Politecnico di Milano,
Scuola MasterF.lli. Pesenti
Master Universitario di 2° Livello in Costruzioni in Calcestruzzo Armato

STRUCTURAL ANALYSIS BY COMPUTER *(B6)*

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Program of the Course.

1. Definition of the structural problem and its framework. Primary and secondary unknowns, global and local quantities. Structural synthesis and analysis processes. Role of the structural modeling in the performance based design. Design environment and contingency scenario. Interaction mechanism. Uncertainties. Evolutive and innovative strategies to design. Basic elements of structural optimization and automatic design. Standards for the documentation of the analysis, CNR 10024/86 for the computer aided design of structures. Style manuals.
2. Concept of model. Functional representations, expert systems, structural discretization. De Saint Venant Principle. Bernoulli-Navier (B) and diffusive (D) regions. Structural system and its decomposition. Convergence of the modeling and of the discretization. Judgment of the mechanical aspects of the modeling. Effective approach to the definition of the solution and judgment of the numerical quality. Constructive approach to the definition of the structural response. Sensibility analysis and bounding techniques. Parametric, probabilistic and fuzzy analysis. Anti-optimization. Numerical objectivity and robustness.
3. Modeling by commercial codes: SAP2000, ANSYS, STRAUS7, ADINA, ALGOR, LUSAS, relative features and possibilities. General organization and peculiarities of a computer structural codes. Pre- and post-processors. Batch control. Documentation, diagnostics and bring to an end criteria. Benchmarking. Conditioning number. Application to specific design problems. Typical problems: modal analysis, dynamic response, buckling analysis, non linear behavior, soil-structure interaction, simulation of misalignments and imperfections. Check of solutions and synthesis of results toward design decisions.
4. Discrete models: truss works and grid works and their use toward design definition.
5. Virtual Work Principle based formulation of finite elements. Stiffness matrix and equivalent load vector formulation in the Displacement Method. Shape functions. Different kind of elements: description, formulation and distinctiveness. Use criterion. Convergence aspects: completeness and conformity. Patch-test. Typical problems: singularities and critical regions.
6. Basic aspects of finite element numerical formulation: interpolation and approximation processes, numerical integration. Isoparametric formulation: coordinates transformation, jacobian and its geometric meaning. Beam elements. Plane elements. Plate elements: Kirchhoff and Mindlin-Reissner theory. Shell elements. FORTRAN based implementation.

References.

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- Malerba P.G., Appunti del Corso di Analisi strutturale con elaboratore elettronico, (*in Italian*).
- Cedolin L., Elementi di analisi strutturale, Quaderni del corso di perfezionamento per le costruzioni in c.a., Tamburini, 1975 (*in Italian*).
- Toniolo G., Analisi strutturale con l'elaboratore elettronico., Masson Italia1984, (*in Italian*).
- Belingardi G., Il Metodo degli elementi finiti nella progettazione meccanica., Levrotto & Bella, 1995 (*in Italian*).
- Cook R.D., Malkus D.S., Plesha M., Witt R.J., Concepts and applications of finite element analysis, John Wiley & Sons, 2001.
- Ghali, A.M. Neville, Structural analysis., E&FN Spon, 2004.

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