TABLE OF CONTENTS

Personnel Publications and Reports		vii
		xii
Intro	oduction	xvii
I.	Physical Electronics	1
1.	Physical Electronics in the Solid State	1
	Characteristics of Semiconductor Junctions	
	Surface States on Semiconductors	1
	Experimental Techniques	7
	Transistorized-Vacuum-Tube Electrometer	2
II.	Microwave Gaseous Discharges	3
	Acceleration of a Neutralized Ion Beam	3
	Microwave Noise Radiation from Plasmas	4
	Anomalous Constriction in Low-Pressure Microwave Discharges in Hydrogen	7
	Construction of a Magnetic Mirror	ç
III.	Plasma Dynamics	12
	Channeling and Compression of a Plasma	12
IV.	Solid State Physics	13
	Focusing Properties of a $3\pi/2$ Electron Spectrometer for Studies of Photoelectric Emission Excited by Soft X-rays	13
	Design of an Iron-Free Magnet for a Focusing Spectrometer	19
	Cyclotron Resonance in Germanium at Low Temperatures	24
	Measurement of Resonant-Frequency Shifts of a Microwave Cavity Caused by the Hall Effect in Semiconductor Materials	25
	Recombination of Electrons with Donors in Germanium	27
v.	Thermoelectric Processes and Materials	34
	Anisotropic Thermoelectric Effects	34
	Theory	34
	Experiments with Bismuth Telluride	37
	Thermal Conductivity Studies	38

CONTENTS

VI.	Microwave Spectroscopy	41
	Ruby Linewidth	41
	Paramagnetic Amplifiers	43
	Phonon-Spin Absorption in Paramagnetic Crystals	44
	Spectroscopy of Free Atoms	45
	Antiferromagnetic Resonance in Manganous Chloride	45
VII.	Nuclear Magnetic Resonance and Hyperfine Structure	47
	Hyperfine Structure of Tl^{203} and Tl^{205} in the 7 $^2S_{1/2}$ State Hyperfine Structure of Cd^{111} and Cd^{113} in the 5s5p 3P_1 State	47 49
	Calculations of Signal-to-Noise Ratios in Double-Resonance Experiments	49
VIII.	Microwave Electronics	5 1
	Noise Measurements on Electron Beams at 3000 MC	5 1
	Plasma Studies	57
	Attenuation in Ion-Loaded Waveguides	57
	Preliminary Transient Analysis of a Plasma Produced in a Resonant Cavity by Microwave Energy	59
	Measurements of the Phase Constants of the Shielded Helix	62
IX.	Atomic Beams	66
	Use of Variable-Capacitance Diode Frequency Multiplier as X-Band Power Source	66
	A Carbon Monoxide Clock	66
х.	Statistical Communication Theory	68
	Second-Order Nonlinear Filters	68
	Continuous Feedback Systems	72
	Path and Tree Probabilities for a Complete Graph	76
	Minimization of Truncation Error in Series Expansions of Random Processes	84
	A Sampling Theorem for Stationary Random Processes	87
	Nonlinear Operators - Cascading, Inversion, and Feedback	93
XI.	Process Analysis and Synthesis	109
	Pattern Recognition in Silhouettes	109
	A Self-Organizing System	111

CONTENTS

XII.	Processing and Transmission of Information	113
	Reproduction of Pictures by Computer Display	113
	The Capacity of a Multiplicative Channel	114
	Asymptotic Behavior of Optimum Fixed-Length and Sequential Dichotomies	117
XIII.	Artificial Intelligence	122
	The LISP Programming System	122
	Engineering Calculations in LISP	122
	Chess	123
	Recursive Functions of Symbolic Expressions and Their Computation by Machine	124
XIV.	Statistical Thermodynamics	153
	The Thermodynamic Classification of Chemical Reactions	153
XV.	Physical Acoustics	156
	Spherical Waves of Finite Amplitude	156
	Excitation of Acoustic Cavities by DC Flow	159
	Sound Transmission through a Velocity Discontinuity	161
	Calculation of Ground-Loss Factor	164
	Attenuation and Regeneration of Sound	167
	Scattering of Sound by Sound	170
	Finite Wave Transmission in Liquid Helium	170
xvı.	Speech Communication	171
	Dynamic Analog Speech Synthesizer	171
xVII.	Mechanical Translation	175
	Compact Encoding of Reference Data	175
xvIII.	Communications Biophysics	179
	Evoked Cortical Responses to Repetitive Photic Stimulation	179
	Electrical Responses to Acoustic Clicks in Monkeys	184

CONTENTS

XIX.	Neurophysiology	188
	On Probabilistic Logic	188
	Spinal-Cord Touch Cells and Their Connections	190
	Frog Vision	191
	Infallible Nets of Fallible Neurons	197
XX.	Signal Detection by Human Observers	198
	An Analysis of Sequential Decisions	198
	Stimulus and Response Theories of Signal Uncertainty	198
	Cuing as a Determiner of Apparent Variability in Sensitivity	200
XXI.	Circuit Theory	201
	Parametric Amplification	201
	Frequency Multiplication with Nonlinear Capacitors	203
	Numerical Method for Determining Pole-Zero Locations	205
XXII.	Noise in Electron Devices	206
	General Noise Analysis of Parametric Amplifiers	206
XXIII.	Shop Notes	210
	A Seal That Permits Movement Within a Vacuum System	210