IFS ACADEMY
Training For The Future!!

Advanced Topics in Finite Element Analysis:

Theory and Applications

Instructor-Led Online Training

Course Curriculum (Duration: 40 Hrs.)

Module 1: Mechanical Engineering Terminologies Relevant to FEA

- Stress and Strain: Basics of mechanical properties and their relation to FEA.
- Elastic Modulus, Yield Strength: Introduction to material properties relevant to FEA.
- Static Equilibrium: Principles governing static conditions and their applications.
- Equations of Motion: Basics of Newton's Laws, work-energy principles, and their relevance.
- Force Analysis: Understanding resultant forces, equilibrium, and free-body diagrams.
- Machine Elements: Overview of basic machine components like gears, bearings, etc.

Module 2: Introduction to Finite Element Analysis (FEA)

- Definition and Importance: Introduction to FEA and its significance in mechanical engineering.
- History and Evolution: Brief history and development of FEA.
- Applications: Various applications of FEA in mechanical design and analysis.
- Overview of the FEA Process: Step-by-step overview of the FEA process.
- Role in Design and Analysis: Importance of FEA in mechanical design and analysis.

Module 3: Mathematical Fundamentals for FEA

- Differential Equations: Introduction to ordinary and partial differential equations.
- Matrix Algebra Basics: Basics of matrix operations, vectors, eigenvalues, and eigenvectors.
- Numerical Methods: Overview of numerical methods used in FEA.
- Discretization Methods: Introduction to discretization and approximation methods in FEA.

Module 4: Fundamentals of Finite Element Method (FEM)

- Mathematical Formulation: Introduction to the mathematical formulation of FEM.
- Meshing in FEA: Basics of meshing and discretization techniques.
- Shape Functions and Interpolation: Understanding shape functions and interpolation in FEA.
- Assembly of Equations: Process of assembling element equations into global equations.
- Boundary Conditions: Introduction to different types of boundary conditions and constraints.

Module 5: Types of Finite Elements and Element Selection

- One-Dimensional Elements: Basics of rod/bar elements and their applications.
- Two-Dimensional Elements: Introduction to plane stress/strain elements.
- Three-Dimensional Elements: Overview of solid elements and their applications.
- Specialized Elements: Understanding beam, shell, and plate elements.
- Element Selection Criteria: Importance of selecting appropriate elements in FEA.

Module 6: Pre-Processing in FEA

- Geometry Cleanup: Importance of preparing geometry for FEA.
- Node and Element Definitions: Basics of defining nodes and elements in FEA.
- Material Properties: Assigning material properties in FEA.
- Boundary Conditions: Application of boundary conditions in FEA simulations.

Module 7: Geometry Clean up tool & FE modelling preparation

- Geometry repair (Missing surfaces/duplicate surfaces/gap fill).
- Geometry Prepare: Midsurface extraction.
- Weld preparation (spot weld/extend/weld)
- 1D Geometry Preparation (Different cross section profile)

Module 8: Fundamental Concepts in FEA

- Convergence and Accuracy: Understanding convergence criteria and accuracy in FEA.
- Element Quality: Importance of mesh quality and refinement.
- Load Types: Types of loads including point, distributed, and thermal loads.
- Solution Techniques: Introduction to direct and iterative solution methods.
- Sensitivity Analysis: Basics of sensitivity analysis and parameter studies in FEA.

Module 9: Post-Processing and Interpretation of Results in FEA

- Interpretation of Results: Understanding stress, strain, and displacement results.
- Visualization Techniques: Overview of visualization methods in FEA.
- Validation and Verification: Importance of validating and verifying FEA results.
- Results in Design: Utilizing FEA results in mechanical design and analysis.

Module 10: Best Practices and Pitfalls in FEA

- Common Mistakes: Identifying and avoiding common mistakes in FEA.
- Verification and Validation: Importance of V&V in FEA.
- Effective Practice: Guidelines for effective FEA practice.
- Advanced Topics: Introduction to advanced FEA topics and applications.

Module 11: Introduction to Computational Mechanics

- Computational Mechanics Basics: Overview of computational mechanics.
- Role of Computational Methods: Importance and applications in engineering analysis.
- Numerical Methods Overview: Introduction to numerical methods used in FEA.
- Computational Modeling: Importance and application in FEA.

Module 12: Importance of Boundary and Initial Conditions

- Boundary Conditions: Definition and types of boundary conditions.
- Imposition Techniques: Methods for applying boundary conditions in FEA.
- Initial Conditions: Understanding initial conditions and their significance.

- Practical Examples: Case studies on boundary and initial conditions.

Module 13: Introduction to Nonlinear Analysis

- Linear vs. Nonlinear Analysis: Basics of linear and nonlinear analysis.
- Types of Nonlinearities: Understanding different types of nonlinear behaviours.
- Challenges and Considerations: Common challenges and considerations in nonlinear analysis.
- Nonlinear Solution Techniques: Introduction to nonlinear solution methods in FEA.

Module 14: Fundamentals of Dynamic Analysis

- Static vs. Dynamic Analysis: Basics of static and dynamic analysis.
- Dynamic Loads and Excitations: Types of dynamic loads and their effects.
- Time and Frequency Analyses: Introduction to time and frequency domain analyses.
- Modal, Harmonic, Transient Analyses: Basics of modal, harmonic, and transient analyses.

Module 15: Fatigue Analysis

- Introduction of Fatigue Analysis
- What is HCF and LCF Fatigue
- S-N & E-N Method
- Set up (preprocessing / Solution / Post processing)
- Life and damage prediction

Module 16: Importance of Model Validation and Verification

- Validation and Verification: Definition, importance, and methods.
- Methods for V&V: Techniques for model validation and verification.
- Challenges in V&V: Common challenges and pitfalls.
- Role in Ensuring FEA Accuracy: Importance of V&V in ensuring accurate FEA results.

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