# University of Colorado at Colorado Springs

Mechanical and Aerospace Engineering

MAE Ph.D. Qualifying Exam Policies

**General Format:**

The qualifying exam is designed to ensure that students achieve a high level of expertise in the subject matter of their major area, preparing them for success in the PhD program and in their broader career endeavors. The exam will cover one of three topical areas chosen from the list below by the student in consultation with his or her advisor. The exam consists of two parts; a written test followed by an oral test. The oral test will usually be given one week after the written test. The exam will emphasize mathematical concepts pertinent to the topical area.

**Topical Areas:**

* Fluids and Thermal Systems
* Solid Mechanics, Structures and Materials
* Dynamics and Controls

**Timing:**

* The qualifying exam will be taken at the first opportunity after the completion of one academic semester following admission into the program.
* Written exam: First Friday of February
* Oral exam: Friday following the written exam

**Written Exam Specifics:**

* Three to five problems (Interdisciplinary students taking the MAE minor exam will be required to complete some subset of these problems)
* Three hours in length
* No notes/no books
* The exam is designed to assess the student’s preparation to succeed in graduate work. The complexity of the problems corresponds to material typically covered in advanced undergraduate courses through the first year of graduate study in the topical area
* The Graduate Committee Chair is responsible for the preparation and administration of the test, although these responsibilities will typically be delegated to faculty in the respective fields
* Copies of graded exams will be distributed to all faculty members prior to the oral exam

**Oral Exam Specifics:**

* May cover, but is not limited to, the problems of the written exam
* All MAE faculty will be invited to attend the oral exam and are allowed to ask questions

**Outcomes:**

* The faculty, led by the professors constructing each exam, will convene after the oral test to determine the outcome of the exam
* The student will be promptly notified of the outcome
* The following are possible outcomes:
  1. Pass
  2. Conditional Pass – Pass with additional requirements defined by the faculty.
  3. Conditional Fail – Additional Requirements and retake the exam the next time it is offered. The retake exam must be in the same topical area as the original exam. The outcomes of the retake exam can only be Pass, Conditional Pass, or Fail.
  4. Fail with no opportunity to retake the exam.

**Topic List:**

The following lists provide the general topical areas for which the student is expected to demonstrate mastery. Although not specifically listed, a strong understanding of the requisite mathematics for each area is also expected.

Fluids and Thermal Systems

Incompressible Flow

                fluid statics

                momentum and energy eqns

                dimensional analysis

                pipe flow

                external flow

                fluid mechanics measurements

                navier stokes eqns

                boundary layer flow

Basic Compressible Flow

1-D isentropic flow relations

Mass, momentum and energy equations

Shock relations

Heat Transfer

                1-D S.S. conduction

                2-D S.S. conduction

                transient conduction

                internal flow convection

                external flow convection

                free convection

                radiation fundamentals

                radiative exchange between surfaces

Thermodynamics

                property relationships for ideal gases

                property relationships near the saturation region

                first law for closed systems

                first law for open systems

                second law principles

                second law for closed and open systems

                gas and vapor power cycles

                refrigeration cycles

Solid Mechanics, Structures and Materials

Theories of Stress and Strain.

Linear Stress-Strain-Temperature Relations.

Inelastic Material Behavior.

Torsion.

Bending of Straight Beams.

Elastic and Inelastic Stability of Columns.

Stress Concentrations.

Fracture Mechanics.

Fatigue

Dynamics and Control

Dynamics

Vector Kinematics and Dynamics of a Particle, System of Particles and Rigid Body

Principle of Work and Energy

Principle of Impulse and Momentum (Linear and Angular)

Collisions

Inertia tensors

Constrained motion

Generalized coordinates

Virtual Work

Lagranges Equations

Controls

Reduction of multiple subsystems

Stability

Steady-state error

Root Locus techniques including design

Frequency response techniques including design

State-space controller design