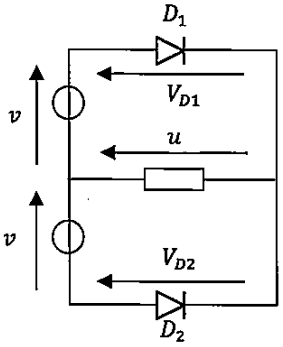
Electronics Final Exam

Calculators and extra-documents are not allowed. The marking scale is given as a rough guide.
Please answer only on exam sheets. If more space is needed, write on the back.

Exercise 1. Rectifier with middle point (5 points)



Consider the following circuit:

The two sources v are exactly the same and $v(t) = V_M sin(\omega t)$.

The diodes will be modelled by the ideal model.

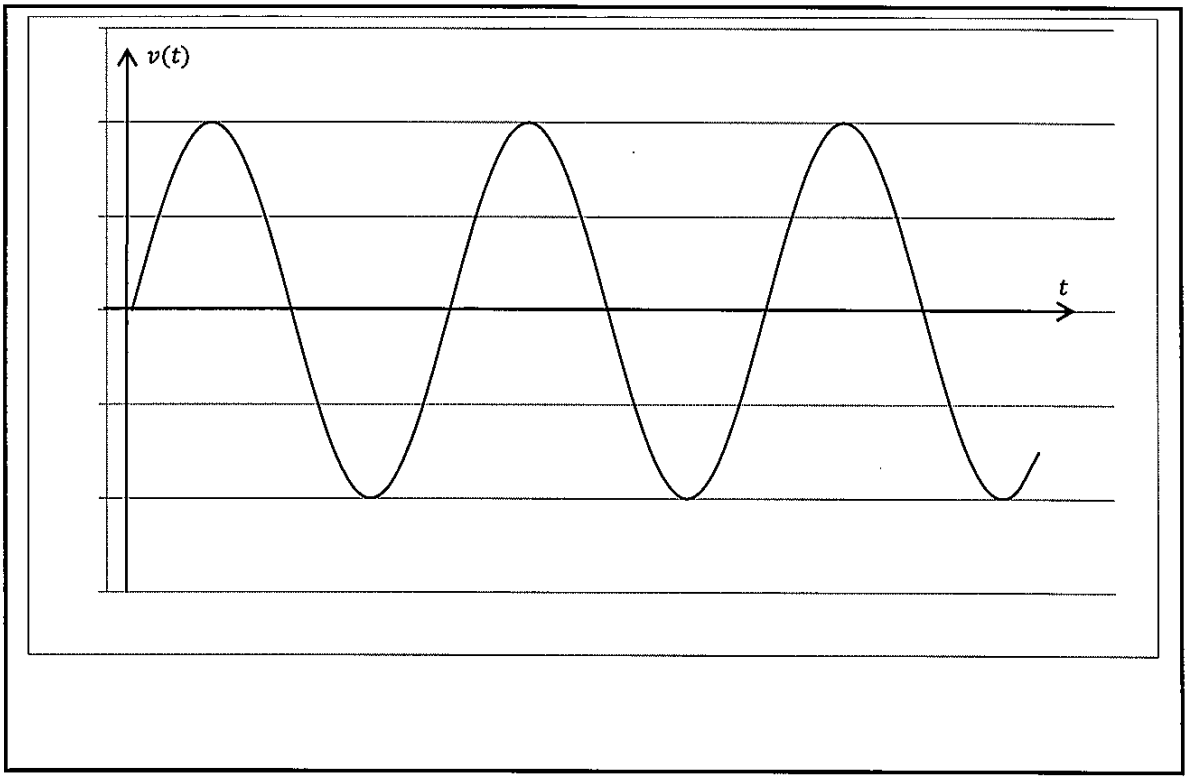
a) When the sources provide a positive voltage ($0 \leq t \leq \frac{T}{2}$), which diode is turned on? Justify your answer.

b) Meanwhile, what is the expression of u?

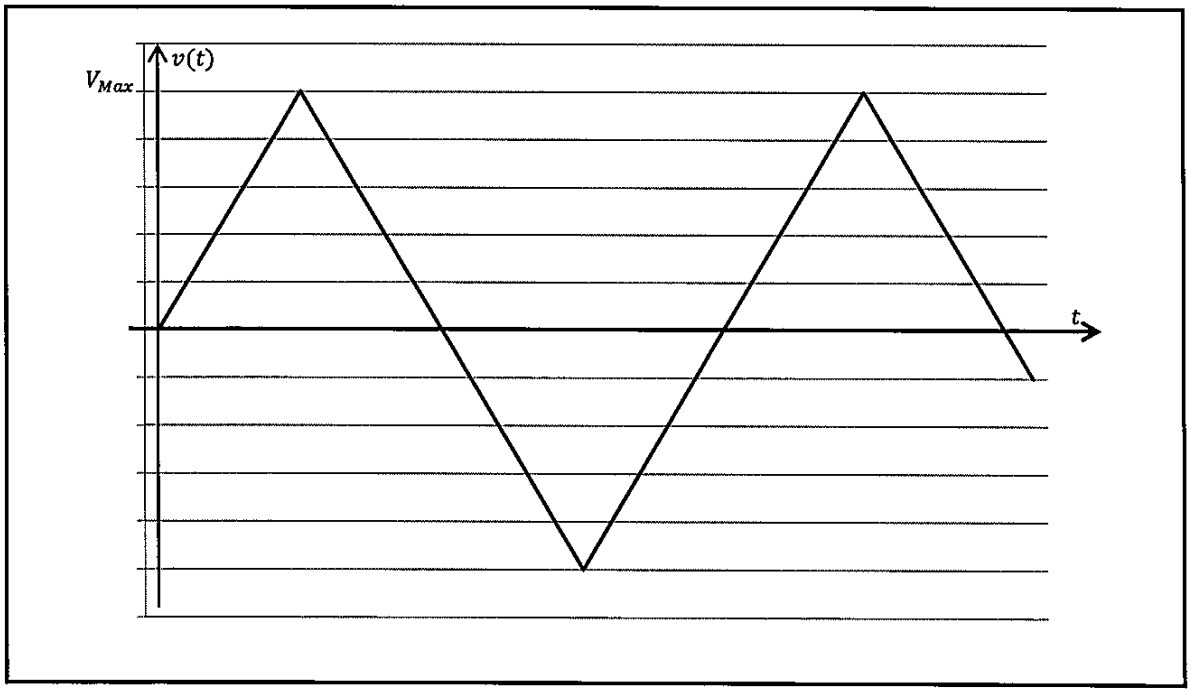
c) When the sources provide a negative voltage ($\frac{T}{2} \leq t \leq T$), which diode is turned on? Justify your answer.

d) Meanwhile, what is the expression of u?

e) Draw $u(t)$.

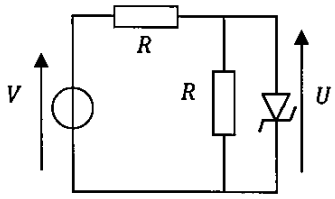


f) One now considers the threshold model for the diodes. Sketch the shape of $u(t)$, and justify your answer. We will denote V_0 the threshold voltage for each diode and we will assume that $V_M > V_0$.



Exercise 2. Zéner's diode (4 points)

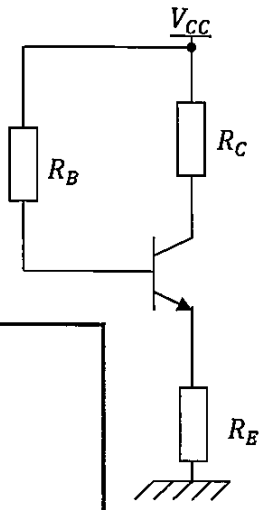
Consider the following diagram. $V \in \mathbb{R}$



Draw the transfer characteristic, namely $U = f(V)$. The diode will be replaced by its real model.

You will explicitly write the equations of each part of the characteristic. We will denote V_0 the threshold voltage, r_D the internal resistance of the diode for direct polarization, V_Z the Zéner threshold voltage and r_Z the internal resistance of the diode for reverse polarization.

Exercise 3. Polarization (4 points)



Consider the following circuit.
Are given:

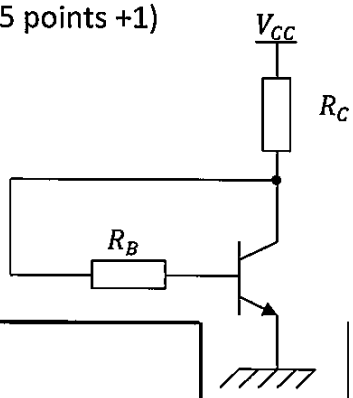
$R_C = 4k\Omega$, $R_E = 1k\Omega$, $V_{CC} = 10V$,
$\beta = 100$, $V_{BE} = 0{,}6V$ if the junction Base-Emitter is turned on.

1. Determine the saturation current $I_{C_{SAT}}$ of the transistor (which is the collector current when the transistor works in saturation regime).

2. Deduce the minimal value of the resistance R_B such that the transistor is linearly polarized in its working regime. We will consider that $\beta + 1 \approx \beta$.

Exercise 4. Polarization with back reaction to the collector (5 points +1)

Consider the following circuit:



Determine the polarization point of the transistor (namely the expressions of the currents I_B, I_C et I_E, and those of the voltages V_{BE}, V_{BC} et V_{CE}).
Consider that $\beta + 1 \approx \beta$.

Bonus Question: By assuming that $V_{BE} = 0{,}7V$ if the junction Base-Emitter is turned on and that $V_{CE_{SAT}} = 0{,}2V$, can the transistor be saturated? Why? Remember that the transistor works in linear regime if $V_{CE} > V_{CE_{SAT}}$.

Exercise 5. MCQ (2 points – No negative point)

Q1. Doping increases the occurrence of thermogeneration.

a- TRUE b- FALSE

Q2. If one takes some Silicium as semiconductor and then dopes it with Silicium, one gets:

a- a N-Doping c- a NP-Doping

b- a P-Doping d- no doping

Q3. In an intrinsic semiconductor, the number of free electrons is:

a- equal to the hole number c- smaller than the hole number

b- larger than the hole number d- none of the above

Q4. Consider the following circuit. Which type of logic gate does this circuit produce?

a- AND c- NOT AND

b- OR d- NOT OR