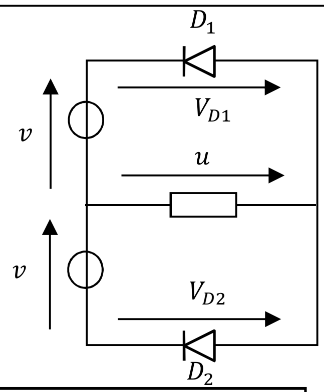
NAME : ……………………………………………… FIRST NAME :…………………………………………… GROUP :………

Final exam of Electronics

Calculators and documents are not allowed. The number of points per question is indicative.
Answers to be written on this document only.



Exercise 1. Midpoint Rectifier (6 points)

We consider the following circuit :

The 2 sources v are perfectly identical and we assume $v(t) = V_M sin(\omega t)$

We use the ideal model for all diodes.

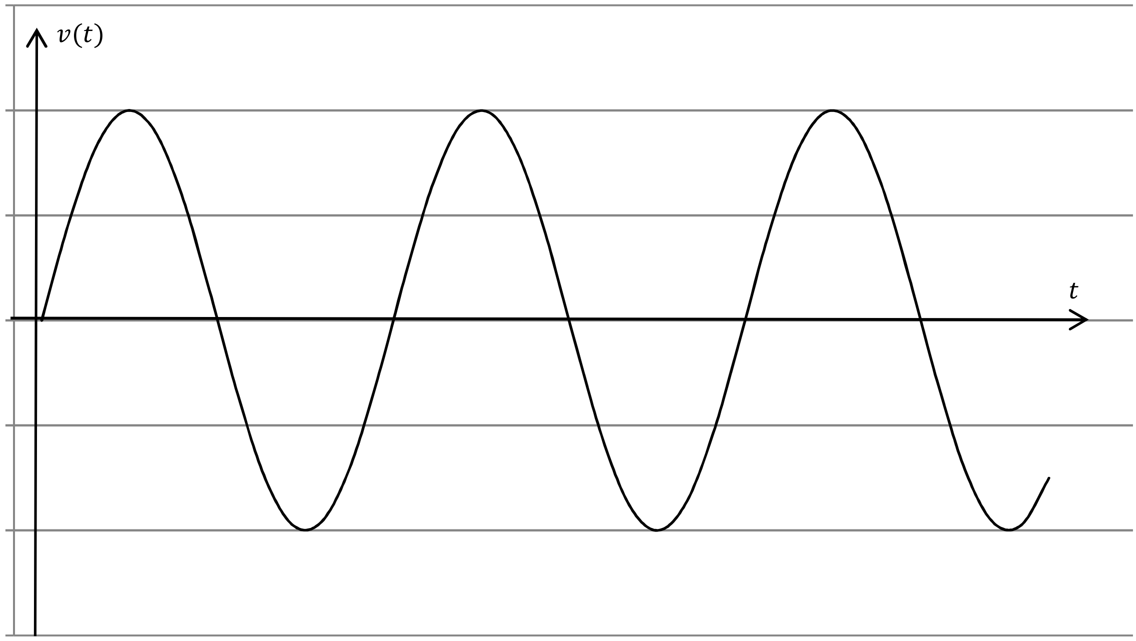
a) If v is positive ($0 \leq t \leq \frac{T}{2}$), which diode is in forward bias ?

b) What is then the expression of u ?

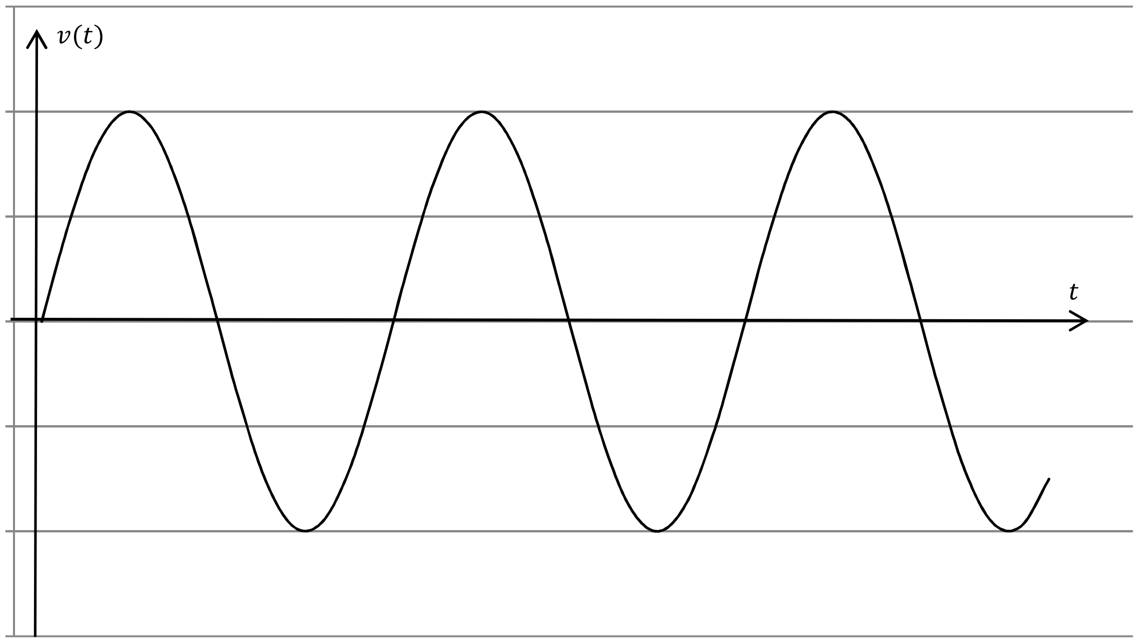
c) If v is negative($\frac{T}{2} \leq t \leq T$), which diode is in forward bias ?

d) What is then the expression of u ?

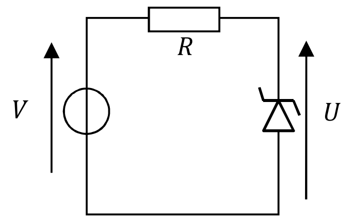
e) Plot $u(t)$.



f) We then replace the diodes with their model with threshold voltage. Plot $\mathrm{u}(\mathrm{t})$, and explain your answer. We note V_0 the threshold voltage of each diode and we assume $V_M > V_0$.



Exercise 2. Zener Diode (4 points)

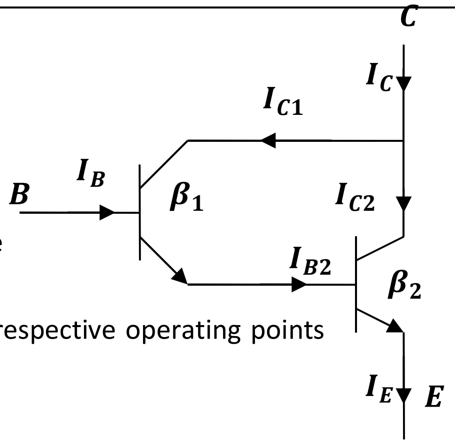


We consider the following circuit. $V \in \mathbb{R}$

Plot the transfer characteristic ie $U = f(V)$ by substituting the diode by its 'real model'.

Give the equations for each part of the characteristic. We note V_0 the direct threshold voltage, r_D, the forward internal diode resistance, V_Z, the Zener threshold voltage and r_Z, the internal diode resistance in reverse bias.

Exercise 3. Darligton Circuit (2 points)



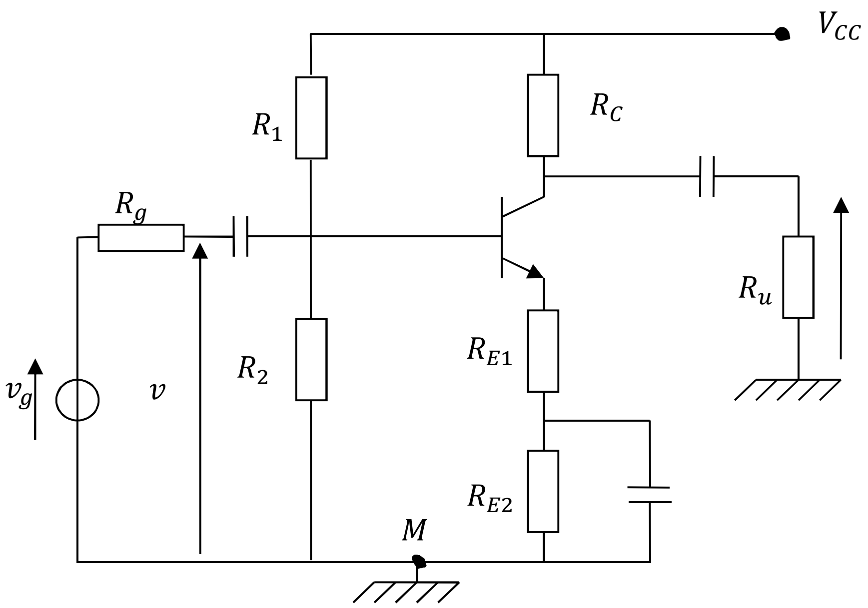
We consider the following circuit.

β_1 is the DC current gain of the left transistor and β_2 the DC current gain of the right transistor, determine the DC current gain β of the equivalent transistor, as a function of β_1 et β_2.

We assume that the biasing of the two transistors is such that their respective operating points are in their respective active gain region.

Exercise 4. Common Emitter Amplifier (8 points)

We consider the following amplifier circuit :



- The capacitors are assumed to be coupling or bypass capacitors.
- v_g is the sinusoidal voltage delivered by the source of internal resistance $R_g = 600\Omega$, maximum amplitude $50\ mV$ and pulsation ω.
- v is the sinusoidal voltage at the input of the amplifier
- u is the sinusoidal voltage at the output of the amplifier
- $R_1 = 20\ k\Omega, R_2 = 4k\Omega,\ R_C = 1.2\ k\Omega,\ R_{E1} = 80\Omega,\ R_{E2} = 37\Omega,\ R_u = 10k\Omega, V_{CC} = 12V$
- Transistor characteristics : $\beta = 100,\ V_{BE} = 0{,}6V$ when the base-emitter junction is in forward bias and $V_{CE_{SAT}} = 0{,}2V$

Question 1 Transistor Biasing *(6 points)*

a. What is equivalent to a transistor in DC current ?

b. Draw the quivalent network in DC current (biasing network).

c. In which region must the operating point of the transistor be so that the previous network be a good amplifier? In which bias are then the base/emitter and base/collector junctions ?

d. We assume that the operating point is such that the previous network is a good amplifier, determine this operating point (ie the currents I_{B0}, I_{C0} and I_{E0}, and the voltages V_{BE} , V_{BC} and V_{CE0}). You can first simplify the network by determining the Thévenin's equivalent network seen from the base.

Question 2 BONUS : Small-signal Study *(3 points)*

a. Determine the equivalent circuit in AC mode (small-signal regime).

b. Expressing v and u as functions of i_b, determine the expression of the voltage gain A_v. (assume that $1+\beta \approx \beta$ and neglect the output resistance of the transistor)