

Contents

PREFACE v

PART 1 Planning, measuring, reporting 1

CHAPTER 1 Purposes and Planning 2

Plan of This Book
 Objectives of Engineering Experimentation
 Planning of Laboratory Projects
 Design of an Experimental Project
 Experimental-plan Checklist
 Timesaving Procedures for the Student

CHAPTER 2 Accuracy and Economy in Experimentation 10

Accuracy and Usefulness of Data
 Accuracy of Measurements Checklist
 Records and Summaries
 Attainment of Objectives
 Economy by the Use of Dimensionless Representation
 Economy by the Use of Statistical Methods
 Statistical Examples

CHAPTER 3 Report Writing 36

Kinds of Reports
 Report Outline
 Checklist for Complete Reports
 Mechanical Details of the Report
 Organizing the Report
 Five Common Errors in Student Reports

PART 2 Primary and electromechanical measurements 47

CHAPTER 4 Transducers and Electrical Measurements 48

Exp. 1 Sensors and Transducers
 Exp. 2 Electrical Measurements and Circuits
 Exp. 3 Electric Meters and Indicators
 Exp. 4 Potential Measurements: Voltage

CHAPTER 5 Mechanical and Thermal Measurements 85

- Exp. 5 Potential Measurements: Pressure and Force
- Exp. 6 Potential Measurements: Temperature
- Exp. 7 Measurements of Dimension, Displacement, and Position
- Exp. 8 Quantity Measurements
- Exp. 9 Measurements of Time and Frequency
- Exp. 10 Energy Measurements: Mechanical Power
- Exp. 11 Energy Measurements: Radiation

PART 3 Dynamic measurements and automatic control 161

CHAPTER 6 Dynamic Measurements and Responses* 162

- Exp. 12 Dynamic Changes and Their Measurements
- Exp. 13 Resistance, Capacitance, and Dynamic Response
- Exp. 14 Periodic Phenomena and Measurements
- Exp. 15 Dynamics of Processes: Frequency Response
- Exp. 16 Mechanical Vibration and Shock
- Exp. 17 Measurements of Sound and Noise
- Exp. 18 Transmission and Modification of Dynamic Signals ■

CHAPTER 7 Automatic Control 231

- Exp. 20 Control Systems and Block Diagrams
- Exp. 21 Flow Control: Fluid Valves
- Exp. 22 Flow Control: Electron Valves
- Exp. 23 Modes of Automatic Process Control: Proportional Action
- Exp. 24 Modes of Automatic Process Control: Integral and Derivative Actions
- Exp. 25 Multiple-capacity Processes
- Exp. 26 The Controlled Process

PART 4 Engineering materials, processes, and unit operations 265

CHAPTER 8 Properties of Engineering Materials 266

- Exp. 27 Structural Properties: Elasticity, Stress, and Strain
- Exp. 28 Structural Materials: Metals and Alloys
- Exp. 29 Structural Materials: Concrete, Masonry, and Wood

* Experiment 19 has been deliberately left open to allow for the insertion of an additional experiment relating to dynamic measurements in later editions of this work. Similarly, Exps. 48, 60, 61, 70, and 71 have also been left open.

- Exp. 30 Thermal Properties of Materials
- Exp. 31 Electrical Properties of Materials
- Exp. 32 Properties of Liquids
- Exp. 33 Properties of Gases and Vapors
- Exp. 34 Humidity and Air-vapor Mixtures
- Exp. 35 Properties of Gaseous Fuels
- Exp. 36 Properties of Liquid Fuels
- Exp. 37 Properties of Solid Fuels
- Exp. 38 Properties of Lubricants

CHAPTER 9 Fluid Flow and Fluid Dynamics 347

- Exp. 39 Laminar, Turbulent, and Supersonic Flow
- Exp. 40 Fluid-flow Measurements: Meters and Equations
- Exp. 41 Fluid-flow Measurements: Orifices, Nozzles, and Venturis
- Exp. 42 Boundary Layers
- Exp. 43 Nozzles and Jets
- Exp. 44 Friction Losses in Flow Systems
- Exp. 45 Aerodynamic Lift, Drag, and Pitching Moment
- Exp. 46 Fluid Couplings and Torque Converters
- Exp. 47 Fluid Power and Control ■

CHAPTER 10 Heat and Mass Transfer 410

- Exp. 49 Convection Coefficients
- Exp. 50 Radiation and Emissivity
- Exp. 51 Conduction Heat Transfer
- Exp. 52 Heat and Mass Transfer: Boiling and Condensation
- Exp. 53 Heat and Mass Transfer: Humidifying and Dehumidifying
- Exp. 54 Heat and Mass Transfer: Sorbent Materials
- Exp. 55 Simple Heat Exchanger
- Exp. 56 Heat-flow Problems by Lumped-parameter Analogs
- Exp. 57 Heat-flow Problems by Potential-field Analogs

CHAPTER 11 Combustion and Chemical Reaction 463

- Exp. 58 Combustion Losses
- Exp. 59 Combustors

PART 5 Machines and systems 481

CHAPTER 12 Pumps and Compressors 482

- Exp. 62 Displacement Pumps
- Exp. 63 Centrifugal and Axial-flow Pumps

- Exp. 64 Jet Pumps and Free Jets
- Exp. 65 Displacement Compressors
- Exp. 66 Centrifugal Fans and Compressors
- Exp. 67 Axial Fans and Compressors

CHAPTER 13 Energy Conversion and Power 519

- Exp. 68 Test of a Steam Generator
- Exp. 69 Steam Turbines

CHAPTER 14 Internal-combustion Engines 532

- Exp. 72 Constant-speed Test of a Piston Engine
- Exp. 73 Performance of Automotive Engines
- Exp. 74 Simulated Road-load Test of an Automotive Engine
- Exp. 75 Engine Heat Balance
- Exp. 76 Air Capacity and Volumetric Efficiency
- Exp. 77 Detonation in Spark-ignition Engines
- Exp. 78 Fuel-Air Mixture Requirements
- Exp. 79 Gas Turbines
- Exp. 80 Aircraft Gas Turbines

CHAPTER 15 Environmental Engineering and Control 572

- Exp. 81 The Thermal Environment
- Exp. 82 Purity of Air and Water
- Exp. 83 Environmental Control in Occupied Spaces
- Exp. 84 Air Conditioning
- Exp. 85 Refrigeration
- Exp. 86 Industrial and Special Environments

APPENDIX 617

- Properties of Steam
- Standard Dimensions for Metal Tubing
- Standard Dimensions for Wrought-iron and Wrought-steel Pipe
- Copper and Steel Wire and Sheet
- Circumferences and Areas of Circles

GENERAL INDEX 627

Index to Reference Material Front Endpapers

Conversion Factors Back Endpapers