Guidelines for the MABE Ph. D. Qualifying Examination
August, 2009

The primary purpose of the MABE Ph. D. Qualifying Examination (QE) is to permit the MABE faculty to judge whether the student's understanding of basic engineering principles is at a level necessary for study at the doctoral level. For each subject exam in the QE, questions are based on fundamental principles and concepts typically taught at the undergraduate level and/or in a first course at the graduate level. Questions will particularly focus on the student's ability to apply these fundamental principles and concepts to practical engineering problems.

The following descriptions and course syllabi (which will be provided to you) indicate the general topics typically covered in the various subjects offered as part of the QE. Students are cautioned that the exam is not limited to these topics, nor to material in any specific texts. Students must use their own judgment in selecting references for review. Any information regarding the QE that may be received from faculty or other graduate students is purely advisory in nature and does not in any way stipulate or restrict specific exam content.

Bio-instrumentation

Fundamental knowledge of bio-electric and electro-chemical signals, optical and electromagnetic waves, Fourier analysis, signal filtering, and data acquisition. Ability to apply the principles and concepts to design bio-sensor, bio-control, and medical imaging systems for disease diagnostics, therapeutics and pharmaceuticals

Biomaterials

Properties (mechanical, chemical and surface) of biomaterials (natural and synthetic); cell and tissue response to biomaterials; requirements for device design.

Biomechanics

Fundamental human physiology, biomechanical principles of human motion, laws of mechanics applied to sport, daily living activities, physical training and injury etiology and prevention. Three-dimensional kinematics and kinetics of the human body, incorporating principles of Kane's mechanics.

Biosystems: Modeling, Analysis & Control

Description: Fundamental organization and communication of cellular systems. Ability to apply engineering principles to understand dynamics and control of cellular systems, and inspiration for biomedical engineering.

Computational Biology

Fundamental modeling and analysis principles in cellular and systems biology. Fundamental knowledge of differential and difference equations in biological applications. Ability to apply concepts of nonlinear dynamics in biological problems.

Computational Fluid Dynamics

Navier-Stokes equations, numerical methods and discretization schemes, pressure-correction techniques.

Controls

Linear SISO control system analysis and design using Laplace, frequency, and state-space techniques.

Dynamics

Dynamics of particles and rigid bodies in two and three dimensions using Newton's laws and Lagrange's equations.

Fluid Mechanics

Fluid mechanics: conservation of mass and momentum – integral and differential forms; dimensional or scaling analysis; boundary-layer flows; similarity solutions; differential and integral methods of solution; laminar and turbulent internal and external flows; potential flows; and compressible flow.

Fracture Mechanics

Linear elastic fracture mechanics, K solutions, fracture toughness, fatigue, environmental effects, testing, life prediction.

Heat Transfer

Heat transfer by conduction, convection and thermal radiation: formulate, derive and solve the mathematical model for a specific heat transfer process based on the physics of the problem.

Mathematics

Complex variables, linear algebra, ordinary differential equations, partial differential equations.

Mechanics of Materials

Stress, strain and deformation of slender structural members subjected to combined loading; shear center; beams on elastic foundations; energy methods; curved beams; stress analysis of basic elements.

Thermodynamics

Ability to apply the fundamental principles of thermodynamics to analyze ideal-gas mixtures, thermodynamic cycles, chemically reactive systems and other thermal systems.

Vibrations

Mechanical vibrations of discrete systems (single DOF and multiple DOF) and continuous systems with one independent spatial variable.

Subject	Syllabi
Bio-instrumentation	ME 345, BME 430, BME 599
Biomaterials	MSE 201, BME 409, MSE 474, MSE/BME 486/588
Biomechanics	BME 473, BME 531
Biosystems: Modeling, Analysis & Control	BME: Nano Biosystems and Biomimetics, BME 599: Systems Biology and Complex System Theory, BME 587, ME 363, ME 231
Computational BIology	BME 599: Computational Physiology, BME 599: Nonlinear Dynamics in Engineering and Biological Systems
Computational Fluid Dynamics	ME 452, ME 515, ES 551
Controls	ME 363, ME 451, ME 547
Dynamics	ME 231, ME 363, ME 533
Fluid Mechanics	AE 341, AE 351, ME 541
Fracture Mechanics	ES 527
Heat Transfer	ME 344, ME 475, ME 511
Mechanics of Materials	ME 321, ME 559
Thermodynamics	ME 331, ME 475, ME 521
Vibrations	ME 363, ME 463, ME 534