
Contents

Preface	iii
1 Perception	1
1.1 Introduction	1
1.2 Cognitive and psychological aspects of perception	1
1.3 Abstraction in perception	2
1.4 Ambiguity in perception	3
1.5 Summary and learning outcomes	5
1.6 Exercises	5
2 Creative signals	7
2.1 Introduction	7
2.2 Waves	7
2.3 Signal processing	8
2.3.1 RADAR	9
2.3.2 Audio signals	9
2.3.3 Image signals	10
2.3.4 Visual art and music	10
2.4 Signal definition	11
2.4.1 Independent variables in signals and systems	12
2.5 Summary and learning outcomes	13
2.6 Exercises	13
3 Signals	15
3.1 Introduction	15
3.2 Octave	15
3.2.1 Installing Octave	16
3.2.2 Installing for different operating systems	16
3.2.3 Running Octave	16
3.2.4 Using Octave	17
3.3 What are signals?	29
3.3.1 One-dimensional signals	29
3.3.2 Octave representation of discrete-time signals	31
3.3.3 The unit impulse	36
3.3.4 The unit step	37
3.3.5 The unit delay	38
3.3.6 Delay operations in Octave	41
3.4 Audio signals	42
3.4.1 Sampling	42
3.4.2 Frequency	43
3.4.3 Amplitude	47
3.4.4 Phase	49
3.5 Summary and learning outcomes	55
3.6 Exercises	55
4 Systems	59
4.1 Introduction	59
4.2 LTI systems	60

4.2.1	Linearity	60
4.2.2	Time invariance	61
4.2.3	Impulse response	61
4.2.4	Convolution	62
4.2.5	Unit impulse and unit delay systems	64
4.2.6	Scaled delay	65
4.2.7	Convolution revisited	65
4.3	Spectral analysis	67
4.3.1	Complex exponentials	67
4.3.2	Signal multiplication by complex exponentials	71
4.3.3	Spectra of signals and systems	72
4.3.4	Fast Fourier Transform (FFT)	73
4.3.5	Convolution by spectrum multiplication	81
4.4	Summary and learning outcomes	82
4.5	Exercises	83
5	Audio and image filtering	85
5.1	Audio effects	85
5.1.1	EQ	85
5.1.2	FIR filter design	88
5.1.3	Sweepable EQ	90
5.1.4	Subtractive synthesis	92
5.1.5	Echo	93
5.1.6	Reverberation	95
5.1.7	Resampling	96
5.2	Image filtering	99
5.2.1	Matrices	99
5.2.2	Image representation	105
5.2.3	Image effects	112
5.3	Summary and learning outcomes	123
5.4	Exercises	124