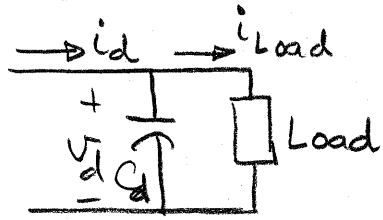
Problem 5-16



Representing the load by a constant instaneous power $p_d(t) = 1000\,W$ has the following consequences:

As v_d increases, i_{Load} goes down instantaneously. This corresponds to a negative incremental resistance (in a normal resistance, as the voltage across it goes up, the current also increases). Therefore, such a load representation introduces a negative damping. Loads such as switch-mode, regulated dc power supplies discussed in chapter 10 are examples of such loads.

With the load represented as above, the system with $C_d = 200\,\mu F$ in part (a) is operated and the dc voltage collapses to zero and the PSpice simulation ends with a convergence error. In part (b) with $C_d = 500\,\mu F$, the simulation becames unstable with unsymmetric current waveforms during the negative half-cycles,

compared to the positive half-cycles. This becomes very clear if the simulation is run upto 200 ms.

The results with C_d of 1000 μF and 1,500 μF are tablulated below based on the following observations from the PSpice output:

$C_d = 1000\,\mu F$	$C_d = 1{,}500\,\mu F$
$v_{d,min} = 131.1\ V$	$v_{d,min} = 133.8\ V$
$v_{d,max} = 164.5\ V$	$v_{d,max} = 156.0\ V$
$\phi_1 = -15.3^\circ$ (i_s lags v_s)	$\phi_1 = -17.81^\circ$
$THD_i = 72.3\%$	$THD_i = 69.7\%$
(based on harmonics upto the 25th)	

[From Eq. 3-45, $PF = \dfrac{1}{\sqrt{1 + THD_i^2}} \cdot DPF$]

$DPF = 0.965$ (lag)	$DPF = 0.952$ (lag)
$\therefore\ PF = 0.782$	$PF = 0.781$
$\Delta V_{d\,p\text{-}p} = 33.4\ V$	$\Delta V_{d\,pp} = 22.2\ V$

As a continuation of this problem, the load

is represented in the attached PSpice listing by a 20 Ω resistor and the resulting dc-voltage V_d waveforms are plotted for the given 4 values of C_d.

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Prob5_16A modified to represent load with a resistance
* Single-Phase, Diode-Bridge Rectifier
.LIB PWR_ELEC.LIB
.PARAM    FREQ = 60.0Hz
.PARAM    CVALUE = 1
*
LS        1   2   2mH
RS        2   3   0.4
*
rdc       4   5   1u
RLOAD     5   6   20
CD        5   6   {CVALUE} IC={160 + (CVALUE - 1000u)/100u}
*
XD1       3   4   DIODE_WITH_SNUB
XD3       0   4   DIODE_WITH_SNUB
XD2       6   0   DIODE_WITH_SNUB
XD4       6   3   DIODE_WITH_SNUB
*
VS        1   0   SIN(0 170V {FREQ} 0 0 0)
*
.TRAN     50us    200ms    0s     50us    UIC
.PROBE
.FOUR     60.0   25 v(1) i(LS)    i(rdc)    v(5,6)
.STEP PARAM CVALUE  LIST 200u,500u,1000u,1500u
.END
```