An Introduction To Error Correcting Codes With Applications

Error-correcting CodesAn Introduction to Error Correcting Codes with ApplicationsFoundations of CodingError-Correction Coding and DecodingFundamentals of Error-Correcting CodesThe Theory of Error-correcting CodesAn Introduction to Error-correcting CodesError Correcting CodesA Short Course on Error Correcting CodesError-correcting CodesA Short Course on Error Correcting CodesError Correcting CodesFundamentals of Classical and Modern Error-Correcting CodesError-correcting CodesA Course in Error-correcting CodesA Commonsense Approach to the Theory of Error Correcting CodesError-correcting Codes with Applications to Computer System DesignA New Class of Nonlinear Error-correcting CodesError Correcting Coding and Security for Data NetworksVLSI Architectures for Modern Error-Correcting Codes William Wesley Peterson Scott A. Vanstone Jiri Adamek Martin Tomlinson W. Cary Huffman Florence Jessie MacWilliams Shu Lin D J. Baylis Neil James Alexander Sloane William Wesley Peterson N.J.A. Sloane Alain Poli Shu Lin J⍰ rn Justesen Benjamin Arazi E. J. Weldon (Jr.) Stanford University. Stanford Electronics Laboratories Grigorii Kabatiansky Xinmiao Zhang

THE CODING PROBLEM INTRODUCTION TO ALGEBRA LINEAR CODES ERROR CORRECTION CAPABILITIES OF LINEAR CODES IMPORTANT LINEAR BLOCK CODES POLYNOMIAL RINGS AND GALOIS FIELDS LINEAR SWITCHING CIRCUITS CYCLIC CODES BOSE CHAUDHURI HOCQUENGHEM CODES ARITHMETIC CODES

ALTHOUGH DEVOTED TO CONSTRUCTIONS OF GOOD CODES FOR ERROR CONTROL SECRECY OR DATA COMPRESSION THE EMPHASIS IS ON THE FIRST DIRECTION INTRODUCES A NUMBER OF IMPORTANT CLASSES OF ERROR DETECTING AND ERROR CORRECTING CODES AS WELL AS THEIR DECODING METHODS BACKGROUND MATERIAL ON MODERN ALGEBRA IS PRESENTED WHERE REQUIRED THE ROLE OF ERROR CORRECTING CODES IN MODERN CRYPTOGRAPHY IS TREATED AS ARE DATA COMPRESSION AND OTHER TOPICS RELATED TO INFORMATION THEORY THE DEFINITION THEOREM PROOF STYLE USED IN MATHEMATICS TEXTS IS EMPLOYED THROUGH THE BOOK BUT FORMALISM IS AVOIDED WHEREVER POSSIBLE

THIS BOOK DISCUSSES BOTH THE THEORY AND PRACTICAL APPLICATIONS OF SELF CORRECTING DATA COMMONLY KNOWN AS ERROR CORRECTING CODES THE APPLICATIONS INCLUDED DEMONSTRATE THE IMPORTANCE OF THESE CODES IN A WIDE RANGE OF EVERYDAY TECHNOLOGIES FROM SMARTPHONES TO SECURE COMMUNICATIONS AND TRANSACTIONS WRITTEN IN A READILY UNDERSTANDABLE STYLE THE BOOK PRESENTS THE AUTHORS TWENTY FIVE YEARS OF RESEARCH ORGANIZED INTO FIVE PARTS PART I IS CONCERNED WITH THE THEORETICAL PERFORMANCE ATTAINABLE BY USING ERROR CORRECTING CODES TO ACHIEVE COMMUNICATIONS EFFICIENCY IN DIGITAL COMMUNICATIONS SYSTEMS PART II EXPLORES THE CONSTRUCTION OF ERROR CORRECTING CODES AND EXPLAINS THE

DIFFERENT FAMILIES OF CODES AND HOW THEY ARE DESIGNED TECHNIQUES ARE DESCRIBED FOR PRODUCING THE VERY BEST CODES PART III ADDRESSES THE ANALYSIS OF LOW DENSITY PARITY CHECK LDPC CODES PRIMARILY TO CALCULATE THEIR STOPPING SETS AND LOW WEIGHT CODEWORD SPECTRUM WHICH DETERMINES THE PERFORMANCE OF TH ESE CODES PART IV DEALS WITH DECODERS DESIGNED TO REALIZE OPTIMUM PERFORMANCE PART V DESCRIBES APPLICATIONS WHICH INCLUDE COMBINED ERROR CORRECTION AND DETECTION PUBLIC KEY CRYPTOGRAPHY USING GOPPA CODES CORRECTING ERRORS IN PASSWORDS AND WATERMARKING THIS BOOK IS A VALUABLE RESOURCE FOR ANYONE INTERESTED IN ERROR CORRECTING CODES AND THEIR APPLICATIONS RANGING FROM NON EXPERTS TO PROFESSIONALS AT THE FOREFRONT OF RESEARCH IN THEIR FIELD THIS BOOK IS OPEN ACCESS UNDER A CC BY 4 0 LICENSE

FUNDAMENTALS OF ERROR CORRECTING CODES IS AN IN DEPTH INTRODUCTION TO CODING THEORY FROM BOTH AN ENGINEERING AND MATHEMATICAL VIEWPOINT AS WELL AS COVERING CLASSICAL TOPICS THERE IS MUCH COVERAGE OF TECHNIQUES WHICH COULD ONLY BE FOUND IN SPECIALIST JOURNALS AND BOOK PUBLICATIONS NUMEROUS EXERCISES AND EXAMPLES AND AN ACCESSIBLE WRITING STYLE MAKE THIS A LUCID AND EFFECTIVE INTRODUCTION TO CODING THEORY FOR ADVANCED UNDERGRADUATE AND GRADUATE STUDENTS RESEARCHERS AND ENGINEERS WHETHER APPROACHING THE SUBJECT FROM A MATHEMATICAL ENGINEERING OR COMPUTER SCIENCE BACKGROUND

ASSUMING LITTLE PREVIOUS MATHEMATICAL KNOWLEDGE ERROR CORRECTING CODES PROVIDES A SOUND INTRODUCTION TO KEY AREAS OF THE SUBJECT TOPICS HAVE BEEN CHOSEN FOR THEIR IMPORTANCE AND PRACTICAL SIGNIFICANCE WHICH BAYLIS DEMONSTRATES IN A RIGOROUS BUT GENTLE MATHEMATICAL STYLE COVERAGE INCLUDES OPTIMAL CODES LINEAR AND NON LINEAR CODES GENERAL TECHNIQUES OF DECODING ERRORS AND ERASURES ERROR DETECTION SYNDROME DECODING AND MUCH MORE ERROR CORRECTING CODES CONTAINS NOT ONLY STRAIGHT MATHS BUT ALSO EXERCISES ON MORE INVESTIGATIONAL PROBLEM SOLVING CHAPTERS ON NUMBER THEORY AND POLYNOMIAL ALGEBRA ARE INCLUDED TO SUPPORT LINEAR CODES AND CYCLIC CODES AND AN EXTENSIVE REMINDER OF RELEVANT TOPICS IN LINEAR ALGEBRA IS GIVEN EXERCISES ARE PLACED WITHIN THE MAIN BODY OF THE TEXT TO ENCOURAGE ACTIVE PARTICIPATION BY THE READER WITH COMPREHENSIVE SOLUTIONS PROVIDED ERROR CORRECTING CODES WILL APPEAL TO UNDERGRADUATE STUDENTS IN PURE AND APPLIED MATHEMATICAL FIELDS SOFTWARE ENGINEERING COMMUNICATIONS ENGINEERING COMPUTER SCIENCE AND INFORMATION TECHNOLOGY AND TO ORGANIZATIONS WITH SUBSTANTIAL RESEARCH AND DEVELOPMENT IN THOSE AREAS

THIS ADVANCED TEXT COVERS BOTH THE THEORY AND APPLICATIONS OF CODING THEORY DRAWING ON RECENT RESEARCH THE BOOK EXPLAINS NEW DEVELOPMENTS IN THE FIELD OF INFORMATION CODING INCLUDED ARE WORKED EXAMPLES AND EXERCISES

USING EASY TO FOLLOW MATHEMATICS THIS TEXTBOOK PROVIDES COMPREHENSIVE COVERAGE OF BLOCK CODES AND TECHNIQUES FOR RELIABLE COMMUNICATIONS AND DATA STORAGE IT COVERS MAJOR CODE DESIGNS AND CONSTRUCTIONS FROM GEOMETRIC ALGEBRAIC AND GRAPH THEORETIC POINTS OF VIEW DECODING ALGORITHMS ERROR CONTROL ADDITIVE WHITE GAUSSIAN NOISE AWGN AND ERASURE AND DATALESS RECOVERY IT SIMPLIFIES A HIGHLY MATHEMATICAL SUBJECT TO A LEVEL THAT CAN BE UNDERSTOOD AND APPLIED WITH A MINIMUM BACKGROUND IN MATHEMATICS PROVIDES STEP BY STEP EXPLANATION OF ALL COVERED TOPICS BOTH FUNDAMENTAL AND ADVANCED AND INCLUDES PLENTY OF PRACTICAL ILLUSTRATIVE EXAMPLES TO ASSIST UNDERSTANDING NUMEROUS HOMEWORK PROBLEMS ARE INCLUDED TO STRENGTHEN STUDENT COMPREHENSION OF NEW AND ABSTRACT CONCEPTS AND A SOLUTIONS MANUAL IS AVAILABLE ONLINE FOR INSTRUCTORS MODERN DEVELOPMENTS INCLUDING POLAR CODES ARE ALSO COVERED AN ESSENTIAL TEXTBOOK FOR SENIOR UNDERGRADUATES AND GRADUATES TAKING INTRODUCTORY CODING COURSES STUDENTS TAKING ADVANCED FULL YEAR GRADUATE CODING COURSES AND PROFESSIONALS WORKING ON CODING FOR COMMUNICATIONS AND DATA STORAGE

THIS BOOK IS WRITTEN AS A TEXT FOR A COURSE AIMED AT ADVANCED UNDERGRADUATES CHAPTERS COVER THE CODES AND DECODING METHODS THAT ARE CURRENTLY OF MOST INTEREST IN RESEARCH DEVELOPMENT AND APPLICATION THEY GIVE A RELATIVELY BRIEF PRESENTATION OF THE ESSENTIAL RESULTS EMPHASIZING THE INTERRELATIONS BETWEEN DIFFERENT METHODS AND PROOFS OF ALL IMPORTANT RESULTS A SEQUENCE OF PROBLEMS AT THE END OF EACH CHAPTER SERVES TO REVIEW THE RESULTS AND GIVE THE STUDENT AN APPRECIATION OF THE CONCEPTS

TEACHING THE THEORY OF ERROR CORRECTING CODES ON AN INTRODUCTORY LEVEL IS A DIFFICULTTASK THE THEORY WHICH HAS IMMEDIATE HARDWARE APPLICATIONS ALSO CONCERNS HIGHLY ABSTRACTMATHEMATICAL CONCEPTS THIS TEXT EXPLAINS THE BASIC CIRCUITS IN A REFRESHINGLY PRACTICAL WAY THATWILL APPEAL TO UNDERGRADUATE ELECTRICAL ENGINEERING STUDENTS AS WELL AS TO ENGINEERS AND TECHNICIANSWORKING IN INDUSTRY ARAZI S TRULY COMMONSENSE APPROACH PROVIDES A SOLID GROUNDING IN THE SUBJECT EXPLAINING PRINCIPLES INTUITIVELY FROM A HARDWARE PERSPECTIVE HE FULLY COVERS ERROR CORRECTIONTECHNIQUES FROM BASIC PARITY CHECK AND SINGLE ERROR CORRECTION CYCLIC CODES TO BURST ERRORCORRECTING CODES AND CONVOLUTIONAL CODES ALL THIS HE PRESENTS BEFORE INTRODUCING GALOIS FIELDTHEORY THE BASIC ALGEBRAIC TREATMENT AND THEORETICAL BASIS OF THE SUBJECT WHICH USUALLY APPEARSIN THE OPENING CHAPTERS OF STANDARD TEXTBOOKS ONE ENTIRE CHAPTER IS DEVOTED TO SPECIFIC PRACTICALISSUES SUCH AS REED SOLOMON

CODES USED IN COMPACT DISC EQUIPMENT AND MAXIMUM LENGTH SEQUENCES USED IN VARIOUS FIELDS OF COMMUNICATIONS THE BASIC CIRCUITS EXPLAINED THROUGHOUT THE BOOK AREREDRAWN AND ANALYZED FROM A THEORETICAL POINT OF VIEW FOR READERS WHO ARE INTERESTED IN TACKLING THEMATHEMATICS AT A MORE ADVANCED LEVEL BENJAMIN ARAZI IS AN ASSOCIATE PROFESSOR IN THE DEPARTMENT OFELECTRICAL AND COMPUTER ENGINEERING AT THE BEN GURION UNIVERSITY OF THE NEGEV HIS BOOK IS INCLUDEDIN THE COMPUTER SYSTEMS SERIES EDITED BY HERB SCHWETMAN

ERROR CORRECTING CODING IS OFTEN ANALYZED IN TERMS OF ITS APPLICATION TO THE SEPARATE LEVELS WITHIN THE DATA NETWORK IN ISOLATION FROM EACH OTHER IN THIS FRESH APPROACH THE AUTHORS CONSIDER THE DATA NETWORK AS A SUPERCHANNEL A MULTI LAYERED ENTITY WHICH ALLOWS ERROR CORRECTING CODING TO BE EVALUATED AS IT IS APPLIED TO A NUMBER OF NETWORK LAYERS AS A WHOLE BY EXPOSING THE PROBLEMS OF APPLYING ERROR CORRECTING CODING IN DATA NETWORKS AND BY DISCUSSING CODING THEORY AND ITS APPLICATIONS THIS ORIGINAL TECHNIQUE SHOWS HOW TO CORRECT ERRORS IN THE NETWORK THROUGH JOINT CODING AT DIFFERENT NETWORK LAYERS DISCUSSES THE PROBLEM OF RECONCILING CODING APPLIED TO DIFFERENT LAYERS USING A SUPERCHANNEL APPROACH INCLUDES THOROUGH COVERAGE OF ALL THE KEY CODES LINEAR BLOCK CODES HAMMING BCH AND REED SOLOMON CODES LDPC CODES DECODING AS WELL AS CONVOLUTIONAL TURBO AND ITERATIVE CODING CONSIDERS NEW AREAS OF APPLICATION OF ERROR CORRECTING CODES SUCH AS TRANSPORT CODING CODE BASED CRYPTOSYSTEMS AND CODING FOR IMAGE COMPRESSION DEMONSTRATES HOW TO USE ERROR CORRECTING CODING TO CONTROL SUCH IMPORTANT DATA CHARACTERISTICS AS MEAN MESSAGE DELAY PROVIDES THEORETICAL EXPLANATIONS BACKED UP BY NUMEROUS REAL WORLD EXAMPLES AND PRACTICAL RECOMMENDATIONS FEATURES A COMPANION WEBSITE CONTAINING ADDITIONAL RESEARCH RESULTS INCLUDING NEW CONSTRUCTIONS OF LDPC CODES JOINT ERROR CONTROL CODING AND SYNCHRONIZATION REED MULLER CODES AND THEIR LIST DECODING BY PROGRESSING FROM THEORY THROUGH TO PRACTICAL PROBLEM SOLVING THIS RESOURCE CONTAINS INVALUABLE ADVICE FOR RESEARCHERS POSTGRADUATE STUDENTS ENGINEERS AND COMPUTER SCIENTISTS INTERESTED IN DATA COMMUNICATIONS AND APPLICATIONS OF CODING THEORY

ERROR CORRECTING CODES ARE UBIQUITOUS THEY ARE ADOPTED IN ALMOST EVERY MODERN DIGITAL COMMUNICATION AND STORAGE SYSTEM SUCH AS WIRELESS COMMUNICATIONS OPTICAL COMMUNICATIONS FLASH MEMORIES COMPUTER HARD DRIVES SENSOR NETWORKS AND DEEP SPACE PROBING NEW GENERATION AND EMERGING APPLICATIONS DEMAND CODES WITH BETTER ERROR CORRECTING CAPABILITY ON THE OTHER HAND THE DESIGN AND IMPLEMENTATION OF THOSE HIGH GAIN ERROR CORRECTING CODES POSE MANY CHALLENGES THEY USUALLY INVOLVE COMPLEX MATHEMATICAL COMPUTATIONS AND MAPPING THEM DIRECTLY TO HARDWARE OFTEN LEADS TO VERY HIGH COMPLEXITY VLSI ARCHITECTURES FOR MODERN ERROR CORRECTING CODES SERVES AS A BRIDGE CONNECTING ADVANCEMENTS IN CODING THEORY TO PRACTICAL HARDWARE IMPLEMENTATIONS INSTEAD OF FOCUSING ON CIRCUIT LEVEL DESIGN TECHNIQUES THE BOOK HIGHLIGHTS INTEGRATED ALGORITHMIC AND ARCHITECTURAL TRANSFORMATIONS THAT LEAD TO GREAT IMPROVEMENTS ON THROUGHPUT SILICON AREA REQUIREMENT AND OR POWER CONSUMPTION IN THE HARDWARE IMPLEMENTATION THE GOAL OF THIS BOOK IS TO PROVIDE A COMPREHENSIVE AND SYSTEMATIC REVIEW OF AVAILABLE TECHNIQUES AND ARCHITECTURES SO THAT THEY CAN BE EASILY FOLLOWED BY SYSTEM AND HARDWARE DESIGNERS TO DEVELOP EN DECODER IMPLEMENTATIONS THAT MEET ERROR CORRECTING PERFORMANCE AND COST REQUIREMENTS THIS BOOK CAN BE ALSO USED AS A REFERENCE FOR GRADUATE LEVEL COURSES ON VLSI DESIGN AND ERROR CORRECTING CODING PARTICULAR EMPHASES ARE PLACED ON HARD AND SOFT DECISION REED SOLOMON RS AND BOSE CHAUDHURI HOCQUENGHEM BCH CODES AND BINARY AND NON BINARY LOW DENSITY PARITY CHECK LDPC CODES THESE CODES ARE AMONG THE BEST CANDIDATES FOR MODERN AND EMERGING APPLICATIONS DUE TO THEIR GOOD ERROR CORRECTING PERFORMANCE AND LOWER IMPLEMENTATION COMPLEXITY COMPARED TO OTHER CODES TO HELP EXPLAIN THE COMPUTATIONS AND EN DECODER ARCHITECTURES MANY EXAMPLES AND CASE STUDIES ARE INCLUDED MORE IMPORTANTLY DISCUSSIONS ARE PROVIDED ON THE ADVANTAGES AND DRAWBACKS OF DIFFERENT IMPLEMENTATION APPROACHES AND ARCHITECTURES

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