Partiel 1 - Electronics

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

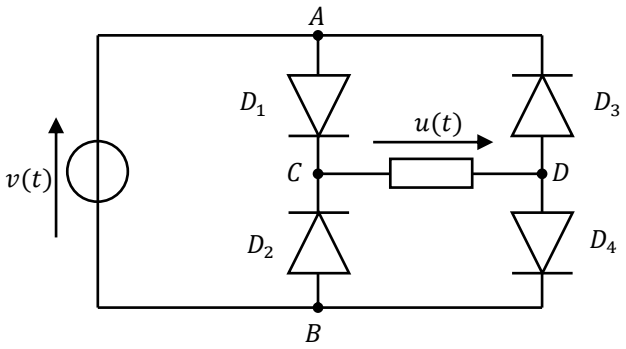
Exercise 1. Diodes (5 points)

We consider the following circuit:

We have $v(t) = V_M sin(\omega t)$

We first use the ideal model for diodes.

When $v(t)$ is positive ($0 \leq t \leq T/2$), which of the diodes are in forward bias? Explain your answer.

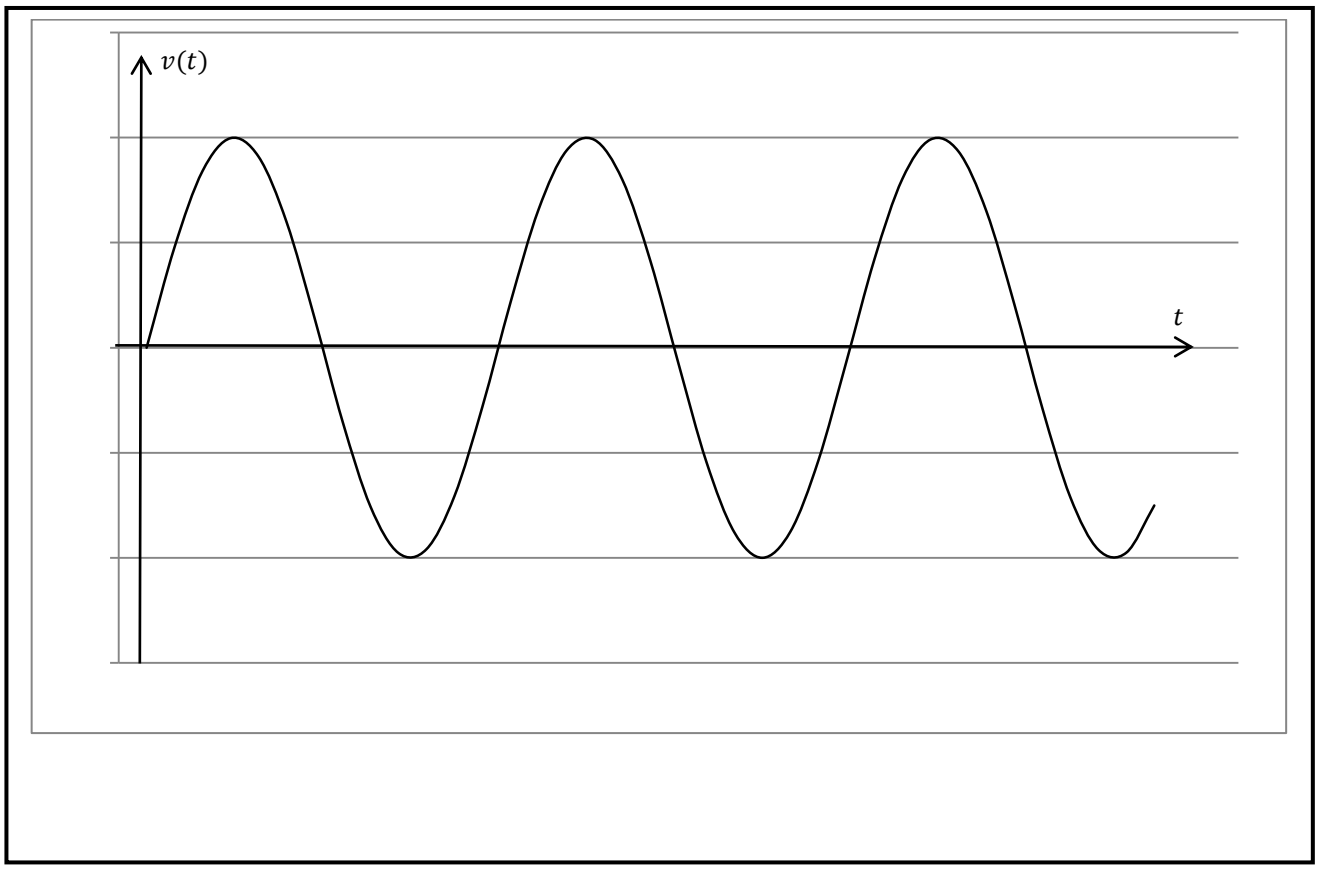


a) What is then the expression of ?

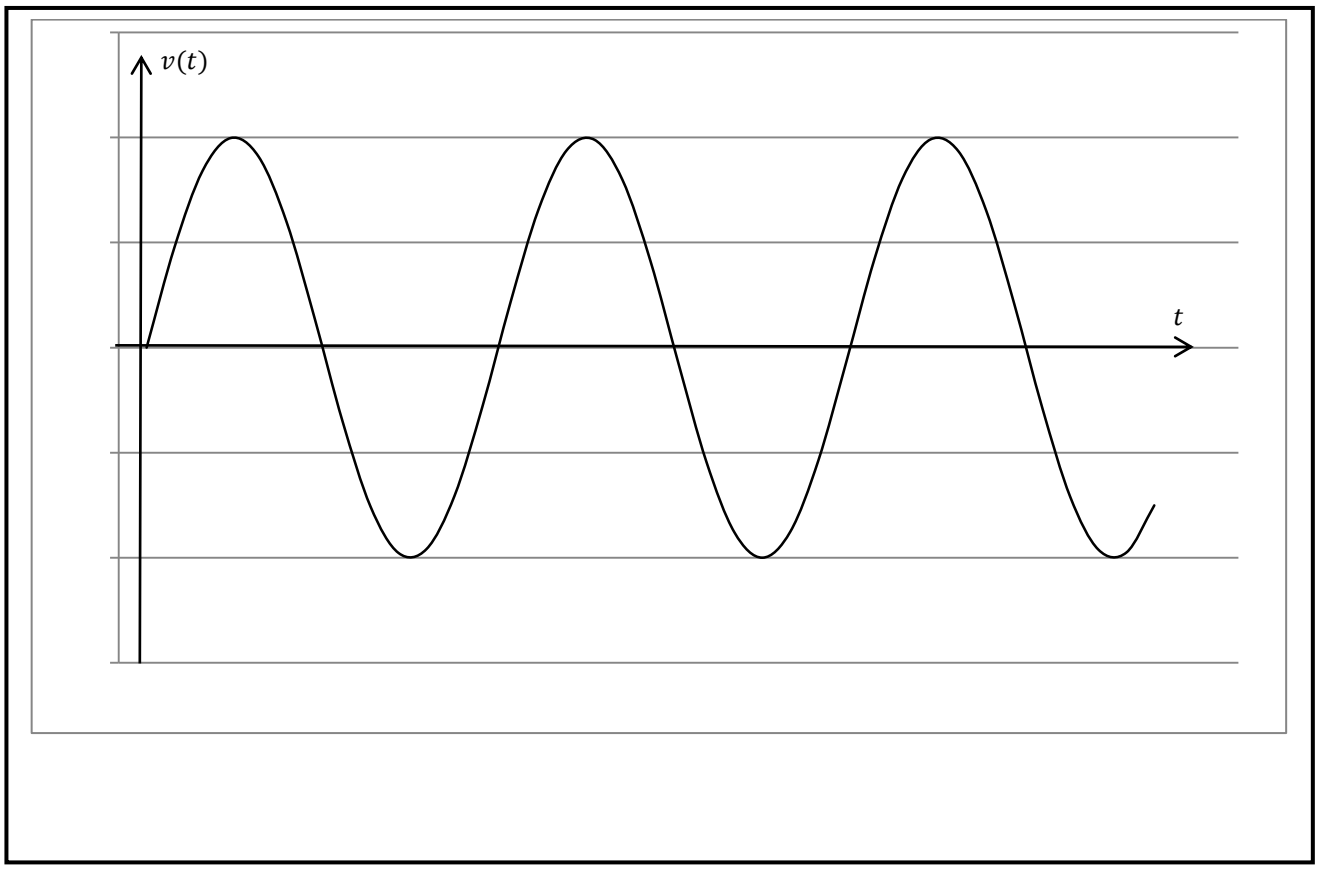
b) When $v(t)$ is negative ($T/2 \leq t \leq T$), which of the diodes are in forward bias ? Explain your answer.

c) What is then the expression of ?

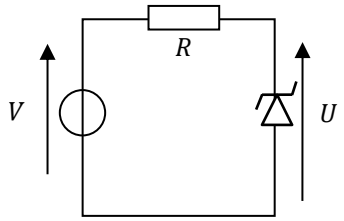
d) Using a different colour, plot $u(t)$ below.



e) We now replace diodes with their model with threshold voltage. Plot $u(t)$, explaining your answer. We define V_0 as the threshold voltage for each diode.



Exercise 2. Zener diode (5 points)

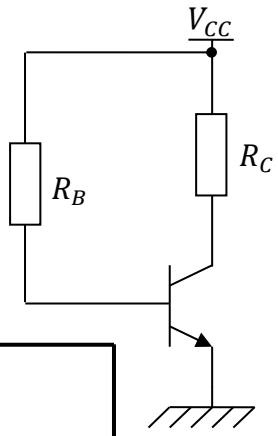


We consider the following circuit. $\boldsymbol{V} \in \mathbb{R}$

Plot the transfer characteristic, ie $U = f(V)$ by replacing the diode with its model with threshold voltage.

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

Exercise 3. Transistor biasing (3 points)



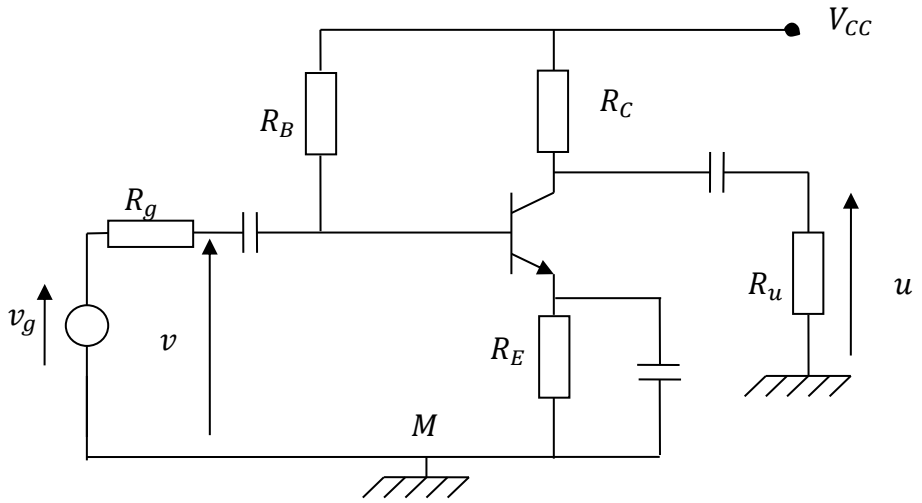
We consider the following circuit.
We assume :
$R_C = 4k\Omega, V_{CC} = 10V,$
$\beta = 100, V_{BE} = 0.6V$ if the base-emitter junction is in forward bias.

1. Give the saturation current $I_{C_{SAT}}$ of the transistor.

2. Give the minimum value of the resistance R_B allowing the transistor biasing to be in its active gain region of operation.

Exercise 4. Common Emitter Amplifier (7 points)

We consider the following amplifier :



- Capacitors are assumed to be coupling or bypass capacitors.
- v_g is the sinusoidal voltage delivered by the source, which has an internal resistor $R_g = 600\Omega$, with a maximum amplitude $50\ mV$ and an angular frequency ω.
- v is the sinusoidal voltage at amplifier input
- u is the sinusoidal voltage at amplifier output
- $R_B = 200k\Omega,\ R_C = 1k\Omega,\ R_E = 1k\Omega,\ R_u = 10k\Omega, V_{CC} = 10V$
- Transistor characteristics : $\beta = 100,\ V_{BE} = 0.7V$ when the base-emitter junction is in forward bias and $V_{CE_{SAT}} = 0{,}2V$

Question 1 Transistor biasing *(5.5 points)*

a. What is the use of coupling capacitors ?

b. Give the equivalent circuit in DC current (biasing circuit)

c. Assuming that the transistor biasing is such that the previous circuit is a good amplifier, determine the currents I_{B0}, I_{C0}, and the votages V_{BE0} and V_{CE0}. Give the expressions first before calculating the values of these quantities. Assume $\beta + 1 \approx \beta$.

Question 2 Small signal *(1.5 points)*

Give the equivalent circuit in AC current (small signal mode).

BONUS : Expressing v and u as functions of i_b, give the expression of the voltage gain $A_v = \left\|\frac{u}{v}\right\|$. (assume that $1 + \beta \approx \beta$ and neglect the transistor output resistance)