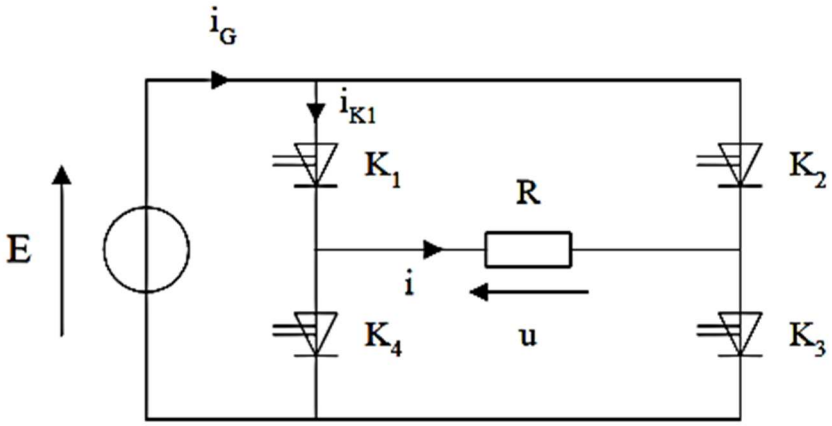
Series 4

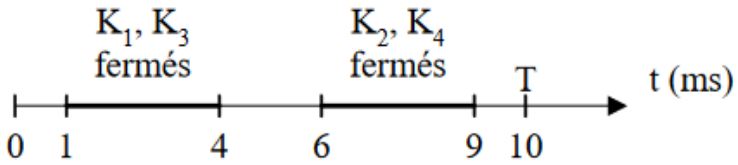
Design methods of static converters at forced switching

Exercise 1

The following assembly is carried out using four electronic switches, operating in pairs.



The DC voltage generator has an e.m.f. E equal to 24 V. The load is a resistor with a value R = 100 Ω. The operation of the switches is summarized in the diagram below:

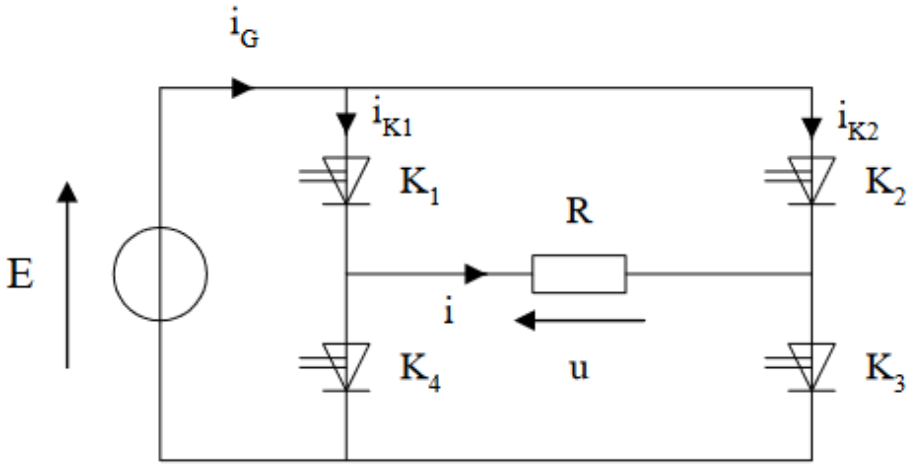


The switches are supposed to be perfect.

1- Represent the chronograms: - the voltage u across the load terminals - currents i, i K1 and i G.
2- Calculate the effective value of the voltage u. Deduce the effective value of the current i and the power received by the load.
3- Calculate the average value of the current delivered by the generator. Deduce the power supplied by the generator and the efficiency of the inverter. Comment ?

Exercise 2

The next inverter is made up of four controlled electronic switches (K1 to K4) assumed to be perfect. E is a perfect direct voltage source with a value of 200 V. The load is a resistor with a value R = 100 Ω.



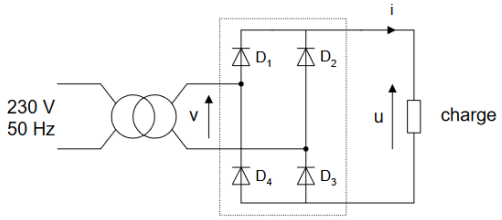
The table below shows the conduction states of the switches.

	$0 < t < \alpha T/2$	$\alpha T/2 < t < T/2$	$T/2 < t < (1+\alpha)T/2$	$(1+\alpha)T/2 < t < T$
K_1	Fermé	Fermé	Ouvert	Ouvert
K_2	Ouvert	Fermé	Fermé	Ouvert
K_3	Fermé	Ouvert	Ouvert	Fermé
K_4	Ouvert	Ouvert	Fermé	Fermé

1- What type of conversion does a standalone inverter perform? Name an application of this type of converter.
2- Represent the voltage u across the load and the current i as a function of time circulating in it (we will take $\alpha = 1/3$).
3- Express the average value and the effective value of the current i as a function of E, R and α. Make the numerical application (with $\alpha = 1/3$).
4- Deduce the average value of the power supplied to the load.
5- Draw the chronograms of the currents i K1, i K2 and i G.
6- Express the average values of the currents i K1, i K2 and i G as a function of E, R and α. Make a digital application.
7- Deduce the average value of the power supplied by source E. Comment ?
8- What components can we use to make the switches?

Exercise 3

The rectifier assembly below is powered by the secondary of a transformer which provides a sinusoidal voltage v:



The diodes are assumed to be perfect (zero threshold voltage).

1-1- Calculate the period, the effective value and the maximum value of this voltage. Draw the chronogram v(t). Data: the transformation ratio of the transformer is 0.21.

1-2- The load is a resistance RC = 17 Ω. Represent in time agreement the voltage across the load u(t) and the voltage v(t). Indicate the conduction intervals of the diodes.

1-3- Calculate the average value < u > of u. Draw the chronogram i(t). Deduce the average value < i > of the current in the resistor.

1-4- Calculate the power consumed by the resistance.

2- The load of the bridge is now constituted by the armature of a direct current motor independent excitation, in series with a smoothing coil of negligible internal resistance and of sufficient inductance so that the armature current is considered constant: I = 2.5 A.

2-1- We admit that the conduction intervals of the diodes are not modified. Deduce the form of the voltage u and its average value < u >.

2-2- What is the relationship between the instantaneous values of the voltages u, uL across the coil and um across the motor armature?

2-3- Justify that < uL> = 0 V. Deduce the average value < um > of um.

2-4- The motor armature having a resistance R = 1 Ω, calculate the value of its e.m.f. E.

2-5- Calculate the power consumed by the motor armature.