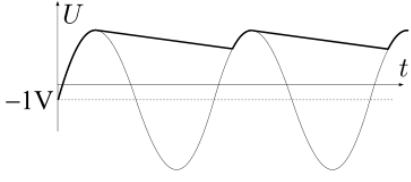
6. Rectifier (8 points)

1) Since none of the DC current through the load can come from the capacitor, all must come through the diode. Hence, the average current through the diode is also $I = 2\,\mathrm{mA}$, and the average power dissipation is obtained by multiplying it with the diode voltage $u = 1\,\mathrm{V}$: $P = 2\,\mathrm{mW}$.

2) If the diode is open, $U_{\mathrm{load}}(t) = U_0 \cos(\omega t) - u$. If the diode is closed [i.e. $U_0 \cos(\omega t) < U_{\mathrm{load}}(t) + u$], the capacitor discharges through the load. However, the relative change of the voltage of the capacitor has to be small (otherwise $\Delta I/I$ would not be small). The respective load voltage as a function of time is sketched in the Figure. So, we can use the above written Kirchoff's law with $U_{\mathrm{load}}(t) \approx IR$, hence $U_0 = IR + u = 21\,\mathrm{V}$.



3) The change of the voltage of the capacitor during the discharge cycle can be estimated as $\Delta U = \Delta Q/C$, where the capacitor's charge drop $\Delta Q = It$, and t is the discharge time. Since the discharge cycle occupies almost all the period (see Figure), we can use $t \approx 1/\nu$. Further, $\Delta I/I = \Delta U/U = \Delta Q/CU = \Delta Q/CIR = 1/CR\nu$. Hence, $C \geq 100/R\nu = 200\,\mu\mathrm{F}$.

4) Initially, the capacitor is empty, so that the charge flowing through the capacitor during the first cycle is $Q = CIR$. Hence, the average power $P_1 = Qu\nu = CIRu\nu = 200\,\mathrm{mW}$.