

FIVE-PHASE UNCONTROLLED LINE COMMUTATED RECTIFIER

Circuit simulated by

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Theory

Few high power DC drive applications require conversion of available AC supply in to DC, in-order to feed the load. Multiphase AC supply is more preferable to drive these high power loads after suitable conversions. Increasing the number of phases of the supply has more benefits when compared to single phase and three phase supply. Increasing the number of phases increases the power density, reduces the size of wire and reduces the harmonics. Hence it is necessary to design multiphase converters to convert multiphase AC to DC.

The circuit shown below is a 5 phase uncontrolled rectifier. It has 10 semiconductor diodes as switches i.e. D_1 to D_{10} , here D_1 to D_5 are positive group of switches and D_6 to D_{10} are negative group of switches. During each cycle of the input one switch from positive group of diodes and one from negative group of diodes will conduct. No diode pair in same leg should conduct simultaneously as it short circuits the source. The diodes will turn on naturally in the following sequence $D_1, D_{10}, D_2, D_6, D_3, D_7, D_4, D_8, D_5, D_9$.

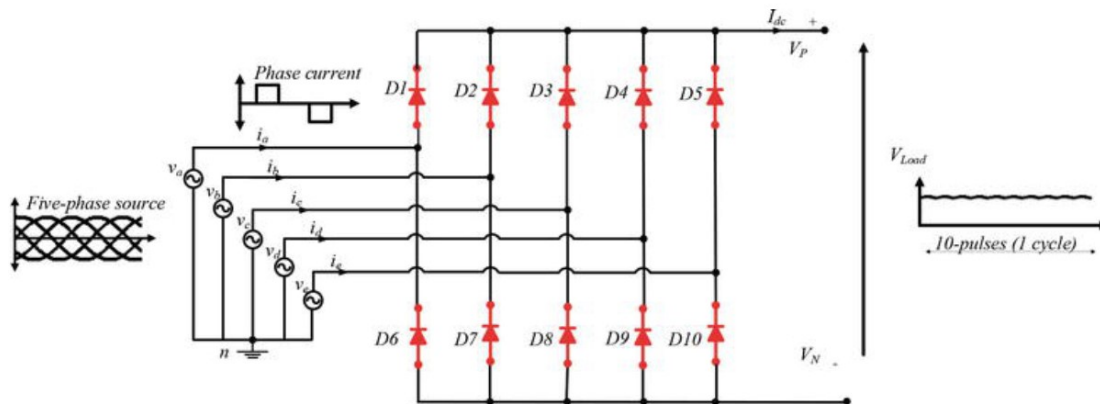


Fig 1: Circuit diagram for five-phase line commutated uncontrolled LC rectifier

The output voltage available at the load will be given as

$$V_{dc} = 1.902V_{ph_max}$$

Where V_{ph_max} is the maximum input phase voltage

The DC output produced here will have 10 pulses within duration of 20ms (50 Hz supply).
The output pulses will have duration of 36° each.

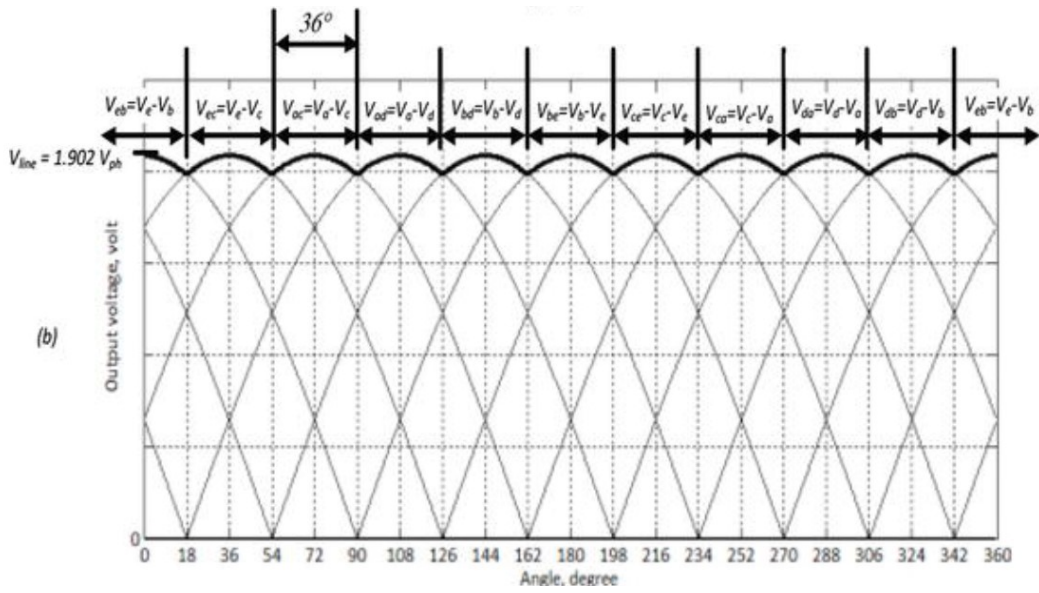


Fig 2: Model waveform for a five phase uncontrolled LC rectifier

Schematic diagram

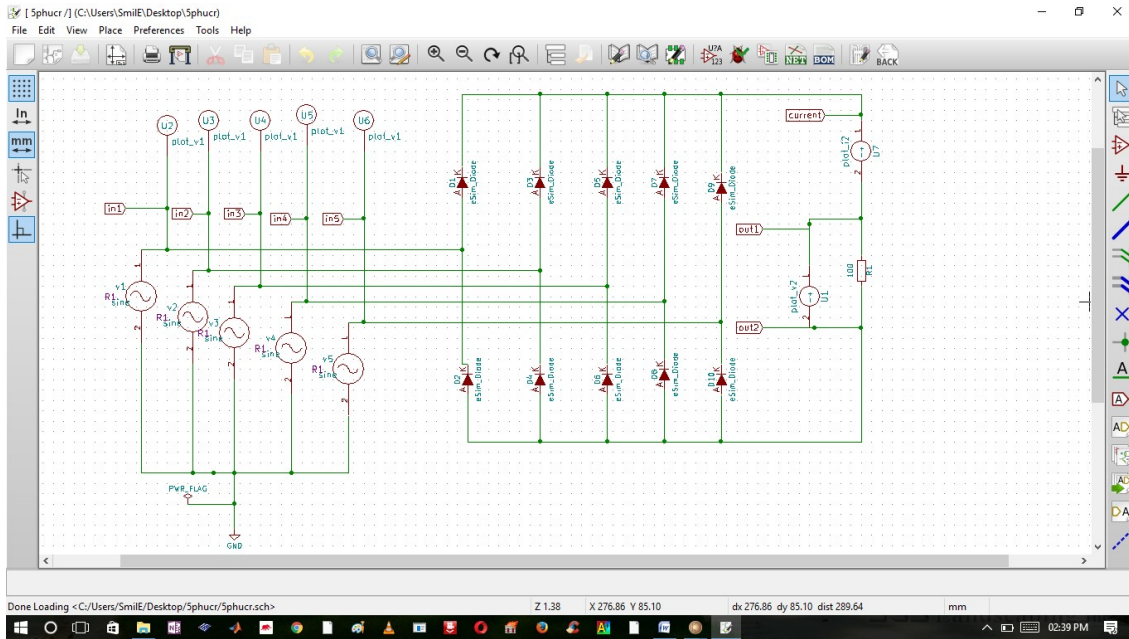


Fig 3: Schematic diagram using esim

Simulation results

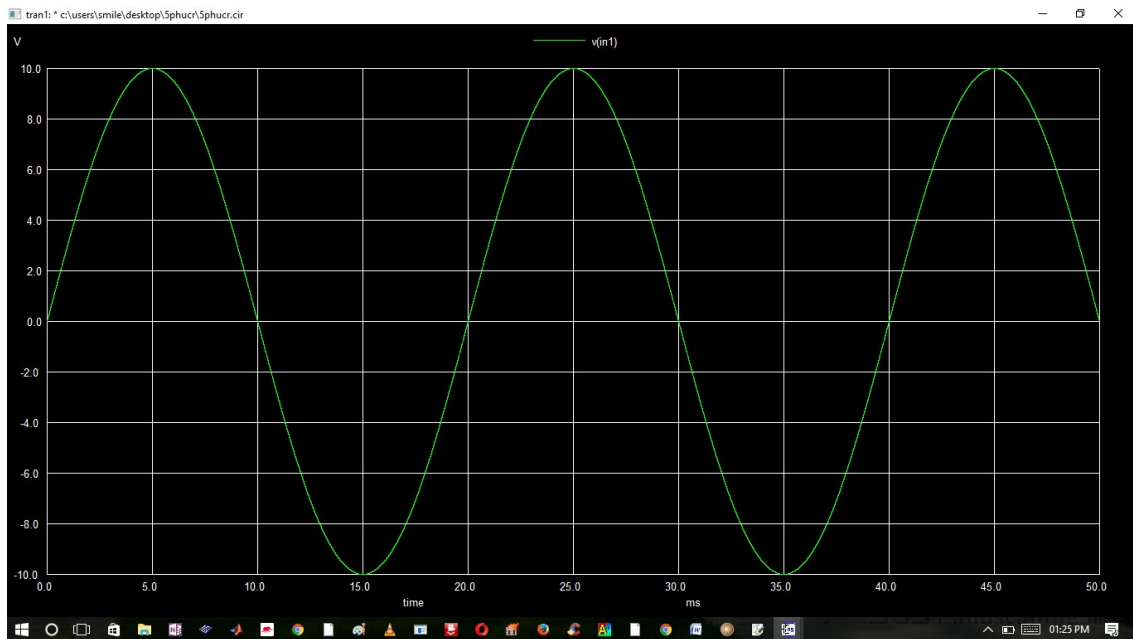


Fig 4: Ngspice plot for AC input with 0° phase shift (Phase A).

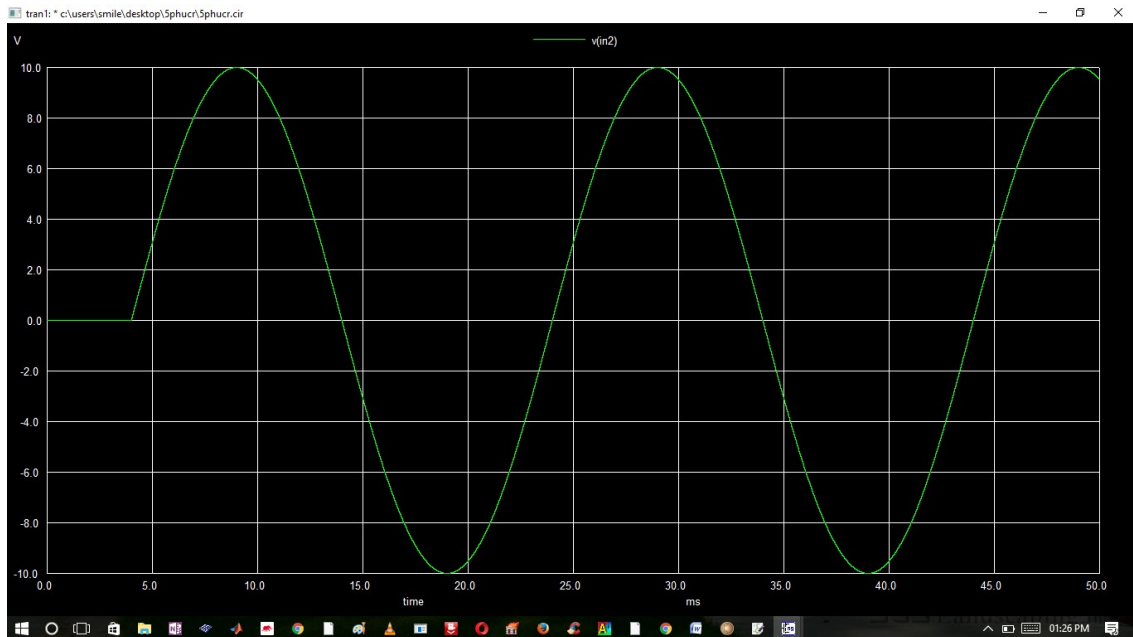


Fig 5: Ngspice plot for AC input with 72° phase shift (Phase B).

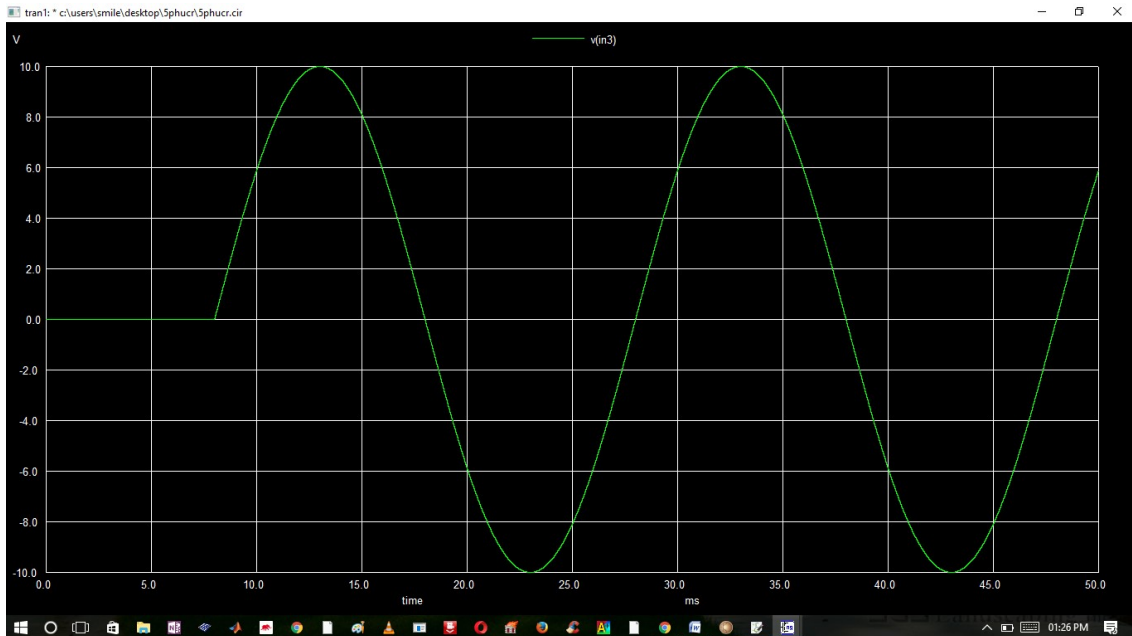


Fig 6: Ngspice plot for AC input with 144° phase shift (Phase C).

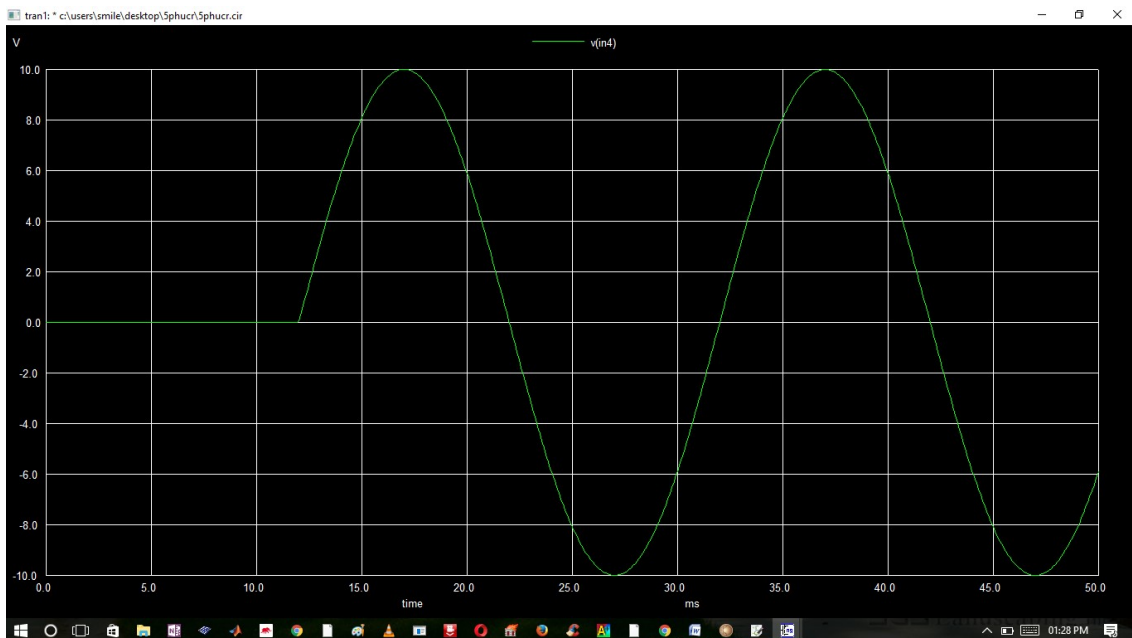


Fig 7: Ngspice plot for AC input with 216° phase shift (Phase D).

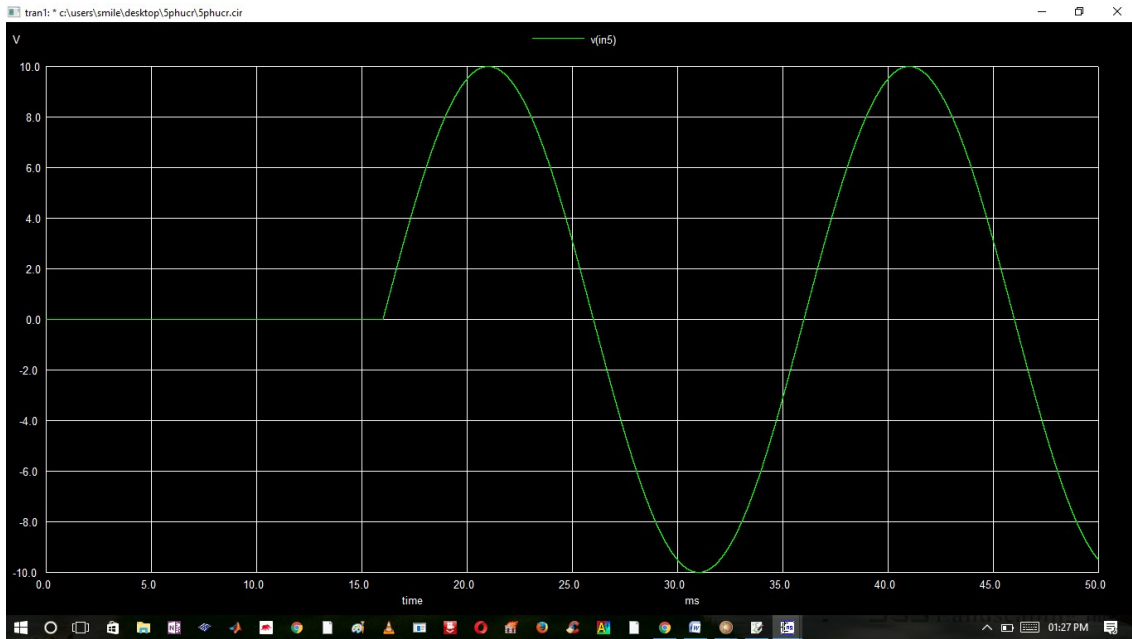


Fig 8: Ngspice plot for AC input with 288° phase shift (Phase E).

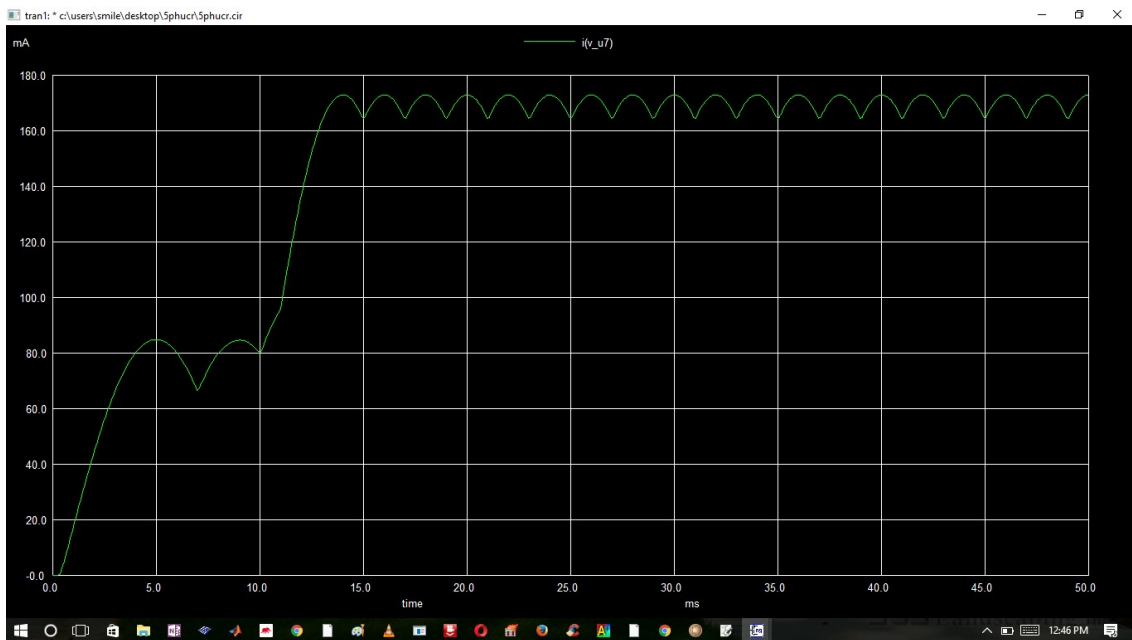


Fig 9: Ngspice plot for DC output current.

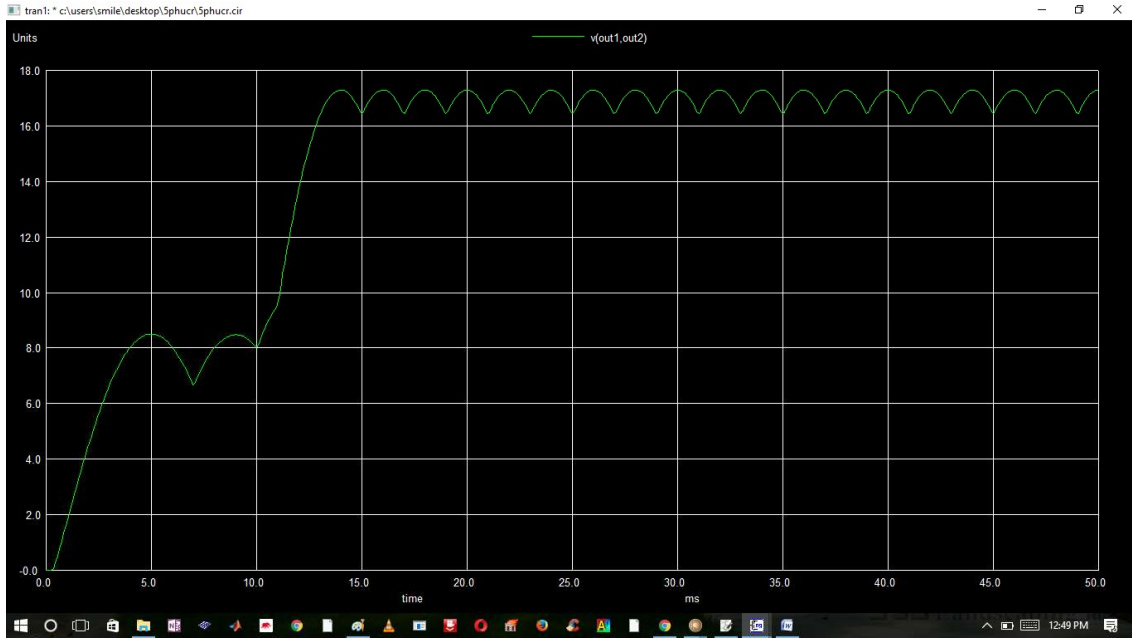


Fig 10: Ngspice plot for DC output voltage

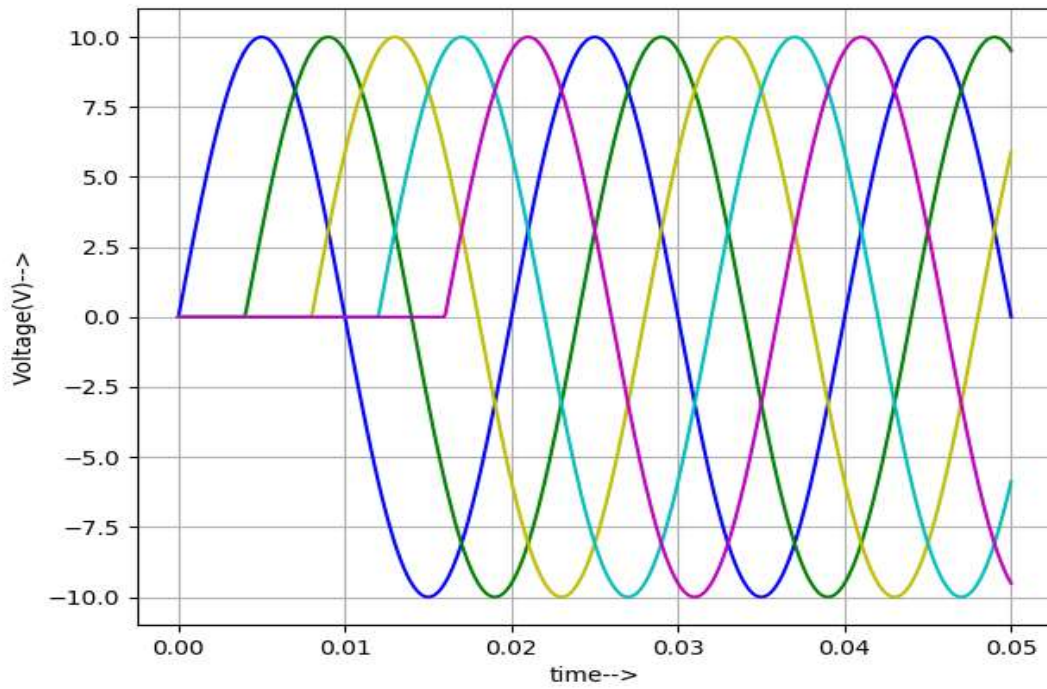


Fig 11: Python plot for AC input with 72° phase difference between adjacent phases

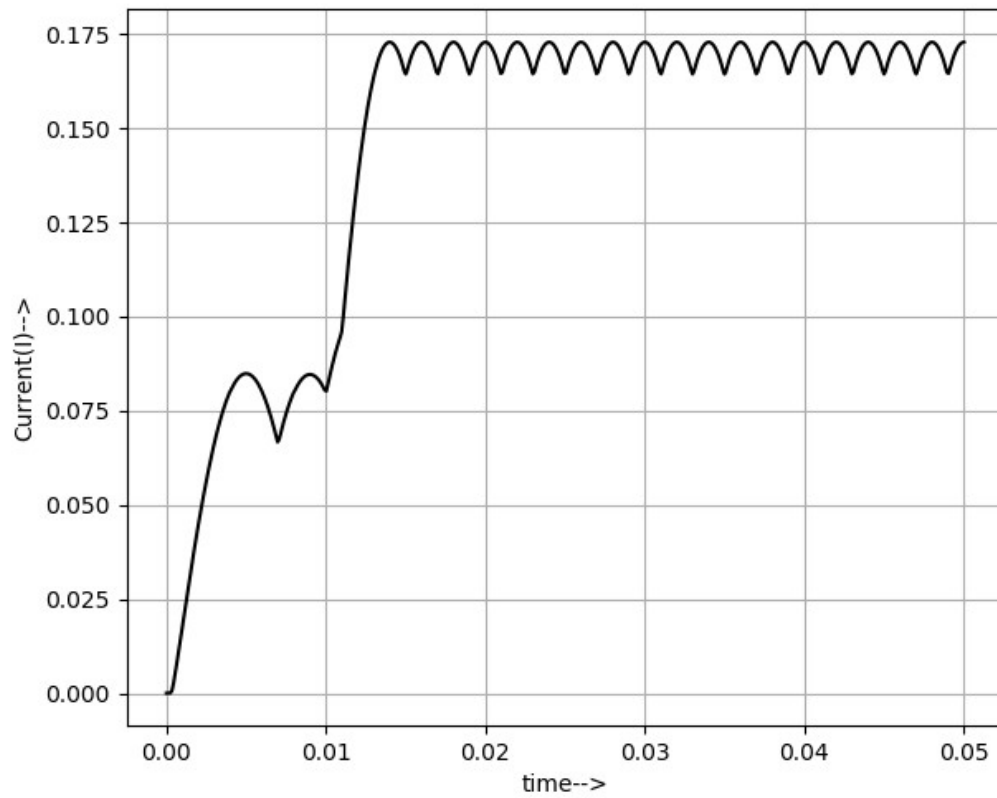


Fig 12: Python plot for DC output current (10 pulse within 20ms).

Reference:

<https://www.intechopen.com/books/electric-power-conversion/five-phase-line-commutated-rectifiers>