

**COURSE TITLE:**  
**FINITE ELEMENTS**

**INSTRUCTOR:**

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**SYLLABUS:**

**Introduction.** Motivation and application context of Finite Element Method (*F.E.M.*). Presentation of matrix methods for mechanics by direct stiffness.

***F.E.M for 1-D problems.*** Prismatic rod (in tension/compression, torsion, plane bending) by a universally applicable approach (weak form and use of integration identities) that does not rely on potential functions, energy theorems, etc. Integrodifferential field equations, differentiability requirements, types of boundary conditions.

***Shape Functions.*** Types (Lagrange, Hermite), analytical and numerical integration, stiffness and mass matrices, and vectors of work-equivalent (“consistent”) nodal “loads”. Elements of computer implementation.

***Multidimensional F.E.*** Element types (simplex, DeCartes, serendipity, wedge, etc.) and corresponding shape functions. Isoparametric elements. Gauss quadrature.

***Solution of large-scale sparse linear systems.*** Incomplete factorizations and iterative solvers. Vector solvers and Preconditioning. Mixed approaches.

***Time dependence.*** Step-by-step integration (explicit and implicit schemes). Linear problems (eigen-analysis, spectral analysis).

***Non-linearity.*** Sources (geometry, material). Handling (quasi-Newton, etc.)

***Introduction to special topics.*** Multiple non-conforming fields, mixed formulations, locking, underintegration, finite rotations, etc.

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2. K. J. Bathe, “Finite Element Procedures in Engineering Analysis”, Prentice-Hall Inc., New Jersey, 1982.
3. T. R. J. Hughes, “The Finite Element Method – Linear Static & Dynamic Finite Element Analysis”, Prentice-Hall ed., Englewood Cliffs, NJ, 1987.
4. J. N. Reddy, “An Introduction to the Finite Element Method”, Second Edition, New York: McGraw - Hill, 1993.
5. G. H. Golub, C. F. Van Loan, “Matrix Computations”, The Johns Hopkins University Press, 1989.
6. T. R. Chandrupatla, A. D. Belegundu, «Introduction to Finite Elements in Engineering», Pearson, 2012.
7. Μ. Παπαδρακάκης, «Ανάλυση Φορέων με την Μέθοδο των Πεπερασμένων Στοιχείων», Παπασωτηρίου, 2001.
8. Χ. Προβατίδης, «Πεπερασμένα Στοιχεία στην Ανάλυση Κατασκευών», Τζιόλα, 2016.
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10. Α. Μπακόπουλος και Ι. Χρυσοβέργης, «Αριθμητικές Μέθοδοι Διαφορικών Εξισώσεων», Συμμετρία, 1986.