The University of Sheffield

Department of Electronic and Electrical Engineering

EEE118 Problem Sheet

Diode, Resistor and Capacitor Circuits.

NOTE: ***A pulse described as "long" has a width that is many times the biggest time constant in the circuit of interest. All the pulses used as inputs in this problem sheet have infinitely fast rising and falling edges.***

Q1 For the circuit of figure 1, sketch the V_O - V_i and I_D - V_i characteristics that you would expect to observe over the range V_i = -10V to V_i = +10V if the diode has a forward voltage drop of 0.7V.

Q2 For the circuit of figure 2, sketch the waveshape that you would expect to observe if V_i was a triangular waveshape with a peak value of 10V (ie, a positive peak of 10V and a negative peak of -10V) and the diode had a forward voltage drop of 0.7V.

What is the largest value of forward current through the diode?

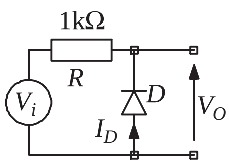

Figure 1

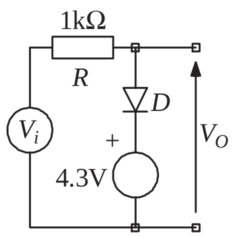

Figure 2

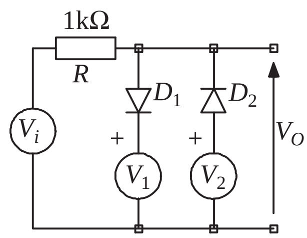

Figure 3

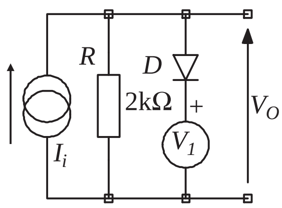

Figure 4

Q3 In the circuit of figure 3, V_i is a triangular wave of 10V peak whose frequency is to be measured by a system that requires its input signals to lie within the range 0V to 3.3V if damage to the system is to be avoided. Assuming the diodes have forward bias voltage drops of 0.7V, choose values for V_1 and V_2 that will clip those parts of the triangular V_i that are higher in voltage than 3.3V and lower in voltage than 0V.

Q4 In figure 4, V_1 = -2V. Sketch V_O as a function of I_i over the range I_i = -3mA to +3mA.

Q5 Design a soft clipping circuit that will realise the V_O-V_i characteristic of figure 5 using diodes that have a turn on voltage of 0.7V. (*Base your design on the circuit of figure 3; keep the 1kΩ resistor, add a series resistor into each of the diode arms and work out suitable values for V_1, V_2 and the two series resistors.*)

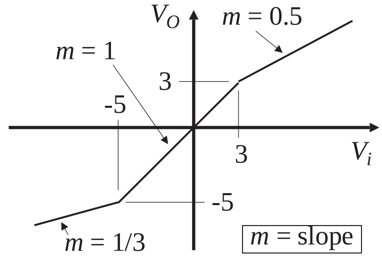

Figure 5

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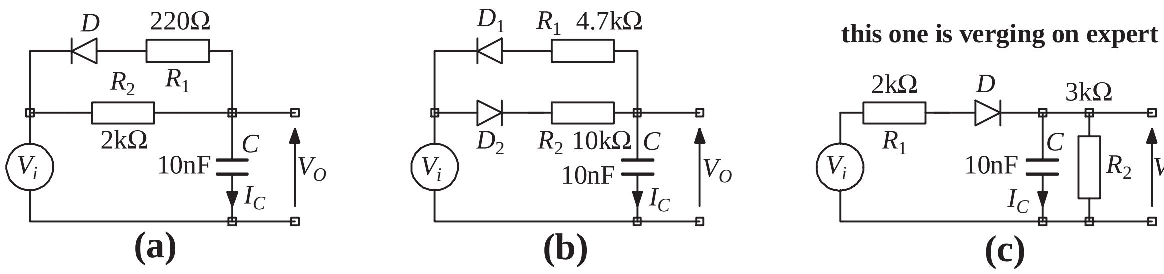

Figure 6

Q6 For each of the circuits of figure 6, sketch the response of V_O and I_C to a 0V to 10V input pulse with a duration of 100µs. You should assume that the diodes are ideal (ie, 0V forward voltage drop) and take care to label your sketch with salient features such as time constants and aiming levels. In the case of figure 6b you will need to work out the voltage reached by V_O at the end of the pulse.

In each case write down the exponential form of the rising and falling edge responses and calculate the width of the output pulse, measured in figure 6a and 6c at half its height and measured in 6b at 5V. *(In one of the three circuits the output pulse height is not the same as the input pulse height.)*

AND FOR EXPERTS

Q7 The circuits of figure 7 are slightly more subtle in their behaviour than those of figure 6. Each circuit is driven by a 0V to 10V input pulse of 100µs duration and uses diodes that can be assumed to be ideal (ie, 0V forward voltage drop).

For figure 7a, sketch the response of V_O and I_C to the input pulse.

For figures 7b and 7c, sketch the response of V_O to the input pulse.

For figure 7c, calculate the time for which V_O is below 2.5V *after* the falling edge of the input pulse.

As in question 6, be sure to label all the salient features of your sketches.

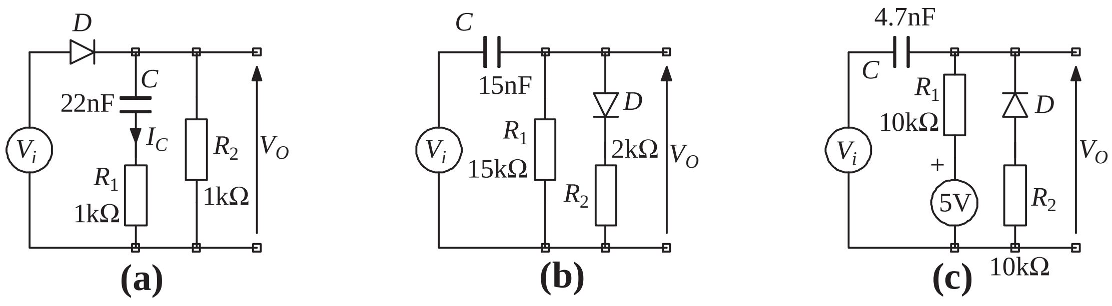

Figure 7