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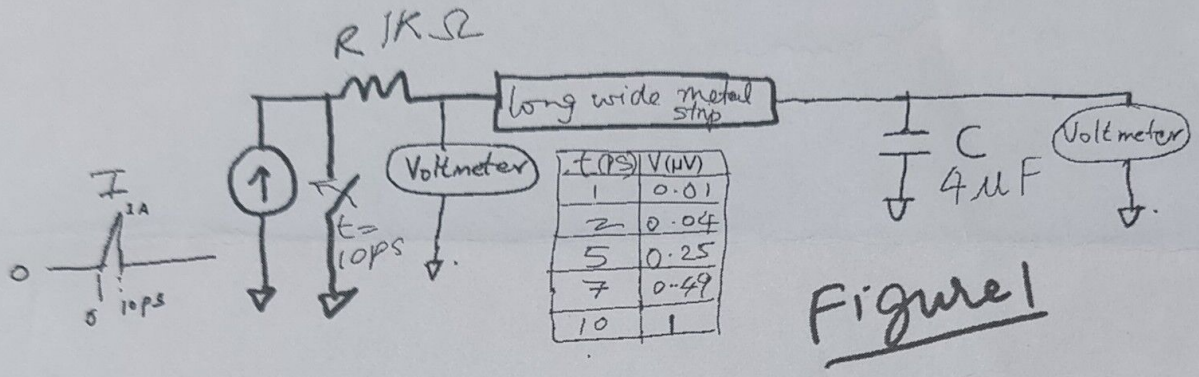
Department of Electronics and Communication Engineering
Indian Institute of Technology Roorkee
Mid-Term Examination (April 2023)
EC 102: Fundamentals of Electronics

Maximum Marks: 52 (Weight: 30%)
Time: 1.5 Hours
(Closed book examination)

Note:

- Write your name and enrolment number on each page of the question paper in the earmarked space.
- Please write the names of all your nearest neighbours on the first page of the answer sheet.
- If necessary, make appropriate assumptions and approximations and state them.
- **You must solve all the the parts of a question in the serial order (else the question would not be evaluated).**

1. The circuit in Figure 1 is realized with an unusually long and wide wire connecting the resistor and the capacitance. The readings of both the voltmeters turns out to be the same as written in the table.
   (a) What is the missing circuit element which can explain the voltmeter readings? (4)
   (b) What is the value of the missing circuit element? (4)
   (c) What is the value of V_c at time t = 1ms? (2)



t(ps)	V(μV)
1	0.01
2	0.04
5	0.25
7	0.49
10	1

Figure 1

2. Please see Figure 2:
   a) What are the values of $V_c(0+)$, $I_L(0+)$, $I_R(0+)$ and $\frac{dI_L}{dt}(0+)$? (5)
   b) The rate of change of I_L = ___ times the rate of change in V_c (2)
   c) If the current I_C increases/decreases with time, voltage V_o increases/decreases with time. (2)
   d) Write KVL across Loop1 to solve for V_c. (4)
   e) What is the value of V_c at time t = 0.25 s and 1 s. (6)

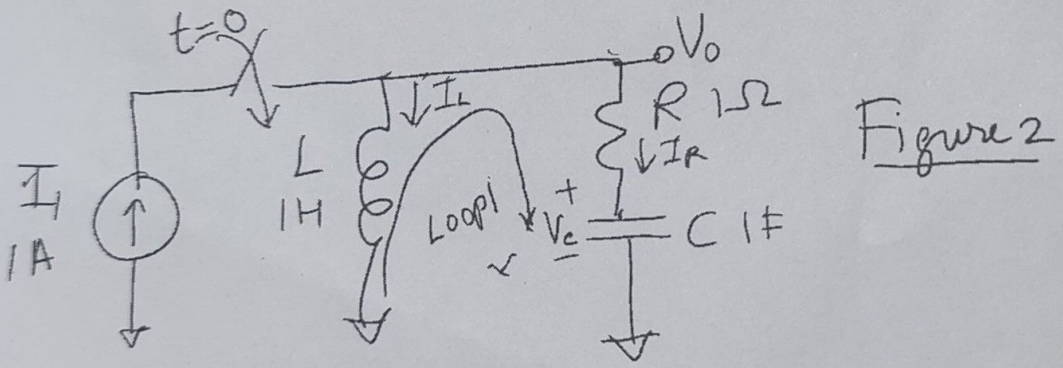


Figure 2

3. If the temperature increases from 300 K to 600 K:
   a) The rate of generation increases/decreases by exp(___) times. (3)
   b) The value of intrinsic carrier density n_i increases/decreases by exp(___) times. (2)

c) For a given forward bias in a PN junction diode, the excess minority hole charge on the N-side increases/decreases by exp(___) times. (3)

4. In Figure 3:
   a) What is the value of the bias voltage V_D (DC)? (8)
   b) Draw a small signal equivalent diagram of the circuit with parameter values. (3)
   c) What is the value of the small signal current across R_2? (4)

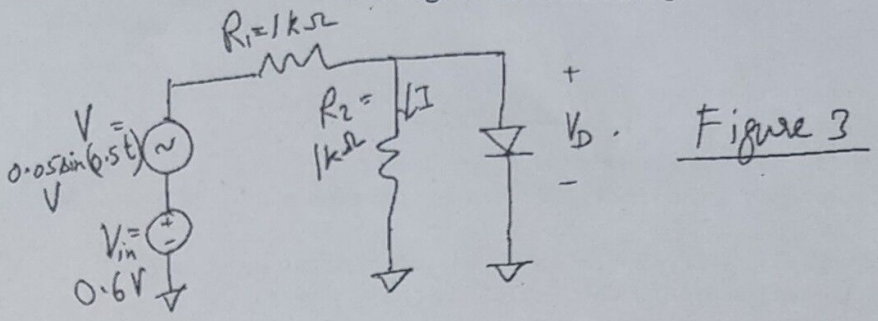


Figure 3

Given:

I_0 = 1pA

η (ideality factor) = 1

$$I_d = I_0 \left(e^{\frac{Vd}{\eta V_T}} - 1\right)$$

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