

MIT OpenCourseWare
<http://ocw.mit.edu>

6.334 Power Electronics
Spring 2007

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.

6.334: Power Electronics

By

David Perreault

Electrical Engineering and Computer Science Department

MIT

Cambridge, Massachusetts

Spring 2008

Contents

1	Introduction and Analysis Methods	1
1.1	Switching Power Electronics	1
1.2	Analysis Techniques	3
1.2.1	Methods of Assumed States	3
1.2.2	Periodic Steady State	6
2	Introduction to Rectifiers	10
2.1	Load Regulation	11
3	Power Factor and Measures of Distortion	16
4	Phase-controlled Rectifiers	28
5	Introduction to DC/DC Converters	34
5.1	Ripple Components and Filter Sizing	47
5.2	Discontinuous Conduction Mode	53

List of Figures

1.1	Linear Regulator	1
1.2	Considering Switching Power Convertor	2
1.3	Add Filtering	3
1.4	Simple Rectifier	3
1.5	Diode	4
1.6	Simple Rectifier	4
1.7	Simple Rectifier with Diode On	5
1.8	Simple Rectifier with Diode Off	5
1.9	Rectifier Waveform	5
1.10	Simple Rectifier with Filter	6
1.11	Simple Rectifier with Filter and Diode On	7
1.12	Rectifier with Filter Waveform	7
1.13	Simple Rectifier with Free Wheeling Diode	8
1.14	Rectifier with Free Wheeling Diode Waveform	8
1.15	Linear Circuit with Sum of Fourier Sources	9
2.1	Simple Half-wave Rectifier	10

2.2	Adding Some AC-Side Inductance	11
2.3	Special Current	12
2.4	Commutation Period	12
2.5	Analyze Waveform	13
2.6	Commutation Period	14
2.7	DC-Side Thevenin Model	15
2.8	Full-Bridge Rectifier	15
3.1	Resistor	17
3.2	Inductor	18
3.3	Rectifier	19
3.4	Example	22
3.5	Reactive Power	23
3.6	R-L Load	24
3.7	Capacitor	25
3.8	Parallel Capacitor	26
4.1	Thyristor	28
4.2	Example	29
4.3	Diode Version	30
4.4	Thyristor Version	30
4.5	Output Voltage	31
4.6	Power Factor	31
4.7	AC-Side Reactance	32

4.8	Summary	33
5.1	KCL	34
5.2	KVL	35
5.3	DC/DC Converter	36
5.4	Buck (down) Converter	38
5.5	Change the Location of Source and Load	39
5.6	Boost (up) Converter	39
5.7	Boost (up) Converter Drawn Left to Right	40
5.8	Direct Canonical Cell	40
5.9	MOSFET	41
5.10	BJT	41
5.11	Combine Elements 1	41
5.12	Combine Elements 2	42
5.13	Combine Elements 3	42
5.14	Canonical Cell	42
5.15	Indirect DC/DC Converter	43
5.16	“Buck/Boost” or “up/down” converter	44
5.17	Averaged Circuit Variables	45
5.18	Big L, C	45
5.19	Direct Converters	46
5.20	Indirect Converters (neglecting ripple)	47
5.21	Direct Converters (neglecting ripple)	47

5.22 Boost Converter Ripple	48
5.23 Capacitor Voltage Ripple	48
5.24 Ripple Model with Capacitor	49
5.25 Ripple	50
5.26 Ripple Model with Inductor	50
5.27 Ripple Ratios	51
5.28 Boost Converter Waveforms	54
5.29 Changing R and L	55
5.30 Different Operating Conditions	56
5.31 DCM Operation Model	57
5.32 Parasitic Ringing	58
5.33 Design in DCM	59

List of Tables

5.1 Effect of Allowed Ripple on Switches 53