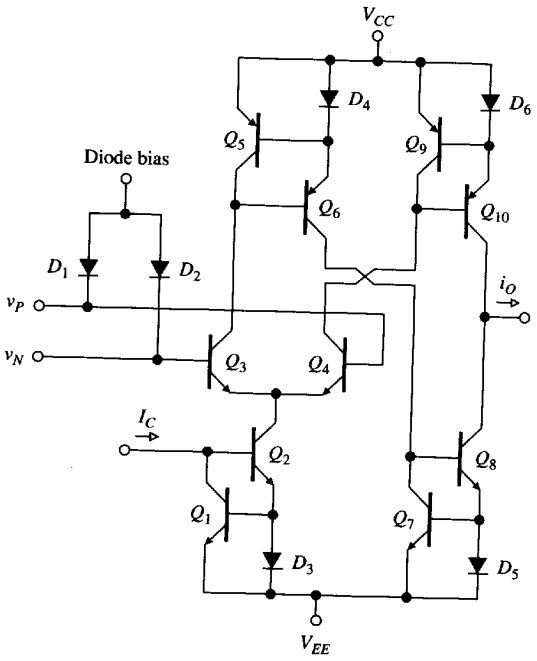
Electronic Complements Second call exam 28 January 2013, 9-12 (Duration: 3 hours)	Universidade do Algarve MIEET

- Write your name, student number and course on all sheets you hand in.
- Talking is not allowed. If you do it, your exam will be canceled. Switch off your cellular telephone.
- If you give up, write "I Desist" on the exam sheet and hand it in.
- The exam has 4 questions and the maximum score for each is written in brackets.
- Write legible.
- Good luck!

Question 1 (5)

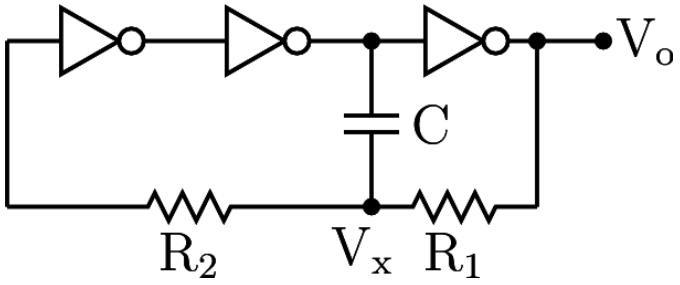
The figure below shows an operational transconductance amplifier (OTA). The heart is formed by the diodes D1, D2 and the transistors Q3 and Q4, while the rest of the transistors and diodes are four Wilson current sources/mirrors: Q5-D4-Q6, Q9-D6-Q10, Q1-D3-Q2, Q7-D5-Q8. Assume all $\beta = \infty$.

The current I_C comes from a voltage-controlled current source, $I_C = aV_x$, and to i_o a load resistance R_L is connected, V_y is defined as V_p-V_n.



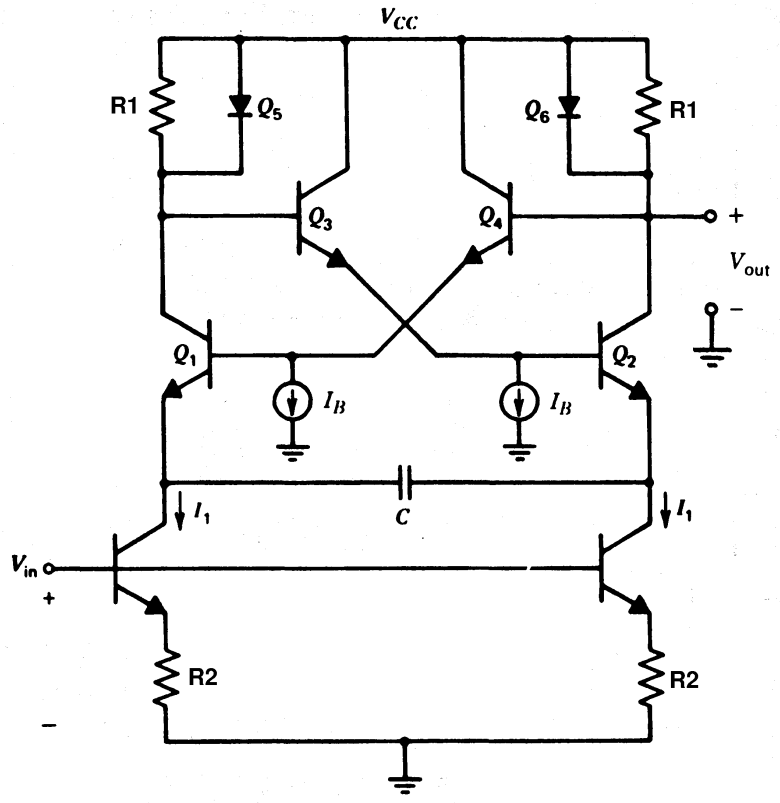
a) What is the collector current of transistor Q2?
b) How many quadrants does this analog multiplier have?
c) How to make a voltage-controlled current source, $I_C = aV_x$?
d) Show that the output is proportional to V_x and V_y.

Question 2 (5)
The figure below shows a logic oscillator made of three logic inverters. Note that the input voltage of these inverters is 'clamped'. This means that they cannot exceed 0 and V_{DD}. In case this occurs, they are fixed at these values (as if the inputs were then ideal voltage sources)



a) Sketch the signal at V_x.
b) What is the output frequency?

Question 3 (5)
The figure below shows a voltage controlled oscillator.



a) How does it work. Make sketches of the signal at relevant points. What is the output frequency?

Question 4 (5)

An FM signal is being modulated over the range of 1 MHz ± 10 kHz, with a modulation frequency of 1 kHz. Using a 4046A PLL, design a circuit to demodulate such a signal. The central frequency of the VCO is given by

$$f_0 = \frac{k_1}{R_1 C} v_E + \frac{k_2}{R_2 C}$$

with v_E defined relative to $V_{DD}/2$, and k_1 and k_2 depending on the PLL (see datasheet). Show th signals at various relevant points of the circuit

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Complementos de Electrónica Exame época recurso 28 de Janeiro de 2013, 9-12 (Duração: 3 horas)	Universidade do Algarve MIEET

- Escreva o seu nome, nº de aluno e curso em todas as folhas que entregar.
- Não é permitido falar com os colegas durante o exame. Se o fizer, terá a prova anulada. Desligue o telemóvel.
- Caso opte por desistir, escreva "Desisto", assine e entregue a prova.
- O exame tem 5 perguntas e a cotação de cada aparece entre parêntesis.
- Faça letra legível.
- Boa sorte!

Pergunta 1 (4)
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