

Practical Basic Finite Element Analysis



Dominique Madier
FEA Analyst

| FEA Consultant | FEA Trainer | Book Author | Speaker |
| Helping Engineers and Students to Learn FEA |

#BEYONDTHE SOFTWARE

REGISTER NOW

FEA ACADEMY

PRACTICAL BASIC FINITE ELEMENT ANALYSIS

17 LECTURES

14 FEA Workflows

Methods & Guidelines

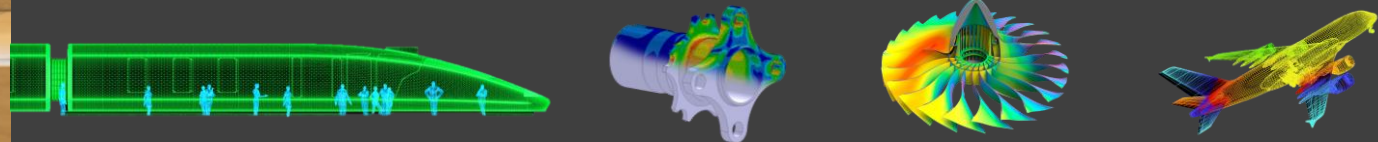
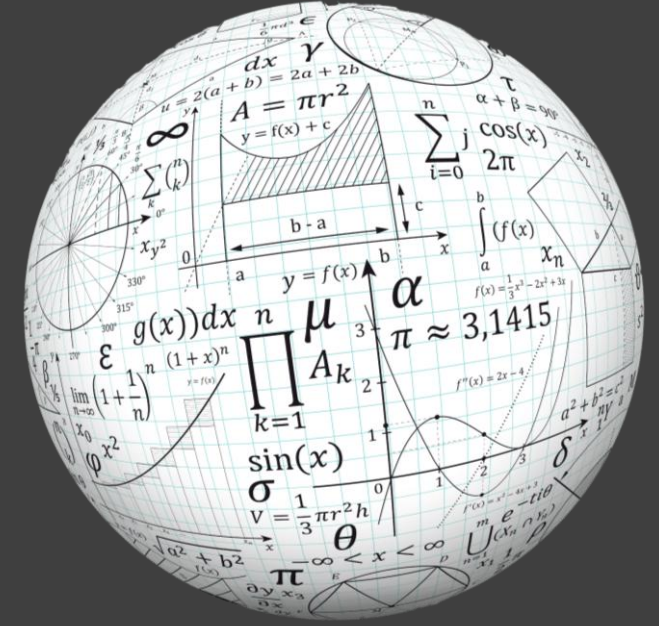
20 HOURS TOTAL

STREAM+1) Online **On-Demand**

Learn the **Modeling Techniques**

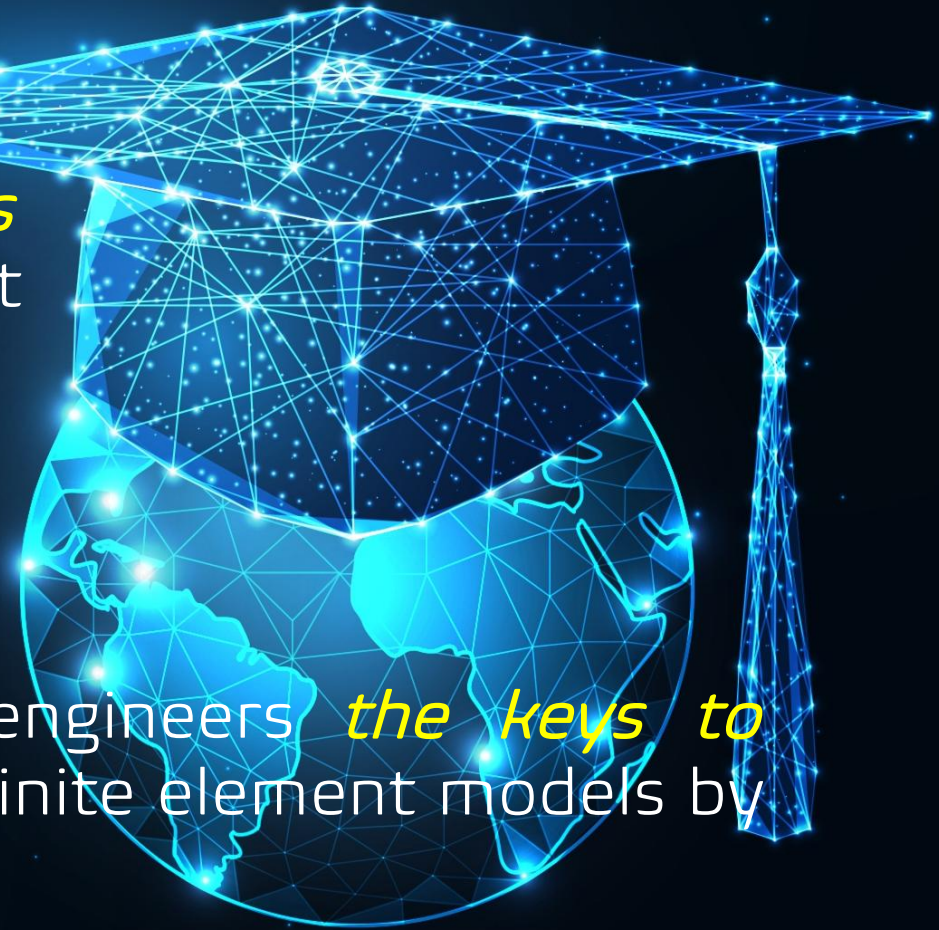
I'm Your Host
Dominique Madier

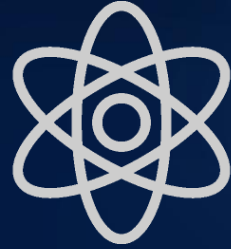
Expand your Career Opportunities
BY LEARNING FEA



Course objectives:

- To offer *the best practical methods and guidelines* for the development and validation of finite element models in solid mechanics and structural analysis.
- To give mechanical structural engineers *the keys to developing* accurate and reliable finite element models by avoiding the most frequent errors.





Because learning FEA is a lot more than just learning a software
It is also about learning the good modeling practices and methods

This course will deliver you
real and practical
knowledge that you need
for your day-to-day work
with FEA



Practical Basic Finite Element Analysis

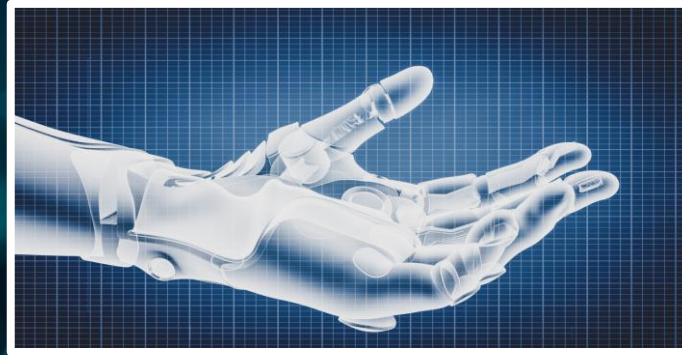
Expand Your Career Horizons: Unlock the Power of FEA and Excel in Engineering



Gain an Edge with Comprehensive FEA Training

LEARNING FEA in Detail Opens Doors to Expanded Career Opportunities and Sets You Apart from the Rest.

MASTER Good Modeling Practices and Propel Your Engineering Skills to New Heights



Boost Your Versatility and Conquer Diverse Projects

FEA is Incredibly Flexible, Enabling Its Application in Various Industries and Projects.

BECOME an Engineering Virtuoso, Navigating Any Challenge with Confidence.



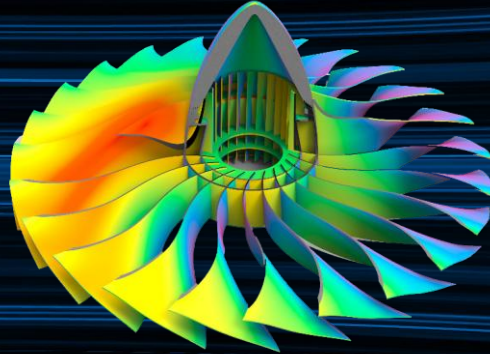
Join an Inspiring Community of FEA Enthusiasts

ENROLL in FEA Academy's Courses and Access a Vibrant Network of Like-Minded Engineers.

COLLABORATE, Share Ideas, and Forge Connections with Instructors and Fellow Students/Engineers.



Structure of the Course



31 On-Demand Videos



20 Hours



Watch the Videos at
Your Own Pace



"Examples showing FEA workflow"
by Steffan Evans
14 videos
5 hours

"Modeling Techniques"
Methods, Guidelines & Examples
by Dominique Madier
17 videos
15 hours

Dominique Madier
FEA Analyst



EVOTECH
Computer-Aided Engineering Ltd



Because learning FEA is a lot more than just learning a software
It is also about learning the good modeling practices and methods

What is the prerequisite to attend the course?

- ✓ A robust general physics background.
- ✓ A review of university-level in solid mechanics, statics & strength of materials is recommended.

Practical Basic Finite Element Analysis

This course will permit you to perform your analysis
for your day-to-day work in FEA.

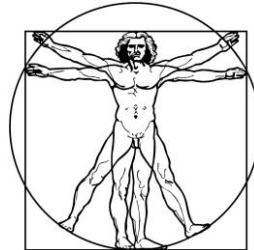
With this course, you will understand FEA in detail
and you will **have confidence in your results**.

Practical Basic Finite Element Analysis



Expand Your Career Opportunities

Learning FEA in detail permits you **expanding your career opportunities** and gives you an edge over other engineers who don't know the good modeling practices.



Improve Your Versatility

FEA is so flexible that it can be used in various applications.

An engineer with very good knowledge of FEA **is much more versatile** than one who does not know it well.

Since the modeling techniques are universal, mastering FEA will permit you to navigate various types of industries and work on diverse projects.

Practical Basic Finite Element Analysis

What You Get in the Course?



17 Lectures (15 hours)

A complete program teaching you the universal FEA modeling techniques and offering the best practical methods, guidelines and examples.



14 FEA Workflows (5 hours)

To augment your learning experience, you will have access to software examples showing particular FEA workflows.



Many Simple Examples

All the presented modeling techniques are illustrated with simple examples to permit you understanding all the FEA concepts in detail.



On-Demand Course

Learn at your pace by watching the videos of the course. Access the virtual classroom 24/7 from everywhere, you just need an internet access.



Unlimited Access

You will have an unlimited access to the FEA Academy virtual classroom to revisit the lectures for your day-to-day work.



Keep Track of Your Knowledge

Use our PDF file containing 200+ questions related to each lecture. Also, test yourself to validate your knowledge by answering the quizzes after each lecture.



Download 1000 Slides

Download all the PDF slides of the 17 lectures.



Geometric & Simulation Files

Download the geometric files in Parasolid, Step and IGES formats as well as the simulation files of the examples (150+ files).



Q&A

During this course, your instructors will be available to answer your questions and will support you in order to help you building a strong FEA knowledge.



“Modeling Techniques” Course Content

17 Lectures
15 hours

Lecture #1

WHAT IS FINITE ELEMENT ANALYSIS (FEA)?

- Methods for Solving an Engineering Problem
- The Different Numerical Methods
- Introduction to Partial Differential Equations
- So, What is FEA?



20 minutes

Lecture #2

WORKING WITH FEA IN MECHANICAL AND STRUCTURAL ANALYSIS

- How FEA Can Help You?
- The FEA Process
- Capabilities of FEA Software
- How Accurate is FEA?
- Why Do FEA?
- What is Needed to Perform an FEA Simulation?



20 minutes

Lecture #3

HOW TO LEARN FEA

- The Three Stages of the FEA Learning Process
- The Main Rule of FEA Learning
- What is the Main Danger of FEA
- What Do You Need to Learn in the FEA Field?
- My 10 Guidelines for FEA Learning
- The Five Advantages of Learning FEA



25 minutes

Lecture #4

DEFINING YOUR FEA STRATEGY

- The 10 Steps to follow to Build an FEA Strategy
- The 14 Questions to Ask Before to Start Modeling



25 minutes

Lecture #5

THE BASIS OF FEM THEORY

- The Equilibrium Equation
- The Displacement Method
- What is a Degree of Freedom?
- What is a Shape Function?
- What is the Stiffness Matrix?
- Elements Stiffness Matrix for Various Topologies
 - i. 1D Truss Element
 - ii. 1D Beam Element
 - iii. 2D Elements
 - iv. 3D Solid Elements
- How the Global Stiffness Matrix of the Complete Problem is Assembled?
- How the FEM Equations are Solved ?



1 hour 15 minutes

Lecture #6

THE LIBRARY OF ELEMENTS

- Type of Elements Used in FEA
 - i. The Basic Building Blocks
 - ii. The 1D Truss Element
 - iii. The 1D Beam Element
 - iv. The 1D Spring Element
 - v. The 2D Shell Element
 - vi. The 3D Solid Elements
 - vii. Special Elements
- Geometry, Size & Shape
- Linear Vs Quadratic Elements
- Element Selection Criteria
- How to Choose the Right Element
- Integration Schemes
- Shear Locking, What is it and How to Prevent it?



1 hour 45 minutes

Lecture #7

MESHING

- Plan the Meshing
- Define the Elements Size
- Mesh Refinement (Why & How)
 - i. Why do Mesh Refinement
 - ii. The Mesh Refinement Process
 - iii. Advantages & Disadvantages
 - iv. Mesh Refinement Techniques
 - v. Convergence Study Methodology
- 1D Meshing Rules
- 2D Meshing Rules
- 3D Meshing Rules
- Physical Interfaces and Mesh Transition
- Various Recommendations for Meshing



1 hour 40 minutes

Lecture #8

DEFINING LOADS AND BOUNDARY CONDITIONS

- What is a Boundary Condition?
- Why Do You Need Boundary Conditions?
- The Different Types of Boundary Conditions
- How to Constrain a Model
- Influence of Boundary Conditions
- Strategy to Define Boundary Conditions
- How to Create Isostatic Restraints
- Over-Stiffening and Under-Stiffening Problems
- About Singularities
- Type of Loadings



1 hour 20 minutes

Lecture #9

RIGID BODY ELEMENTS & MULTI-POINT CONSTRAINT

- Terminology
- Why to Use Rigid Elements
- Rigid Body Elements (RBE)
- Constraint Element (MPC)
- Examples of RBE & MPC Usage



1 hour

Lecture #10

MODELING BOLTED JOINTS

- Bolt Behaviors
- Do you Really Need to Model the Bolts?
- Fasteners modeled with Rigid Elements
- Fasteners modeled with 1D Spring Elements
- Fasteners modeled with Beam Elements
- Fasteners Stiffness Calculation
- How to Connect the Fasteners to the Surrounding Mesh?
- How to Capture the Prying Effect with 1D Spring Elements?
- Modeling the Bolt Preload



1 hour 15 minutes

Lecture #11

SUBMODELING

- What is Submodeling?
- Why Do Submodeling?
- How to Do Submodeling
 - i. Submodel a Global FEM
 - ii. Extract a Part of the Global FEM
 - iii. Examples
- Tips and Hints for Submodeling



20 minutes

Lecture #12

VERIFY & VALIDATE YOUR FEA

- What is Verification & Validation?
- Accuracy Checks
- Mathematical Checks
- Examples
- Correlation
- My Checklist



1 hour

Lecture #13

UNDERSTANDING FEM OUTPUTS

- Standard Outputs
 - i. Deformations
 - ii. Element Force
 - iii. Freebody Diagram
 - iv. Stresses
- The Basic Rules of Post-Processing
- How to Deal with Singularities in Stress Models



1 hour 30 minutes

Lecture #14

OVERVIEW OF THE BASIC FEA SOLUTIONS IN SOLID MECHANICS

LINEAR STATIC ANALYSIS

- What is Linear Static Analysis?
- How to Solve a Linear Static Problem?
- Characteristics of a Linear Static Analysis
- Examples



30 minutes

Lecture #15

OVERVIEW OF THE BASIC FEA SOLUTIONS IN SOLID MECHANICS

LINEAR BUCKLING ANALYSIS

- What is Linear Buckling Analysis?
- Assumptions and Limitations of LBA
- The LBA Outcomes
- How do an FE Solver Computes LBA Problems?
- Linear Buckling Strategy
- Examples



45 minutes

Lecture #16

OVERVIEW OF THE BASIC FEA SOLUTIONS IN SOLID MECHANICS

NORMAL MODE ANALYSIS

- Introduction to Modal Analysis
- The Eigen Equation
- Numerical Methods for Solving the Eigen Equation
- What a Mode is and What a Mode is Not?
- How are Natural Frequencies and Mode Shape Influenced?
- Why Compute Modal Analysis?
- Influence of the Pre-Stiffness on the Natural Frequencies
- Examples



45 minutes

Lecture #17

OVERVIEW OF THE BASIC FEA SOLUTIONS IN SOLID MECHANICS

HOW TO CHOOSE THE RIGHT SOLUTION?

- Should I Run a Static or a Dynamic Solution?
- Should I Run a Linear or a Nonlinear Solution?
- Should I Run a Buckling Solution?
- Should I Run a Normal Mode Solution?



10 minutes

Practical Basic Finite Element Analysis

Steffan Evans



"FEA Workflow
Examples"

14 Videos
5 hours

➤ **Meshing**

- ✓ 1D Meshing
- ✓ 2D Meshing
- ✓ 3D Meshing
- ✓ Mesh Refinement
- ✓ Mesh Convergence

 1h30

➤ **Defining Loads and Boundary Conditions**

- ✓ Boundary Conditions
- ✓ Loading

 50 min

➤ **RBEs and MPCs**

- ✓ RBEs Application

 10 min

➤ **Modeling Bolted Joints**

- ✓ Joints Example

 25 min

➤ **Submodeling**

- ✓ Submodeling Application

 35 min

➤ **Understanding FEM Outputs**

- ✓ Typical Post-Processing

 40 min

➤ **Linear Static Analysis**

- ✓ Modeling a Stiffened Panel

 30 min

➤ **Linear Buckling Analysis**

- ✓ A Complete Linear Buckling Workflow

 10 min

➤ **Normal Mode Analysis**

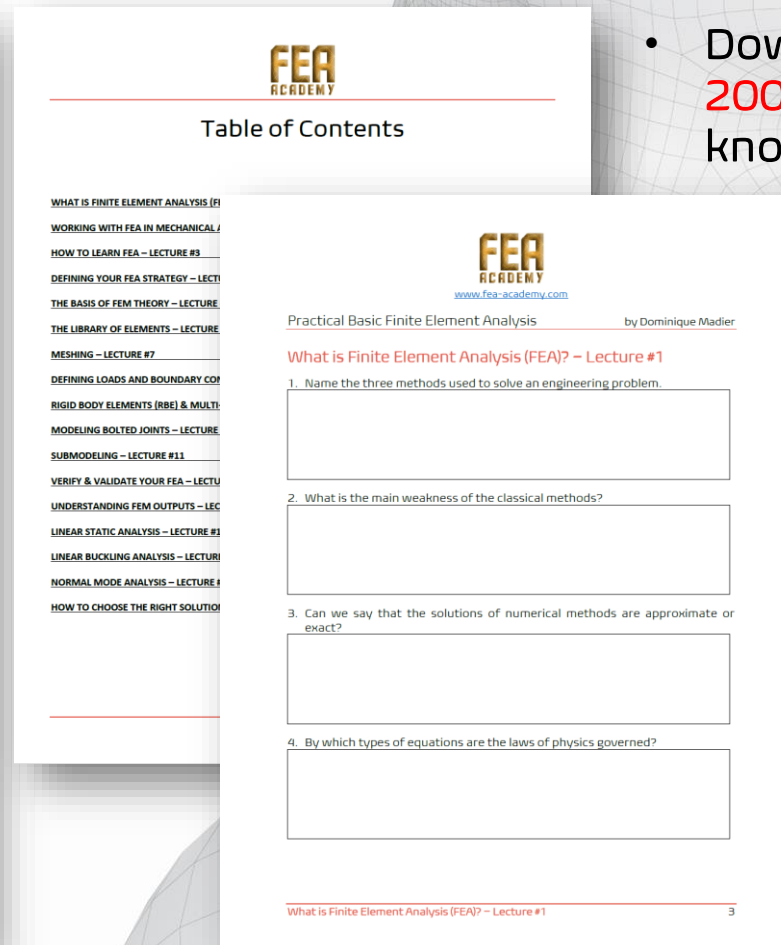
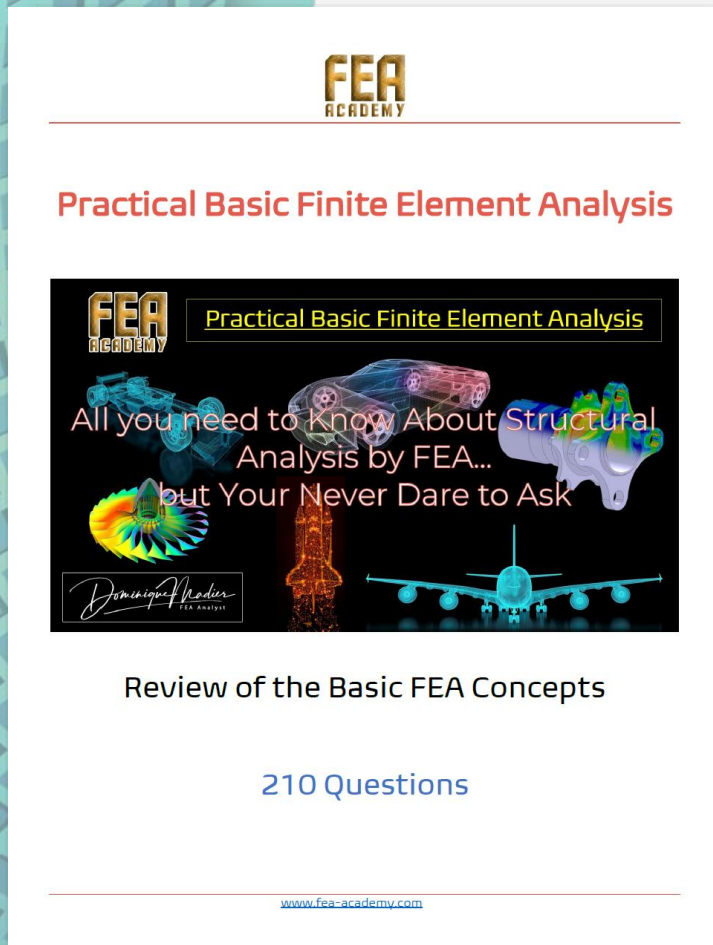
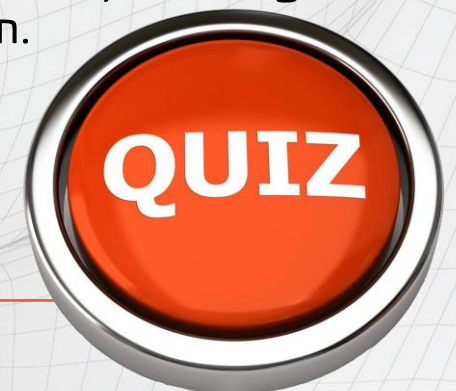
- ✓ Capturing Natural Frequencies

 10 min

Keep Track of Your Knowledge

- Download our pdf document with **200+ questions** to review your knowledge.

- Download our pdf document with **all the answers** to the 200+ questions.
- Test yourself by answering the quizzes after each lecture in the FEA Academy learning platform.



Supporting Files

Download from the Virtual Classroom

17 PDF FILES



LECTURES SLIDES ~1000 SLIDES

150+ MODELING FILES

- Nastran Model Files of the Lectures Examples (convertible in any FEA package format)
- Geometric Files to Replicate the Lectures and FEA Workflow Examples:
 - ✓ Parasolid (.x_t)
 - ✓ Step (.stp)
 - ✓ IGES (.igs)

Your instructor for "Modeling Techniques"



Dominique Madier

| FEA Analyst | FEA Trainer | Book Author | Speaker |
| Founder & Director of FEA Academy & FEA Experts |
dominique.madier@fea-academy.com

👉 Senior FEA consultant, trainer and coach with 25+ years of experience in FEA.

👉 He has an advanced expertise in Finite Element Analysis (FEA) of static and dynamic problems for linear and nonlinear structural behaviors on aerospace metallic and composite structures such as aircraft fuselage, wing, empennage, nacelle, engine pylon and systems.

👉 Dominique conducted detailed finite element analyses for aerospace companies in Europe and in North America: Airbus, Dassault Aviation, Safran, Bell Helicopter, Bombardier Aerospace, Pratt & Whitney Canada, Beta Technologies, and their subcontractors.

👉 He is the author of the books **"Practical Finite Element Analysis for Mechanical Engineer"** and **"Harness the Power of FEA"**, which provide practical methods and guidelines for engineers and students in developing and validating finite element models. Additionally, these books offer valuable insights for technical managers on building and managing effective FEA teams.

👉 Dominique is the founder & director of FEA Academy and FEA Experts, companies offering FEA Consulting Services as well as FEA Training, Coaching and Mentoring Services.

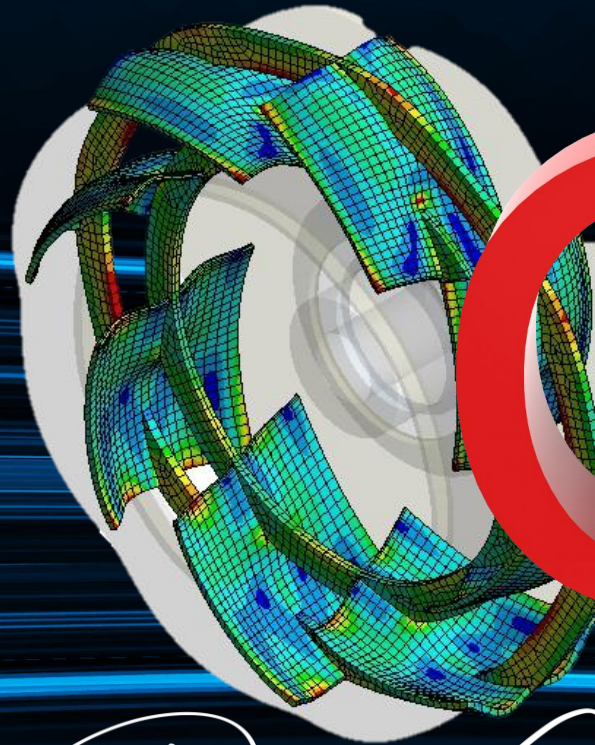
Your instructor for "FEA Workflows"



Steffan Evans

| FEA Analyst & Trainer | Director of Evotech CAE Ltd. |
info@evotechcae.com

- 👉 Doctor of Engineering, 'Multi-Parameter Structural Optimisation'.
- 👉 Steff is a Chartered Mechanical Engineer in UK.
- 👉 He obtained the NAFEMS Certification Professional Simulation Engineer at Advanced Level.
- 👉 Steff spent 20 Years in Airbus/BAE Systems Supply Chain involved in Strategic FEA Development, Analysis and Verification.
- 👉 Since the last 5 years, he is running Evotech CAE Ltd, an engineered product consultancy company in CAE, FEA and Design Optimisation, partnered with MSC Software for training and technical resales.
- 👉 Steff is known as "The Apex Guy" on LinkedIn.

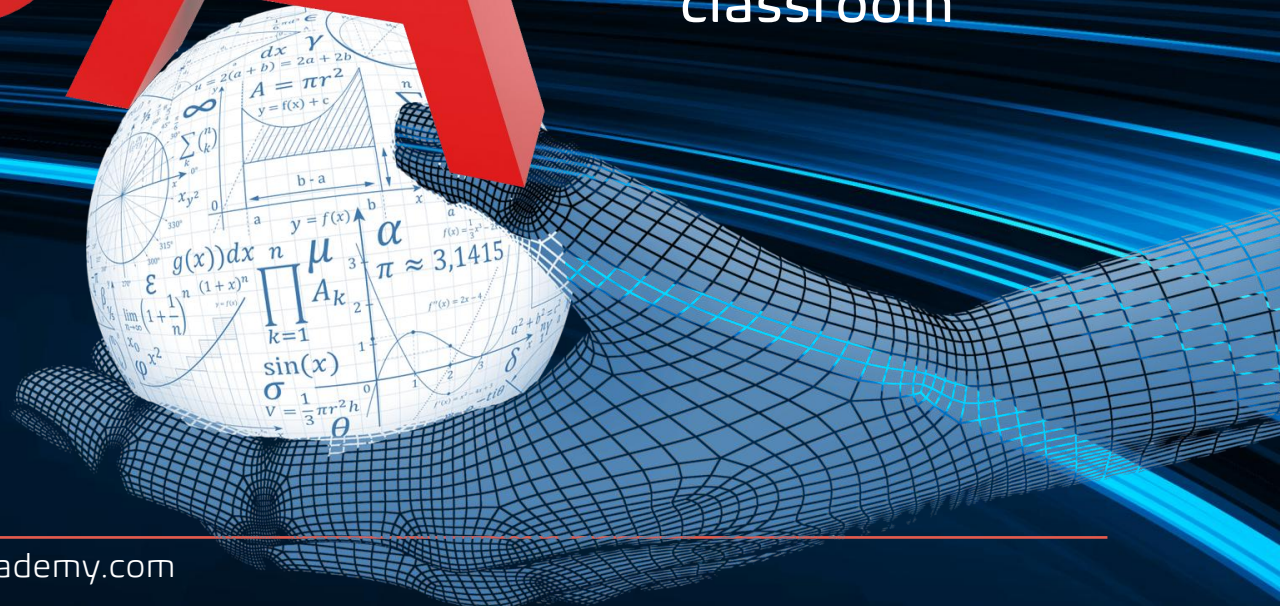


Q&A

Ask your questions in
the “**Discussion**”
sections available with
each lecture in the
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« *Practical Finite Element Analysis for Mechanical Engineers* »

650 PAGES OF FEA BEST PRACTICAL METHODS & GUIDELINES – 100+ EXAMPLES

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