

# CONTENTS

<b>PREFACE</b> .....	1
<b>CHAPTER 1. INTRODUCTION</b> .....	3
1.1 Theoretical Background.....	4
<b>CHAPTER 2. SURVEY OF EXPERIMENTAL RESULTS</b> .....	21
2.1 Introduction.....	21
2.2 Rhombohedral Ternary Molybdenum Chalcogenides.....	22
2.3 Tetragonal Rare Earth Rhodium Borides.....	27
2.3.1 Experimental Observations on Polycrystalline Samples of ErRh <sub>4</sub> B <sub>4</sub> .....	33
2.3.2 Experimental Observations on Single-Crystal Samples of ErRh <sub>4</sub> B <sub>4</sub> .....	40
2.4 Rare Earth Rhodium-Tin Intermetallic Compounds.....	40
2.5 Superconductivity in Heusler Alloys.....	43
2.6 Ternaries with Ce, Eu, Tm and Yb.....	44
2.7 Superconductivity in RE Ternary Compounds RPd <sub>2</sub> Si <sub>2</sub> , RRh <sub>2</sub> Si <sub>2</sub> (R = Y, La and Lu) and RE <sub>2</sub> Fe <sub>3</sub> Si <sub>5</sub> (RE = Tm).....	45
2.8 Pseudoternaries.....	46
2.9 Magnetic Field Induced Superconductivity (MFIS).....	50
2.10 Very Weak Itinerant Ferromagnetic Superconductivity (VWIFS).....	51
2.11 Heavy-Fermion or Heavy-Electron Metal Superconductors.....	53
2.11.1 CeCu <sub>2</sub> Si <sub>2</sub> .....	54
2.11.2 UBe <sub>13</sub> .....	58
2.11.3 UPt <sub>3</sub> .....	60
2.11.4 URu <sub>2</sub> Si <sub>2</sub> .....	63
2.12 Cuprate Superconducting Ceramics.....	69
2.12.1 (La <sub>1-x</sub> A <sub>x-2</sub> )CuO <sub>4</sub> (A = Ca, Sr, Ba) Compounds.....	75
2.12.2 RBa <sub>2</sub> Cu <sub>3</sub> O <sub>7-<math>\delta</math></sub> (R = Rare Earth) Compounds.....	76
2.12.3 (A''O) <sub>2</sub> A'' <sub>2</sub> Ca <sub>n-1</sub> Cu <sub>n</sub> O <sub>2+2n</sub> (A'' is Bi or Tl, A' is Ba or Sr, and n is the number of Cu-O sheets stacked consecutively).....	79
<b>CHAPTER 3. REENTRANT SUPERCONDUCTIVITY:     FERROMAGNETIC SUPERCONDUCTORS</b> .....	85
3.1 Introduction.....	85
3.2 Phenomenological Models.....	86
3.2.1 Generalized Ginzburg-Landau Model.....	86

3.2.2	$\Delta$ Constant and $M$ Spatially Varying Cryptoferromagnetic (Spiral) State or Helical Ordering.....	88
3.2.3	$\Delta$ and $M$ Both Spatially Nonuniform (Vortex-Like State).....	92
3.2.4	Renormalization Group Method.....	94
3.3	Microscopic Models.....	99
3.3.1	Pure Superconductor in a Magnetic Field.....	100
3.3.2	A Superconductor Containing Magnetic Impurities.....	102
3.3.3	The Conduction and $f$ -electron Interaction in a Superconductor.....	103
3.3.4	The Hybrid Coupling in a Superconductor.....	126
3.3.5	Umezawa, Matsumoto and Whitehead Model (Phenomenological)..	131
3.3.6	Effects of the Crystal Field.....	134
3.3.7	Superconductivity of Thin Films.....	135
<b>CHAPTER 4. ANTIFERROMAGNETIC SUPERCONDUCTORS.....</b>		<b>137</b>
4.1	Introduction.....	137
4.2	Fulde and Keller Model.....	139
4.3	Mackawa and Tachiki Model.....	141
4.4	Jagadish and Sinha Model.....	143
4.5	Levin-Nass and Ro Model.....	145
4.6	Buzdin and Bulaevskii Model.....	147
4.7	Upper Critical Field.....	149
4.8	Coexistent States of Ferro- and Antiferromagnetism in Magnetic Superconductors.....	154
<b>CHAPTER 5. MAGNETIC FIELD INDUCED SUPERCONDUCTIVITY.....</b>		<b>157</b>
5.1	Magnetic Field Induced Superconductivity.....	157
<b>CHAPTER 6. ITINERANT FERROMAGNETIC SUPERCONDUCTIVITY.....</b>		<b>159</b>
6.1	Introduction.....	159
6.2	Theory of Itinerant Ferromagnetic Superconductors.....	159
<b>CHAPTER 7. HEAVY FERMION SUPERCONDUCTIVITY.....</b>		<b>165</b>
7.1	Introduction.....	165
7.2	Specific Heat.....	166
7.3	Transport Properties.....	168
7.4	Theoretic Models.....	169
7.5	Conclusions.....	177

<b>CHAPTER 8. HIGH TEMPERATURE SUPERCONDUCTORS.....</b>	<b>179</b>
8.1 Introduction.....	179
8.2 Discussion of Experimental Results.....	179
8.2.1 Transport.....	179
8.2.2 Electromagnetic Response.....	180
8.2.3 Thermal Properties.....	181
8.2.4 Spectroscopic Results.....	181
8.3 Lattice Related Effects.....	182
8.4 Band Structure Calculations.....	183
8.5 Phase Diagram of the Cuprate Oxide Superconductors.....	184
8.6 Theories of High $T_c$ Superconductors.....	185
8.6.1 Phonons.....	186
8.6.2 Charge Fluctuations.....	187
8.6.3 Spin Fluctuations.....	192
8.6.4 Strong Correlation Limit: Resonating Valence Bond (RVB) Theory.....	194
<b>GLOSSARY OF TERMS.....</b>	<b>197</b>
<b>REFERENCES.....</b>	<b>201</b>
<b>SUBJECT INDEX.....</b>	<b>215</b>