

## Contents

PREFACE . . . . .	v
Chapter 1. Establishing algorithms for the cognition process . . . . .	1
1.1 The logical and formal rules for producing images of reality . . . . .	1
1.2 Physical scales and the ambiguity of images of reality . . . . .	18
1.3 Multidimensional scales . . . . .	28
Chapter 2. Standards and the propagation of standards . . . . .	37
2.1 Establishing the standards of units of measurement . . . . .	37
2.2 Propagation of standards . . . . .	42
2.2.1 Single comparison . . . . .	46
2.2.2 $n$ -fold comparison with the same primary standard . . . . .	49
2.2.3 $m$ -fold comparison with different standards . . . . .	50
2.2.4 $n$ -fold comparison with $m$ different primary standards . . . . .	51
2.2.5 $m$ times larger measure of a secondary standard . . . . .	52
2.2.6 $m$ times smaller measure of a secondary standard . . . . .	54
2.3 The certified reference materials . . . . .	60
Chapter 3. Modelling of measurement systems . . . . .	67
3.1 The general principles of modelling . . . . .	67
3.2 Modelling of the characteristics of measurement systems . . . . .	72
3.2.1 The static model . . . . .	73
3.2.2 Dynamic models . . . . .	76
3.2.3 Discrete-time models of measurement systems . . . . .	86
3.3 The modelling of error sources. Probabilistic models . . . . .	89
3.3.1 Nonlinear elements . . . . .	95
3.3.2 Dynamic elements . . . . .	98
3.3.3 Non-stationary error sources . . . . .	100
3.4 The general model of error . . . . .	104
3.4.1 The continuous-time model . . . . .	104
3.4.2 The discrete-time model . . . . .	111
3.4.3 The correlation of errors . . . . .	113
3.5 Identification of models of measurement systems . . . . .	117
3.5.1 Determination of the variables of a model . . . . .	118
3.5.2 Correlation analysis . . . . .	121
3.5.3 Regression analysis . . . . .	130
3.5.4 The least squares method . . . . .	140
3.5.5 Other methods . . . . .	144
Chapter 4. The theory of error . . . . .	146
4.1 Images of reality in measurement systems. Principles of image production . .	146

4.2 Optimization of calibration procedures . . . . .	150
4.3 Definitions and classification of errors . . . . .	153
4.4 The metrological characteristics of measurement systems and standards . . . . .	164
4.5 Metrological characteristics. Methodology of their determination and interpretation . . . . .	174
4.5.1 Determination of class 1 characteristics . . . . .	174
4.5.2 Theoretical determination of the limiting distributions of errors . . . . .	185
4.5.3 Experimental determination of the limiting distributions of errors . . . . .	193
4.5.4 Interpretation of the concept of accuracy class . . . . .	199
4.6 The basic concepts of inference in the theory of error . . . . .	207
Chapter 5. Measurement procedures. . . . .	220
5.1 Definition of measurement . . . . .	220
5.2 Procedures describing measurement methods. . . . .	225
5.3 Calibration procedures . . . . .	230
5.4 Reading checking and adjustment of measurement systems . . . . .	242
5.5 Measurement procedures for constant quantities . . . . .	247
5.5.1 Single measurement . . . . .	248
5.5.2 Multiple measurement—the measurement series . . . . .	250
5.6 Measurement procedures for time-dependent quantities . . . . .	256
5.6.1 Single measurement . . . . .	257
5.6.2 Multiple measurement . . . . .	265
Chapter 6. The design of measurements and experiments . . . . .	266
6.1 Selection of standards for calibration of measuring instruments . . . . .	266
6.1.1 Transfer of a measure of a standard onto measuring instruments . . . . .	266
6.1.2 Selection of the calibration points . . . . .	272
6.1.3 The boundary problems of <i>G</i> -optimum designs . . . . .	279
6.1.4 The design principles of calibration processes . . . . .	282
6.2 Selection of the error sampling interval . . . . .	285
6.2.1 Error estimation in a correlated-error measurement series . . . . .	285
6.2.2 Total error analysis for a measuring instrument . . . . .	289
Appendix. The Lebesgue measure of a set . . . . .	292
References . . . . .	294
Index . . . . .	