Physics – Exam 1 – Semester 1

November 10, 2023 - Duration 1h30

*The marks will account not only for the results, but also for the justifications, and the way you analyze the results. Moreover, any result must be given **in its literal form involving only the data given in the text**. It is also reminded that the general clarity and cleanness of your paper may also be taken into account.*
No document allowed. No mobile phone. Non-programmable calculator allowed. The proposed grading scale is only indicative.

Exercise 1: Iron (≈ 6 points)

To remove wrinkles from your clothes, use an iron. Its technical datasheet states the following information: 220-240V and 2000-2400W. We will assume in the following that the iron works in direct current (DC) as a heating resistance.

Important: All results or processes must be justified and all numerical results presented along with their uncertainty as: (…. ± ….) unit.

1. Explain the meaning of the different quantities mentioned on the datasheet, as well as their dimensions as a function of the base dimensions.
2. Indicate the physical mechanism at play in an iron, then fill the following sentence:
   "An iron is a device that transforms … energy into … energy."
3. Deduce the electric current flowing through the iron, and its equivalent resistance.
4. The iron is used for 35 min. Deduce the energy consumed in J.
5. A kWh costs 0.10€ TTC, how much should you pay for this 35 min use?

Exercise 2: Diode (≈ 14 points)

Consider a diode having the following characteristics:
- when the voltage U_d across the diode is negative (reverse mode) or lower than a threshold voltage $e_{th} = 1.5\ V$, the diode acts as an open switch (see figure 1-left).
- when the voltage U_d across the diode is higher than a threshold voltage $e_{th} = 1.5\ V$, the diode is equivalent to a real voltage source with a counter electromotive force (cemf) $e_{th} = 1.5\ V$ in series with an internal resistance $r_d = 5\Omega$ (see figure 1-right): the diode operates in the **forward** mode.

In this exercise, the values of the following physical quantities are considered as perfectly known without uncertainty: e_{th}, r_d, E_g and R_g.

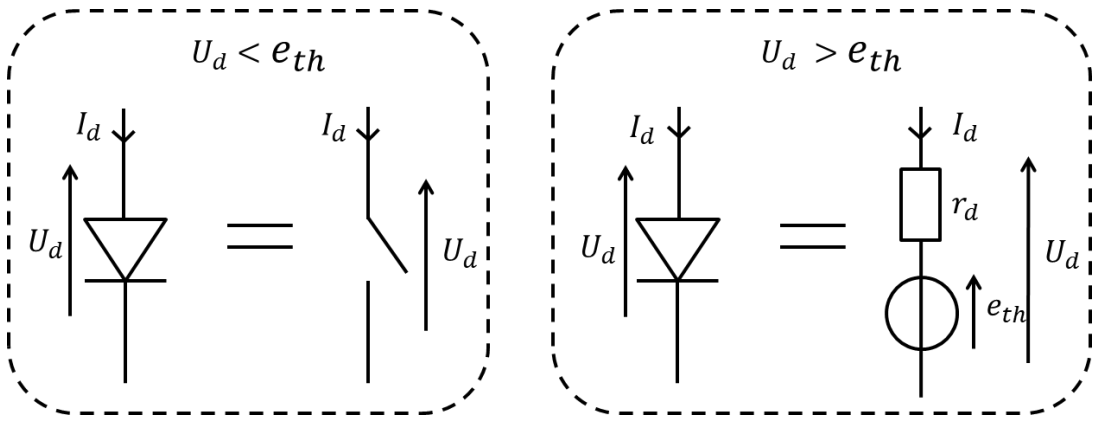
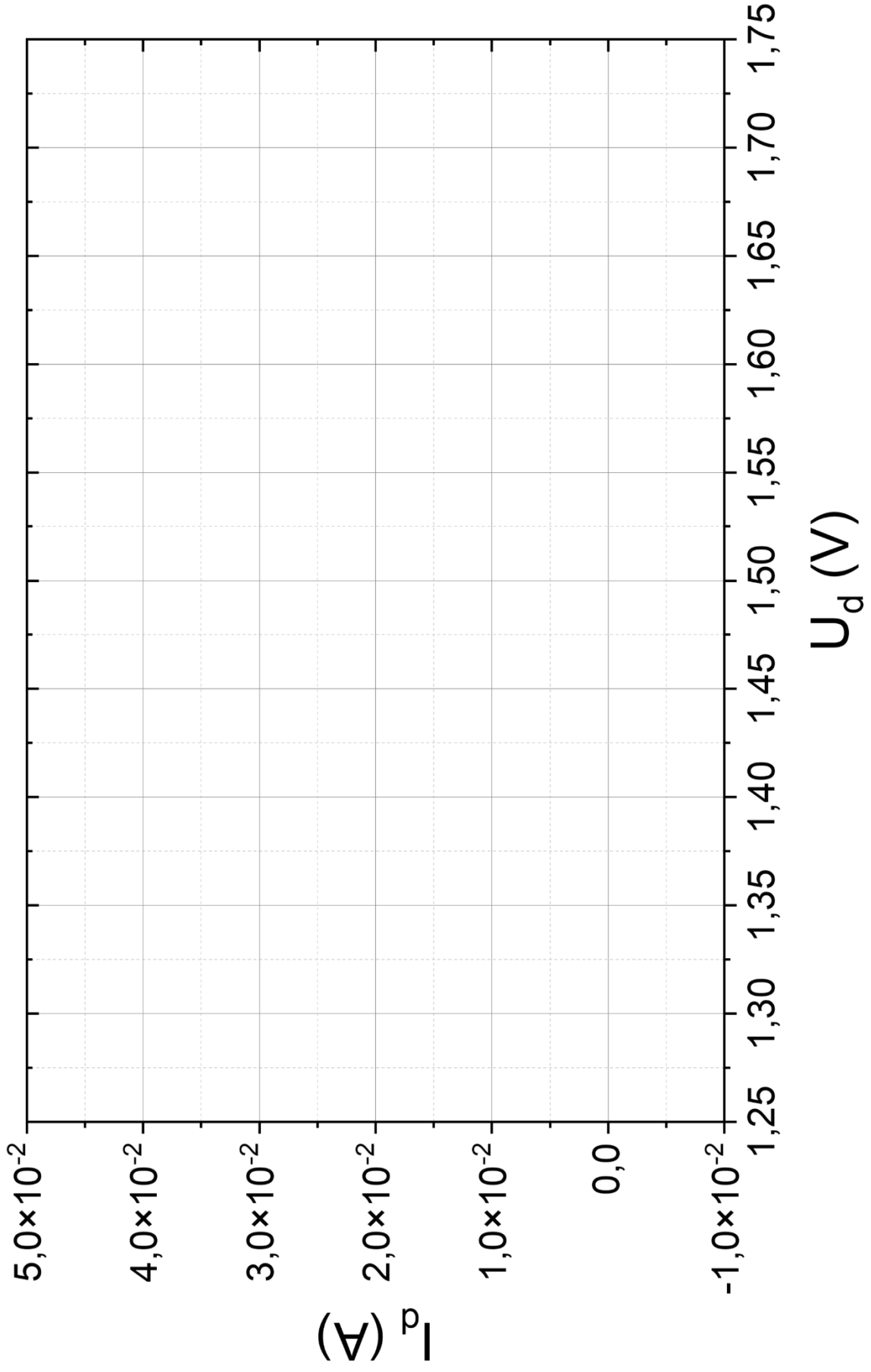


Figure 1: Electric equivalent models for the diode.

1) Plot on the appendix the I-V characteristic curve of the diode, specifying the convention used. List the main features of this curve.
2) The diode is now connected to a generator of emf $E_g = 3V$ and internal resistance $R_g = 50\Omega$.
    a. Give the electric scheme of the circuit such that the diode will operate in the forward mode.
    a. In this configuration, determine the operating point of the circuit along with its uncertainty using a **graphical method**. Estimate the overall uncertainty affecting this graphical determination and justify your uncertainty calculation.
    b. Check your result by calculation using Kirchhoff's circuit laws.

We now want to limit the current flowing through the diode to $I_d = 10mA$ (known without uncertainty). For that purpose, we add **in series** a so-called protection resistor R_p.

3) Determine graphically what should be the voltage difference U_d across the diode along with its uncertainty.
4) Deduce the value (with its uncertainty) of the protection resistance R_p to add to the circuit for reaching this new operating point.



Last name: First name: Group: