Introduction to Power Electronics Sample problems

Uncontrolled Rectifier Circuits

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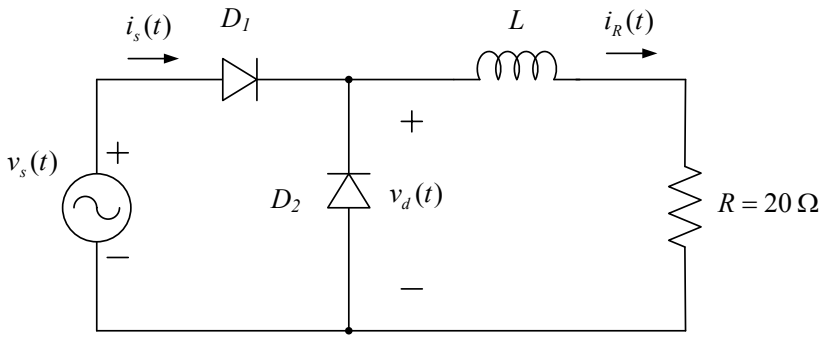
P1: The following converter is a half-wave rectifier made with ideal components. Assume the source voltage is equal to $v_s(t) = 200\sin(\omega t)$ volt. Also assume that the inductance value of the filter inductor (L) is very large, and so the ripple at the inductor current can be ignored.

a) Sketch the waveforms of $v_d(t)$, $i_s(t)$ and $i_R(t)$.

b) Find the average power dissipated in the resistor.



Answer: PR=202.643 W

P2: The following circuit is a full-wave rectifier. Assume all components are ideal and the source voltage is equal to $v_s = 377\sin\omega t$ volt. Also assume that the LC filter at the output is an ideal low-pass filter.

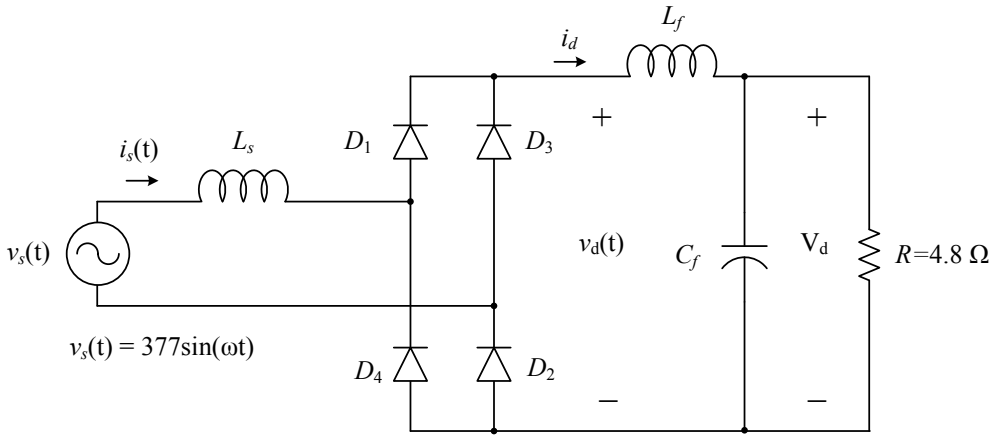
a) Sketch the waveforms of $v_d(t)$ and $i_s(t)$ when the source inductance is zero ($L_s = 0$).

b) Determine the average output voltage V_d and the power P_d for the above case.

c) Also determine the real, reactive and apparent power delivered by the source.

d) Find the displacement and distortion power factor and THD of the source current.

e) Determine the average output voltage V_d and the power P_d for the above case where $L_s = 1$ mH



Answer: If Ls=0: Vd=240 V, Pd=12 kW, Ps=12 kW, Ss=13329 VA, Qs=5801.83 Var, kp=1, kd=0.9, THD=48%.
If Ls=1e-3 H: Vd=230 V

P3: A balanced three-phase Y-connected ideal voltage source supplies power to a DC load though a three-phase uncontrolled rectifier. The DC load is represented as an ideal current source equal to 100 A. Assume that all the components are ideal and the line-to-neutral source voltages are given below:

$v_{an} = 420\sin(\omega t)$ V

$v_{bn} = 420\sin(\omega t - 120°)$ V

$v_{cn} = 420\sin(\omega t + 120°)$ V

a) Sketch the waveform of the output voltage and derive the equation that finds the average output voltage.

b) Determine Vd, Pd, Ps, Ss, Qs, the distortion and the displacement power factors.

c) Determine the %THD of the source current.

Answer: Vd=694.43, Pd=Ps=34721.5 W, Ss=36373 VA, kp=1, kp=0.955, %THD=%31