GUIDELINES FOR THE PHD WRITTEN EXAMINATION
ENGINEERING MECHANICS GRADUATE STUDENTS

The written qualifying examinations ascertain that students intending to pursue the PhD degree in Engineering Mechanics have a general knowledge of the principles and techniques in engineering analysis and two of the following disciplines: aerothermodynamics, control theory, dynamics, fluid mechanics, orbital mechanics, and solid/structural mechanics. For each discipline, questions are formulated to test the student's knowledge of the assumptions and limitations of the engineering theory, the derivation of the governing equations, and the solution of typical problems and interpretation of the solution.

The written examinations are composed of three-hour examinations in each of the three subjects. The examination is offered once a year, usually during the second week of June. If a student does not pass the written examinations, the EM Graduate Studies Committee decides if the student may take the examinations again. If a student is given another opportunity, all three examinations must be retaken.

The exam combinations which are automatically approved are shown below. If you are interested in another combination, you should discuss it with the Graduate Advisor.

Engineering Analysis
Dynamics or
Fluid Mechanics
Solid/Structural Mechanics

Listed below are courses, topics and references which give some idea of the extent and depth of the material examined in each area. The graduate courses which are listed are offered on a regular basis, but they do not review all the material of the undergraduate courses which are listed nor do they contain all of the material for which you are responsible. Finally, copies of the three previous examinations are available at http://www.ae.utexas.edu/graduate-programs/ase/degree-info/302-ase-qual-guidelines-samples.

ENGINEERING ANALYSIS

COURSES:
Undergraduate mathematics courses relevant to engineering analysis:

    ASE 380P.1   Mathematical Analysis - Analytical Methods I

    ASE 380P.2   Mathematical Analysis - Analytical Methods II

TOPICS COVERED IN FIRST COURSE:
1. Real Analysis - limits and continuity, sequences and series in general, power series, Fourier series, differentiation and integration of the real line, ditto for R (n=2 in particular), functions of several variables.
2. Vector Calculus - differential operators (e.g., gradient, divergence, curl), basic integral identities (e.g., divergence theorem, Stoke's theorem, etc.), applications in geometry.
3. Complex Analysis - sequences and series in general, differentiation and integration, power series, analytic function theory, residue theory.
4. Transform Calculus - basis theorems and identities, convolution and inversion of Fourier and Laplace transforms.

TOPICS COVERED IN SECOND COURSE:
5. Linear Algebra and Analysis - matrix algebra, elementary properties of abstract linear spaces, inner product spaces, eigenvalues and eigenvectors, eigenfunction expansions.
6. Variational Methods - minimization of a functional, basic calculus of variations.
7. Ordinary and Partial Differential Equations - classification and properties, elementary methods of solution, characteristics, Green's function, special functions, Strum-Liouville theory, etc.

REFERENCES:
1. Greenberg, <u>Foundations of Applied Mathematics</u>, Prentice-Hall, 1977.

ADDITIONAL REFERENCES:
1. Butkou, <u>Mathematical Physics</u>, Addision Wesley.
2. Hildebrand, Advanced <u>Calculus for Applications</u>, McGraw-Hill, 1960.
3. Kreyszig, <u>Advanced Calculus for Applications</u>, McGraw-Hill, 1960.
4. Pipes/Harvill, <u>Applied Mathematics for Engineers and Physicists</u>, McGraw-Hill.
5. Sokolnikoff/Redheffer, <u>The Mathematics of Modern Engineering</u>, McGraw-Hill.

DYNAMICS

<u>**COURSES**</u>:

ASE 311	Dynamics
ASE 372.K	Advanced Space Craft Dynamics
EM 381	Advanced Dynamics

<u>**TOPICS**</u>:

1. Newtonian Mechanics - particle and rigid body kinematics and dynamics, vibrations of lumped-mass systems, dynamical stability.
2. Lagrangian Mechanics - LaGrange's equations, conservative and non - conservative systems, impulsive considerations, applications to particle and rigid body systems. Lagrangian Density Functions for distributed parameter systems and approximation theory.
3. Introductory Hamiltonian Mechanics - Hamilton's equations, phase space, canonical transformations.

<u>**REFERENCES**</u>:

1. Beer/Johnston, <u>Vector Mechanics for Engineers</u>, McGraw-Hill, 1977.
2. Goldstein, <u>Classical Mechanics</u>, Addision-Wesley, 1980.
3. Greenwood, <u>Classical Dynamics</u>, Prentice-Hall, 1977.
4. Greenwood, <u>Principles of Dynamics</u>, Prentice-Hall, 1965.
5. Meriam, <u>Dynamics</u>, Wiley, 1975.

FLUID MECHANICS

COURSES:

ASE 320	Introduction to Incompressible Fluid Mechanics
ASE 340	Boundary Layer Theory & Heat Transfer (or equivalent undergraduate courses in general fluid mechanics and convective heat transfer in lieu of the above courses)
ASE 346	Viscous Fluid Flow
ASE 382Q.1/EM 387	Foundations of Fluid Mechanics
ASE 347	Introductory Computational Fluid Dynamics
(or)	
EM 393N	Numerical Methods for Flow Problems

TOPICS:

1. Convective heat transfer.
2. The governing equations of fluid motion: continuity, momentum, energy, state, including variable density; integral and differential forms.
3. Supplementary physical laws and concepts: Kelvin's theorem, vorticity, stream functions, potential functions, etc.
4. Applications: inviscid and viscous incompressible flow, as typified by material in the above four courses.
5. Approximations of flow and heat and mass transport equations using finite difference and finite element methods at introductory level. Basic solution techniques.

REFERENCES:

1. Chapman, <u>Heat Transfer</u>, MacMillan, 1974.
2. Craig/Oden, <u>Finite Elements, Fluid Mechanics</u>, (Vol. VI) Prentice Hall, 1986.
3. Currie, <u>Fundamental Mechanics of Fluids</u>, McGraw-Hill, 1993.
4. Fox & McDonald<u>, Introduction to Fluid Mechanics</u>, 4th ed, Wiley.
5. Panton, <u>Incompressible Flow</u>, 2nd ed., Wiley, 1996.
6. Schlichting, <u>Boundary Layer Theory</u>, Pergamon Press, 1979.
7. Tannehill, Anderson and Pletcher, <u>Comp. Fluid Mechanics and Heat Transfer</u>, 2nd ed., 1997.
8. White, <u>Fluid Mechanics</u>, 1999.
9. White, <u>Viscous Flow</u>, McGraw-Hill. 1991.

Rev. 6/02

SOLID/STRUCTURAL MECHANICS

COURSES:

ASE 365	Structural Dynamics
ASE 384P.1/EM 388	Solid Mechanics I
ASE/EM 339	Advanced Strength of Materials

TOPICS:

1. Beams - symmetric and unsymmetric bending; curved beams, beams on elastic foundation, inelastic bending.
2. Torsion - circular and noncircular sections, approximate theory of thin-walled sections.
3. Stability - column buckling, beam columns.
4. Energy Methods - formulation and solution of problems, methods of minimum potential energy and virtual work.
5. Structural Analysis - stiffness method of analysis of elastic trusses and frames.
6. Structural Dynamics - free and forced response of single degree of freedom systems, modeling of linear multi-degree of freedom systems, modal analysis, vibration of continuous structural elements.
7. Elasticity - analysis of stress and strain; material response: linear elastic, elastic-plastic (elementary); formulation of boundary value problems; solution of plane problems, St-Venant problems, axisymmetric problems.

REFERENCES:

1. Craig, Structural Dynamics, Wiley, 1981.
2. Fung, Foundations of Solid Mechanics, Prentice-Hall, 1965.
3. Gere & Timoshenko, Mechanics of Materials, PWS Publishers, 1984 (or equivalent).
4. Gould, Introduction to Linear Elasticity, Springer-Verlag, 1983.
5. Oden & Ripperger, Mechanics of Elastic Structures, McGraw-Hill, 1981.
6. Timoshenko & Goodier, Theory of Elasticity, McGraw-Hill, 1975.