EECS40 **Spring 2004**

Midterm Exam # 2
April 15, 2004
Time Allowed: 80 minutes

Name:______________________, ________________________
Last First

Student ID #:________________, Signature:________________________

Discussion Section:_____________________________________

This is a closed-book exam, except for use of two 8.5 x 11 inch sheets of your notes. Show all your work to receive full or partial credit. Write your answers clearly in the spaces provided.

Problem #:	Points:
1	/10
2	/20
3	/20
Total	/50

1.

a) (5 points)

A silicon sample is uniformly doped with Boron to a concentration of $10^{16}\ atoms/cm^3$. Determine the resistivity of the sample at room temperature.
Use electron mobility = $\mu_n = 1000$ cm^2/v-s, hole mobility = $\mu_p = 400$ cm^2/v-s,

$q = 1.6 \cdot 10^{-19}$ C and $n_i = 10^{10}$ at room temperature.

b) (5 points)

The same sample is then to be counter doped to a depth of $5\mu m$ with Arsenic atoms to create a resistor technology with resistance of $100\Omega/\square$.

Determine the required Arsenic doping density.

2.

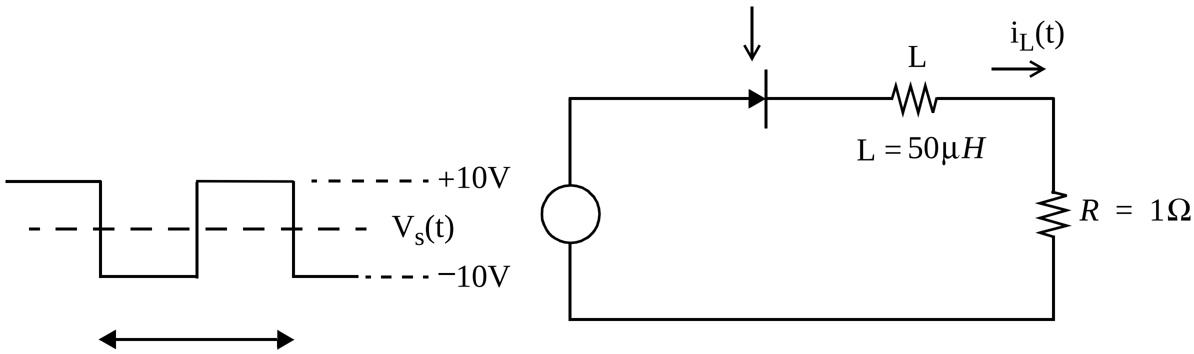
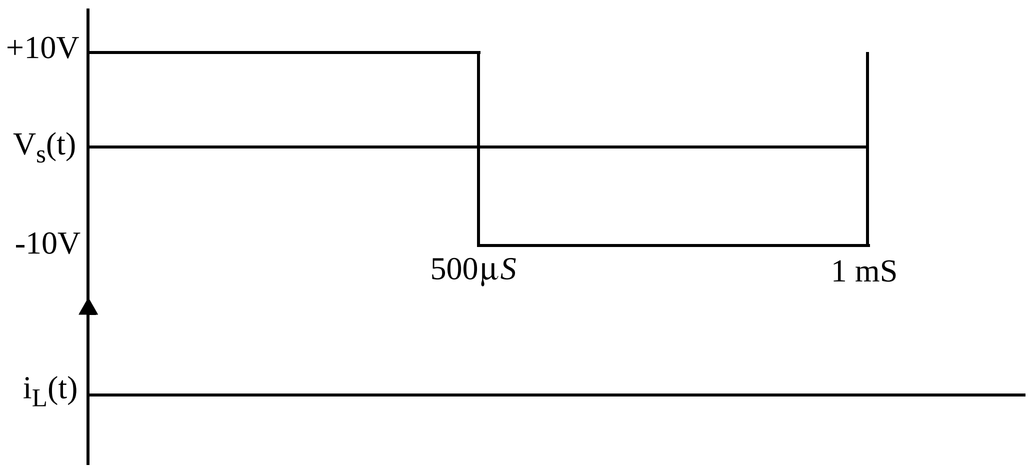


Figure 2(a)

a) (10 points)
The diode in Figure 2(a) is ideal. The waveform $V_S(t)$ is a balanced square wave with amplitude of 10 V and period of 1mS. Take L = $50\mu H$ and R = 1Ω.

The circuit operates in a periodic steady state. Sketch and carefully dimension one period of the $i_L(t)$ waveform on the axes below. Make reasonable approximations.



b) (10 points)

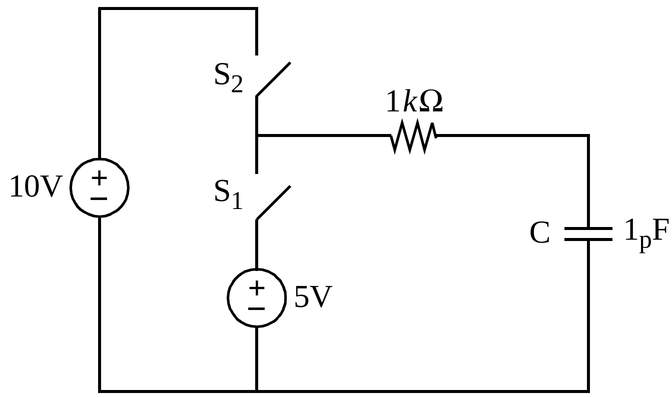


Figure 2(b)

In the circuit of Figure 2(b), switch S_1 is initially closed and the circuit is in equilibrium. Switch S_1 is then opened and switch S_2 is closed for a sufficiently long time so that the circuit can be considered to be in equilibrium. How much energy is dissipated in the $1k\Omega$ resistor during the transient?

Hint: Think in terms of net charge and energy flow. Detailed transient analysis is **NOT** needed.

3.

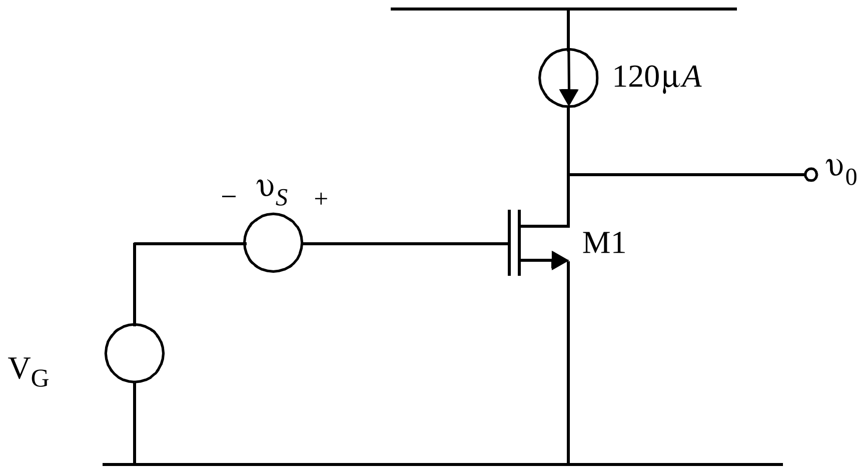


Figure 3

$\lambda = 0.1V^{-1}$

$V_T = 0.5V$

$k' = 100\mu A/V^2$

$\frac{W}{L} = 2$

Mosfet M1 in Figure 3 is modeled by $i_D = \frac{1}{2}k'\frac{W}{L}(\upsilon_{GS} - V_T)^2(1 + \lambda\upsilon_{DS})$ in saturation with parameters listed in Figure 3.

a) (5 points)
Determine the requires bias voltage V_G so that M1 is biased in saturation with V_{DS} = 2V. Take $\upsilon_S = 0$ for this calculation.

b) (10 points)

Draw the small signal model for this circuit. Compute the parameters of this small signal model.

c) (5 points)

Determine the small signal gain $A_\upsilon = \dfrac{\upsilon_0}{\upsilon_S}$.