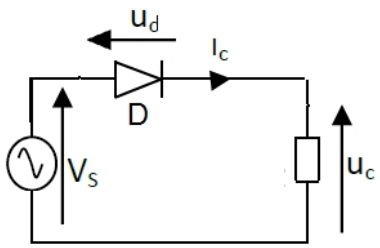
AC/DC Converters

Prob 01 :

A single-phase half-wave rectifier is supplied by a sinusoidal voltage source **Vs(ɵ) = Vm sin(ɵ)** with Vm = 100 V. The load is resistive R = 10 Ω.



a. Draw the waveforms of the input voltage **V_S(ɵ)**, the output voltage **U_C(ɵ)** across the load, the current **I_C(ɵ)** through the load, and the voltage **U_d(ɵ)** across the diode D.

b. Calculate the ***average*** and ***rms*** values of the load voltage.

Prob 02 :

If the load of «Prob 1» is replaced by an inductive load $Z = (10 + j10)\ \Omega$.

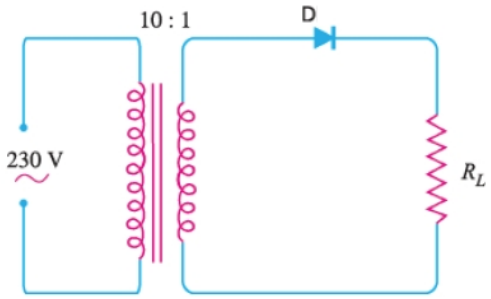
a. Draw the waveforms of the input voltage **V_S(ɵ)**, the output voltage **U_C(ɵ)** across the load, and the voltage **U_d(ɵ)** across the diode D.

b. Calculate the ***average*** and ***rms*** values of the load voltage.

c. A freewheeling diode is inserted in anti-parallel with the load,
- Draw the waveforms of **U_C(ɵ)**, and **U_d(ɵ)**.
- What is the ***average*** and ***rms*** values of the load voltage.

Prob 03 :

An a.c. supply of **230 V (rms)** is applied to a **half-wave rectifier** circuit through a transformer of turn ratio **(10 : 1)** .



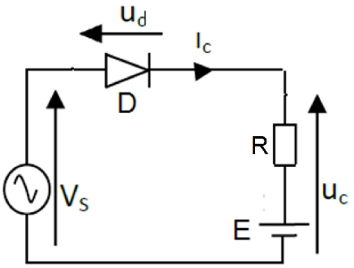
Assume the diode to be ideal, find :

a. the ***rms*** value of the output d.c. voltage.

b. the peak inverse voltage (PIV).

Prob 04 :

The single-phase rectifier shown in figure supplies a resistive load from a sinusoidal source Vs = 220V / 50Hz, R = 5Ω,
E = 180V.

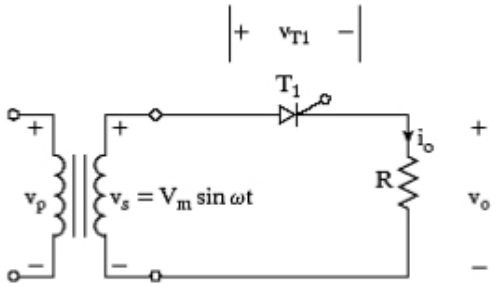


a. Draw the waveforms of the input voltage **V_S(ɵ)**, the output voltage **U_C(ɵ)** across the load, the current **I_C(ɵ)** through the load, and the voltage **U_d(ɵ)** across the diode D.

b. Calculate the ***average*** and ***rms*** values of the load voltage.

Prob 05:

Single-phase half-wave controlled rectifier is connected to ***220 V, 50Hz*** supply to feed ***10Ω*** resistor. If the firing angle ***α = 30°***. Draw output voltage and voltage across the thyristor along with the supply voltage. Then, calculate,



a. The ***average*** and ***rms output voltage***

b. The ***average*** and ***rms output currents***

c. Peak Inverse Voltage (PIV) of the thyristor.

Prob 06 :

Single-phase half wave converter is operated from a ***120 V, 60-Hz*** supply and the load resistive load is ***R=10 Ω***. If the average output voltage is ***25%*** of the maximum possible average output voltage, calculate:

a. The ***delay angle***.

b. The ***average*** and ***rms output currents***.

Prob 07 :

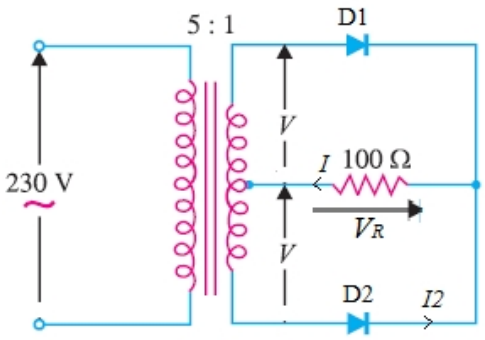
Single phase half-wave-controlled rectifier is connected to ***220 V, 50Hz*** supply to feed ***5 Ω*** resistor in series with ***10 mH*** inductor if the firing angle ***α = 30°.***

a. Draw the waveform of load voltage if current extinction angle $\beta \approx (\pi + \text{impedance angle})$

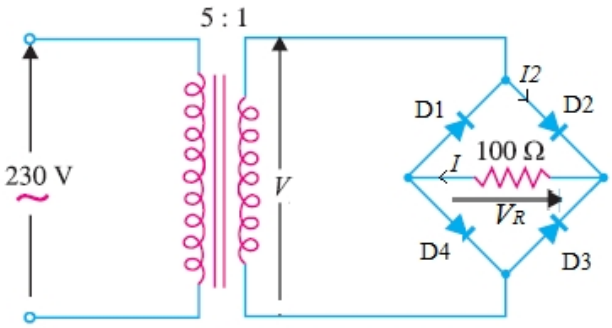
b. Find the ***average*** and ***rms*** value of output ***voltage***.

Prob 08 :

Fig. (a) and Fig. (b) show the centre-tap and bridge type circuits having the same loadresistance and transformer turn ratio. The primary of each is connected to 230V, 50 Hz supply.Assume the diodes to be ideal:



(a)



(b)

a. Draw the waveforms of ***$V_R(\Theta)$***, ***I2(Θ)*** in each case

b. Find the ***average***outputvoltage in each case.

c.Peak Inverse Voltage (***PIV***) of diodes for each case.

Prob 09 :

Single – phase ***center tap*** controlled rectifier has load of ***R = 15 Ω*** and, ***Vs = 220 sin 314t*** and ***unity transformer ratio***. If it is required to obtain an average output voltage of ***70 %*** of the maximum possible average output voltage, calculate:

a. The ***delay angle***.

b. The ***average*** and ***rms output currents***.

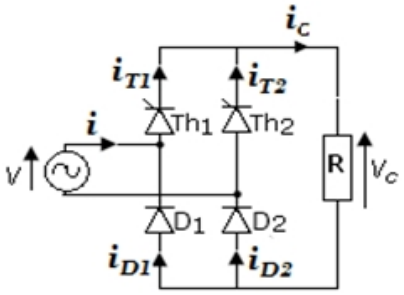
c. The ***peak inverse voltage (PIV)***.

Prob 10 :

The full-wave controlled ***bridge rectifier*** has an AC input of ***120 V*** at ***50 Hz*** and a ***20 Ω*** load resistor. The delay angle is ***40^o.***

a. Draw the load voltage and current (V_C , i_c), thyristor and diode currents (i_{T1} , i_{T2} , i_{D1} , i_{D2}), and supply current (i).

b. Calculate the average and rms current in the load.



Prob11 :

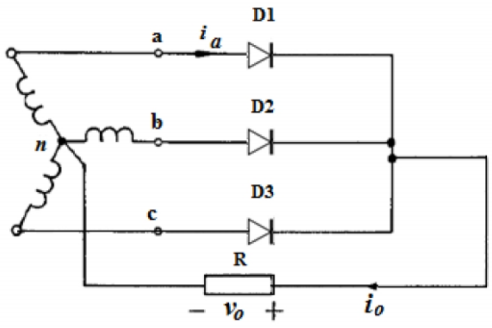
Power is supplied to a load resistor R=10 Ωfrom a three-phase supply of balanced sinusoidal voltages using half-wave bridge circuit of figure below. The three diodes may be considered as ideal switches. Draw:

a. the output current waveform $i_o(\omega t)$ with respect to the phase voltage $V_{an}(\omega t) = V_m \sin \omega t$.

b. the phase current waveform $i_a(\omega t)$ in phase-a with respect to the phase voltage $V_{an}(\omega t) = V_m \sin \omega t$.

c. Show that the rms value of the phase current is:$i_{a_{rms}} = 0.485.(V_m/R)$

Hence, calculate $\boldsymbol{I_{a_{rms}}}$ of the phase current.



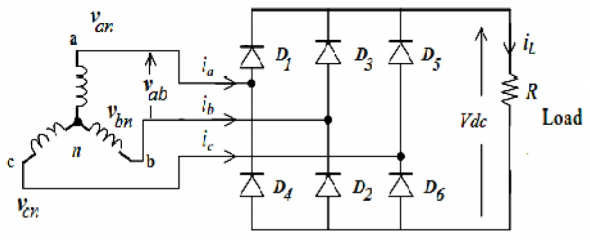
Prob 12 :

Power is supplied to a load resistor R from a three-phase supply of balanced sinusoidal voltages using full-wave uncontrolled bridge circuit of figure below. The six diodes may be considered as ideal switches.

If the supply voltage for phase-a is $\boldsymbol{v_{an}(\omega t) = V_m \sin(\omega t)}$, and the ligne-to-line voltage is

$$v_{ab}(\omega t) = \sqrt{3}\, V_m \sin\left(\omega t + \frac{\pi}{6}\right)$$

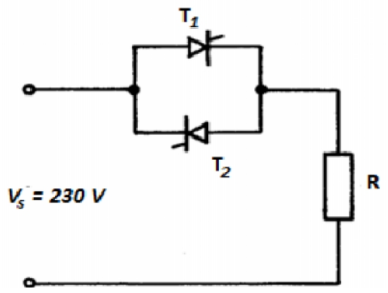
a. Calculate <V_{dc}> and <i_L> if V_m=300 V, R=50 Ω



AC/AC Converters

Prob13 :

A single-phase full-wave a.c. voltage controller consists of two thyristors connected in inverse-parallel as shown in figure. The supply voltage is Vs =230 V (rms) at 50 Hz. The controller is used as a light dimmer to control the light intensity of a group of lamps with total resistance of 10 Ω. The triggering mode of the thyristors is symmetrical with α = 60°.



a. Sketch compatible waveforms for the load and thyristor voltages.
b. Sketch compatible waveforms for the load and thyristor current.
c. Calculate the rms value of the load voltage.
d. Calculate the rms value of the load current.

Prob 14 :

If thyristor T2 of «Prob 13» is replaced by a diode,
a. what will be the compatible waveforms for the load and diode voltages.
b. Calculate the rms value of the load voltage.

Prob15 :

A single-phase full-wave AC voltage controller supplies an RL load. The supply rms voltage is 120 V, 60 Hz. The load has R=2.5 Ω and L=6.5 mH, the firing delay angles of thyristors are equal: α1= α2= π/2.
If the extinction angle (β) is 220°:
a. Sketch the waveforms for the load and thyristor voltages.
b. Calculate the rms value of the load voltage.

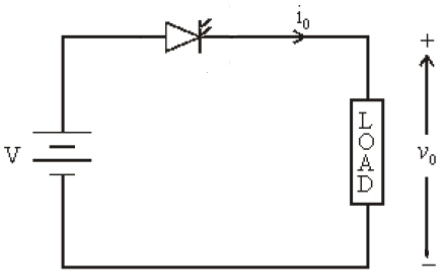
Prob16 :

Rework the same «Problem 15» assuming that the firing delay angles of the thyristors are equal to:
$\alpha_1 = \alpha_2 = \pi/6$.

DC/DC Converters

Prob17 :

A transistor dc chopper circuit (Buck converter) is supplied with power form an ideal battery of 100 V. The load voltage waveform consists of rectangular pulses of duration 1 ms in an overall cycle time of 2.5 ms. Calculate, for resistive load of 10 Ω.



a. The duty cycle D.
b. The average value of the output voltage $<V_0>$.
c. The rms value of the output voltage V_0rms.

Prob18 :

A Chopper circuit is operating at a frequency of 2 kHz on a 460 V supply. If the average value of the load voltage is 350 volts,
a. Calculate the conduction duration of the switch in each cycle.
b. Sketch the waveforms for the load and switch voltages.

DC/AC Converters

Prob19 :

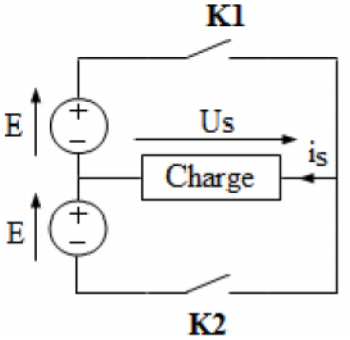
The single-phase half-bridge inverter shown in figure has a resistive load of R = 100 Ω and the d.c. input voltage E = 200 V. If the inverter output voltage is a square wave:

a. Sketch the output voltage waveform

b. Determine the rms value of the output voltage

c. Sketch one switch current and give its average value.

d. What is the peak inverse voltage of the switches?

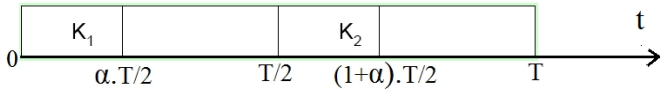


Prob20 :

In the inverter of problem 18, the control logic for power electronics devices is so adjusted (see diagram below) that the output voltage waveform produced is a quasi-square.

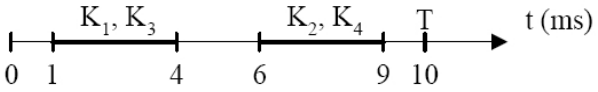
a. Draw the output voltage and load current waveforms for α=1/3 and output voltage frequency *fr*= 50 Hz.

b. Determine the value of the rms output voltage in terms of E and α.
Calculate rms output voltage for α=1/3.



Prob21 :

A single-phase bridge inverter has a resistive load of 100 Ω and input voltage of 24 V. The operation of the switches is summarized in the diagram below:



a. Draw the output voltage *u*and load current waveforms *i*.

b. Draw current waveforms i_{k1} and i_G.

c. Calculate the rms output voltage.