Innovent

PROPELLING ENGINEERING DREAMS

A Upskilling Program for New Product Design, Innovation & Research

Master Certification Course

CAE Skills in

STRUCTURAL MECHANICS, DESIGN & ANALYSIS

An E-learning platform for engineering skills

Course evaluated by AICTE

implemented by

N·E·A·T

प्रौद्योगिकी के लिए राष्ट्रीय शैक्षणिक सहयोग

National Educational Alliance for Technology

An Initiative of the Ministry of Education Govt. of India
CAE Skills in Structural Mechanics Design and Analysis
Conforms to National Occupations Standards
defined in the Quality Pack (NSQF level 7)
that complies with the guidelines of Sector Skill Council of NASSCOM.

"Building critical thinking problem solvers for the future with unparalleled competitive spirit"

EnggSkills

Institute to Designer's desk

Master Certification Course

CAE SKILLS IN STRUCTURAL MECHANICS DESIGN & ANALYSIS

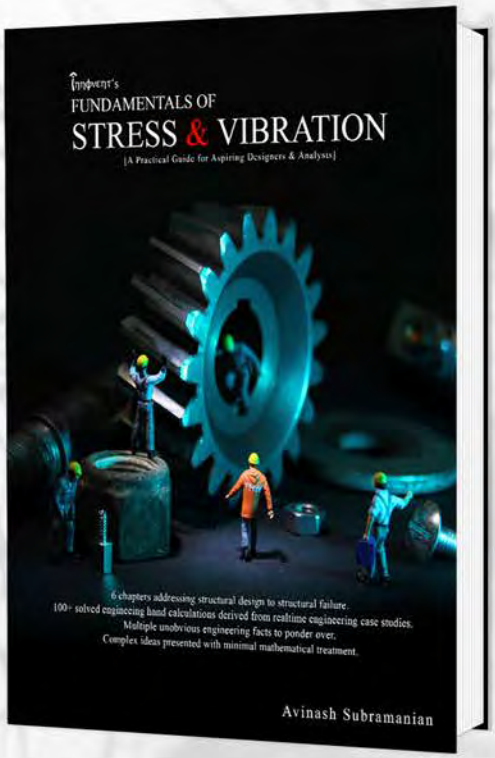
This course is designed to cater to both young learners and practicing engineers. The young engineers who complete this course successfully would be equivalent to engineers with 2 years of experience in CAE skills in Structural Mechanics, Design & Analysis. The following are the objectives of the course:

- ☐ **Industry readiness**
- ☐ **Complete preparation for top notch research interviews**
- ☐ **Strong Foundation for industry relevant simulation skill.**
- ☐ **Introduction to ANSYS Workbench (free with the course)**
- ☐ **Assessments designed to test and map critical thinking and problem-solving skills.**

PACKAGE DEFINITION

MODULE	What it contains?	Key Engineering takeaway
Module - 1	Structural physics recast for product development • Engineering mechanics (FBD and RBD) • Material mechanics (BMD&SFD, Stress analysis and stiffness and buckling) • Vibration analysis (Free vibration and shaft dynamics) • FEM	• Detailed understanding of loads and load path (Mechanical and thermal loads) • A detailed appreciation for stress, vibration and buckling margin of a component. • Strong fundamental foundation on stress and vibration from component design perspective
Module - 2	Introduction to ANSYS workbench latest version with 34 workshops and 12 tests Comes free with the course	• Introduction simulation culture and role of an analyst. • A thorough familiarity with all ANSYS facilities for structural simulation
Module - 3	5 levels of assessments, that test and map against critical industry requirements	• Critical thinking • Visualisation • Feel for numbers • Simulation and physics proficiency
Module - 4	Advanced concepts on engineering design and manufacture for product development. Design covers 36 critical concept and 7 design case studies. Manufacture covers 10 critical concepts including tolerance analysis. 7 Detailed design assignments and a comprehensive test on design and manufacture	• Concept sketching to component design • Engineering failures (Emphasis on unobvious failures) • Probabilistic methods and sensitivity analysis Reliability • Elements of digital twin and additive manufacture
Module - 5	Engineering processes for not just addressing not just data and knowledge management but also situations involving product validation, quality systems and effective organisation structure for product development. This module has 48 assessment situations.	• Data and Knowledge management • Engineering communication (Risk register, design standardisation reports etc) • Product validation strategy and challenges • Quality systems

GO-TO MASTER REFERENCE BOOKS



FUNDAMENTALS OF STRESS & VIBRATION

Salient Features

- 100 plus idealized product situations that systematically and mathematically explain design facets
- Concepts are naturalized : equations of motion are used to explain Newmark integration formulae
- All chapters of structural physics are given equal emphasis
- Mathematics relevant to structural physics is presented with practical examples
- Important tools for designers, such as Campbell diagram and Goodman diagram, are detailed with uses and its possible abuses caused from misinterpretations
- Highest clarity is provided on stress concentration fatigue and fracture.
- Foundation for advanced structural learning including detailed mathematical treatment of axisymmetric situations
- Product relevant engineering facts as part of conclusions are given
- Large numbers of graphs are plotted, be it stress or a mechanics situation, to provide insight and assume generalisation
- Optimisation (calculus based) is carried out in many situations to provide young engineers a detailed sense of why and how of optimisation
- In line with current practices, a stochastic optimisation example is included to prepare the candidate for advanced learning

ENGINEERING CRITICAL THINKING

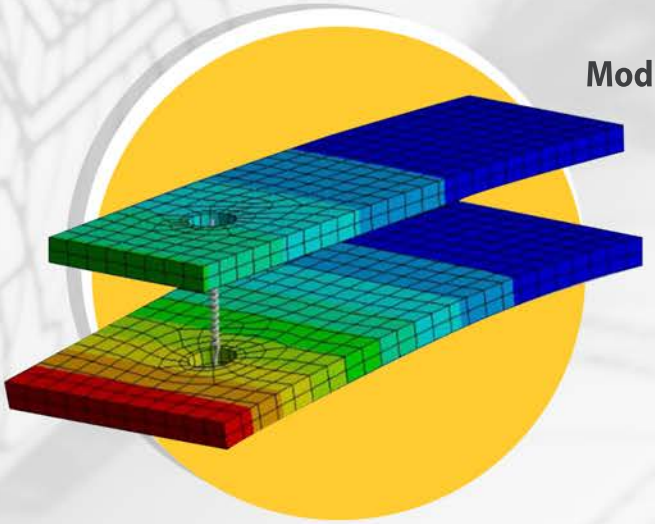
Salient Features

- 100 plus numerical situations that test the critical thinking skills of a young engineer
- Learning methods are well exemplified with various learning philosophies
- Challenges of product development are well documented
- Probabilistic methods are detailed with examples in random vibration fatigue and fracture mechanics
- A devoted chapter on critical thinking has situations from design, manufacture, measurements and thermal sciences
- Application of critical thinking on real time situations is well demonstrated
- Transformation is extensively used in both mechanics and material mechanics
- Many advanced topics both in mechanics and material mechanics (material non-linearity) are explained lucidly
- Four mega challenges are included with exhaustive solutions
- More than 100 engineering notes are provided, summarising the critical aspects of design and providing direction for future investigations
- A chapter on mathematics involves several topics relevant to FEM
- FEM is not exclusively dealt with but is naturalised in the book
- Many advanced situations are numerically solved to give clarity on all facets of a situation
- Many problems are solved by multiple methods to reinforce the grasp of physics

Module 1: Structural physics for CAE

This lays the foundation for CAE skills in mechanics, design & analysis and streamlines the thinking pattern of young minds. The primary endeavour of this module is to map everything to product development

- How do you idealise systems for hand calculations: Example: Could we idealise windmill tower as a cantilevered beam with lumped mass?
- Why design is driven by operating conditions. Example: Temperature has multiple effects such as reduction in vibration and buckling margin, contribute to stress, contribute deflection etc.
- How constraints could affect the stiffness and load capacity of a component. Example: A simply supported beam has lesser capacity than a fixed -fixed beam for the same material and geometry. This is a long list
- How to conceive the obvious and unobvious failures which are strength based in nature.
- Also, this lays foundation for hand-calculation culture for product development
- Finally, module details on OEM and Research interview expectations for young engineers via 49 mock interviews.



Module 2: Introduction to Basic Simulation Culture ANSYS Workbench

Today design is driven by simulation as concept are verified against against various strength failures using simulation. This module primarily make the candidates familiar with simulation procedure and best practices. Emphasis is given to geometry and material modelling and result interpretation.

The following are the highlights

- A comprehensive familiarity with GUI is gained and facilities
- 34 workshops covering stress, vibration, and elastic stability
- 12 case studies
- Voiced over demo of various stress vibration analyses in ANSYS.

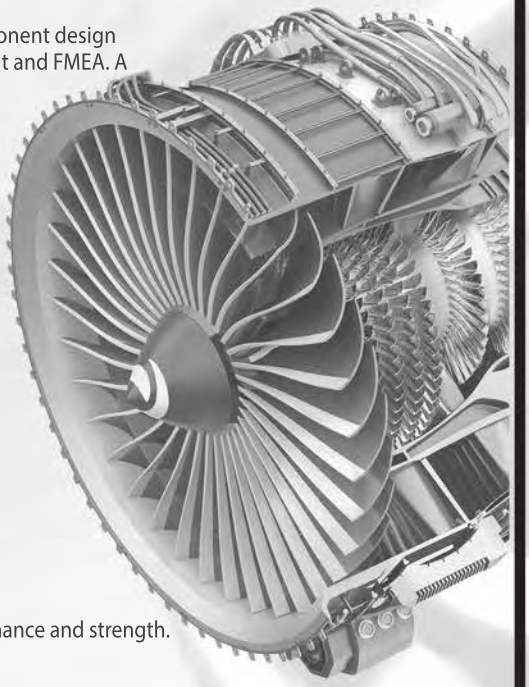
Module 3: Assessments with LRS (Learning Reporting System)

Assessment is crucial in any learning and assume highest criticality. These must be conceived scientifically to build effective problem-solving skills by streamlining critical thinking pattern.

1. Concept registration	**Checks rigorously the appreciation of physics facts**
2. Gamified assessments	**It builds problem solving skills fun way without number jugglery**
3. Summative assessments	**It checks concept clarity for the entire course and problem-solving skills**
4. Industry mapping	**It is designed to check the ability to visualise and think critically**
5. Simulation assessment	**This focusses on modelling, boundary conditions and result interpretation**

The tests are arranged in the order of difficulty and degree of conceptualisation which ensure that learning is complete and every facet important from engineering design and analysis are grasped and appreciated. Totally module comprises of 600 plus situations.

Module 4: Design and manufacture



This module is designed to provide real time exposure incepting from concept sketching till component design verification. The best practices such as probabilistic approach, sensitivity analysis, risk management and FMEA. A chapter on tolerance analysis is of huge significance for designers and analysts

Module comprises of 3 sub-modules

- Engineering design
- Manufacture
- 7 Design case studies and best practices

Salient Features

- Holistic appreciation for engineering design process from concept to component
- Appreciation for component drawing and various aspects
- Detailed appreciation for various types of engineering failures
- Appreciation of off design failures
- Appreciation for use of various structural elements for various load situations
- Introduction to challenges of material selection and material utilisation.
- Examples on probabilistic design margin.
- Appreciation for safe life and fail-safe design, use of Goodman and S-N diagrams.
- Appreciation for why and how of sensitivity analysis
- A detailed appreciation for tolerance analysis and tolerance stackup and impact on performance and strength.
- Introduction to additive manufacture
- Introduction Risk management and FMEA
- Introduction to heat treatment and surface engineering
- A detailed appreciation for vibration margin.
- A detailed appreciation for excitation agencies
- Development and interpretation of Campbell diagrams
- A comprehensive Case study of centrifugal loading.
- 7 Design case-studies with best practices

Module 5: Engineering processes

Engineering communication is of utmost significance be it authoring a standardisation report or a risk register. Also, procedures adopted to carryout product validation are of fundamental significance and hence must be carefully understood for all facets. This module focusses on explaining all these aspects.

Salient Features

- Engineering documentation with report authoring
- Engineering knowledge communication
- Engineering quality systems
- Engineering verification and validation
- Organisation policies and structure
- Knowledge management

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