Final exam

Electronics & Signal processing

10-04-2015

Prof. Dr. G. Palasantzas

Grade of written exam:

Points scored from each problem can give you total max: 10

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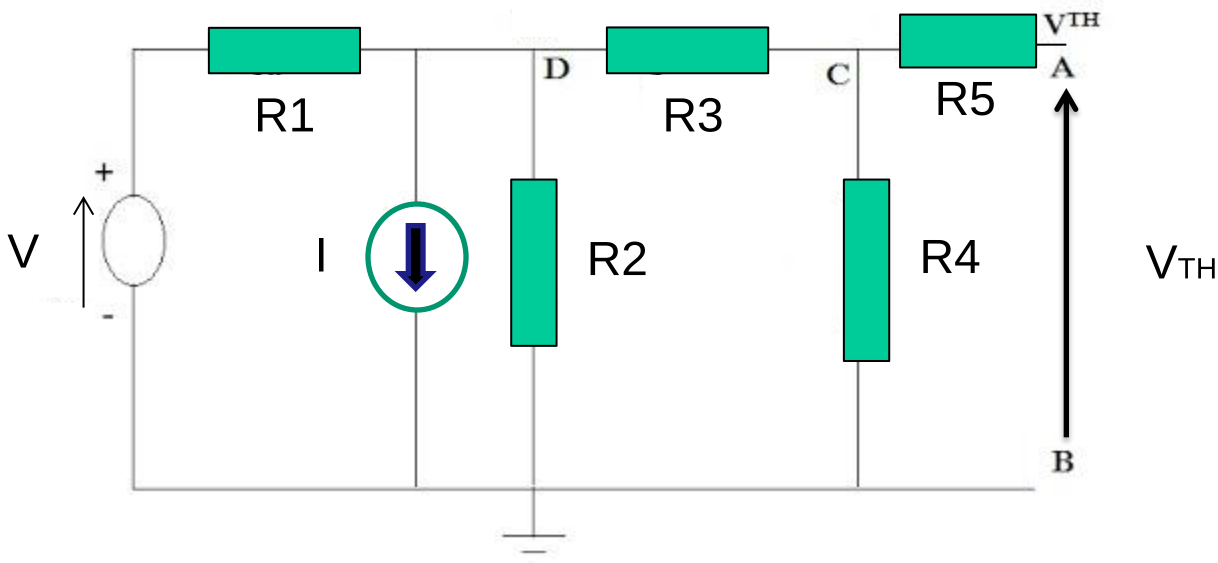
Problem 1 (2 points)

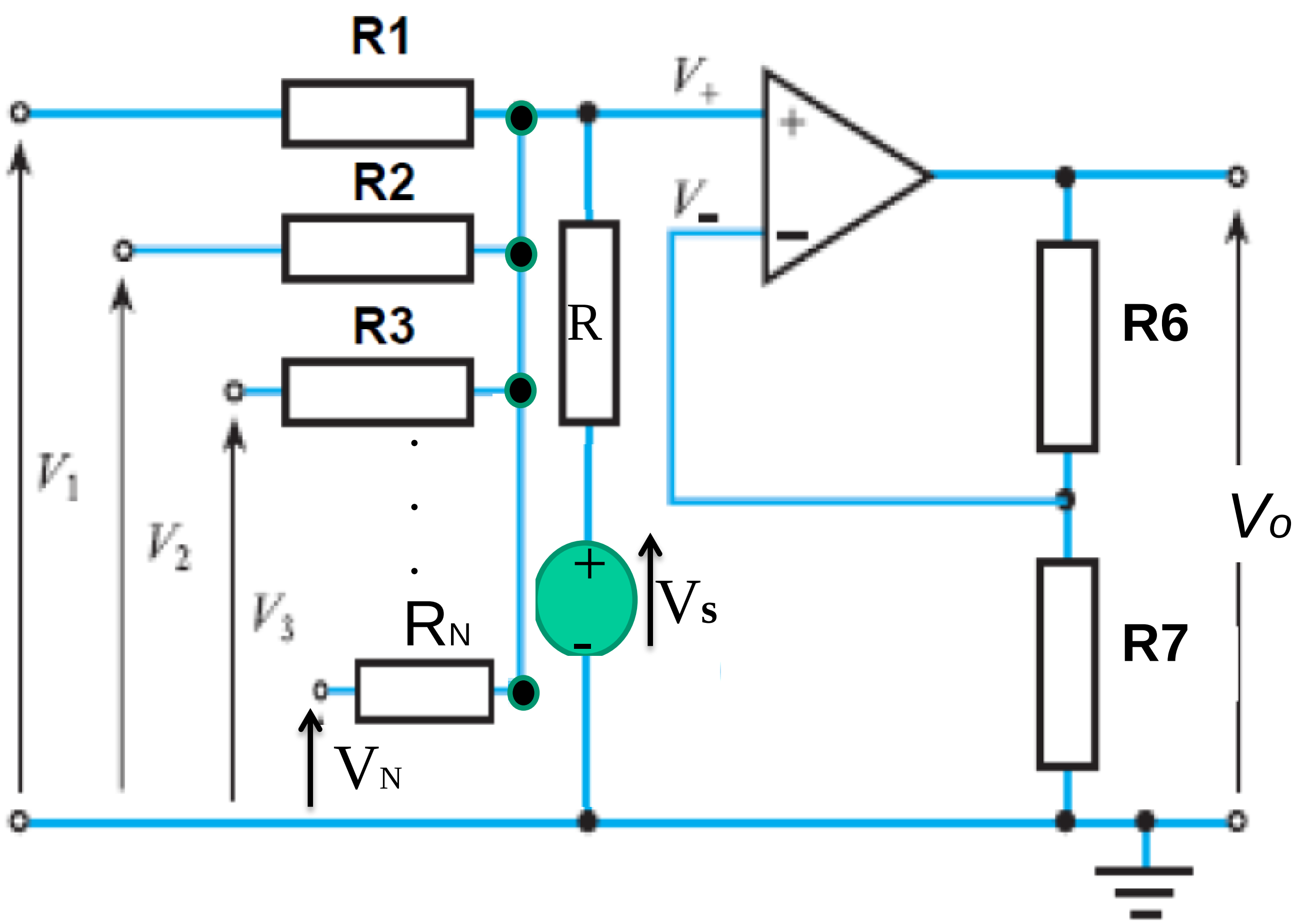


(a: 1.5 points) Derive the Thévenin equivalent between points A and B by calculating the potential V_{TH} (1 point) and R_{TH} (0.5 points) using <u>only the Thevenin-Norton</u> concepts to analyze the circuit.

(b: 0.5 points) If you connect a resistor R_L across the terminals A and B then calculate the current that flows through the resistor R_L.

Problem 2 (2 points)

Ideal opamp: V+=V-



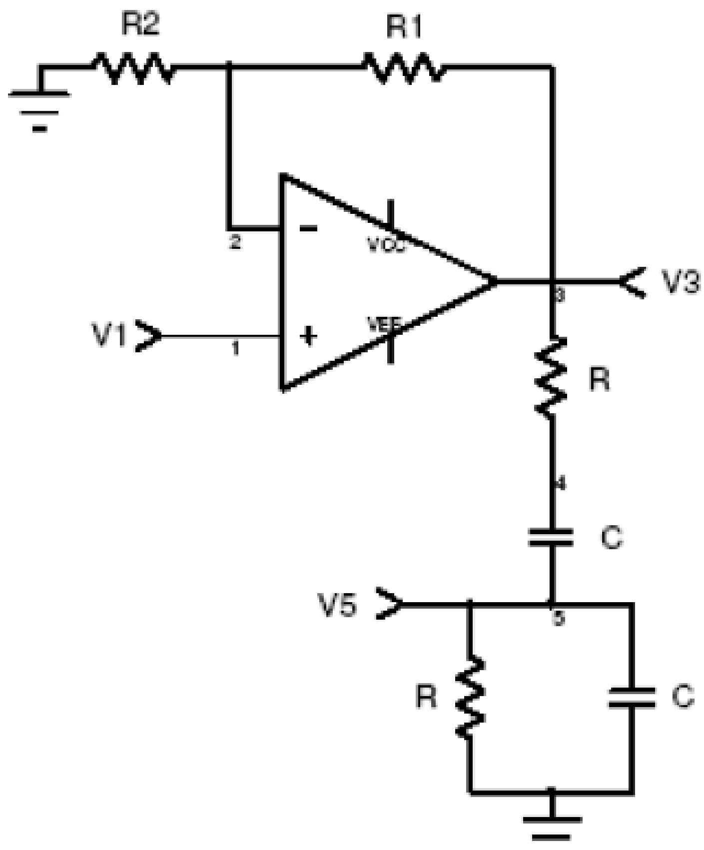
Consider a circuit with input of N voltage sources V_i (i=1, 2, …N). The resistor R is connected to the input of the ideal opamp and to an additional voltage source V_s.

(a) Calculate the potential V+ (1 point) as a function of the potentials V_i (i=1…N), V_s and the resistors R_i (i=1…N) and R.

(b) Calculate the output voltage *Vo* as a functions of the V_i's, V_s, and the resistors of the opamp circuit shown above (1 point).

Problem 3 (1.5 points)

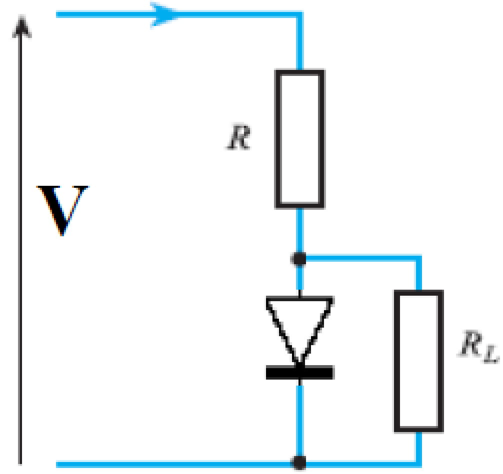
Consider the circuit (Wien bridge oscillator):



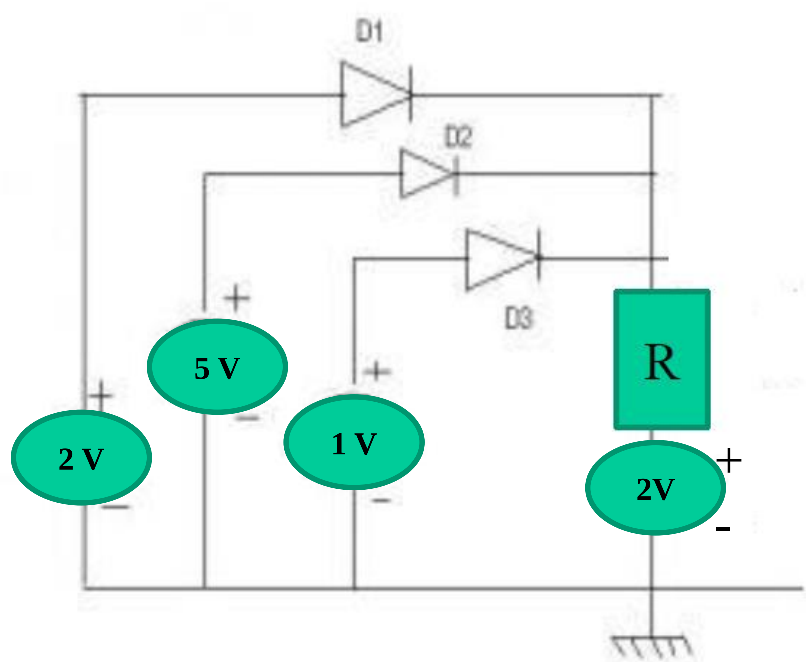
(a) Calculate the transfer ratio A=V3/V1 (V+=V-; 0.5 points)
(b) Calculate the transfer ratio B=V5/V3 and derive the value of ωRC for which B is real (0.5 points)?
(c) For what value of R_1 / R_2 is AB = 1 in order to establish an oscillator by connecting points 1 and 5 (0.5 points) ?.

Problem 4 (1.5 points)

(a:0.5 points) The diode is ideal with forward conduction voltage V_C. Calculate the current through the resistor R_L assuming the supply voltage is $V > 0$.



(b)



(b1: 0.5 point) Find which diode conducts current [*the diodes Di (i=1,2,3) are ideal with voltage for forward conduction Vc=0.5 V*]. Explain briefly your answer.

(b2: 0.5 point) After you answer point (b1) calculate the current via the resistor R.

Problem 5 (1.5 points)

Design a synchronous counter that goes through the states (use J-K flip flops) 0, 1, 2, 4, 5, 6 shown below:

	Before state			**After state**		
	Q3	**Q2**	**Q1**	**Q3**	**Q2**	**Q1**
0	0	0	0			
1	0	0	1			
2	0	1	0			
4	1	0	0			
5	1	0	1			
6	1	1	0			

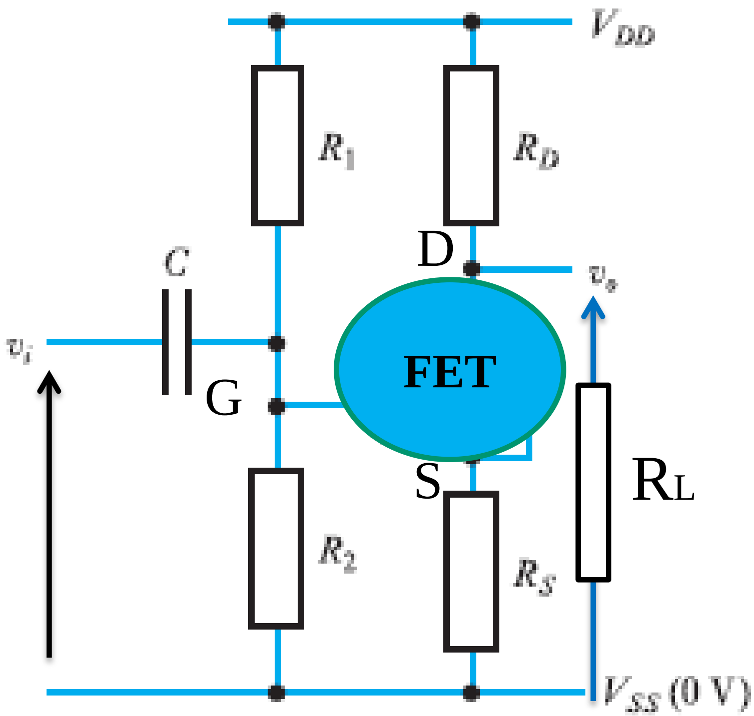
Q_{n-1}	Q_n	J	K
0	0	0	*
0	1	1	*
1	0	*	1
1	1	*	0

∗: 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 (1.5 points)

Application of a small varying input signal υ_i leads to small variation of the gate (G), drain (D), and source (S) potentials of the FET shown bellow:



$$V'_G = V_G + \upsilon_g$$

$$V'_D = V_D + \upsilon_d$$

$$V'_S = V_S + \upsilon_s$$

If we connect a load resistor RL at output of the drain D (and the ground Vss=0), then show that the amplification ratio υ_o/υ_i, with υ_o the variation of the output potential, is given by:

$$\frac{\upsilon_o}{\upsilon_i} = -\frac{g_m(R_D // R_L)}{1 + g_m R_S + [(R_D // R_L + R_S)/r_d]}$$

with g_m the transconductance and r_d the differential resistance of the FET at saturation.