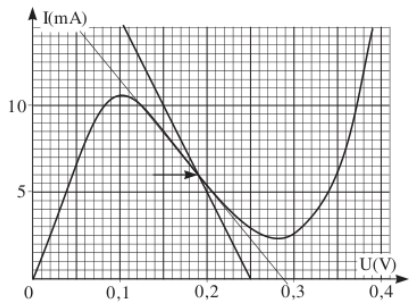
4. Tunnel diode (8 pts)

1) For voltages below 0.08 V, the graph is almost a straight line corresponding to a constant resistance $R_D = 0.05\,\mathrm{V}/6.5\,\mathrm{mA} \approx 7.7\,\Omega$. Hence $I = (U_{\mathrm{in}} + \mathcal{E})/(R + R_D) \approx 4.5\,\mathrm{mA}$.

2) The output voltage can be found graphically: the diode voltage $U(I) = \mathcal{E} - IR$, hence, the intersection point of the graph and the straight line $U = \mathcal{E} - IR$, gives us the diode current 6 mA; then, the output voltage $IR = 60\,\mathrm{mV}$ (see the graph).



3) One millivolt input shifts the line intersecting the graph a little-bit sideward, but the shift is so small that the graph can be approximated by a straight line. The cotangent of the slope of that line gives us the differential resistance of the diode, $R_d = -16\,\Omega$. Then, a small change in the input voltage ΔU will lead to a current change ΔI given by the relationship $(R + R_d)\Delta I = \Delta U$; hence, $\Delta I = \Delta U/(R_d + R)$. The output voltage change $\Delta U_{\mathrm{out}} = IR = R\,\Delta U/(R_d + R)$, and the amplification factor $\Delta U_{\mathrm{out}}/\Delta U = R/(R_d + R) \approx 1.7$. Consequently, the output voltage is 1.7 mV, and ...

4) the output graph is exactly the same as the input graph, except that it is vertically stretched by a factor of -1.7.