

Contents



UNIVERSIDAD NACIONAL DE ENTRE RÍOS
FACULTAD DE INGENIERIA
CENTRO DE MEDIOS
BIBLIOTECA

Nº 1515

Preface xi
List of Symbols xiii

Chapter one

Basic concepts of instrumentation 1

Walter H. Olson

- 1.1 Generalized instrumentation system 1
- 1.2 Alternative operational modes 4
- 1.3 Medical measurement constraints 6
- 1.4 Classifications of biomedical instruments 9
- 1.5 Interfering and modifying inputs 9
- 1.6 Compensation techniques 12
- 1.7 Generalized static characteristics 15
- 1.8 Nonlinear static characteristics 23
- 1.9 Generalized dynamic characteristics 26
- 1.10 Design criteria 40
- 1.11 Generalized instrument specifications 42

Chapter two

Basic transducers and principles 49

Robert A. Peura and John G. Webster

- 2.1 Displacement measurements 49
- 2.2 Resistive transducers 50
- 2.3 Bridge circuits 57
- 2.4 Inductive transducers 59
- 2.5 Capacitive transducers 62
- 2.6 Piezoelectric transducers 66
- 2.7 Temperature measurements 70
- 2.8 Thermocouples 70
- 2.9 Thermistors 73
- 2.10 Radiation thermometry 79
- 2.11 Chemical thermometry 83

- 2.12 Optical measurements 83
- 2.13 Radiation sources 84
- 2.14 Geometrical and fiber optics 89
- 2.15 Optical filters 92
- 2.16 Radiation detectors 95
- 2.17 Optical combinations 98

Chapter three

Amplifiers and signal processing 103

John G. Webster

- 3.1 Ideal op amps 103
- 3.2 Inverters 105
- 3.3 Followers 108
- 3.4 Differential amplifiers 109
- 3.5 Comparators 112
- 3.6 Rectifiers 116
- 3.7 Logarithmic amplifiers 117
- 3.8 Integrators 118
- 3.9 Differentiators 120
- 3.10 Active filters 121
- 3.11 Frequency response 125
- 3.12 Offset voltage 127
- 3.13 Bias current 129
- 3.14 Input and output resistance 132
- 3.15 Phase-sensitive demodulators 134
- 3.16 Microcomputers in medical instrumentation 137

Chapter four

The origin of biopotentials 143

John W. Clark

- 4.1 Electrical activity of excitable cells 143
- 4.2 Volume conductor fields 151
- 4.3 Functional organization of the peripheral nervous system 154
- 4.4 The electroneurogram (ENG) 156
- 4.5 The electromyogram (EMG) 160
- 4.6 The electrocardiogram (ECG) 163
- 4.7 The electroretinogram (ERG) 177
- 4.8 The electroencephalogram (EEG) 184

Chapter five**Biopotential electrodes 215**

Michael R. Neuman

- 5.1 The electrode-electrolyte interface 215
- 5.2 Polarization 219
- 5.3 Polarizable and nonpolarizable electrodes 223
- 5.4 Electrode behavior and circuit models 231
- 5.5 The electrode-skin interface and motion artifact 236
- 5.6 Body-surface recording electrodes 241
- 5.7 Internal electrodes 250
- 5.8 Microelectrodes 255
- 5.9 Electrodes for electrical stimulation of tissue 264
- 5.10 Practical hints in using electrodes 267

Chapter six**Biopotential amplifiers 273**

Michael R. Neuman

- 6.1 Basic requirements 273
- 6.2 The electrocardiograph 275
- 6.3 Problems frequently encountered 284
- 6.4 Transient protection 297
- 6.5 Common-mode and other interference-reduction circuits 299
- 6.6 Amplifiers for other biopotential signals 304
- 6.7 Example of a biopotential preamplifier 307
- 6.8 Other biopotential signal processors 309
- 6.9 Cardiac monitors 321
- 6.10 Radiotelemetry 326

Chapter seven**Blood pressure and sound 336**

Robert A. Peura

- 7.1 Direct measurements 336
- 7.2 Harmonic analysis of blood-pressure waveforms 339
- 7.3 Dynamic properties of pressure-measurement systems 340
- 7.4 Measurement of system response 347
- 7.5 Effects of system parameters on response 350

- 7.6 Bandwidth requirements for measuring blood pressure 351
- 7.7 Typical pressure-waveform distortion 352
- 7.8 Systems for measuring venous pressure 354
- 7.9 Heart sounds 355
- 7.10 Phonocardiography 359
- 7.11 Intracardiac phonocardiography 362
- 7.12 Heart-sound instrumentation systems 362
- 7.13 Cardiac catheterization 367
- 7.14 Effects of potential and kinetic energy on pressure measurements 371
- 7.15 Indirect measurements of blood pressure 372
- 7.16 Tonometry 377

Chapter eight

Measurement of flow and volume of blood 385

John G. Webster

- 8.1 Indicator-dilution method that uses continuous infusion 385
- 8.2 Indicator-dilution method that uses rapid injection 388
- 8.3 Electromagnetic flowmeters 391
- 8.4 Ultrasonic flowmeters 399
- 8.5 Thermal-convection velocity sensors 414
- 8.6 Chamber plethysmography 417
- 8.7 Electrical-impedance plethysmography 420
- 8.8 Photoplethysmography 427

Chapter nine

Measurements of the respiratory system 434

Frank P. Primiano, Jr.

- 9.1 Modeling the respiratory system 435
- 9.2 Measurement of pressure 442
- 9.3 Measurement of gas-flow rate 444
- 9.4 Lung volume 452
- 9.5 Measurement of alveolar pressure and lung volume by total-body plethysmography 461
- 9.6 Some tests of respiratory mechanics 469
- 9.7 Measurement of gas concentration 485
- 9.8 Some tests of gas transport 494

Chapter ten**Clinical laboratory instrumentation 511***Lawrence A. Wheeler*

- 10.1 Spectrophotometry 512
- 10.2 Automated chemical analyzers 523
- 10.3 Blood gas and acid-base measurements 536
- 10.4 Chromatography 542
- 10.5 Electrophoresis 545
- 10.6 Hematology 548

Chapter eleven**Medical imaging systems 558***Melvin P. Siedband and James E. Holden*

- 11.1 Information content of an image 558
- 11.2 Modulation transfer function 567
- 11.3 Noise-equivalent bandwidth 568
- 11.4 Photography 569
- 11.5 Television systems 572
- 11.6 Radiography 578
- 11.7 Thermography 585
- 11.8 Nuclear medicine 593
- 11.9 Ultrasonic scanning 600
- 11.10 Computer-assisted tomography 605

Chapter twelve**Therapeutic and prosthetic devices 615***Michael R. Neuman*

- 12.1 Cardiac pacemakers and other electrical stimulators 615
- 12.2 Defibrillators and cardioverters 631
- 12.3 Mechanical cardiovascular orthotic and prosthetic devices 640
- 12.4 Hemodialysis 644
- 12.5 Ventilators 648
- 12.6 Infant incubators 653
- 12.7 Surgical instruments 655
- 12.8 Therapeutic applications of the laser 660
- 12.9 Speculation on the future 661

Chapter thirteen

Electrical safety 667

Walter H. Olson

- 13.1 Physiological effects of electricity 668
- 13.2 Important susceptibility parameters 670
- 13.3 Distribution of electric power 675
- 13.4 Macroshock hazards 678
- 13.5 Microshock hazards 681
- 13.6 Electrical safety standards 688
- 13.7 Basic approaches to shock protection 690
- 13.8 Protection: power distribution 690
- 13.9 Protection: equipment design 694
- 13.10 Testing the electrical system 698
- 13.11 Electrical-appliance tests 700

Appendix

- A.1 Physical constants 708
- A.2 SI prefixes 709
- A.3 SI units 710
- A.4 Abbreviations 711
- A.5 Chemical elements 714