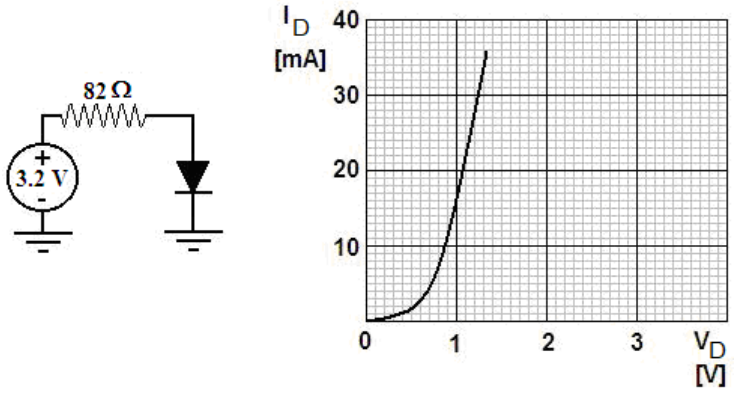
Electronics

Diodes, Q point

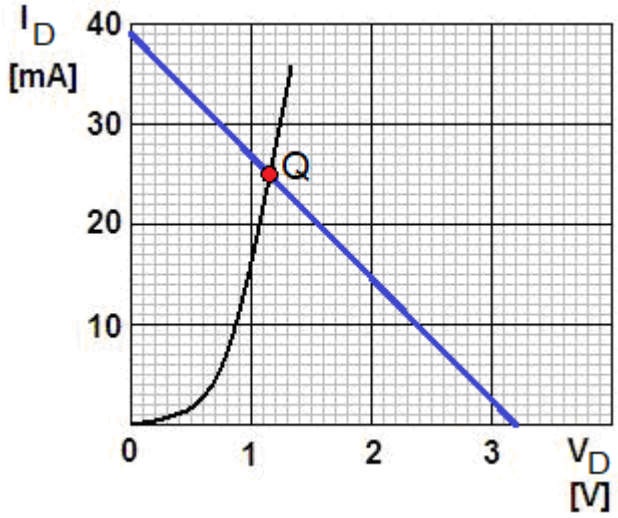
Problem 1.- Find the operating point of the diode (Q-point, voltage and current).



Solution: To find the operating point of the diode we write the load equation:

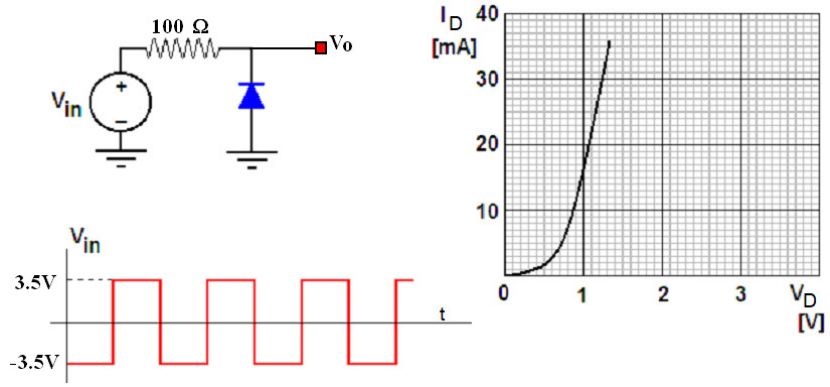
$$3.2V - 82\Omega I_D - V_D = 0$$

This equation is a straight line that has y-intercept at $I_D = \frac{3.2V}{82\Omega} = 39mA$ and x-intercept at $V_D = 3.2V$. We get the operating point graphically:



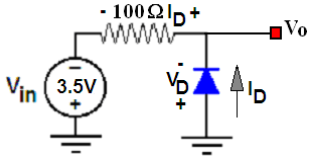
The operating point is $V_D = 1.15V$ and $I_D = 25mA$

Problem 2.- Find the voltage in the diode as a function of time.



Solution: When the source voltage is positive, the diode is reversed-biased and behaves like an open circuit. This means that the current through the 100Ω resistor is zero and the voltage drop is zero too, so the output voltage will be equal to the source voltage (3.5V).

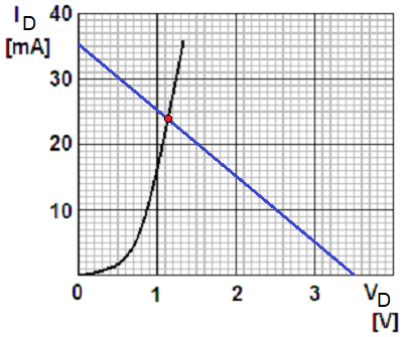
When the source voltage is negative, the diode is forward biased, and it will conduct electricity. To get the operating point we should look at its I-V curve. The point of operation will be the intersection between the curve and the "load line" that we can get from the rest of the circuit:



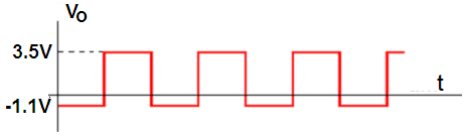
The equation will be:

$-3.5V + 100\Omega I_D + V_D = 0$

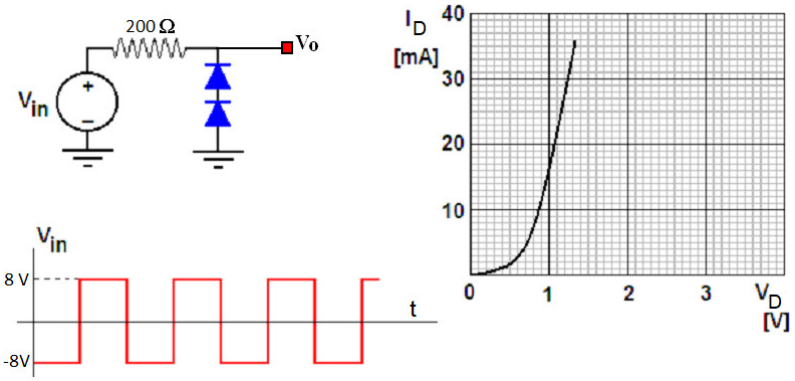
This equation is a straight line that has y-intercept at $I_D = 35mA$ and x-intercept at $V_D = 3.5V$, we get the operating point graphically:



The operating point is $V_D = 1.1V$, so the output voltage will be -1.1V. The output signal will look like this:



Problem 3.- Two diodes are used as limiters for the input voltage of a delicate instrument as shown in the circuit below. Sketch the output voltage V_o as a function of time, given the input voltage shown.
For your calculations you are given the I-V curve of the diodes.

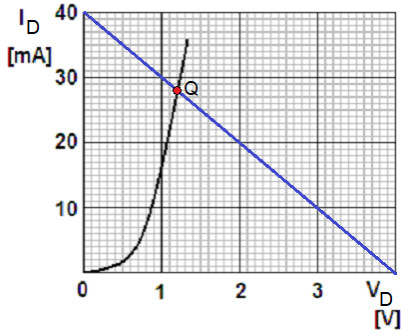


Solution:
Case 1: If the input voltage is +8V, as the diodes are in reverse, they will behave as open circuits and all 8 volts will appear at the output.

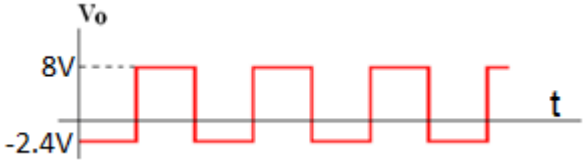
Case 2: If the input voltage is -8V instead, the diodes will conduct current. To analyze this case, notice that the load line in short circuit will have a current of

$$I_{\text{load-line}} = \frac{8}{200} = 40mA$$

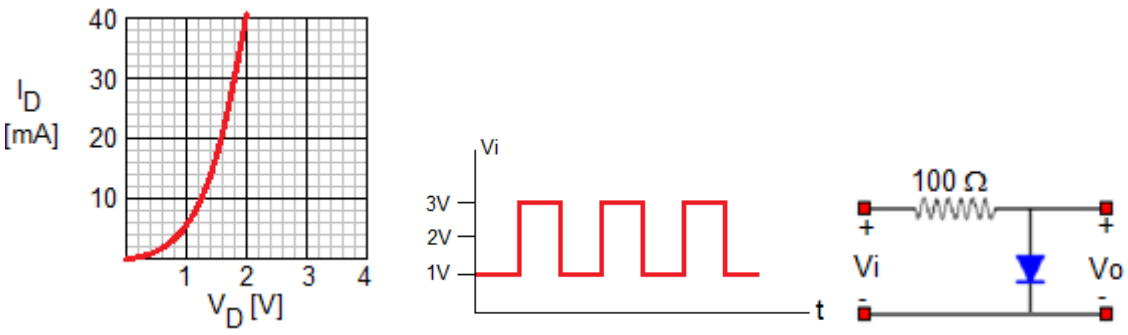
And if I=0, the 8 volts will be shared by the two diodes, so each diode will have 4 V. This gives us the second intercept of the load line as shown below.



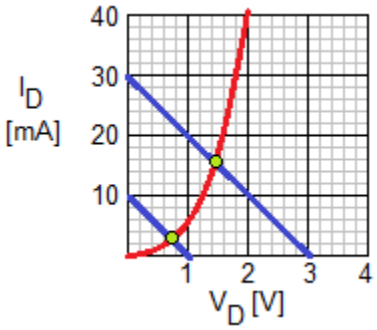
The graphical result is that each diode will have ~1.2V. Then, the output will be -2.4V considering that the diodes are in series:



Problem 4.- The circuit shown serves as a limiting device for voltages. Given the input voltage shown, find the output signal.



Solution: We find the operating points at 1V and 3V by drawing the load lines on the diode I-V curve:



We get Q points at 0.75V and 1.45V approximately, which gives the output signal indicated below.

Problem 5.- The circuit shown has two identical diodes whose I-V curve is given. Given the input voltage V_i.

- Find graphically the operating point at 2V and 6V.
- Sketch the output voltage V_o as a function of time.