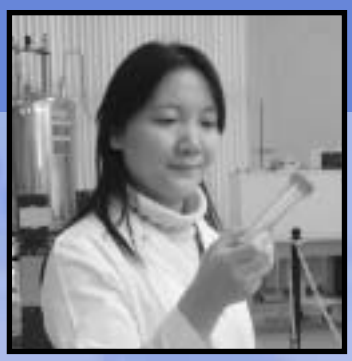

BIOMEDICAL ENGINEERING

(Joint program with The University of Texas at Arlington)

CHAIR, GRADUATE PROGRAM

Peter P. Antich, Ph.D.

DEGREES OFFERED

Doctor of Philosophy
Master of Science

FACULTY AND RESEARCH INTERESTS

Thiru M. Annaswamy, Associate Professor
M.D., Mysore Medical College, India, 1992
Physical medicine and rehabilitation; motor control; neuroscience.

Peter P. Antich, Professor
Ph.D., Johns Hopkins University, 1971
Molecular imaging; Alzheimer's disease; tumor stem cells; bone biophysics.

Richard W. Briggs, Professor
Ph.D., University of Arkansas at Fayetteville,1978
Integrated functional brain imaging using fMRI, EEG; NIR optical imaging, MR spectroscopy and diffusion/perfusion imaging applied to Gulf War illness, stroke, Alzheimer's disease, traumatic brain injury and other diseases and pathologies.

Spencer Brown, Associate Professor
Ph.D., University of Pennsylvania, 1984
Wound healing; fat metabolism; biological signaling (cytokines, growth factors); microdialysis; ultramicro-protein metabolism.

Jeffrey A. Cadeddu, Professor
M.D., Johns Hopkins University, 1993
Urology: laporoscopy, telesurgical mentoring.

Roger Chan, Associate Professor
Ph.D., University of Iowa, 1988
Acoustics, biomechanics and physiology of speech and voice production; tissue engineering of the vocal fold.

Sergey Cheshkov, Assistant Professor
Ph.D., University of Texas at Austin, 2001
Magnetic resonance spectroscopy and chemical shift imaging; multimodal imaging (fMRI, EEG, DTI); Gulf War syndrome.

Michael D. Devous, Professor
Ph.D., Texas A&M University, 1976
Psychiatric and neurologic disorders; PET; SPECT.

J. Michael DiMaio, Professor
M.D., University of Miami, 1987
Measures to reduce death and disability from ASHD; cardiac regeneration.

Robert C. Eberhart, Professor
Ph.D., University of California, Berkeley, 1965
Biomaterials; circulatory-assist devices.

Thomas Ferree, Assistant Professor
Ph.D., University of Colorado, 1992
Physiological signal processing; integrated EEG and fMRI; modeling neural oscillations; cognitive neuroscience.

Maureen A. Finnegan, Associate Professor
M.D., University of British Columbia, Canada, 1974
Orthopaedics.

Kaundinya Gopinath, Assistant Professor
Ph.D., University of Florida, 2003
fMRI.

Frederick Grinnell, Professor
Ph.D., Tufts University School of Medicine, 1970
Cell migration and extracellular matrix organization; tissue engineering and biomaterials; wound repair.

Nick V. Grishin, Associate Professor
Ph.D., UT Southwestern Medical Center, 1998
Computational biology; analysis of protein sequences and structures.

Herbert K. Hagler, Professor
Ph.D., Southern Methodist University, 1975
Analytical electron microscopy.

Donald W. Hilgemann, Professor
Ph.D., University of Tübingen, Germany, 1980
Membrane transporters and membrane transport; the processes of endo- and exocytosis.

Connie C.W. Hsia, Professor
M.D., University of Toronto Faculty of Medicine, 1982
Heart-lung interaction; lung morphometry; structure-function correlation of lung growth.

Chou-Long Huang, Professor
M.D., Taipei Medical University, Taiwan, 1981; Ph.D., University of California, San Francisco, 1988
Ion channels and human diseases caused by dysregulation of ion channels, including hypertension, polycystic kidney disease, kidney stone disease, and genetic diseases of K+ and Mg2+ disorder.

Michael E. Jessen, Professor
M.D., University of Manitoba, Canada, 1981
Circulatory-assist devices; cardiac metabolism.

Robert L. Johnson Jr., Professor
M.D., Northwestern University, 1951
Pulmonary and critical care.

Nitin J. Karandikar, Associate Professor
M.D., University of Pune, India, 1990; Ph.D., Northwestern University, 1997
Immunology of multiple sclerosis/autoimmune demyelination; immune responses to HCV infections; allodepletion to prevent graft-versus-host disease; immune regulation by T cells.

Steven G. Kernie, Associate Professor
M.D., University of Washington School of Medicine, 1992
Neural stem cells in traumatic brain injury; hippocampal development.

Vikram Kodibagkar, Assistant Professor
Ph.D., Washington University, St. Louis, 1997
Magnetic resonance physics and imaging; computational methods in imaging.

Padmakar V. Kulkarni, Professor
Ph.D., Rensselaer Polytechnic Institute, 1973
Nuclear chemistry.

Matthew A. Lewis, Assistant Professor
Ph.D., UT Southwestern Medical Center, 2002
Acoustic inverse scattering for breast sonography; task-based inverse methods; ultrasonic assessment of the bone elasticity tensor; microSPECT and bioluminescent tomography; biomedical compressive sensing and sparsity.

Wen-Hong Li, Associate Professor
Ph.D., University of California, San Diego, 1996
MRI contrast agents; novel reporters of metabolic processes; fluorescence techniques.

Hanzhang Lu, Assistant Professor
Ph.D., Johns Hopkins University, 2004
Perfusion MRI; fMRI; cerebrovascular physiology; diffusion MRI; MR physics and pulse sequence design.

Kevin Luebke, Assistant Professor
Ph.D., California Institute of Technology, 1992
Genetics and genetic analysis.

Craig R. Malloy, Professor
M.D., University of California, San Francisco, 1977
Carbon-13 NMR spectroscopy for analysis of intermediary metabolism; analysis of metabolism in intact tissues by NMR spectroscopy; development of new methods to understand metabolic processes in functioning cells.

Ralph P. Mason, Professor
Ph.D., University of Cambridge, England, 1986
19F NMR, PET-MR, MRI, pO2; pH, bone trabecular architecture; prostate and breast tumors; myocardial ischemia, blood flow, bold MRI, fMRI.

Roderick W. McColl, Associate Professor
Ph.D., University of Warwick, England, 1992
fMRI; DICOM.

Jere H. Mitchell, Professor
M.D., UT Southwestern Medical Center, 1954
Cardiovascular physiology.

Ohwofiemu Nwariaku, Associate Professor
M.D., University of Ibadan, Nigeria, 1987
Drug delivery to tumors; tumor vascular endothelium in thyroid cancer.

Zbyszek Otwinowski, Professor
Ph.D., University of Chicago, 1989
Crystallography; protein folding.

Lech Papiez, Associate Professor
Silesian University, Poland, 1977
Cranial and extracranial radiosurgery; SBRT; optimization of IMRT delivery in the presence of motion of body anatomy; development of very-high-energy electron-beam radiation therapy.

Karen Pawlowski, Assistant Professor
Ph.D., University of Texas at Dallas, 2000
Cellular mechanisms involved in sensory neural hearing loss; biomedical engineering technologies applied to the temporal bone and auditory system; role of biofilms in chronic recurrent infections of the temporal bone.

Ronald M. Peshock, Professor
M.D., UT Southwestern Medical Center, 1976
MRI.

W. Matthew Petroll, Professor
Ph.D., University of Virginia, 1989
Wound healing; confocal microscopy.

A. Dean Sherry, Professor
Ph.D., Kansas State University, 1971
Biomedical magnetic resonance techniques; applications of 13C NMR to study intermediary metabolism; lanthanide-based MRI contrast agents, 23Na paramagnetic shift agents and lanthanide-macrocyclic complexes.

Scott Smith, Associate Professor
Ph.D., University of North Texas Health Science Center, 1999
Neural and humoral mechanisms regulating the abnormal cardiovascular response to exercise in heart failure and hypertension.

Xiankai Sun, Assistant Professor
Ph.D., University of New Hampshire, 2000
Development of PET/SPECT imaging probes to assess biological abnormalities.

Philip J. Thomas, Professor
Ph.D., University of South Dakota, 1988
Physical basis of membrane protein folding; molecular mechanisms for cellular quality control of membrane protein maturation; structure and function of ATP-dependent transporters and channels.

Gaylord S. Throckmorton, Professor
Ph.D., University of Chicago Pritzker School of Medicine, 1974
Craniofacial biomechanics.

Ellen S. Vitetta, Professor
Ph.D., New York University School of Medicine, 1968
Antibody-based therapies; cancer dormancy; vaccines; nanotechnology.

E. Sally Ward, Professor
Ph.D., University of Cambridge, England, 1985
Genetic manipulation and structure/function studies of antibodies and T-cell receptors; T cell-mediated autoimmunity.

Masashi Yanagisawa, Professor
M.D., Ph.D., University of Tsukuba, Japan, 1985, 1988
Molecular genetics of sleep/wake regulation; orphan GPCRs and their neuropeptide ligands.

UT ARLINGTON FACULTY

George Alexandrakis, Assistant Professor
Ph.D., McMaster University, Canada, 2000
Medical imaging.

Gaik Ambartsoumian, Assistant Professor
Ph.D., Texas AS&M University, 2006
Inverse problems; computerized tomography; integral geometry; mathematical problems of imaging.

Khosrow Behbehani, Professor
Ph.D., University of Toledo, 1979
Signal processing; control theory; instrumentation.

Charles C.J. Chuong, Professor
Ph.D., University of California, San Diego, 1981
Cardiovascular and pulmonary biomechanics; extracorporeal shock-wave lithotripsy; finite element applications in biomechanics.

Digant Davé, Assistant Professor
Ph.D., Texas A&M University, 1994
Optical observance tomography; new methods in optical imaging and detection of biomolecules.

Ronald L. Elsenbaumer, Professor
Ph.D., Stanford University, 1978
Biomaterials/polymers.

Jean Gao, Assistant Professor
Ph.D., Purdue University, 2002
Computer vision and pattern recognition (biometrics, video object tracking); video sensor network; bioinformatics (gene expression/protein expression microarray analysis, mass spectrometry for proteomics); molecular/cellular image processing; image/video processing; statistical machine learning; data mining.

George V. Kondraske, Professor
Ph.D., University of Texas at Arlington and UT Southwestern Medical Center, 1982
Human performance theory and instrumentation.

Hanli Liu, Professor
Ph.D., Wake Forest University, 1994
Bioinstrumentation; biomedical optics for tissue characteristics; tumor diagnosis; medical imaging using near infrared light.

Michael T. Manry, Professor
Ph.D., University of Texas at Austin, 1976
Signal/image processing; estimation theory; neural networks.

Kytai Nguyen, Assistant Professor
Ph.D., Rice University, 2000
Molecular and cellular engineering; tissue engineering; drug delivery systems, including micro- and nanoparticles; cell-material interactions; effects of biomechanical

and biochemical factors on vascular cells; mechanisms of cancer metastasis.

Lynn L. Peterson, Associate Dean of Engineering for Academic Affairs
Ph.D., UT Southwestern Medical Center, 1978
Knowledge representation; artificial intelligence applications; medical computer science.

Mario Romero-Ortega, AssociateProfessor
Ph.D., Tulane University, 1997
Nerve development and injury repair; enticing nerve growth through gene transfer; peripheral nerve repair.

Liping Tang, Professor
Ph.D., University of Minnesota, 1992
Biomaterials; tissue engineering.

Richard B. Timmons, Professor
Ph.D., Catholic University of America, 1962
Biomaterials.

Jian Yang, Assistant Professor
Ph.D., Institute of Chemistry, Chinese Academy of Science, 2002
Methodology of novel biomaterial development; tissue engineering; orthopaedic devices; drug delivery; nanotechnology.

Karel Zuzak, Assistant Professor
Ph.D., University of Minnesota, 1998
Optical imaging; hyperspectal imaging and spectral deconvolution.

ADJUNCT FACULTY

Jeannette E. Ahrens, Adjunct Instructor, Institute for Spine and Biomedical Research, Plano, Texas
Ph.D., Tulane University, 1995
Spinal disorders.

Kenneth R. Diller, Adjunct Professor, University of Texas at Austin
Sc.D., Massachusetts Institute of Technology, 1972
Bioheat transfer.

Vladislav S. Markin, Adjunct Professor
Ph.D., Academy of Science of the USSR, Russia, 1964; D.Sc., Moscow Institute of Engineering Physics, 1976
Biophysics of membranes.

Raimund Ober, Adjunct Professor, University of Texas at Dallas
Ph.D., University of Cambridge, England, 1987
Developing quantitative techniques for imaging at the molecular level.

David B. Wallace, Vice President, Technology Development, MicroFab Technologies, Plano
Ph.D., University of Texas at Arlington, 1987
Bioinstrumentation and human performance; microfabrication for medical treatment.

Jihong Wang, Adjunct Associate Professor
Ph.D., University of Colorado at Boulder, 1994
Human perception and viewing environment optimization in radiology; picture archiving and communication system and fMRI research.

OBJECTIVES

Biomedical engineering is an interdisciplinary science that employs the engineering method to define and solve life-science problems, with primary emphasis on the development of advanced procedures for the detection, diagnosis and treatment of disease and disability. The Joint Program

in Biomedical Engineering is administered by UT Southwestern Graduate School of Biomedical Sciences and The University of Texas at Arlington. The objective of the program is to prepare individuals for distinguished careers in biomedical engineering research, teaching and practice.

The program coordinates research and teaching activities of many departments on both the medical center and UT Arlington campuses. The faculty listed at UT Southwestern represent the departments of Anesthesiology and Pain Management, Biochemistry, Cardiovascular and Thoracic Surgery, Cell Biology, Internal Medicine, Ophthalmology, Orthopaedic Surgery, Otolaryngology – Head and Neck Surgery, Pathology, Physical Medicine and Rehabilitation, Physiology, Radiation Oncology, Radiology, Surgery, and Urology. In short, strong interactions of engineering students with clinical and basic science departments are provided. Graduate study and research are offered in the areas of artificial organs, bioheat transfer, biomaterials, biomedical instrumentation, biosensors, cardiopulmonary mechanics, medical computer engineering, medical imaging and image processing, protein engineering and biotechnology, orthopaedics (UTA only), neurosurgical instrumentation, and rehabilitation.

Course work is organized in seven tracks to support these research objectives: 1) bioinstrumentation and human performance; 2) biomaterials and tissue engineering; 3) biomechanics; 4) medical imaging; 5) molecular and computational biomedical engineering; 6) orthopaedics and 7) protein engineering. Research also may be carried out with faculty members in other medical centers and UT Arlington departments as appropriate.

Internships with local biomedical industry are offered to selected students at or near completion of the M.S. degree.

Facilities

Well-equipped research laboratories are available, reflecting the interests of the Biomedical Engineering faculty at UT Southwestern, UT Arlington and other affiliated institutions. Classrooms and graduate student office space exist on both campuses.

The Division of Biostatistics in the Department of Clinical Sciences at UT Southwestern supports interactive clinical information systems and real-time central laboratory automation. There are numerous laboratory computer work stations and computer classrooms available for student research and training at UT Southwestern and UT Arlington.

Requirements for Admission

The Joint Graduate Studies Committee in Biomedical Engineering (UT Southwestern/UT Arlington) constitutes the admissions committee for the program. Although students officially are enrolled at both institutions, application should be made to only one institution, chosen in accordance with individual preferences. This institution will be the applicant's "home" institution.

UT Southwestern Graduate School of Biomedical Sciences participates in cooperative degree programs with UT Arlington. Acceptance into a cooperative degree program is conditioned upon the understanding that institutional sponsorship of the program may change during the period of matriculation. If the sponsorship changes and the student's home institution is not then the sponsoring institution, this may subject the student to different policies and procedures. In addition, the identity of the institution or institutions officially granting the degree upon successful completion of the program will depend upon official sponsorship of the program at that time.

In addition to the admission requirements listed in the Admission section of Student Information, applicants for advanced degrees in biomedical engineering should have an undergraduate grade-point average of at least 3.0 in engineering, bioengineering or an allied discipline; three letters of recommendation; and a statement of personal objectives. International applicants must take the TOEFL examination. A strong additional focus on the biological sciences would be considered a plus.

While it is expected that most applicants will have an engineering background, applicants from other disciplines will be admitted but must remedy

deficiencies in course work while meeting the degree requirements.

Financial research support is available, generally in the form of a student research assistantship for students in good standing. A request for a graduate assistantship must be filed at the time of application for admission.

The deadline for application for fall admission is May 1.

CURRICULUM

Students in the Joint Program in Biomedical Engineering take courses at both UT Southwestern and UT Arlington appropriate to their individual tracks. Because of the interdisciplinary nature of the program, the courses listed in the Biomedical Engineering section of the catalog represent only a portion of the courses available. Students should consult the UT Arlington graduate catalog for a complete listing of engineering course offerings.

Students in the master's degree program must successfully defend a thesis.

DOCTORAL DEGREE

The Ph.D. degree course requirements are 48 didactic credit hours plus a minimum of 30 hours of research credit hours for all degree plans, with the exception of the protein engineering degree plan that requires 36 didactic credit hours, 42 credit hours of research and passage of Exams I, II and III. (Course numbers followed by an "A" indicate courses offered at UT Arlington.

LIFE SCIENCES (15 credit hours)

5306 Biochemistry
5309 Human Physiology
One life science elective

ENGINEERING (21 credit hours)

Six courses with one other engineering course in a different discipline*

COMPUTER SCIENCE, MATHEMATICS, STATISTICS AND PHYSICAL SCIENCES (6 credit hours)

Two courses*

BIOMEDICAL ENGINEERING (11 credit hours)

5101 Biomedical Engineering Seminar
6103 Doctoral Student Seminar in Biomedical Engineering
5344A Bioinstrumentation I
5382A Laboratory Principles
6194 Doctoral Diagnostic Examination (Exam I)
6195 Doctoral Research Proposal Examination (Exam II)
6397, 6697 or 6997 Doctoral Research in Biomedical Engineering
6399, 6699 or 6999 Dissertation Preparation and Defense (Exam III)

ELECTIVES (Three required for the Ph.D.*)

5331 Polymers in Biomedical Engineering
5360 Design and Application of Artificial Organs
5361 Biomaterials and Blood Compatibility
5362 Thermoregulation and Bioheat Transfer
5363 Digital Processing of Medical Images
5370 Biomaterial-Living Systems Interaction
5335A Biological Materials, Mechanics and Processes
5340A Finite Element Applications in Engineering
5345A Biosensors and Applications
5350A Modeling and Control of Biological Systems
5351A Digital Control of Biomedical Systems
5300, 5301 or 5302 Special Topics in Biomedical Engineering

*Written consent of graduate adviser required.

All doctoral students must pass three examinations (I, II and III). Exam I (6194) is a diagnostic exam, usually given following completion of the first year. It consists of a written examination, based on a broad problem in the area of the student's research track, and an oral examination to defend the written one. The oral exam also may cover areas of perceived weakness in the student's background. Exam II (6195) is for admission to candidacy for a Ph.D. It consists of a detailed written prospectus of the proposed dissertation research (6397, 6697 or 6997) and an oral examination. Exam III (6399, 6699 or 6999) is the final oral defense of the completed dissertation.

Master's Degree — Thesis Option

The master's degree thesis option (31 credit hours) consists of the following courses. (Those followed by an "A" indicate courses offered at UT Arlington.) Thesis defense is required. The student must register for six hours of research, which includes the thesis defense (5398, 5698 or 5998). Thesis defense replaces the M.S. comprehensive examination.

LIFE SCIENCES

5306 Biochemistry
5307 Human Anatomy Lecture
5309 Human Physiology

(5308 Human Anatomy Lab can be taken in conjunction with 5307 but does not stand alone.)

ENGINEERING

Five engineering courses (four must be BME)

BIOMEDICAL ENGINEERING

5101 Biomedical Engineering Seminar (one year, first year)
5344A Bioinstrumentation I
5382A Laboratory Principles

ELECTIVES

(Two required for the master's degree*)
5306 Biochemistry (or equivalent*)
The list of electives given for the doctoral program applies.

*Written consent of graduate adviser required.

Master's Degree — Thesis-Substitution Option

The master's degree thesis-substitution option (31 credit hours) is similar to the thesis option except 5191, 5291 or 5391 replaces 5398, 5698 or 5998 and a written master's comprehensive exam (5293) must be passed. This option is available only at UT Arlington.

Course Descriptions

The following courses represent only a portion of the relevant courses available on both campuses. Appropriate sections of this catalog and the catalog of UT Arlington should be consulted. The graduate adviser should be contacted for additional course offerings.

5101 BIOMEDICAL ENGINEERING SEMINAR

The various topics covered in this course are in multiple formats ranging from lectures by faculty or guest speakers to presentations by participating students. It is required for all students.

5300, 5301, 5302 SPECIAL TOPICS IN BIOMEDICAL ENGINEERING

Advanced studies in topics related to biomedical engineering, such as principles of animal surgery, molecular imaging and nuclear magnetic resonance instrumentation, are offered in this course. This course is given as an organized class or an independent study, as circumstances warrant. *Prerequisite:* program approval. Course may be repeated for credit when topics vary.

5306 BIOCHEMISTRY

Fundamental aspects of human biochemistry are introduced in this class. Topics include structure and intermediary metabolism of carbohydrates,

fats, proteins, nucleic acids, vitamins and minerals.

5307 HUMAN ANATOMY LECTURE
This course offers the lecture portion of a comprehensive study of the structure and function of human body systems and their mechanisms. Emphasis is placed on the major characteristics of each body system and on its function and relationship to other body systems.

5308 HUMAN ANATOMY LABORATORY
This course offers the dissection laboratory portion of a comprehensive study of the structure and function of human body systems and their mechanisms.
Prerequisite: 5307.

5309 HUMAN PHYSIOLOGY
This course offers a comprehensive study of the basic physiological principles dealing with body systems and their interrelationships.

5331 POLYMERS IN BIOMEDICAL ENGINEERING
This is a foundation course in polymeric biomaterial design, synthesis, characterization and processing. The topics include design, surface engineering, functionalization, characterization as well as micro- and nanofabrication of polymeric biomaterials. The biomedical applications of the polymeric biomaterials and their interactions with cell/tissue are discussed.

5360 DESIGN AND APPLICATION OF ARTIFICIAL ORGANS
This course offers instruction on the fundamental principles of fluid mechanics, mass transfer and chemical reaction in engineered biological systems. Simple solutions are developed for the design of artificial hearts, lungs and kidneys. Examples are given of applications in clinical situations and evaluations of system performance.

5361 BIOMATERIALS AND BLOOD COMPATIBILITY
This course is an introduction to polymer structure and fabrication methods. Blood and tissue interactions with materials and methods to improve biocompatibility of materials are discussed.

5362 THERMOREGULATION AND BIOHEAT TRANSFER
This course focuses on the application of engineering analysis to problems in physiological and clinical heat transfer. Hyperthermia (including laser, electromagnetic and ultrasound heating of tissue), hypothermia (including circulatory arrest and tissue freezing) and other applications are analyzed.

5363 DIGITAL PROCESSING OF MEDICAL IMAGES
The instrumentation and techniques for creation of digital medical images (radiographs, scintigrams, ultrasound scans, magnetic resonance scans and tomographic reconstructions) and their restoration, enhancement and compression are treated in this course. Other topics of interest, including segmentation, representation and description, may be discussed.

5370 BIOMATERIALS-LIVING SYSTEMS INTERACTION
This course describes current developments in molecular structure and organization at synthetic material interfaces and the subsequent influences on cells and cell membranes. It is designed to lay the groundwork for an improved understanding of events at the biomaterial-living system interface.

5191, 5291, 5391 RESEARCH IN BIOMEDICAL ENGINEERING (THESIS OR THESIS-SUBSTITUTION)
This course is open to students who are qualified to pursue thesis or thesis-substitution research or other supervised investigations.

5398, 5698, 5998 M.S. THESIS RESEARCH AND DEFENSE

5293 M.S. COMPREHENSIVE EXAMINATION (THESIS-SUBSTITUTION OPTION)
This course includes instruction, directed study and examination of course work leading to the thesis-substitution M.S. degree in Biomedical Engineering. It is required for all thesis-substitution M.S. students.

6103 DOCTORAL STUDENT SEMINAR IN BIOMEDICAL ENGINEERING
This course offers advanced topics in biomedical engineering. It is required for doctoral students and must be completed twice.

6194 DOCTORAL DIAGNOSTIC EXAMINATION (EXAM I)
This course offers individual instruction, directed study, consultation and examination. It is required for all doctoral students.

6195 DOCTORAL RESEARCH PROPOSAL EXAMINATION (EXAM II)
This course offers individual instruction, directed study, consultation and examination of the written dissertation research proposal. It is required for all doctoral students.

PREREQUISITE: PASSAGE OF 6194 DOCTORAL DIAGNOSTIC EXAMINATION (EXAM I)

6395 INDUSTRY INTERNSHIP IN BIOMEDICAL ENGINEERING
The student works 20 hours per week in a Dallas/Fort Worth-area firm to gain experience in the application of biomedical engineering principles in an industrial setting. Topics may vary. Students are encouraged to take the EIT (engineering certification) exam upon completion of the internship.
Prerequisites: completion of all master's degree course work and approval of the graduate adviser.

6397, 6697, 6997 DOCTORAL RESEARCH IN BIOMEDICAL ENGINEERING
Approved research projects leading to a doctoral dissertation.

6399, 6699, 6999 DISSERTATION PREPARATION AND DEFENSE (EXAM III)
This course is the defense of the completed doctoral dissertation. Doctoral students must register for this course in the term of graduation.
Prerequisite: passage of 6195 Doctoral Research Proposal Examination (Exam II)

UT ARLINGTON COURSES

5293A MASTER'S COMPREHENSIVE EXAMINATION
This course offers individual instruction, directed study, consultation and a comprehensive examination over course work leading to the Master of Science degree in bioengineering.

5335A BIOLOGICAL MATERIALS, MECHANICS AND PROCESSES
This course offers a study of typical, functional behavior of various biological materials, flow properties of blood, bioviscoelastic fluids and solids, and mass transfer in biological systems.

5340A FINITE ELEMENT APPLICATIONS IN BIOENGINEERING
This course describes the fundamental principles of the finite element method and various numerical modeling techniques. Topics include variational and Galerkin formulations, linear and Hermitian elements, accuracy and convergence. Appications in biological systems and the design of prosthetic devices are emphasized. Topic areas include linear elasticity, fluid dynamics, heat transfer and mass transport processes.

5344A BIOINSTRUMENTAION I
This course presents fundamental principles of bioinstrumentation, including operational amplifiers and instrumentation amplifiers; measurements of biopotentials; signals and noise in biological systems; mechanical transducers; resistive, inductive and capacitive tranducers; measurements of temperature, blood pressure and flow; electrical safety.

5345A BIOSENSORS AND APPLICATIONS
This course presents fundamental principles of biosensors, including electrochemical and fiber-optic sensors. Topics include introduction to fabrication, miniaturization techniques, and discussion of future directions including semiconductor fabrication and nanofabrication technology.

5350A MODELING AND CONTROL OF BIOLOGICAL SYSTEMS
This course is an introduction to fundamental methods of modeling, analysis and control of biological systems; linear system modeling; state-space modeling; stability analysis; and basic identification techniques. Examples from cardiopulmonary, visual and motor control systems are given.

5351A DIGITAL CONTROL OF BIOMEDICAL SYSTEMS
This course offers students information on design and control strategies for microprocessor-based medical equipment, discrete and sampled data systems, Z transform, digital control design meth-

ods, stability considerations, and closed-loop system response.

5382A LABORATORY PRINCIPLES
This course is an introduction to fundamental biomedical-engineering laboratory procedures, including human and animal studies. Data collection, analysis and interpretation are emphasized.
Prerequisite: permission of instructor.

5396A DIRECTED LABORATORY PROJECT
Students participate in assigned projects in areas appropriate to their research and degree plans under the direction of their mentors.

6390A, 6690A OR 6990A HOSPITAL INTERNSHIP FOR BIOMEDICAL ENGINEERS
Each student interns at local hospitals under the individual supervision of the course instructor and a hospital staff member. During the term, the student rotates through areas such as cardiac, pulmonary, prosthetics, neurosurgery, anesthesiology, radiology, catheterization and emergency care.
Prerequisites: BME 5309 and permission of instructor.