Reference Reading List for SEMM Doctoral Preliminary Examination

Mathematics

References

BM Boas, Mary L., *Mathematical Methods in the Physical Sciences*, 3rd Edition, John Wiley and Sons, 2006
KE Kreyszig, Erwin, *Advanced Engineering Mathematics*, 9th Edition, John Wiley and Sons, 2006

All necessary material for the examination can be found in BM; KE presents most of the same material in an alternative format. Some of the material is also covered in the course MATH 121A, *Mathematical Tools for the Physical Sciences*, for which the current textbook is BM.

Subject

1. Linear Algebra: Linear vector spaces, matrices and determinants, systems of linear equations, eigenvalue and eigenvector problems, applications of diagonalization.

   BM Chapter 3
   KE Chapter 7 and Chapter 8

2. Multivariable Calculus: Chain rule, implicit differentiation, maximum and minimum problems, change of variables, differentiation of integrals, multiple integrals, the Jacobian, and surface integrals.

   BM Chapter 4 and Chapter 5

3. Vector Analysis: Vector multiplication, triple products, differentiations of a vector field: Grad, Div, Curl, directional derivative, divergence theorem and Stokes' theorem.

   BM Chapter 6
   KE Chapter 9 and Chapter 10

4. Series expansion of functions: Power series, Taylor series, Fourier series, integrals, and transforms, applications of Fourier series, simple harmonic motion, and wave motion.

   BM Chapter 1 and Chapter 7
   KE Chapter 11 and Chapter 15

5. Ordinary Differential Equations (ODE's): Separable equations, first order linear ODE's, second order linear ODE's, the Dirac delta function, introduction to Green's function.

   BM Chapter 8
   KE Chapter 1 and Chapter 2

6. Partial Differential Equations (PDE's): Separation of variables, Laplace's equation, the heat diffusion equation, the wave equation, vibration of strings, circular and rectangular membranes, Fourier series solution.

   BM Chapter 13
   KE Chapter 12

Reference Reading List for SEMM Doctoral Preliminary Examination
Statistics

References

DS DeGroot, Schervish. *Probability and Statistics*. 4th Edition, Pearson, 2012.
HTZ Hogg, Tanis, Zimmerman. *Probability and Statistical Inference*. 10th Edition, Pearson, 2018.
PP Papoulis, Pillai. *Probability, random variables, and stochastic processes*. 4th Edition, McGraw-Hill, 2002

Subject

1. **Basic rules of probability**: axioms of probability, conditional probability, Bayes' rule, statistical independence, the law of total probability
   - DS Chapter 1 and Chapter 2
   - HTZ Chapter 1
   - PP Chapter 1,2,3

2. **Probability distributions**: random variables, probability mass functions, probability density functions, cumulative distribution functions, conditional distributions, functions of random variables, basic probability models: uniform, Binomial, Poisson, Gaussian, discrete-time finite-state Markov chain
   - DS Chapter 3 and Chapter 5
   - HTZ Chapter 2,3,4,5 (HTZ does not cover Markov chains)
   - PP Chapter 4,5,6,7,15

3. **Expectations:** variance, covariance, moments, (Pearson) correlation coefficient, expectations of functions of random variables, conditional expectations, moment generating functions
   - DS Chapter 4
   - HTZ Chapter 2,3,4,5
   - PP Chapter 5,6,7

4. **Asymptotic theorems**: Markov and Chebyshev inequalities, the law of large numbers, the central limit theorem
   - DS Chapter 6
   - HTZ Chapter 5
   - PP Chapter 7

5. **Statistical Inference**: maximum likelihood estimation, method of moments, Bayesian estimation, binary hypothesis test
   - DS Chapter 7 and Chapter 9
   - HTZ Chapter 6 and Chapter 8
   - PP Chapter 8

6. **Regression**: linear regression with maximum likelihood estimation
   - DS Chapter 11
   - HTZ Chapter 6

Reference Reading List for SEMM Doctoral Preliminary Examination

Mechanics

References

AG Anand and Govindjee, *Continuum Mechanics of Solids*, Oxford University Press, 2020.
SC Shames and Cozzarelli, *Elastic and Inelastic Stress Analysis*, Revised Printing, Taylor & Francis, 1997.

AG represents the expected level of understanding for all topics. SC represents an alternate presentation of the same.

Subject

1. Kinematics: motion, displacement, measures of finite and infinitesimal strain, invariants and principal values

AG Chapter 3
SC Chapter 3

2. Forces and Stress: traction and body forces, momentum balance (local and global), Cauchy stress, Cauchy's Law, invariants and principal values

AG Chapter 4
SC Chapter 2

3. Constitutive Response (Elastic): Isotropic and anisotropic elastic response

AG Chapter 7
SC Chapter 5

4. Constitutive Response (Viscoelasticity): Kelvin, Maxwell, and Standard Linear Solids, differential and convolution forms

AG Chapter 29 (Sections 29.1 – 29.11)
SC Chapter 6

5. Constitutive Response (Plasticity): Rate independent plasticity, von Mises yield condition, associated plastic flow, linear isotropic and kinematic hardening

AG Chapter 19, Sections 20.1, 20.2, 20.4, 21.1—21.6, 22.1—22.3, Chapter 23, Chapter 24
SC Chapter 8 (omit viscoplasticity sections)

6. Boundary Value Problems: Structure of the governing equations in strong, weak, and potential form, and solution methods

AG Chapters 8, 9, 10, 12
SC Chapter 9, 12

Reference Reading List for SEMM Doctoral Preliminary Examination

Analysis

Reference

F F.C. Filippou, *Structural Analysis, Theory and Applications*, Course reader, SEMM Report, Fall 2008.

Subject

1. Equilibrium equations for plane trusses and frames; nodal and element loads; force influence matrices

   F pp. 1-20, pp. 48-78

2. Lower bound theorem of plastic analysis; collapse load factor for complete and partial collapse cases

   F pp. 79-104

3. Kinematic matrix for plane trusses and frames; compatibility conditions; stability criterion; linear constraints

   F pp. 129-232

4. Real work; principles of virtual work and complementary virtual work (virtual forces); plastic work increment

   F pp. 257-279

5. Upper bound theorem of plastic analysis; complete and partial collapse mechanism

   F pp. 280-292

6. Deformation-force relations for determinate structures; flexibility matrix; determination of displacements; displacements and plastic deformations at incipient collapse

   F pp. 305-352

7. Force method of analysis; treatment of nodal and element loads; treatment of thermal effects

   F pp. 353-410

8. Displacement (stiffness) method of analysis; nodal and element loads; thermal effects; support settlements

   F pp. 434-527

9. Substructuring

   F pp. 563-591

10. Symmetry considerations

    F pp. 592-644

Reference Reading List for SEMM Doctoral Preliminary Examination

Structural Dynamics

Reference

C Anil K. Chopra, *Dynamics of Structures*, Third edition, Prentice Hall, 2007.

The scope is limited to linear vibratory systems.

Subject

1. Single-Degree-of-Freedom Systems

(a)	Free Vibration	C Secs.	2.1, 2.2., 2.3
(b)	Response to Harmonic Excitations	C Secs.	3.1 through 3.9
(c)	Response to Arbitrary, Step, and Pulse Excitations	C Chapter 4	
(d)	Generalized SDF Systems and Rayleigh's Method of Frequency Analysis	C Chapter 8	
(e)	Earthquake Response Analysis; Response Spectra	C Secs.	6.1 through 6.7

2. Multi-Degree-of-Freedom Systems

(a)	Formulation of Mass and Stiffness Matrices and Force Vectors	C Secs.	9. 1 through 9.5
(b)	Natural Vibration Frequencies and Modes	C Secs.	10. 1 through 10.10
(c)	Modal Analysis of Response to Applied Forces and Earthquakes	C Secs.	12.1 through 12.7, and 13.1-13.3 13.7-13.9

Reference Reading List for SEMM Doctoral Preliminary Examination

Design

The design portion of the examination is intended to test the student's understanding of broad principles of structural design and their application to structures. The student is expected to understand the nature of loads (including gravity, wind, and seismic), principles of expected performance under various loads (including serviceability and safety), procedures for determining or controlling yielding mechanisms, load combinations for design, load paths (vertical and horizontal), and the basic design of structural systems of concrete and steel. An important component of the examination is the student's demonstrated ability to integrate these subjects to produce structures that will perform appropriately in their environment. For each topic, students are expected to be familiar with all the cited material; it is not an option to be familiar with only one of the references for each topic.

References

W Wight and MacGregor, Reinforced Concrete: Mechanics and Design, Prentice-Hall, 5th ed., 2008.
L Leet, Uang, and Gilbert, Fundamentals of Structural Analysis, McGraw Hill, 3rd ed., 2008.
S Sequi, LRFD Steel Design, Thomson, 4th Edition, 2007.
C Chopra, Dynamics of Structures, Prentice-Hall, 3rd ed., 2007.

Subject

1. General principles of structural design

   W Sections 2.1-2.6, 9.5
   S Chapters 1 and 2, Section 5.9

2. Loading, environmental conditions and requirements of service. Students must be able to recognize the sources of forces and environmental conditions that must be considered in design, must understand load combinations for design, and must be familiar with capacity design concepts to promote ductile yielding mechanisms.

   W 2.7-2.8, 5.2, 19.1-19.4, 19.6
   L Ch. 2, 8.1-8.5, 8.11
   S Chapters 1 and 2
   C 6.7-6.9, 7.4-7.8, 7.11-7.13, 13.8

3. Load paths, structural systems for gravity load and lateral load resistance; diaphragms.

   W 5.2, 18.5-18.8
   L 2.2, 2.5
   S Chapter 2, Section 5.11

4. Design of beams and columns in reinforced concrete and steel

   W 4.1-4.6, 5.3, 6.1-6.5, 11.1-11.5
   S Chapter 4 (skip Section 4.8), Chapter 5 (skip Sections 5.6, and 5.12 through 5.15), Chapter 6 (skip Section 6.8)

5. Connection design

   W 17.12
   S Chapter 3 (skip Sections 3.7 and 3.8), Chapter 7, Chapter 8