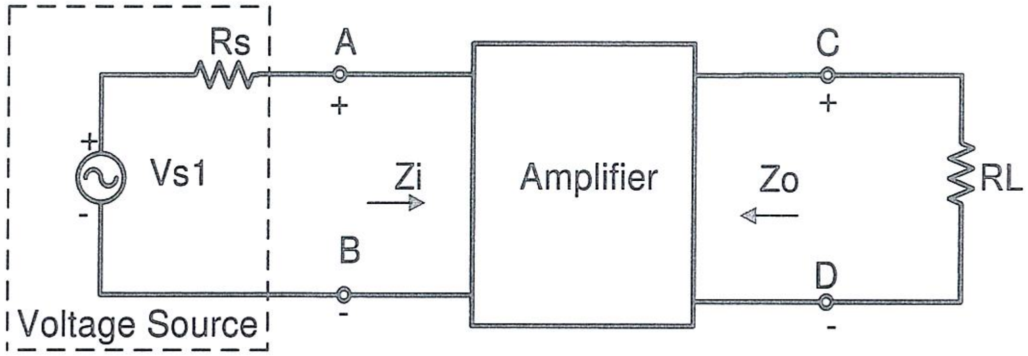
7) $$dB = 20\log A_{V_L}$$

$$= 20\log 8$$

$$= 18{,}06\,dB$$

QUESTION 1 [7]

In the circuit below, the voltage between A and B is 50mV RMS and that between C and D is 400mV RMS. If the load RL is disconnected and there is an open circuit between C and D, the voltage between C and D rises to 750mV RMS. RL is 100Ω and Rs is 1kΩ.



Determine the following:

The value of Zo:	87,5Ω.
The Voltage Gain of **Amplifier 1** with **RL** disconnected (open circuit between C and D):	~~18~~ ~~15~~ 15
The Voltage Gain of **Amplifier 1** with **RL** connected (as it is shown in the circuit diagram):	8
The value of **Zi**, if the voltage rises to 75mV RMS between A and B if **Amplifier 1** is disconnected from A and B :	2000Ω.
The Current Gain of **Amplifier 1** with **RL** connected (as it is shown in the circuit diagram)	160
The RMS current value flowing at point C with the load resistor **RL** connected, as it is shown in the circuit diagram:	4mA
The voltage gain of **Amplifier 1** in decibel with the load **RL** connected (as it is shown in the circuit diagram), given dB = 20 log Vout / Vin	18,06dB.

Q2

1) $V_{S1_{Rms}} = \frac{V_{Peak}}{\sqrt{2}}$

$= \frac{15m}{\sqrt{2}}$

$= 10,61mV$

2) $F = \frac{1}{T}$

$= \frac{1}{200\mu s}$

$= 5000Hz$

$= 5KHz.$

3) $V_{R1} = V_{S1} \frac{R_1}{R_1 + r_S}$

$10m = 15m \frac{R_1}{R_1 + 100}$

$R_1 + 100 = \frac{15m}{10m} R_1$

$\therefore R_1 = 200\Omega.$

4) $I_{Peak} = \frac{V_{R1}}{R_1}$

$= \frac{10m}{200}$

$= 50\mu A$

$I_{Rms} = \frac{I_{Peak}}{\sqrt{2}} = \frac{50\mu}{\sqrt{2}}$

$= 35,36\mu A.$

5) $dB = 20 \log V_o/V_i$

$= 20 \log \frac{10m}{15m}$

$= -3,52 dB.$

6) $V_{R1} = V_{S1} \frac{R_1}{R_1 + r_S}$

$1m = 10,61m \frac{R_1}{R_1 + 100}$

$R_1 + 100 = \frac{10,61m}{1m} R_1$

$R_1 = 10,41\Omega$

7) $I = \frac{V_{S1}}{R_1 + r_S}$

$= \frac{10,61m}{0 + 100}$

$= 0,106mA$

$= 106\mu A.$

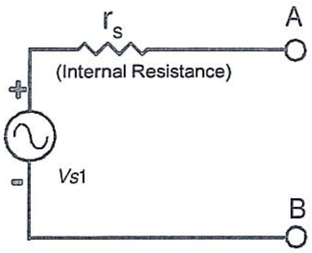
8) $P = VI$

$= V_{S1} I_{S1}$

$= 10,61m \times 106\mu$

$= 1,125\mu W.$

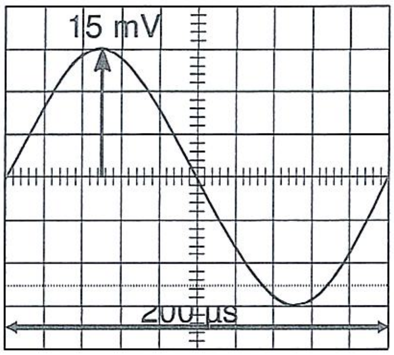
QUESTION 2 [8]

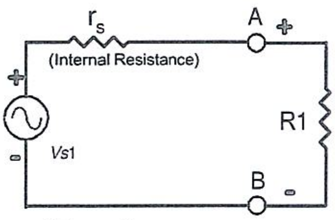


Voltage Source

In the circuit on the left, the voltage between A and B is shown in the oscilloscope on the right. ***Vs1*** is a voltage source with internal resistance r_s.

When a resistor **R1** is connected to the circuit, as shown in the next circuit, the voltage between A and B changes to that shown in the next oscilloscope screen:

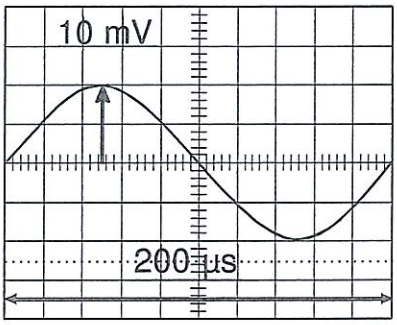




Voltage Source

r_s is 100 Ω

Determine the following for Vs and R1:



The RMS voltage value of the voltage source Vs1 with no load resistor, assuming it is a pure sine wave:	10,61 mV
The frequency of the voltage source Vs1 with no load resistor:	5 Khz
The value of the load resistor R1, using the difference between the two oscilloscope traces:	200 Ω
The RMS current value flowing at point A with the load resistor R1 connected, assuming it is a pure sine wave:	35,36 μA
The voltage ratio in decibel between points A and B with no load connected versus that with the load R1 connected,	− 3,52 dB
The value of the load resistor R1, if the voltage between A and B would be 1 millivolt RMS	10,41 Ω
The RMS current value flowing at point A with the load resistor R1 replaced by a short circuit, assuming it is a pure sine wave:	106 μA
The RMS power wasted in the voltage source with the load resistor R1 replaced by a short circuit, assuming it is a pure sine wave:	1,125 μW

Q3

1) i) $V_{R2} = 15 \frac{6,8K}{6,8K + 33K} =$
$= 2,563\ V$

ii) $V_E = V_{R_2} - V_{BE} = 2,563 - 0,7$
$= 1,863\ V$

iii) $I_E = \frac{V_E}{R_{e_1} + R_{e_2}} = \frac{1,863}{270 + 390}$
$= 2,82\ mA$

2) $h_{ib} = \frac{25m}{2,82m}$
$= 8,865\Omega$.

3) $h_{ie} = h_{fe} \cdot h_{ib} = 180 \times 8,865$
$= 1595,7$.

4) $Z_o = R_c$
$= 1800\Omega = 1,8K$

5) i) $R_{BB} = R_1 // R_2 = 33K // 6,8K$
$= 5638\ \Omega$.

ii) $Z_b = h_{ie} + (h_{fe}+1) R_{e_1}$
$= 1595,7 + (180+1) 270$
$= 50465,7\ \Omega$.

iii) $Z_i = R_{BB} // Z_b$
$= 5638 // 50465,7$
$= 5071\ \Omega$
$= 5,071\ K\Omega$.

6) $A_{V_{NL}} = - \frac{h_{fe} R_c}{h_{ie} + (h_{fe}+1) R_E}$
$= - \frac{180 \times 1800}{50465,7}$
$= -6,42$

7) $A_{V_L} = A_{V_{NL}} \frac{R_L}{R_L + R_c}$
$= -6,42 \frac{12K}{12K + 1,8K}$
$= -5,58$

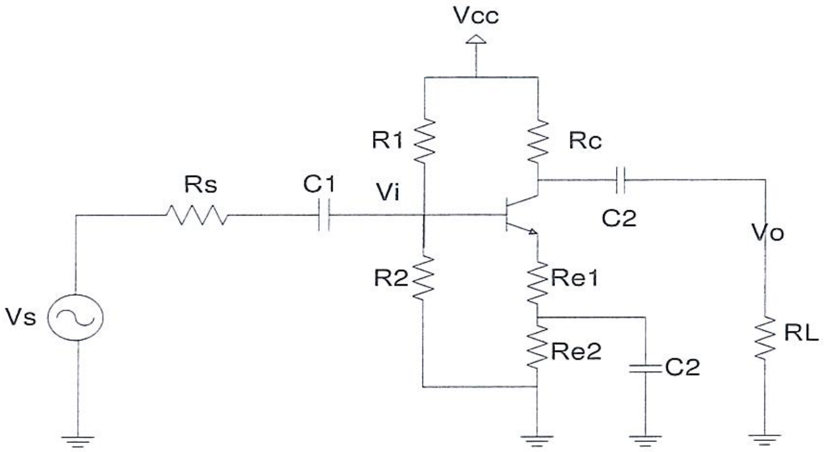
8) $dB = 20 \log A_{V_L}$
$= 20 \log 5,58$
$= 14,93\ dB$

9) $A_{V_s} = A_{V_L} \frac{Z_i}{Z_i + R_s}$
$= -5,58 \frac{5071}{5071 + 2\text{?}}$
$= -5,35$

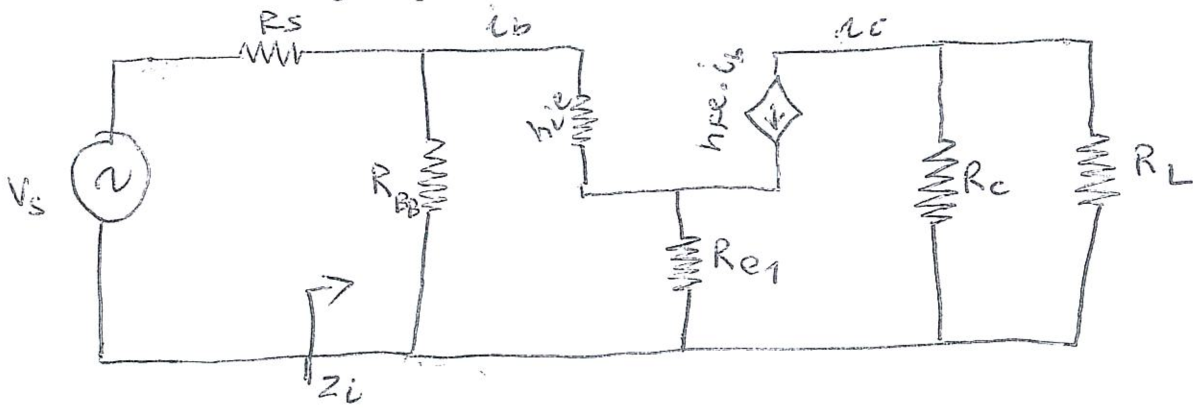
10) $A_{V_s} dB = 20 \log A_{V_s}$
$= 20 \log 5,35$
$= 14,57$

QUESTION 3 [14]

For the circuit below, Vcc = 15V, R1 = 33 kΩ, R2 = 6.8 kΩ, Rc = 1.8 kΩ, $1/h_{oe}$ = very large, Rs = 220 Ω, Re1 = 270 Ω, Re2 = 390 Ω, RL = 12 kΩ and $h_{fe} = 180$
$h_{ib} = 25mV \div I_E$; $h_{ie} = h_{fe} \times h_{ib}$



3.1 Sketch the small-signal equivalent model for the circuit in above. (4)



3.2 Complete the following table:

I_E	2,82 mA	(1)	h_{ib}	8,865 Ω	(1)
h_{ie}	1595,6 Ω	(1)	Z_o	1,8 K	(1)
Z_{in}	5071 Ω	(1)	$A_{v\text{-unloaded}}$	− 6,42	(1)
$A_{v\text{-loaded}}$	−5,58	(1)	$A_{v\text{-loaded}}$(dB)	14,93 dB	(1)
A_{vs}	− 5,35	(1)	A_{vs}(dB)	14,57 dB	(1)

Q:4

1) i) $V_{R_2} = 10 \dfrac{18K}{18K + 22K}$

$= 4,5V$

ii) $V_E = 4,5 - 0,7$

$= 3,8V$

iii) $I_E = \dfrac{V_E}{R_E} = \dfrac{3,8}{1,5K}$

$= 2,53\,mA$

2) $h_{ib} = \dfrac{25m}{\cancel{h_{fe}}\, I_E} = \dfrac{25m}{2,53m}$

$= 9,88\,\Omega.$

3) $h_{ie} = h_{fe} \cdot h_{ib}$

$= 200 \times 9,88$

$= 1976\,\Omega.$

4) i) $Z_O = R_E // \dfrac{h_{ie} + R_{BB}}{h_{fe}+1}$

ii) $R_{BB} = R_1 // R_2 = 22K // 18K$

$= 9,9K$

$= 9900\,\Omega.$

iii) $\dfrac{h_{ie} + R_{BB}}{h_{fe}+1} = \dfrac{1976 + 9900}{200+1}$

$= 59,08$

$\therefore$ iv) $Z_O = 1500 // 59,08$

$= 56,84\,\Omega.$

5) i) $Z_{i_{NL}} = R_{BB} // Z_{b_{NL}}$

$Z_{b_{NL}} = h_{ie} + (h_{fe}+1) R_E$

$= 1976 + (200+1)1500$

$= 303476\,\Omega.$

$\therefore$ ii) $Z_{i_{NL}} = 9900 // 303476$

$= 9587\,\Omega$

6) i) $Z_{i_L} = R_{BB} // Z_{b_L}$

ii) $Z_{b_L} = h_{ie} + (h_{fe}+1)(R_E // R_L)$

iii) $R_E // R_L = 1500 // 1000$

$= 600\,\Omega$

$\therefore$ iv) $Z_{b_L} = 1976 + (200+1)600$

$= 122576\,\Omega.$

$\therefore$ v) $Z_{i_L} = 9900 // 122576$

$= 9160\,\Omega.$

7) $A_{V_{NL}} = \dfrac{(h_{fe}+1)R_E}{h_{ie} + (h_{fe}+1)R_E}$

$= \dfrac{(200+1)1500}{303476}$

$= 0,993$

8) $A_{V_L} = \dfrac{(h_{fe}+1)(R_E // R_L)}{h_{ie} + (h_{fe}+1)(R_E // R_L)}$

$= \dfrac{(200+1)600}{122576}$

$= 0,984$

9) $A_{V_S} = A_{V_L} \cdot \dfrac{Z_i}{Z_i + R_S}$

$= 0,984 \dfrac{9160}{9160+600}$

$= 0,923$

10) $2\pi f = 12,566 \times 10^3$

$f = 1999,9\ Hz$

$= 2\,KHz$

11) $V_{S\,peak} = 10 \times 10^{-3}$

$= 10\,mV.$

QUESTION 4 [14]

Fill in the answers into the blocks provided. Do not do calculations inside blocks intended for answers. You may be penalised for untidy work. Answers will not be marked **unless correct units are given**. All silicon junction voltages are 0,7 V in forward bias. Answers must be accurate to the first three significant figures.

$h_{ib} = 25mV \div I_E$; $h_{ie} = h_{fe} \times h_{ib}$

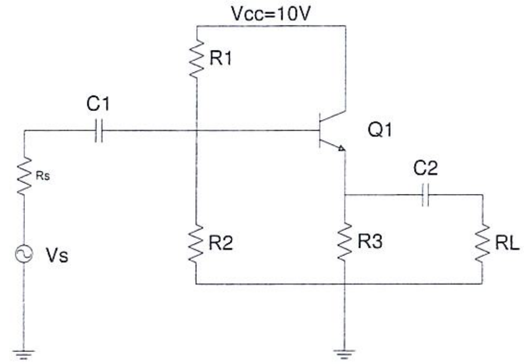
$R1 = 22k\Omega$ $R2 = 18k\Omega$

$R3 = 1{,}5k\Omega$ $R_L = 1k\Omega$

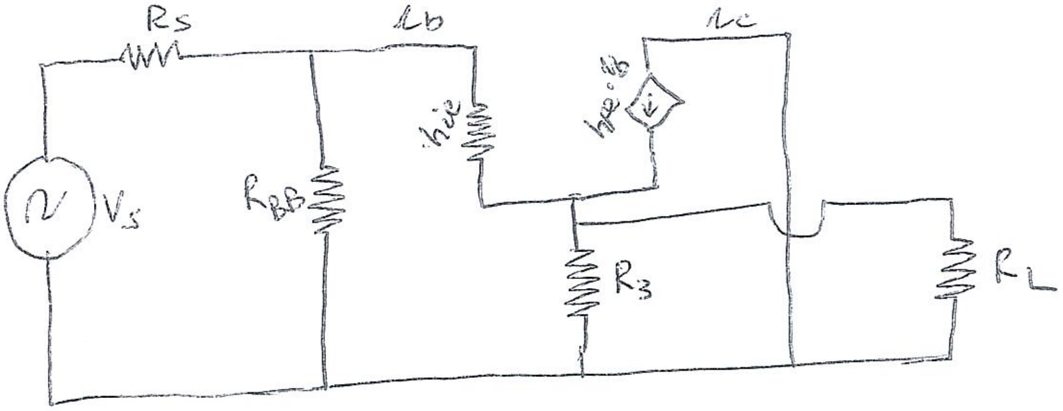
$V_s = 10\times10^{-3}\text{Sin}(12.566\times10^3 t)$

$R_S = 600\Omega$ $h_{fe} = 200$

Note $V_s = V_{peak}\,\text{Sin}2\pi ft$



4.1 Sketch the small-signal equivalent model for the circuit in above. (4)



4.2 Complete the following table:

I_E	2,53 mA	(1)	h_{ie}	1976 Ω	(1)
$Z_{o\text{-(unloaded)}}$	56,84 Ω	(1)	$Z_{i\text{-(unloaded)}}$	9587 Ω.	(1)
$Z_{i\text{-(loaded)}}$	9160 Ω	(1)	$A_{v\text{-unloaded}}$	0,993	(1)
$A_{v\text{-loaded}}$	0,984	(1)	A_{vs}	0,923	(1)
Input frequency	2 KHz	(1)	$V_{s\,(peak)}$	10 mV.	(1)

Q5

1) $I_B = \frac{V_{CC} - V_{BE}}{R_b}$

$= \frac{60 - 0,7}{3,3 \times 10^6}$

$= 17,97 \mu A.$

2) $V_B = V_{BE}$

$= 0,7 V.$

3) $I_C = \beta I_B$

$= 150 \times 17,97 \mu A$

$= 2,696 mA$

4) $V_{R_b} = V_{CC} - V_{BE}$

$= 60 - 0,7$

$= 59,3 V$

5) $I_E = I_B + I_C$

$= 17,97 \mu A + 2696 \mu A$

$= 2,714 mA.$

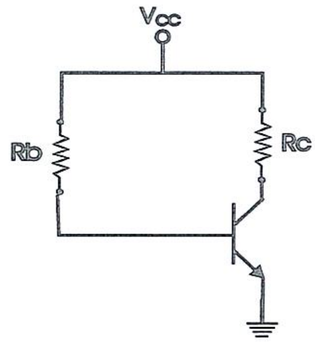
6) $V_{RC} = I_C R_C$

$= 2,696 m \times 1,2K$

$= 3,235 V$

QUESTION 5 [6]

Given: $V_{CC} = 60$ V, $R_B = 3,3$ MΩ, $R_C = 1,2$ kΩ, $\beta dc = 150$, $V_{BE} = 0,7$ V



Fill in the table with respect to the above circuit.

I_B	17,97 μA	V_B	0,7 V
I_C	2,696 mA	V_{Rb}	59,3 V
I_E	2,714 mA	V_{RC}	3,235 V