

# Mathematical Modelling Of Cardiac Electrical Activity

AS RECOGNIZED, ADVENTURE AS WITHOUT DIFFICULTY AS EXPERIENCE NOT QUITE LESSON, AMUSEMENT, AS WITHOUT DIFFICULTY AS ACCORD CAN BE GOTTEN BY JUST CHECKING OUT A BOOK **MATHEMATICAL MODELLING OF CARDIAC ELECTRICAL ACTIVITY** AS WELL AS IT IS NOT DIRECTLY DONE, YOU COULD UNDERTAKE EVEN MORE MORE OR LESS THIS LIFE, APPROACHING THE WORLD.

WE MANAGE TO PAY FOR YOU THIS PROPER AS SKILLFULLY AS SIMPLE SHOWING OFF TO GET THOSE ALL. WE COME UP WITH THE MONEY FOR MATHEMATICAL MODELLING OF CARDIAC ELECTRICAL ACTIVITY AND NUMEROUS BOOK COLLECTIONS FROM FICTIONS TO SCIENTIFIC RESEARCH IN ANY WAY. IN THE COURSE OF THEM IS THIS MATHEMATICAL MODELLING OF CARDIAC ELECTRICAL ACTIVITY THAT CAN BE YOUR PARTNER.

## **MATHEMATICAL CARDIAC ELECTROPHYSIOLOGY** - PIERO COLLI FRANZONE 2014-10-30

THIS BOOK COVERS THE MAIN MATHEMATICAL AND NUMERICAL MODELS IN COMPUTATIONAL ELECTROCARDIOLOGY, RANGING FROM MICROSCOPIC MEMBRANE MODELS OF CARDIAC IONIC CHANNELS TO MACROSCOPIC BIDOMAIN, MONODOMAIN, EIKONAL MODELS AND CARDIAC SOURCE REPRESENTATIONS. THESE ADVANCED MULTISCALE AND NONLINEAR MODELS DESCRIBE THE CARDIAC BIOELECTRICAL ACTIVITY FROM THE CELL LEVEL TO THE BODY SURFACE AND ARE EMPLOYED IN BOTH THE DIRECT AND INVERSE PROBLEMS OF ELECTROCARDIOLOGY. THE BOOK ALSO COVERS ADVANCED NUMERICAL TECHNIQUES NEEDED TO EFFICIENTLY CARRY OUT LARGE-SCALE CARDIAC SIMULATIONS, INCLUDING TIME AND SPACE DISCRETIZATIONS, DECOUPLING AND OPERATOR SPLITTING TECHNIQUES, PARALLEL FINITE ELEMENT SOLVERS. THESE TECHNIQUES ARE EMPLOYED IN 3D CARDIAC SIMULATIONS ILLUSTRATING THE EXCITATION MECHANISMS, THE ANISOTROPIC EFFECTS ON EXCITATION AND REPOLARIZATION WAVEFRONTS, THE MORPHOLOGY OF ELECTROGRAMS IN NORMAL AND PATHOLOGICAL TISSUE AND SOME REENTRY PHENOMENA. THE OVERALL AIM OF THE BOOK IS TO PRESENT RIGOROUSLY THE MATHEMATICAL AND NUMERICAL FOUNDATIONS OF COMPUTATIONAL ELECTROCARDIOLOGY, ILLUSTRATING THE CURRENT RESEARCH DEVELOPMENTS IN THIS FAST-GROWING FIELD LYING AT THE INTERSECTION OF MATHEMATICAL PHYSIOLOGY, BIOENGINEERING AND COMPUTATIONAL BIOMEDICINE. THIS BOOK IS ADDRESSED TO GRADUATE STUDENT AND RESEARCHERS IN THE FIELD OF APPLIED MATHEMATICS, SCIENTIFIC COMPUTING, BIOENGINEERING, ELECTROPHYSIOLOGY AND CARDIOLOGY.

## **INTRODUCTION TO COMPUTATIONAL CARDIOLOGY** - BORIS J.A. KOGAN 2009-12-09

INTRODUCTION TO COMPUTATIONAL CARDIOLOGY PROVIDES A COMPREHENSIVE, IN-DEPTH TREATMENT OF THE FUNDAMENTAL CONCEPTS AND RESEARCH CHALLENGES INVOLVED IN THE MATHEMATICAL MODELING AND COMPUTER SIMULATION OF DYNAMICAL PROCESSES IN THE HEART, UNDER NORMAL AND PATHOLOGICAL CONDITIONS. ABOUT THIS TEXTBOOK: - PRESENTS DESCRIPTIONS OF MODELS USED IN BOTH BIOLOGY AND MEDICINE FOR DISCOVERING

THE MECHANISMS OF HEART FUNCTION AND DYSFUNCTION ON SEVERAL PHYSIOLOGICAL SCALES ACROSS DIFFERENT SPECIES. - PROVIDES SEVERAL EXAMPLES THROUGHOUT THE TEXTBOOK AND EXERCISES AT THE END WHICH FACILITATE UNDERSTANDING OF BASIC CONCEPTS AND INTRODUCES, FOR IMPLEMENTATION, TREATED PROBLEMS TO PARALLEL SUPERCOMPUTERS. INTRODUCTION TO COMPUTATIONAL CARDIOLOGY SERVES AS A SECONDARY TEXTBOOK OR REFERENCE BOOK FOR ADVANCED-LEVEL STUDENTS IN COMPUTER SCIENCE, ELECTRICAL ENGINEERING, BIOMEDICAL ENGINEERING, AND CARDIAC ELECTROPHYSIOLOGY. IT IS ALSO SUITABLE FOR RESEARCHERS EMPLOYING MATHEMATICAL MODELING AND COMPUTER SIMULATIONS OF BIOMEDICAL PROBLEMS.

## **BIOPACEMAKING** - J.A.E SPAAN 2007-08-08

THE DEVELOPMENT OF A BIO-ENGINEERED PACEMAKER IS OF SUBSTANTIAL CLINICAL AND ALSO SCIENTIFIC INTEREST BECAUSE IT PROMISES TO OVERCOME SEVERAL LIMITATIONS OF ELECTRONIC PACEMAKERS. MOREOVER IT MAY ANSWER THE LONGSTANDING QUESTION OF WHETHER THE COMPLEX STRUCTURE OF THE SINUS NODE IS INDEED A PREREQUISITE FOR RELIABLE PACEMAKING, OR SIMPLER STRUCTURES MIGHT WORK AS WELL. THIS BOOK GIVES AN OVERVIEW OF THE CURRENT STATE-OF-THE-ART OF CREATING A BIO-ENGINEERED PACEMAKER. IT SHOWS THE APPROACHES TO DEVELOP OF GENETIC AND CELL-BASED ENGINEERING METHODS SUITABLE TO IMPLEMENT THEM WITH SAFETY AND STABILITY. IT ALSO ILLUMINATES THE PROBLEMS THAT NEED TO BE SOLVED BEFORE BIO-PACEMAKING CAN BE CONSIDERED FOR CLINICAL USE.

## **COMPUTATIONAL CARDIOVASCULAR MECHANICS** - JULIUS M. GUCCIONE 2010-01-08

COMPUTATIONAL CARDIOVASCULAR MECHANICS PROVIDES A COHESIVE GUIDE TO CREATING MATHEMATICAL MODELS FOR THE MECHANICS OF DISEASED HEARTS TO SIMULATE THE EFFECTS OF CURRENT TREATMENTS FOR HEART FAILURE. CLEARLY ORGANIZED IN A TWO PART STRUCTURE, THIS VOLUME DISCUSSES VARIOUS AREAS OF COMPUTATIONAL MODELING OF CARDIOVASCULAR MECHANICS (FINITE ELEMENT MODELING OF VENTRICULAR MECHANICS, FLUID

DYNAMICS) IN ADDITION TO A DESCRIPTION AN ANALYSIS OF THE CURRENT APPLICATIONS USED (SOLID FE MODELING, CFD). EDITED BY EXPERTS IN THE FIELD, RESEARCHERS INVOLVED WITH BIOMEDICAL AND MECHANICAL ENGINEERING WILL FIND COMPUTATIONAL CARDIOVASCULAR MECHANICS A VALUABLE REFERENCE.

**MULTISCALE MODELING OF THE VENTRICLES** - DAVID URS JOSEF KELLER 2014-08-22

THIS WORK IS FOCUSED ON DIFFERENT ASPECTS WITHIN THE LOOP OF MULTISCALE MODELING: ON THE CELLULAR LEVEL, EFFECTS OF ADRENERGIC REGULATION AND THE LONG-QT SYNDROME HAVE BEEN INVESTIGATED. ON THE ORGAN LEVEL, A MODEL FOR THE EXCITATION CONDUCTION SYSTEM WAS DEVELOPED AND THE ROLE OF ELECTROPHYSIOLOGICAL HETEROGENEITIES WAS ANALYZED. ON THE TORSO LEVEL A DYNAMIC MODEL OF A DEFORMING HEART WAS CREATED AND THE EFFECTS OF TISSUE CONDUCTIVITIES ON THE SOLUTION OF THE FORWARD PROBLEM WERE EVALUATED

MODELING AND SIMULATING CARDIAC ELECTRICAL ACTIVITY - DAVID J. CHRISTINI 2020

THIS BOOK PROVIDES A THOROUGH INTRODUCTION TO THE TOPIC OF MATHEMATICAL MODELING OF ELECTRICAL ACTIVITY IN THE HEART, FROM MOLECULAR DETAILS OF IONIC CHANNEL DYNAMICS TO CLINICALLY DERIVED PATIENT-SPECIFIC MODELS. IT DISCUSSES HOW CELLULAR IONIC MODELS ARE FORMULATED, INTRODUCES COMMONLY USED MODELS AND EXPLAINS WHY THERE ARE SO MANY DIFFERENT MODELS AVAILABLE. THE CHAPTERS COVER MODELING OF THE INTRACELLULAR CALCIUM HANDLING THAT UNDERLIES CELLULAR CONTRACTION AS WELL AS MODELING MOLECULAR-LEVEL DETAILS OF CARDIAC ION CHANNELS, AND ALSO FOCUS ON SPECIALIZED TOPICS SUCH AS CARDIOMYOCYTE ENERGETICS AND SIGNALLING PATHWAYS. IT IS AN EXCELLENT RESOURCE FOR EXPERIENCED AND SPECIALISED RESEARCHERS IN THE FIELD, BUT ALSO BIOLOGICAL SCIENTISTS WITH A LIMITED BACKGROUND IN MATHEMATICAL MODELLING AND COMPUTATIONAL METHODS. PART OF BIOPHYSICAL SOCIETY-IOP SERIES.

PHYSICS OF HEART AND CIRCULATION, - JAN STRACKEE 1993-09

THIS BOOK IS AIMED AT THOSE WORKING ON THE PHYSICAL ASPECTS OF HEART AND CIRCULATION. HOWEVER, THE BOOK HAS A MUCH WIDER SCOPE: IT ALSO PRESENTS THE PHYSICAL AND MATHEMATICAL BASIS FOR THE STUDY OF BIOLOGICAL SYSTEMS, NOT ONLY AS A WAY OF THINKING BUT ALSO PRESENTING BASIC INFORMATION ON ALL ASPECTS OF THE CARDIOVASCULAR SYSTEM, SUCH AS FLUID DYNAMICS, ELASTICITY, POTENTIAL THEORY, MATHEMATICAL MODELLING, ETC. THE BOOK IS OF INTEREST TO GRADUATE STUDENTS AND RESEARCHERS IN BIOMEDICAL ENGINEERING, MEDICAL PHYSICS AND THE CLINICAL SCIENCES.

**STUDY OF THE ELECTROMECHANICAL MODELS FOR CARDIAC ACTIVITY** - RANA ITANI 2017

"THE MATHEMATICAL MODELING OF THE COMPLEX PHYSICAL PHENOMENA OCCURRING IN THE HEART IS AN AREA OF INCREASING INTEREST, AS IT FACILITATES THE BETTER UNDERSTANDING OF RELEVANT MECHANISMS DRIVING THE BEHAVIOR OF THE SYSTEM IN BOTH PHYSIOLOGICAL AND PATHOLOGICAL CONTEXTS. IN THIS WORK, WE ARE INTERESTED IN THE STUDY OF THE INTERACTION BETWEEN THE PROPAGATION OF THE ELECTRICAL POTENTIAL THROUGH THE CARDIAC TISSUE AND THE RELATED MECHANICAL RESPONSE. TWO MATHEMATICAL MODELS

FOR THIS ELECTROMECHANICAL COUPLING WILL BE PRESENTED: THE FIRST MODEL IS BASED ON AN ACTIVE-STRESS APPROACH THAT ADDS AN ACTIVE CONTRIBUTION TO THE STRESS OF THE MATERIAL, AND THE SECOND MODEL IS BASED ON AN ACTIVE-STRAIN APPROACH THAT ADOPTS A MULTIPLICATIVE DECOMPOSITION OF THE TENSOR GRADIENT OF DEFORMATION. COMPARISON BETWEEN THESE TWO MODELS AND NUMERICAL RESULTS WILL BE PRESENTED ILLUSTRATING SOME IMPORTANT FEATURES OF THE CARDIAC ELECTROMECHANICAL COUPLING."--ABSTRACT.

**COMPREHENSIVE ELECTROCARDIOLOGY** - PETER W. MACFARLANE 2010-11-05

NEW EDITION OF THE CLASSIC COMPLETE REFERENCE BOOK FOR CARDIOLOGISTS AND TRAINEE CARDIOLOGISTS ON THE THEORY AND PRACTICE OF ELECTROCARDIOGRAPHY, ONE OF THE KEY MODALITIES USED FOR EVALUATING CARDIOLOGY PATIENTS AND DECIDING ON APPROPRIATE MANAGEMENT STRATEGIES.

**RECENT ADVANCES IN UNDERSTANDING THE BASIC MECHANISMS OF ATRIAL FIBRILLATION USING NOVEL COMPUTATIONAL APPROACHES** - JICHAO ZHAO 2019-11-25

**THEORY OF HEART** - LEON GLASS 2012-12-06

IN RECENT YEARS THERE HAS BEEN A GROWTH IN INTEREST IN STUDYING THE HEART FROM THE PERSPECTIVE OF THE PHYSICAL SCIENCES: MECHANICS, FLUID FLOW, ELECTROMECHANICS. THIS VOLUME IS THE RESULT OF A WORKSHOP HELD IN JULY 1989 AT THE INSTITUTE FOR NONLINEAR SCIENCES AT THE UNIVERSITY OF CALIFORNIA AT SAN DIEGO THAT BROUGHT TOGETHER SCIENTISTS AND CLINICIANS WITH GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS WHO SHARED AN INTEREST IN THE HEART. THE CHAPTERS WERE PREPARED BY THE INVITED SPEAKERS AS DIDACTIC REVIEWS OF THEIR SUBJECTS BUT ALSO INCLUDE THE STRUCTURE, MECHANICAL PROPERTIES, AND FUNCTION OF THE HEART AND THE MYOCARDIUM, ELECTRICAL ACTIVITY OF THE HEART AND MYOCARDIUM, AND MATHEMATICAL MODELS OF HEART FUNCTION.

*MATHEMATICAL MODELLING OF CARDIAC ELECTRICAL ACTIVITY WITHIN A HETEROGENEOUS BIDOMAIN FRAMEWORK* - THUSHKA MAHARAJ 2008

PARAMETER ESTIMATION OF A CARDIAC MODEL USING THE LOCAL ENSEMBLE TRANSFORM KALMAN FILTER - NATHAN HOLT 2019

"CARDIAC ARRHYTHMIAS ARE IRREGULARITIES IN THE ELECTRICAL ACTIVITY IN THE HEART; THE ELECTRICAL IMPULSES IN THE HEART BECOME CHAOTIC OR DISORGANIZED, WHICH CAN CAUSE A POSSIBLY LETHAL PROBLEM TO THE CONTRACTION OF THE HEART. IN ORDER TO UNDERSTAND THE DYNAMICS OF ARRHYTHMIAS AND TO BE ABLE TO PREDICT AND TREAT THEM, NUMERICAL MODELS HAVE BEEN DEVELOPED TO CAPTURE THE DYNAMICS OF THE ELECTRICAL IMPULSES IN THE HEART. IN A CLINICAL SETTING, OPTICAL MAPPING TECHNOLOGIES — USING CAMERAS AND VOLTAGE-SENSITIVE DYES TO CAPTURE THE ELECTRICAL IMPULSES PROPAGATING ACROSS THE HEART — HAVE BEEN USED TO CAPTURE THE DYNAMICS OF THE ELECTRICAL ACTIVITY ALONG THE SURFACE OF THE HEART WITH HIGH SPATIAL AND

TEMPORAL RESOLUTION. DESPITE THE HIGH RESOLUTION PROVIDED BY THE OPTICAL MAPPING TECHNOLOGIES ALONG THE SURFACE OF THE HEART, THE TECHNIQUES ARE UNABLE TO CAPTURE MEASUREMENTS OF THE VOLTAGE IN THE INTERIOR OF THE HEART. KALMAN FILTERS ATTEMPT TO SOLVE THIS PROBLEM BY COMBINING EXPERIMENTAL DATA — THAT WHICH IS OBTAINED BY DIRECT MEASUREMENT, SUCH AS BY OPTICAL MAPPING METHODS — WITH A MATHEMATICAL MODEL. THIS HAS BEEN SHOWN USING SYNTHETIC DATA TO BE AN EFFECTIVE METHOD OF RECONSTRUCTING THE DYNAMICS OF CERTAIN CARDIAC ARRHYTHMIAS IN TISSUE. IT IS DESIRABLE TO BE ABLE TO OBTAIN THE VALUES OF THE PARAMETERS THAT GUIDE THE DYNAMICAL BEHAVIOR OF THE CARDIAC ARRHYTHMIAS IN A GIVEN MATHEMATICAL MODEL. KNOWLEDGE OF THE VALUES OF THE MODEL PARAMETERS CAN BE USED TO RETROACTIVELY EXPLAIN WHY DYNAMICAL EFFECTS OCCURRED OR TO PREDICT FUTURE BEHAVIOR OF THE ELECTRICAL IMPULSES PROPAGATING THROUGHOUT THE CARDIAC TISSUE. IN THIS THESIS, WE UTILIZE A STATE-AUGMENTATION METHOD OF ESTIMATING MODEL PARAMETERS USING A NONLINEAR EXTENSION OF THE GENERAL KALMAN FILTER. WE USE A THREE-VARIABLE MODEL OF THE CARDIAC ACTION POTENTIAL IN CONJUNCTION WITH THE LOCAL ENSEMBLE TRANSFORM KALMAN FILTER (LETKF) IN ORDER TO ESTIMATE THE STATE OF THE ELECTRICAL IMPULSES TRAVELING ALONG CARDIAC TISSUE. WE SHOW THE VIABILITY OF THE STATE-AUGMENTATION METHODS OF PARAMETER ESTIMATION WITH THE LETKF AND DETERMINE THREE CRITERIA THAT CAN BE USED TO EXPLAIN THE EFFECTIVENESS OF THE PARAMETER ESTIMATION ALGORITHM. WE FIRST ESTABLISH THE RESULTS BY ESTIMATING A SINGLE PARAMETER, AND THEN EXPAND OUR RESULTS BY SHOWING THE SAME CRITERIA HOLD WHEN ESTIMATING MULTIPLE MODEL PARAMETERS SIMULTANEOUSLY. THE RESULTS PROVIDE EVIDENCE THAT THIS METHOD OF PARAMETER ESTIMATION IS USEFUL FOR CARDIAC MODELS — BOTH BY A GOOD ESTIMATION OF THE STATE AND THE PREDICTABLE ESTIMATION OF THE MODEL PARAMETERS — AND SUGGEST ADDITIONAL AVENUES OF RESEARCH FOR THE PRELIMINARY WORK PRESENTED IN THIS THESIS.”--ABSTRACT.

**COMPLEX SYSTEMS SCIENCE IN BIOMEDICINE** - THOMAS DEISBOECK 2007-06-13  
 COMPLEX SYSTEMS SCIENCE IN BIOMEDICINE THOMAS S. DEISBOECK AND J. YASHA KRESH  
 COMPLEX SYSTEMS SCIENCE IN BIOMEDICINE COVERS THE EMERGING FIELD OF SYSTEMS SCIENCE INVOLVING THE APPLICATION OF PHYSICS, MATHEMATICS, ENGINEERING AND COMPUTATIONAL METHODS AND TECHNIQUES TO THE STUDY OF BIOMEDICINE INCLUDING NONLINEAR DYNAMICS AT THE MOLECULAR, CELLULAR, MULTI-CELLULAR TISSUE, AND ORGANISMIC LEVEL. WITH ALL CHAPTERS HELMED BY LEADING SCIENTISTS IN THE FIELD, COMPLEX SYSTEMS SCIENCE IN BIOMEDICINE'S GOAL IS TO OFFER ITS AUDIENCE A TIMELY COMPENDIUM OF THE ONGOING RESEARCH DIRECTED TO THE UNDERSTANDING OF BIOLOGICAL PROCESSES AS WHOLE SYSTEMS INSTEAD OF AS ISOLATED COMPONENT PARTS. IN PARTS I & II, COMPLEX SYSTEMS SCIENCE IN BIOMEDICINE PROVIDES A GENERAL SYSTEMS THINKING PERSPECTIVE AND PRESENTS SOME OF THE FUNDAMENTAL THEORETICAL UNDERPINNINGS OF THIS RAPIDLY EMERGING FIELD. PART III THEN FOLLOWS WITH A MULTI-SCALED APPROACH, SPANNING FROM THE MOLECULAR TO MACROSCOPIC LEVEL, EXEMPLIFIED BY STUDYING SUCH

DIVERSE AREAS AS MOLECULAR NETWORKS AND DEVELOPMENTAL PROCESSES, THE IMMUNE AND NERVOUS SYSTEMS, THE HEART, CANCER AND MULTI-ORGAN FAILURE. THE VOLUME CONCLUDES WITH PART IV THAT ADDRESSES METHODS AND TECHNIQUES DRIVEN IN DESIGN AND DEVELOPMENT BY THIS NEW UNDERSTANDING OF BIOMEDICAL SCIENCE. KEY TOPICS INCLUDE: • HISTORIC PERSPECTIVES OF GENERAL SYSTEMS THINKING • FUNDAMENTAL METHODS AND TECHNIQUES FOR STUDYING COMPLEX DYNAMICAL SYSTEMS • APPLICATIONS FROM MOLECULAR NETWORKS TO DISEASE PROCESSES • ENABLING TECHNOLOGIES FOR EXPLORATION OF SYSTEMS IN THE LIFE SCIENCES COMPLEX SYSTEMS SCIENCE IN BIOMEDICINE IS ESSENTIAL READING FOR EXPERIMENTAL, THEORETICAL, AND INTERDISCIPLINARY SCIENTISTS WORKING IN THE BIOMEDICAL RESEARCH FIELD INTERESTED IN A COMPREHENSIVE OVERVIEW OF THIS RAPIDLY EMERGING FIELD. ABOUT THE EDITORS: THOMAS S. DEISBOECK IS CURRENTLY ASSISTANT PROFESSOR OF RADIOLOGY AT MASSACHUSETTS GENERAL HOSPITAL AND HARVARD MEDICAL SCHOOL IN BOSTON. AN EXPERT IN INTERDISCIPLINARY CANCER MODELING, DR. DEISBOECK IS DIRECTOR OF THE COMPLEX BIOSYSTEMS MODELING LABORATORY WHICH IS PART OF THE HARVARD-MIT MARTINOS CENTER FOR BIOMEDICAL IMAGING. J. YASHA KRESH IS CURRENTLY PROFESSOR OF CARDIOTHORACIC SURGERY AND RESEARCH DIRECTOR, PROFESSOR OF MEDICINE AND DIRECTOR OF CARDIOVASCULAR BIOPHYSICS AT THE DREXEL UNIVERSITY COLLEGE OF MEDICINE. AN EXPERT IN DYNAMICAL SYSTEMS, HE HOLDS APPOINTMENTS IN THE SCHOOL OF BIOMEDICAL ENGINEERING AND HEALTH SYSTEMS, DEPT. OF MECHANICAL ENGINEERING AND MOLECULAR PATHOBIOLOGY PROGRAM. PROF. KRESH IS FELLOW OF THE AMERICAN COLLEGE OF CARDIOLOGY, AMERICAN HEART ASSOCIATION, BIOMEDICAL ENGINEERING SOCIETY, AMERICAN INSTITUTE FOR MEDICAL AND BIOLOGICAL ENGINEERING.

**DIFFERENTIAL EQUATIONS WITH APPLICATIONS TO BIOLOGY** - SHIGUI RUAN

THIS BOOK PRESENTS THE PROCEEDINGS FROM THE INTERNATIONAL CONFERENCE HELD IN HALIFAX, NS IN JULY 1997. FUNDED BY THE FIELDS INSTITUTE AND LE CENTRE DE RECHERCHES MATHÉMATIQUES, THE CONFERENCE WAS HELD IN HONOR OF THE RETIREMENT OF PROFESSORS LYNN ERBE AND HERB I. FREEDMAN (UNIVERSITY OF ALBERTA). FEATURED TOPICS INCLUDE ORDINARY, PARTIAL, FUNCTIONAL, AND STOCHASTIC DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS TO BIOLOGY, EPIDEMIOLOGY, NEUROBIOLOGY, PHYSIOLOGY AND OTHER RELATED AREAS. THE 41 PAPERS INCLUDED IN THIS VOLUME REPRESENT THE RECENT WORK OF LEADING RESEARCHERS OVER A WIDE RANGE OF SUBJECTS, INCLUDING BIFURCATION THEORY, CHAOS, STABILITY THEORY, BOUNDARY VALUE PROBLEMS, PERSISTENCE THEORY, NEURAL NETWORKS, DISEASE TRANSMISSION, POPULATION DYNAMICS, PATTERN FORMATION AND MORE. THE TEXT WOULD BE SUITABLE FOR A GRADUATE OR ADVANCED UNDERGRADUATE COURSE STUDY IN MATHEMATICAL BIOLOGY. FEATURES: AN OVERVIEW OF CURRENT DEVELOPMENTS IN DIFFERENTIAL EQUATIONS AND MATHEMATICAL BIOLOGY. AUTHORITATIVE CONTRIBUTIONS FROM OVER 60 LEADING WORLDWIDE RESEARCHERS. ORIGINAL, REFEREED CONTRIBUTIONS.

*MATHEMATICAL MODELS FOR DIRECT AND INVERSE SOLUTIONS OF THE ELECTRICAL*

*ACTIVITY OF HEART* - SYED IMTIAZ AHMAD 1967

*PROTEIN - PROTEIN INTERACTION* - MEIKE WERTHER 2008-08-28

THIS BOOK COVERS TRENDS IN MODERN BIOTECHNOLOGY. IT TREATS ALL ASPECTS OF THIS INTERDISCIPLINARY TECHNOLOGY, WHERE KNOWLEDGE, METHODS AND EXPERTISE ARE REQUIRED FROM CHEMISTRY, BIOCHEMISTRY, MICROBIOLOGY, GENETICS, CHEMICAL ENGINEERING AND COMPUTER SCIENCE.

**MATHEMATICALLY MODELLING THE ELECTRICAL ACTIVITY OF THE HEART** - ANDREW J. PULLAN 2005

THIS BOOK ON MODELLING THE ELECTRICAL ACTIVITY OF THE HEART IS AN ATTEMPT TO DESCRIBE CONTINUUM BASED MODELLING OF CARDIAC ELECTRICAL ACTIVITY FROM THE CELL LEVEL TO THE BODY SURFACE (THE FORWARD PROBLEM), AND BACK AGAIN (THE INVERSE PROBLEM). BACKGROUND ANATOMY AND PHYSIOLOGY IS COVERED BRIEFLY TO PROVIDE A SUITABLE CONTEXT FOR UNDERSTANDING THE DETAILED MODELLING THAT IS PRESENTED HEREIN. THE QUESTIONS OF WHAT IS MATHEMATICAL MODELLING AND WHY ONE WOULD WANT TO USE MATHEMATICAL MODELLING ARE ADDRESSED TO GIVE SOME PERSPECTIVE TO THE PHILOSOPHY BEHIND OUR APPROACH. OUR VIEW OF MATHEMATICAL MODELLING IS BROAD ? IT IS NOT SIMPLY ABOUT OBTAINING A SOLUTION TO A SET OF MATHEMATICAL EQUATIONS, BUT INCLUDES SOME MATERIAL ON ASPECTS SUCH AS EXPERIMENTAL AND CLINICAL VALIDATION.

ELECTRICAL HEART ACTIVITY - CHIH HSU CHAO 1972

MATHEMATICAL MODELLING OF THE HUMAN CARDIOVASCULAR SYSTEM - ALFIO QUARTERONI 2019-05-09

MATHEMATICAL AND NUMERICAL MODELLING OF THE HUMAN CARDIOVASCULAR SYSTEM HAS ATTRACTED REMARKABLE RESEARCH INTEREST DUE TO ITS INTRINSIC MATHEMATICAL DIFFICULTY AND THE INCREASING IMPACT OF CARDIOVASCULAR DISEASES WORLDWIDE. THIS BOOK ADDRESSES THE TWO PRINCIPAL COMPONENTS OF THE CARDIOVASCULAR SYSTEM: ARTERIAL CIRCULATION AND HEART FUNCTION. IT SYSTEMATICALLY DESCRIBES ALL ASPECTS OF THE PROBLEM, STATING THE BASIC PHYSICAL PRINCIPLES, ANALYSING THE ASSOCIATED MATHEMATICAL MODELS THAT COMPRISE PDE AND ODE SYSTEMS, REVIEWING SOUND AND EFFICIENT NUMERICAL METHODS FOR THEIR APPROXIMATION, AND SIMULATING BOTH BENCHMARK PROBLEMS AND CLINICALLY INSPIRED PROBLEMS. MATHEMATICAL MODELLING ITSELF IMPOSES TREMENDOUS CHALLENGES, DUE TO THE AMAZING COMPLEXITY OF THE CARDIOVASCULAR SYSTEM AND THE NEED FOR COMPUTATIONAL METHODS THAT ARE STABLE, RELIABLE AND EFFICIENT. THE FINAL PART IS DEVOTED TO CONTROL AND INVERSE PROBLEMS, INCLUDING PARAMETER ESTIMATION, UNCERTAINTY QUANTIFICATION AND THE DEVELOPMENT OF REDUCED-ORDER MODELS THAT ARE IMPORTANT WHEN SOLVING PROBLEMS WITH HIGH COMPLEXITY, WHICH WOULD OTHERWISE BE OUT OF REACH.

**RECENT PROGRESS ON REACTION-DIFFUSION SYSTEMS AND VISCOSITY SOLUTIONS** - YIHONG

DU 2009

THIS BOOK CONSISTS OF SURVEY AND RESEARCH ARTICLES EXPANDING ON THE THEME OF THE ?INTERNATIONAL CONFERENCE ON REACTION-DIFFUSION SYSTEMS AND VISCOSITY SOLUTIONS?, HELD AT PROVIDENCE UNIVERSITY, TAIWAN, DURING JANUARY 3?6, 2007. IT IS A CAREFULLY SELECTED COLLECTION OF ARTICLES REPRESENTING THE RECENT PROGRESS OF SOME IMPORTANT AREAS OF NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS. THE BOOK IS AIMED FOR RESEARCHERS AND POSTGRADUATE STUDENTS WHO WANT TO LEARN ABOUT OR FOLLOW SOME OF THE CURRENT RESEARCH TOPICS IN NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS. THE CONTRIBUTORS CONSIST OF INTERNATIONAL EXPERTS AND SOME PARTICIPANTS OF THE CONFERENCE, INCLUDING NILS ACKERMANN (MEXICO), CHAO-NIEN CHEN (TAIWAN), YIHONG DU (AUSTRALIA), ALBERTO FARINA (FRANCE), HITOSHI ISHII (WASEDA), N ISHIMURA (JAPAN), SHIGEAKI KOIKE (JAPAN), CHU-PIN LO (TAIWAN), PETER POLACIK (MINNESOTA), KUNIMUCHI SAKAMOTO (HIROSHIMA), RICHARD TSAI (TEXAS), MINGXIN WANG (CHINA), YOSHIO YAMADA (WASEDA), EJI YANAGIDA (TOHOKU), AND XIAO-QIANG ZHAO (CANADA).

**MATHEMATICAL PHYSIOLOGY** - JAMES KEENER 2006-04-18

DIVIDED INTO TWO PARTS, THE BOOK BEGINS WITH A PEDAGOGICAL PRESENTATION OF SOME OF THE BASIC THEORY, WITH CHAPTERS ON BIOCHEMICAL REACTIONS, DIFFUSION, EXCITABILITY, WAVE PROPAGATION AND CELLULAR HOMEOSTASIS. THE SECOND, MORE EXTENSIVE PART DISCUSSES PARTICULAR PHYSIOLOGICAL SYSTEMS, WITH CHAPTERS ON CALCIUM DYNAMICS, BURSTING OSCILLATIONS AND SECRETION, CARDIAC CELLS, MUSCLES, INTERCELLULAR COMMUNICATION, THE CIRCULATORY SYSTEM, THE IMMUNE SYSTEM, WOUND HEALING, THE RESPIRATORY SYSTEM, THE VISUAL SYSTEM, HORMONE PHYSIOLOGY, RENAL PHYSIOLOGY, DIGESTION, THE VISUAL SYSTEM AND HEARING.

DRUG DISCOVERY TOXICOLOGY - YVONNE WILL 2016-04-18

AS A GUIDE FOR PHARMACEUTICAL PROFESSIONALS TO THE ISSUES AND PRACTICES OF DRUG DISCOVERY TOXICOLOGY, THIS BOOK INTEGRATES AND REVIEWS THE STRATEGY AND APPLICATION OF TOOLS AND METHODS AT EACH STEP OF THE DRUG DISCOVERY PROCESS. • GUIDES RESEARCHERS AS TO WHAT DRUG SAFETY EXPERIMENTS ARE BOTH PRACTICAL AND USEFUL • COVERS A VARIETY OF KEY TOPICS – SAFETY LEAD OPTIMIZATION, IN VITRO-IN VIVO TRANSLATION, ORGAN TOXICOLOGY, ADME, ANIMAL MODELS, BIOMARKERS, AND -OMICS TOOLS • DESCRIBES WHAT EXPERIMENTS ARE POSSIBLE AND USEFUL AND OFFERS A VIEW INTO THE FUTURE, INDICATING KEY AREAS TO WATCH FOR NEW PREDICTIVE METHODS • FEATURES CONTRIBUTIONS FROM FIRSTHAND INDUSTRY EXPERIENCE, GIVING READERS INSIGHT INTO THE STRATEGY AND EXECUTION OF PREDICTIVE TOXICOLOGY PRACTICES

ALGORITHMS AND ARCHITECTURES FOR PARALLEL PROCESSING - JESUS CARRETERO 2016-11-30

THIS BOOK CONSTITUTES THE REFEREED WORKSHOP PROCEEDINGS OF THE 16TH INTERNATIONAL CONFERENCE ON ALGORITHMS AND ARCHITECTURES FOR PARALLEL PROCESSING, ICA3PP 2016, HELD IN GRANADA, SPAIN, IN DECEMBER 2016. THE 30 FULL

PAPERS PRESENTED WERE CAREFULLY REVIEWED AND SELECTED FROM 58 SUBMISSIONS. THEY COVER MANY DIMENSIONS OF PARALLEL ALGORITHMS AND ARCHITECTURES, ENCOMPASSING FUNDAMENTAL THEORETICAL APPROACHES, PRACTICAL EXPERIMENTAL PROJECTS, AND COMMERCIAL COMPONENTS AND SYSTEMS TRYING TO PUSH BEYOND THE LIMITS OF EXISTING TECHNOLOGIES, INCLUDING EXPERIMENTAL EFFORTS, INNOVATIVE SYSTEMS, AND INVESTIGATIONS THAT IDENTIFY WEAKNESSES IN EXISTING PARALLEL PROCESSING TECHNOLOGY.

**ELECTRICAL CARDIAC ACTIVITY AND RESPONSE TO DRUG ADMINISTRATION: A MATHEMATICAL MODEL** - Moshé Morris Zloof 1972

*MATHEMATICAL AND NUMERICAL MODELING OF THE CARDIOVASCULAR SYSTEM AND APPLICATIONS* - DANIELE BOFFI 2018-11-03

THE BOOK COMPRISES CONTRIBUTIONS BY SOME OF THE MOST RESPECTED SCIENTISTS IN THE FIELD OF MATHEMATICAL MODELING AND NUMERICAL SIMULATION OF THE HUMAN CARDIOCIRCULATORY SYSTEM. IT COVERS A WIDE RANGE OF TOPICS, FROM THE ASSIMILATION OF CLINICAL DATA TO THE DEVELOPMENT OF MATHEMATICAL AND COMPUTATIONAL MODELS, INCLUDING WITH PARAMETERS, AS WELL AS THEIR EFFICIENT NUMERICAL SOLUTION, AND BOTH IN-VIVO AND IN-VITRO VALIDATION. IT ALSO CONSIDERS APPLICATIONS OF RELEVANT CLINICAL INTEREST. THIS BOOK IS INTENDED FOR GRADUATE STUDENTS AND RESEARCHERS IN THE FIELD OF BIOENGINEERING, APPLIED MATHEMATICS, COMPUTER, COMPUTATIONAL AND DATA SCIENCE, AND MEDICINE WISHING TO BECOME INVOLVED IN THE HIGHLY FASCINATING TASK OF MODELING THE CARDIOVASCULAR SYSTEM.

**ALTERNATING DIRECTION IMPLICIT METHOD FOR THE ELECTRO-CARDIOLOGY MODELS** - ZEINAB RAMMAL 2017

"ELECTROPHYSIOLOGY IS AN AREA OF SCIENCE THAT LED TO INNOVATIVE EXPERIMENTATIONS BETWEEN CLINICIANS AND SCIENTISTS. STUDYING AND UNDERSTANDING CARDIAC DYNAMICS PLAYS A KEY ROLE IN DESIGNING THERAPIES, PREOPERATIVE PLANNING, AND STUDYING ARRHYTHMIAS, FIBRILLATIONS AND OTHER CARDIAC ANOMALIES. EXPLORING THE HEART DYNAMICS IN THREE DIMENSIONS IN VIVO IS DIFFICULT, AND HENCE AN ALTERNATIVE IS NEEDED. MATHEMATICAL MODELLING OFFERS A VALUABLE, YET COMPUTATIONALLY EXPENSIVE TOOL FOR SUCH EXPLORATION. THE MATHEMATICAL MODELS OF THE ELECTRICAL ACTIVITY OF THE HEART CONSIST OF A SYSTEM OF NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS COUPLED WITH A SYSTEM OF STIFF ORDINARY DIFFERENTIAL EQUATIONS. NUMERICAL SIMULATION OF THIS COUPLED SYSTEM REQUIRES ACCURATE SPACE AND TIME DISCRETIZATION. IN THIS WORK, AN ALTERNATING DIRECTION IMPLICIT METHOD (ADI) IS PRESENTED AS A NEW NUMERICAL SCHEME FOR SOLVING THE ELECTRICAL MODEL OF THE HEART. TWO-DIMENSIONAL NUMERICAL RESULTS ARE PRESENTED ILLUSTRATING THE ADVANTAGES AND ROBUSTNESS OF THIS PROPOSED METHOD. COMPARISON WITH THE CRANK-NICOLSON ADAMS BASHFORTH (CNAB) METHOD IS DEMONSTRATED AND THE ADVANTAGES OF ADI ARE EXPLAINED IN TERMS OF RUN TIME AND MEMORY CONSUMPTION."--ABSTRACT.

**COMPUTATIONAL BIOLOGY OF THE HEART** - ALEXANDER V. PANFILOV 1997-03-28

MODELLING THE GENESIS AND PROPAGATION OF ELECTRICAL ACTIVITY IN THE HEART IN QUANTITATIVE TERMS IS ONE OF THE MOST IMPORTANT RECENT APPLICATIONS OF MATHEMATICAL MODELLING IN BIOLOGY. THE MAIN RESEARCH DIRECTION, AND THE MOST IMPORTANT FOR BIOLOGICAL AND MEDICAL APPLICATIONS, IS THE DEVELOPMENT OF REALISTIC MODELS OF ELECTRICAL ACTIVITY IN CARDIAC TISSUE AND THE WHOLE MAMMALIAN HEART. RECENT PROGRESS IN NONLINEAR DYNAMICS, ADVANCES IN COMPUTER TECHNOLOGY AND EXPERIMENTS ON CARDIAC TISSUE HAVE MADE FEASIBLE THE CONSTRUCTION OF SUCH MODELS. COMPUTATIONAL BIOLOGY OF THE HEART IS THE FIRST BOOK TO PROVIDE A COMPREHENSIVE SURVEY OF RECENT RESEARCH TOGETHER WITH A SYSTEMATIC OVERVIEW OF THE SUBJECT. THE CONTRIBUTIONS, ALL WRITTEN BY EXPERTS IN THE DIFFERENT AREAS OF THE SUBJECT, COVER ALL MAIN ASPECTS OF WHOLE HEART MODELLING: FROM EXCITATION IN SINGLE CELLS, TO TWO AND THREE DIMENSIONAL MODELS OF CARDIAC TISSUE AND THE WHOLE HEART. VARIOUS COMPUTATIONAL MODELS AND TECHNIQUES ARE DESCRIBED AND THEN APPLIED TO RECONSTRUCT AND VISUALISE MODELLED ACTIVITY IN BOTH NORMAL AND PATHOLOGICAL HEART TISSUES. THE MODELS ARE NONLINEAR AND USE TECHNIQUES OF ORDINARY DIFFERENTIAL EQUATIONS, PARTIAL DIFFERENTIAL EQUATIONS AND EIKONAL EQUATIONS. THE BOOK ALSO PROVIDES A REVIEW OF MODELLING CARDIAC CONTRACTION, MAPPING ELECTRICAL ACTIVITY FROM ELECTROCARDIOGRAMS, AND RECENT EXPERIMENTAL OBSERVATIONS OF WAVE PROPAGATION IN THE WHOLE HEART. GRADUATE STUDENTS AND RESEARCHERS IN SUCH AREAS AS APPLIED MATHEMATICAL BIOLOGY, CLINICAL PHYSIOLOGY AND CARDIOLOGY WILL FIND THIS BOOK TO BE AN INVALUABLE RESOURCE FOR THEIR WORK. ANATOMY AND PHYSIOLOGY OF THE CIRCULATORY AND VENTILATORY SYSTEMS - MARC THIRIET 2013-11-27

TOGETHER, THE VOLUMES IN THIS SERIES PRESENT ALL OF THE DATA NEEDED AT VARIOUS LENGTH SCALES FOR A MULTIDISCIPLINARY APPROACH TO MODELING AND SIMULATION OF FLOWS IN THE CARDIOVASCULAR AND VENTILATORY SYSTEMS, ESPECIALLY MULTISCALE MODELING AND COUPLED SIMULATIONS. THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS ARE TIGHTLY COUPLED, AS THEIR PRIMARY FUNCTION IS TO SUPPLY OXYGEN TO, AND REMOVE CARBON DIOXIDE FROM, THE BODY'S CELLS. BECAUSE PHYSIOLOGICAL CONDUITS HAVE DEFORMABLE AND REACTIVE WALLS, MACROSCOPIC FLOW BEHAVIOR AND PREDICTION MUST BE COUPLED TO NANO- AND MICROSCOPIC EVENTS IN A CORRECTOR SCHEME OF REGULATED MECHANISM. THEREFORE, INVESTIGATION OF FLOWS OF BLOOD AND AIR IN PHYSIOLOGICAL CONDUITS REQUIRES AN UNDERSTANDING OF THE BIOLOGY, CHEMISTRY, AND PHYSICS OF THESE SYSTEMS, TOGETHER WITH THE MATHEMATICAL TOOLS TO DESCRIBE THEIR FUNCTIONING IN QUANTITATIVE TERMS. THE PRESENT VOLUME FOCUSES ON MACROSCOPIC ASPECTS OF THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS IN NORMAL CONDITIONS, I.E., ANATOMY AND PHYSIOLOGY, AS WELL AS THE ACQUISITION AND PROCESSING OF MEDICAL IMAGES AND PHYSIOLOGICAL SIGNALS.

**COMPLEX SYSTEMS IN BIOMEDICINE** - A. QUARTERONI 2007-03-20

MATHEMATICAL MODELING OF HUMAN PHYSIOLOGY IS A TREMENDOUSLY AMBITIOUS TASK. IT ENCOMPASSES THE MODELING OF MOST DIVERSE COMPARTMENTS SUCH AS THE CARDIOVASCULAR, RESPIRATORY, SKELETAL AND NERVOUS SYSTEMS, AS WELL AS THE MECHANICAL AND BIOCHEMICAL INTERACTION BETWEEN BLOOD FLOW AND ARTERIAL WALLS, AND ELECTROCARDIAC PROCESSES AND ELECTRIC CONDUCTION IN BIOLOGICAL TISSUES. MATHEMATICAL MODELS CAN BE SET UP TO SIMULATE BOTH VASCULOGENESIS (THE AGGREGATION AND ORGANIZATION OF ENDOTHELIAL CELLS DISPERSED IN A GIVEN ENVIRONMENT) AND ANGIOGENESIS (THE FORMATION OF NEW VESSELS SPROUTING FROM AN EXISTING VESSEL) THAT ARE RELEVANT TO THE FORMATION OF VASCULAR NETWORKS, AND IN PARTICULAR TO THE DESCRIPTION OF TUMOR GROWTH. THE INTEGRATION OF MODELS AIMED AT SIMULATING THE COOPERATION AND INTERRELATION OF DIFFERENT SYSTEMS IS AN EVEN MORE DIFFICULT TASK. IT CALLS FOR THE SETTING UP OF, FOR INSTANCE, INTERACTION MODELS FOR THE INTEGRATED CARDIOVASCULAR SYSTEM AND THE INTERPLAY BETWEEN THE CENTRAL CIRCULATION AND PERIPHERAL COMPARTMENTS, MODELS FOR THE MID-TO-LONG RANGE CARDIOVASCULAR ADJUSTMENTS TO PATHOLOGICAL CONDITIONS (E.G., TO ACCOUNT FOR SURGICAL INTERVENTIONS, CONGENITAL MALFORMATIONS, OR TUMOR GROWTH), MODELS FOR INTEGRATION AMONG CIRCULATION, TISSUE PERFUSION, BIOCHEMICAL AND THERMAL REGULATION, MODELS FOR PARAMETER IDENTIFICATION AND SENSITIVITY ANALYSIS TO PARAMETER CHANGES OR DATA UNCERTAINTY – AND MANY OTHERS.

**DEVELOPMENTS AND APPLICATIONS FOR ECG SIGNAL PROCESSING** - JOAO PAULO DO VALE MADEIRO 2018-11-29

DEVELOPMENTS AND APPLICATIONS FOR ECG SIGNAL PROCESSING: MODELING, SEGMENTATION, AND PATTERN RECOGNITION COVERS RELIABLE TECHNIQUES FOR ECG SIGNAL PROCESSING AND THEIR POTENTIAL TO SIGNIFICANTLY INCREASE THE APPLICABILITY OF ECG USE IN DIAGNOSIS. THIS BOOK DETAILS A WIDE RANGE OF CHALLENGES IN THE PROCESSES OF ACQUISITION, PREPROCESSING, SEGMENTATION, MATHEMATICAL MODELLING AND PATTERN RECOGNITION IN ECG SIGNALS, PRESENTING PRACTICAL AND ROBUST SOLUTIONS BASED ON DIGITAL SIGNAL PROCESSING TECHNIQUES. USERS WILL FIND THIS TO BE A COMPREHENSIVE RESOURCE THAT CONTRIBUTES TO RESEARCH ON THE AUTOMATIC ANALYSIS OF ECG SIGNALS AND EXTENDS RESOURCES RELATING TO RAPID AND ACCURATE DIAGNOSES, PARTICULARLY FOR LONG-TERM SIGNALS. CHAPTERS COVER CLASSICAL AND MODERN FEATURES SURROUNDING ECG SIGNALS, ECG SIGNAL ACQUISITION SYSTEMS, TECHNIQUES FOR NOISE SUPPRESSION FOR ECG SIGNAL PROCESSING, A DELINEATION OF THE QRS COMPLEX, MATHEMATICAL MODELLING OF T- AND P-WAVES, AND THE AUTOMATIC CLASSIFICATION OF HEARTBEATS. GIVES COMPREHENSIVE COVERAGE OF ECG SIGNAL PROCESSING PRESENTS DEVELOPMENT AND PARAMETRIZATION TECHNIQUES FOR ECG SIGNAL ACQUISITION SYSTEMS ANALYZES AND COMPARES DISTORTIONS CAUSED BY DIFFERENT DIGITAL FILTERING TECHNIQUES FOR NOISE SUPPRESSION APPLIED OVER THE ECG SIGNAL DESCRIBES HOW TO IDENTIFY IF A DIGITIZED ECG SIGNAL PRESENTS IRREVERSIBLE DISTORTION THROUGH ANALYSIS OF ITS FREQUENCY COMPONENTS PRIOR TO, AND AFTER, FILTERING

CONSIDERS HOW TO ENHANCE QRS COMPLEXES AND DIFFERENTIATE THESE FROM ARTEFACTS, NOISE, AND OTHER CHARACTERISTIC WAVES UNDER DIFFERENT SCENARIOS  
MATHEMATICAL MODELLING OF THE HUMAN CARDIOVASCULAR SYSTEM - ALFIO QUARTERONI 2019-05-09

ADDRESSES THE MATHEMATICAL AND NUMERICAL MODELLING OF THE HUMAN CARDIOVASCULAR SYSTEM, FROM PATIENT DATA TO CLINICAL APPLICATIONS.

UNDERSTANDING ATRIAL FIBRILLATION - LUCA MAINARDI 2022-05-31

THE BOOK PRESENTS RECENT ADVANCES IN SIGNAL PROCESSING TECHNIQUES FOR MODELING, ANALYSIS, AND UNDERSTANDING OF THE HEART'S ELECTRICAL ACTIVITY DURING ATRIAL FIBRILLATION. THIS ARRHYTHMIA IS THE MOST COMMONLY ENCOUNTERED IN CLINICAL PRACTICE AND ITS COMPLEX AND METAMORPHIC NATURE REPRESENTS A CHALLENGING PROBLEM FOR CLINICIANS, ENGINEERS, AND SCIENTISTS. RESEARCH ON ATRIAL FIBRILLATION HAS STIMULATED THE DEVELOPMENT OF A WIDE RANGE OF SIGNAL PROCESSING TOOLS TO BETTER UNDERSTAND THE MECHANISMS RULING ITS INITIATION, MAINTENANCE, AND TERMINATION. THIS BOOK PROVIDES UNDERGRADUATE AND GRADUATE STUDENTS, AS WELL AS RESEARCHERS AND PRACTICING ENGINEERS, WITH AN OVERVIEW OF TECHNIQUES, INCLUDING TIME DOMAIN TECHNIQUES FOR ATRIAL WAVE EXTRACTION, TIME-FREQUENCY ANALYSIS FOR EXPLORING WAVE DYNAMICS, AND NONLINEAR TECHNIQUES TO CHARACTERIZE THE VENTRICULAR RESPONSE AND THE ORGANIZATION OF ATRIAL ACTIVITY. THE BOOK INCLUDES AN INTRODUCTORY CHAPTER ABOUT ATRIAL FIBRILLATION AND ITS MECHANISMS, TREATMENT, AND MANAGEMENT. THE SUCCESSIVE CHAPTERS ARE DEDICATED TO THE ANALYSIS OF ATRIAL SIGNALS RECORDED ON THE BODY SURFACE AND TO THE QUANTIFICATION OF VENTRICULAR RESPONSE. THE REST OF THE BOOK EXPLORES TECHNIQUES TO CHARACTERIZE ENDO- AND EPICARDIAL RECORDINGS AND TO MODEL ATRIAL CONDUCTION. UNDER THE APPEARANCE OF BEING A MONOTHEMATIC BOOK ON ATRIAL FIBRILLATION, THE READER WILL NOT ONLY RECOGNIZE COMMON PROBLEMS OF BIOMEDICAL SIGNAL PROCESSING BUT ALSO DISCOVER THAT ANALYSIS OF ATRIAL FIBRILLATION IS A UNIQUE CHALLENGE FOR DEVELOPING AND TESTING NOVEL SIGNAL PROCESSING TOOLS. TABLE OF CONTENTS: ANALYSIS OF VENTRICULAR RESPONSE DURING ATRIAL FIBRILLATION / ORGANIZATION MEASURES OF ATRIAL ACTIVITY DURING FIBRILLATION / MODELING ATRIAL FIBRILLATION: FROM MYOCARDIAL CELLS TO ECG / ALGORITHMS FOR ATRIAL TACHYARRHYTHMIA DETECTION FOR LONG-TERM MONITORING WITH IMPLANTABLE DEVICES

**COMPUTATIONAL MODELING IN BIOMEDICAL ENGINEERING AND MEDICAL PHYSICS** - ALEXANDRU MOREGA 2020-09-15

MATHEMATICAL AND NUMERICAL MODELLING OF ENGINEERING PROBLEMS IN MEDICINE IS AIMED AT UNVEILING AND UNDERSTANDING MULTIDISCIPLINARY INTERACTIONS AND PROCESSES AND PROVIDING INSIGHTS USEFUL TO CLINICAL CARE AND TECHNOLOGY ADVANCES FOR BETTER MEDICAL EQUIPMENT AND SYSTEMS. WHEN MODELLING MEDICAL PROBLEMS, THE ENGINEER IS CONFRONTED WITH MULTIDISCIPLINARY PROBLEMS OF ELECTROMAGNETISM, HEAT AND MASS TRANSFER, AND STRUCTURAL MECHANICS WITH, POSSIBLY, DIFFERENT TIME AND SPACE

SCALES, WHICH MAY RAISE CONCERNS IN FORMULATING CONSISTENT, SOLVABLE MATHEMATICAL MODELS. COMPUTATIONAL MEDICAL ENGINEERING PRESENTS A NUMBER OF ENGINEERING FOR MEDICINE PROBLEMS THAT MAY BE ENCOUNTERED IN MEDICAL PHYSICS, PROCEDURES, DIAGNOSIS AND MONITORING TECHNIQUES, INCLUDING ELECTRICAL ACTIVITY OF THE HEART, HEMODYNAMIC ACTIVITY MONITORING, MAGNETIC DRUG TARGETING, BIOHEAT MODELS AND THERMOGRAPHY, RF AND MICROWAVE HYPERTHERMIA, ABLATION, EMF DOSIMETRY, AND BIOIMPEDANCE METHODS. THE AUTHORS DISCUSS THE CORE APPROACH METHODOLOGY TO POSE AND SOLVE DIFFERENT PROBLEMS OF MEDICAL ENGINEERING, INCLUDING ESSENTIALS OF MATHEMATICAL MODELLING (E.G., CRITERIA FOR WELL-POSED PROBLEMS); PHYSICS SCALING (HOMOGENIZATION TECHNIQUES); CONSTRUCTAL LAW CRITERIA IN MORPHING SHAPE AND STRUCTURE OF SYSTEMS WITH INTERNAL FLOWS; COMPUTATIONAL DOMAIN CONSTRUCTION (CAD AND, OR RECONSTRUCTION TECHNIQUES BASED ON MEDICAL IMAGES); NUMERICAL MODELLING ISSUES, AND VALIDATION TECHNIQUES USED TO ASCERTAIN NUMERICAL SIMULATION RESULTS. IN ADDITION, NEW IDEAS AND VENUES TO INVESTIGATE AND UNDERSTAND FINER SCALE MODELS AND MERGE THEM INTO CONTINUOUS MEDIA MEDICAL PHYSICS ARE PROVIDED AS CASE STUDIES. PRESENTS THE FUNDAMENTALS OF MATHEMATICAL AND NUMERICAL MODELING OF ENGINEERING PROBLEMS IN MEDICINE DISCUSSES MANY OF THE MOST COMMON MODELLING SCENARIOS FOR BIOMEDICAL ENGINEERING, INCLUDING, ELECTRICAL ACTIVITY OF THE HEART HEMODYNAMIC ACTIVITY MONITORING, MAGNETIC DRUG TARGETING, BIOHEAT MODELS AND THERMOGRAPHY, RF AND MICROWAVE HYPERTHERMIA, ABLATION, EMF DOSIMETRY, AND BIOIMPEDANCE METHODS INCLUDES DISCUSSION OF THE CORE APPROACH METHODOLOGY TO POSE AND SOLVE DIFFERENT PROBLEMS OF MEDICAL ENGINEERING, INCLUDING ESSENTIALS OF MATHEMATICAL MODELLING, PHYSICS SCALING, CONSTRUCTAL LAW CRITERIA IN MORPHING SHAPE AND STRUCTURE OF SYSTEMS WITH INTERNAL FLOWS, COMPUTATIONAL DOMAIN CONSTRUCTION, NUMERICAL MODELLING ISSUES, AND VALIDATION TECHNIQUES USED TO ASCERTAIN NUMERICAL SIMULATION RESULTS

**AN INTRODUCTION TO MATHEMATICAL MODELING IN PHYSIOLOGY, CELL BIOLOGY, AND IMMUNOLOGY** - JAMES SNEYD

IN MANY RESPECTS, BIOLOGY IS THE NEW FRONTIER FOR APPLIED MATHEMATICIANS. THIS BOOK DEMONSTRATES THE IMPORTANT ROLE MATHEMATICS PLAYS IN THE STUDY OF SOME BIOLOGICAL PROBLEMS. IT INTRODUCES MATHEMATICIANS TO THE BIOLOGICAL SCIENCES AND PROVIDES ENOUGH MATHEMATICS FOR BIOSCIENTISTS TO APPRECIATE THE UTILITY OF THE MODELLING APPROACH. THE BOOK PRESENTS A NUMBER OF DIVERSE TOPICS, SUCH AS NEUROPHYSIOLOGY, CELL BIOLOGY, IMMUNOLOGY, AND HUMAN GENETICS. IT EXAMINES HOW RESEARCH IS DONE, WHAT MATHEMATICS IS USED, WHAT THE OUTSTANDING QUESTIONS ARE, AND HOW TO ENTER THE FIELD. ALSO GIVEN IS A BRIEF HISTORICAL SURVEY OF EACH TOPIC, PUTTING CURRENT RESEARCH INTO PERSPECTIVE. THE BOOK IS SUITABLE FOR MATHEMATICIANS AND BIOLOGISTS INTERESTED IN MATHEMATICAL METHODS IN BIOLOGY.

**FUNCTIONAL IMAGING AND MODELING OF THE HEART** - FRANK B. SACHSE 2007-07-10

THIS BOOK CONSTITUTES THE REFEREED PROCEEDINGS OF THE 4TH INTERNATIONAL

CONFERENCE ON FUNCTIONAL IMAGING AND MODELING OF THE HEART, FIMH 2007, HELD IN SALT LAKE CITY, UT, USA IN JUNE 2007. THE CONTRIBUTIONS DESCRIBE BOTH EXPERIMENTAL AND COMPUTATIONAL STUDIES AND COVER TOPICS SUCH AS IMAGING AND IMAGE ANALYSIS, CARDIAC ELECTROPHYSIOLOGY, ELECTRO- AND MAGNETOCARDIOGRAPHY, CARDIAC MECHANICS AND CLINICAL APPLICATION, IMAGING AND ANATOMICAL MODELING.

**COMPUTING THE ELECTRICAL ACTIVITY IN THE HEART** - JOAKIM SUNDNES 2007-06-26

THIS BOOK DESCRIBES MATHEMATICAL MODELS AND NUMERICAL TECHNIQUES FOR SIMULATING THE ELECTRICAL ACTIVITY IN THE HEART. IT GIVES AN INTRODUCTION TO THE MOST IMPORTANT MODELS, FOLLOWED BY A DETAILED DESCRIPTION OF NUMERICAL TECHNIQUES. PARTICULAR FOCUS IS ON EFFICIENT NUMERICAL METHODS FOR LARGE SCALE SIMULATIONS ON BOTH SCALAR AND PARALLEL COMPUTERS. THE RESULTS PRESENTED IN THE BOOK WILL BE OF PARTICULAR INTEREST TO RESEARCHERS IN BIOENGINEERING AND COMPUTATIONAL BIOLOGY.

**MODELING AND SIMULATING CARDIAC ELECTRICAL ACTIVITY** - TRINE KROGH-MADSEN 2020-12-03

THIS BOOK PROVIDES A THOROUGH INTRODUCTION TO THE TOPIC OF MATHEMATICAL MODELING OF ELECTRICAL ACTIVITY IN THE HEART, FROM MOLECULAR DETAILS OF IONIC CHANNEL DYNAMICS TO CLINICALLY DERIVED PATIENT-SPECIFIC MODELS. IT DISCUSSES HOW CELLULAR IONIC MODELS ARE FORMULATED, INTRODUCES COMMONLY USED MODELS AND EXPLAINS WHY THERE ARE SO MANY DIFFERENT MODELS AVAILABLE. THE CHAPTERS COVER MODELING OF THE INTRACELLULAR CALCIUM HANDLING THAT UNDERLIES CELLULAR CONTRACTION AS WELL AS MODELING MOLECULAR-LEVEL DETAILS OF CARDIAC ION CHANNELS, AND SPECIALIZED TOPICS SUCH AS CARDIOMYOCYTE ENERGETICS AND SIGNALLING PATHWAYS. IT IS AN EXCELLENT RESOURCE FOR EXPERIENCED AND SPECIALIZED RESEARCHERS IN THE FIELD, BUT ALSO BIOLOGICAL SCIENTISTS WITH A LIMITED BACKGROUND IN MATHEMATICAL MODELLING AND COMPUTATIONAL METHODS. KEY FEATURES THOROUGH INTRODUCTION TO THE TOPIC OF MATHEMATICAL MODELING OF ELECTRICAL ACTIVITY IN THE HEART FOCUSES ON USE OF EXPERIMENTAL DATA IN MATHEMATICAL MODELING, AND ON EXPLANATIONS RATHER THAN EQUATIONS IN ADDITION TO BEING EXPERTS IN THE FIELD, THE CONTRIBUTING AUTHORS ARE EXPERT SCIENCE COMMUNICATORS

**MATHEMATICAL MODELS FOR DIRECT AND INVERSE SOLUTIONS OF THE ELECTRICAL ACTIVITY OF HEART (MICROFILM)** - S.I. AHMAD 1970

**HANDBOOK OF PHYSICS IN MEDICINE AND BIOLOGY** - ROBERT SPLINTER 2010-04-05

IN CONSIDERING WAYS THAT PHYSICS HAS HELPED ADVANCE BIOLOGY AND MEDICINE, WHAT TYPICALLY COMES TO MIND ARE THE VARIOUS TOOLS USED BY RESEARCHERS AND CLINICIANS. WE THINK OF THE OPTICS PUT TO WORK IN MICROSCOPES, ENDOSCOPES, AND LASERS; THE ADVANCED DIAGNOSTICS PERMITTED THROUGH MAGNETIC, X-RAY, AND ULTRASOUND IMAGING; AND EVEN THE NANOTOOLS, THAT ALLOW US TO TINKER WITH MOLECULES. WE BUILD THESE INSTRUMENTS IN ACCORDANCE WITH THE CLOSEST THING TO ABSOLUTE TRUTHS WE KNOW, THE LAWS OF PHYSICS, BUT SELDOM DO WE APPLY THOSE SAME CONSTANTS OF PHYSICS TO

THE STUDY OF OUR OWN CARBON-BASED BEINGS, SUCH AS FLUIDICS APPLIED TO THE FLOW OF BLOOD, OR THE LAWS OF MOTION AND ENERGY APPLIED TO WORKING MUSCLE. INSTEAD OF CONSIDERING ONE ASPECT OR THE OTHER, HANDBOOK OF PHYSICS IN MEDICINE AND BIOLOGY EXPLORES THE FULL GAMUT OF PHYSICS' RELATIONSHIP TO BIOLOGY AND MEDICINE IN MORE THAN 40 CHAPTERS, WRITTEN BY EXPERTS FROM THE LAB TO THE CLINIC. THE BOOK BEGINS WITH A BASIC DESCRIPTION OF SPECIFIC BIOLOGICAL FEATURES AND DELVES INTO THE PHYSICS OF EXPLICIT ANATOMICAL STRUCTURES STARTING WITH THE CELL. LATER CHAPTERS LOOK AT THE BODY'S SENSES, ORGANS, AND SYSTEMS, CONTINUING TO EXPLAIN BIOLOGICAL FUNCTIONS IN THE LANGUAGE OF PHYSICS. THE TEXT THEN DETAILS VARIOUS ANALYTICAL MODALITIES SUCH AS IMAGING AND DIAGNOSTIC METHODS. A FINAL SECTION TURNS TO FUTURE PERSPECTIVES RELATED TO TISSUE ENGINEERING, INCLUDING THE BIOPHYSICS OF

PROSTHESES AND REGENERATIVE MEDICINE. THE EDITOR'S APPROACH THROUGHOUT IS TO ADDRESS THE MAJOR HEALTHCARE CHALLENGES, INCLUDING TISSUE ENGINEERING AND REPRODUCTIVE MEDICINE, AS WELL AS DEVELOPMENT OF ARTIFICIAL ORGANS AND PROSTHETIC DEVICES. THE CONTENTS ARE ORGANIZED BY ORGAN TYPE AND BIOLOGICAL FUNCTION, WHICH IS GIVEN A CLEAR DESCRIPTION IN TERMS OF ELECTRIC, MECHANICAL, THERMODYNAMIC, AND HYDRODYNAMIC PROPERTIES. IN ADDITION TO THE PHYSICAL DESCRIPTIONS, EACH CHAPTER DISCUSSES PRINCIPLES OF RELATED CLINICAL DIAGNOSTIC METHODS AND TECHNOLOGICAL ASPECTS OF THERAPEUTIC APPLICATIONS. THE FINAL SECTION ON REGENERATIVE ENGINEERING, EMPHASIZES BIOCHEMICAL AND PHYSIOCHEMICAL FACTORS THAT ARE IMPORTANT TO IMPROVING OR REPLACING BIOLOGICAL FUNCTIONS. CHAPTERS COVER MATERIALS USED FOR A BROAD RANGE OF APPLICATIONS ASSOCIATED WITH THE REPLACEMENT OR REPAIR OF TISSUES OR ENTIRE TISSUE STRUCTURES.