Exam Electronics & Signal processing
PHYSICS - Students
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Dr. G. Palasantzas

Georg Simon Ohm

Problem 1

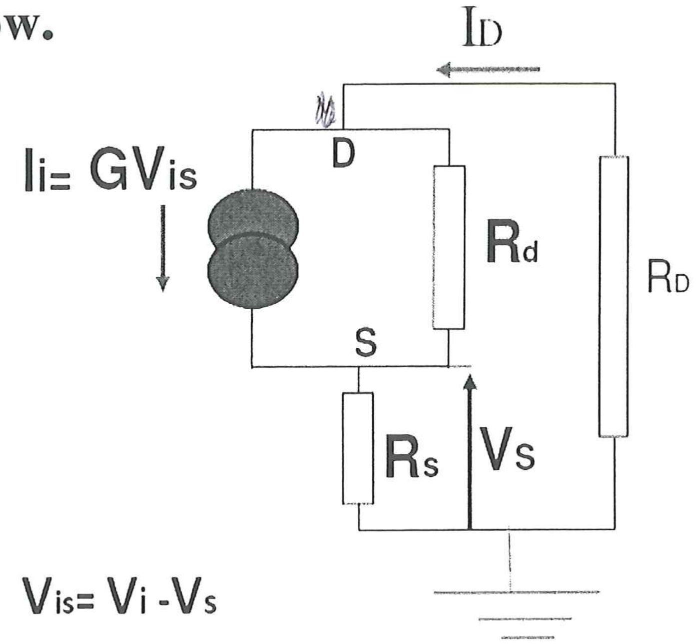
(1.5 point)

Assume that an external voltage Vi drives a circuit in a way that we can represent its effect via a current source $I_i = GV_{is} = G(V_i - V_s)$ in parallel with a resistor R_d as shown below.

G: is a constant

V_D: Potential at point D

V_s: potential at point S



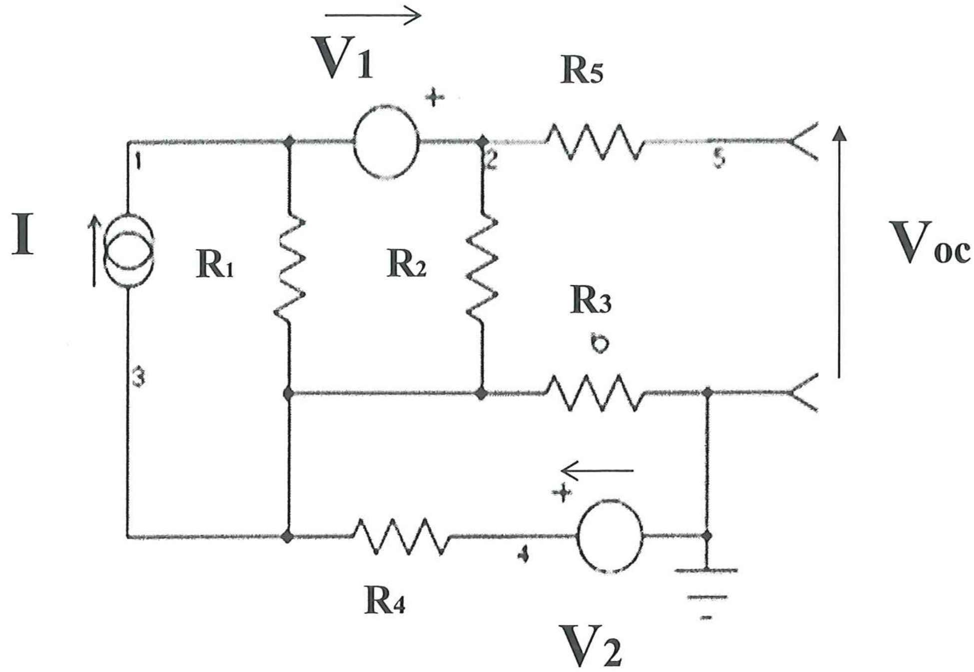
Then prove for V_s/V_i:

$$V_S / V_i = GR_S / [\, 1 + GR_s + [(R_s + R_D)/R_d]\,]$$

$$\frac{V_s}{V_i} = \frac{GR_s}{1 + GR_s + \frac{R_s + R_D}{R_d}}$$

Problem 2

(1.5 points)

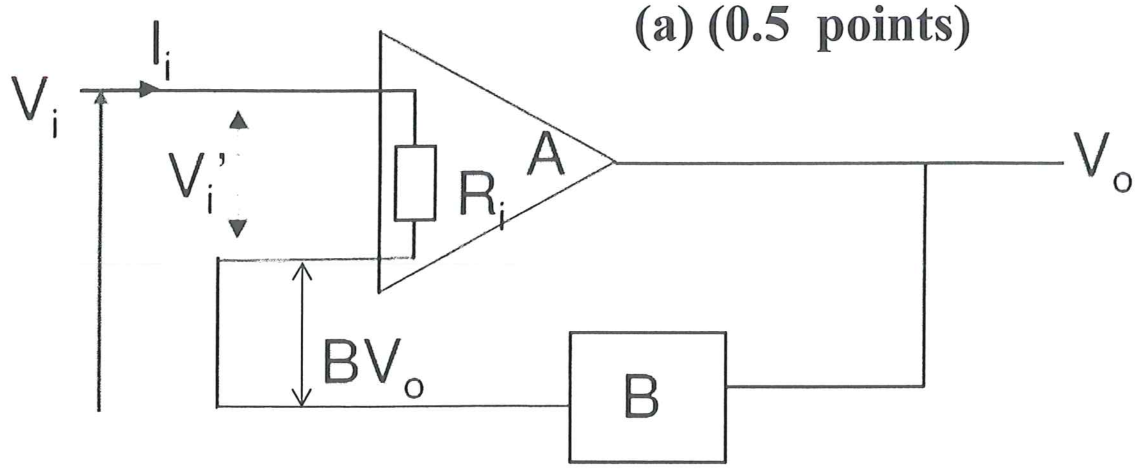


Consider the Circuit →

Give the equivalent Thévenin and calculate V_{oc} en Roc.

Problem 3

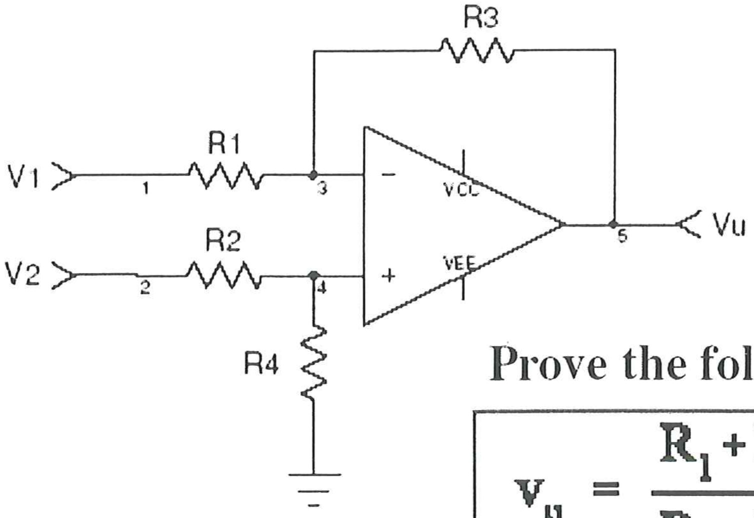
(a) (0.5 points)



Prove that the feedback increases the input resistance Ri of an amplifier or:

$$\textbf{Input resistance} = \frac{V_i}{I_i} = R_i(1 + AB)$$

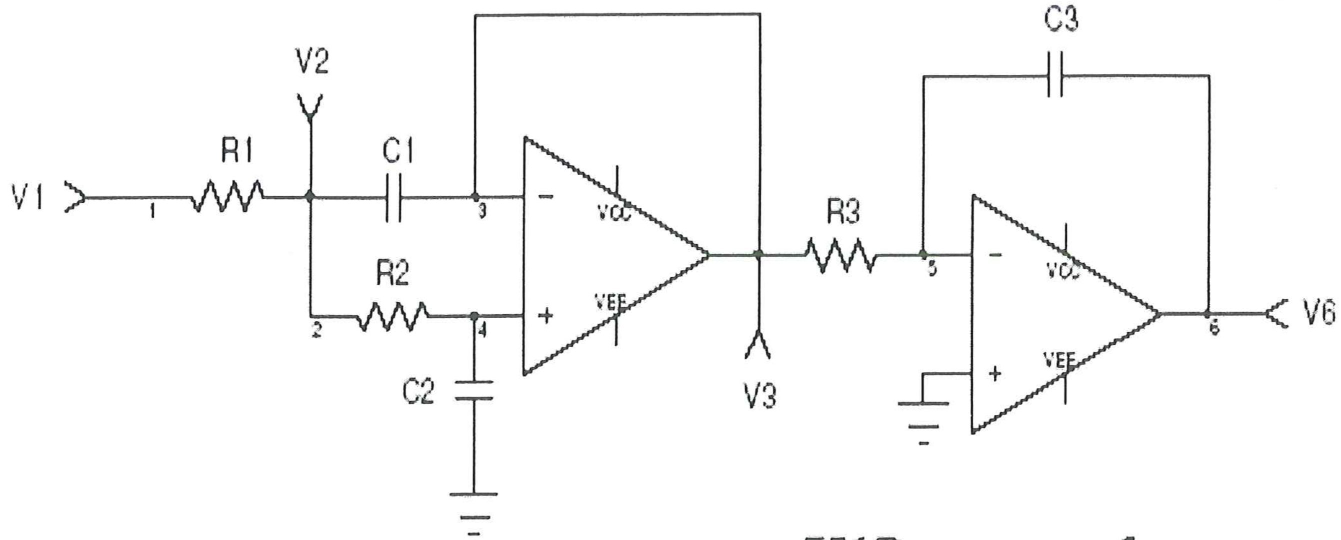
(b) (1 point)



Prove the following:

$$v_u = \frac{R_1 + R_3}{R_2 + R_4} \frac{R_4}{R_1} v_2 - \frac{R_3}{R_1} v_1$$

Problem 4



(a: 0.5 points) Prove: $$\frac{V(6)}{V(3)} = -\frac{1}{j\omega\tau_3}$$

$\tau_3 = R_3C_3$.

(b: 1 point) Prove: $$V(2) = \frac{\left(\frac{R_1}{R_2} + j\omega\tau_1\right)V(3) + V(1)}{1 + \frac{R_1}{R_2} + j\omega\tau_1}$$

$\tau_1 = R_1C_1$.

(c: 0.5 points) Prove: $$V(3) = V(4) = \frac{V(2)}{1 + j\omega\tau_2}$$

$\tau_2 = R_2C_2$.

Tips: *Ideal opamps (V+=V-). For (b) use superposition between V(3) and V(1) and V(3)=V(4) [if you do this correctly then you have done the most essential step for (b)].*

Problem 5

(a: 0.5 points)

Y: CD \ AB	00	01	11	10
00	1	0	0	0
01	1	1	1	0
11	1	1	0	1
10	1	0	0	0

Prove:

$$Y = \overline{A}\,\overline{B} + \overline{A}D + B\overline{C}D + \overline{B}CD$$

(b: 0.5 points)

Y: CD \ AB	00	01	11	10
00	0	0	x	0
01	1	1	x	1
11	0	0	x	x
10	1	1	x	x

x: don't care

Prove:

$$Y = C\overline{D} + \overline{C}D$$

Tip: indicate the proper grouping of terms

(c) (1.5 points)

Build a synchronous 3-counter (1→4) / use 3 J-K

	Voor			Na		
	Q3	Q2	Q1	Q3	Q2	Q1
1	0	0	1			
2	0	1	0			
3	0	1	1			
4	1	0	0			

Q_{n-1}	Q_n	J	K
0	0	0	*
0	1	1	*
1	0	*	1
1	1	*	0

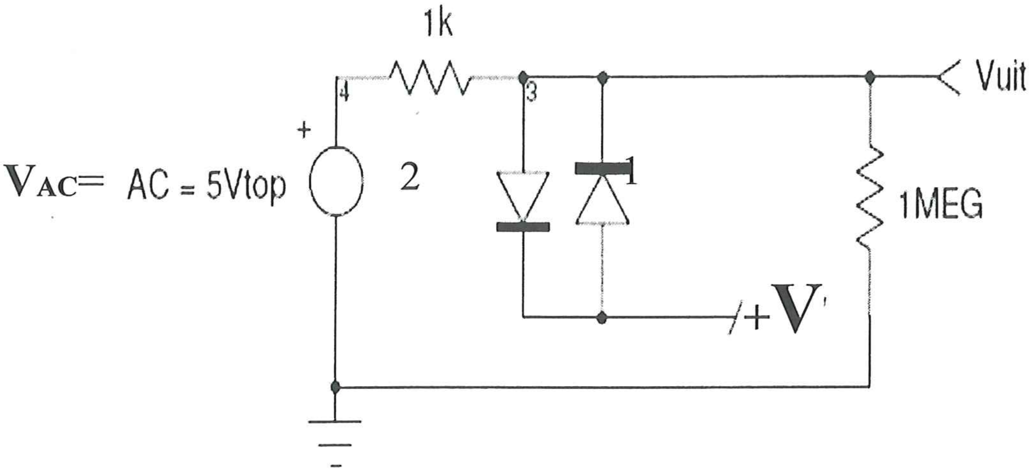
*: don't care

J	K	Q_n
0	0	Q_{n-1}
0	1	0
1	0	1
1	1	$\overline{Q_{n-1}}$

Problem 6

(1 point)

Assume that $V + V_c < V_{AC}$



V_c=0.5 V (diode voltage for forward conduction)
V=3.5 V

<u>Draw</u> V_{uit}

DONDERDAG NA 15:00
VRIJDAG VOOR 15:00

Boolean laws:

$$\overline{A+B} = \overline{A} \cdot \overline{B}$$

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

$$A + AB = A$$

$$A(A+B) = A$$

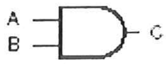
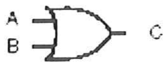
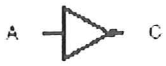
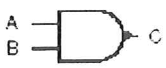
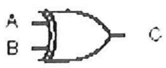
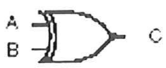
$$(AB)C = A(BC)$$

$$(A+B)+C = A+(B+C)$$

$$A(B+C) = AB + AC$$

$$(A+B)(A+C) = A + BC$$

Tabel 1 Logische poorten.

Functie	Symbool	Boolean	Waarheidstabel
AND		$C = A \cdot B$	A B C 0 0 0 0 1 0 1 0 0 1 1 1
OR		$C = A \times B$	A B C 0 0 0 0 1 1 1 0 1 1 1 1
NOT		$B = \overline{A}$	A B 0 1 1 0
NAND		$C = \overline{A \cdot B}$	A B C 0 0 1 0 1 1 1 0 1
NOR		$C = \overline{A \times B}$	A B C 0 0 1 0 1 0 1 0 0 1 1 0
XOR		$C = A \oplus B$	A B C 0 0 0 0 1 1 1 0 1 1 1 0
XNOR		$C = \overline{A \ominus B}$	A B C 0 0 1 0 1 0 1 0 0 1 1 1