Inventt

PROPELLING ENGINEERING DREAMS

A Upskilling Program for New Product Design, Innovation & Research

Master Certification Course

HOLISTIC ENGINEERING FINISHING SCHOOL

for Industries & Academic Avenues

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 Literacy in Structural 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

HOLISTIC ENGINEERING FINISHING SCHOOL

for Industries & Academic Avenues

This course is designed to cater to both young learners and practicing engineers and the course is mapped to 21 plus Trades across product industries and leading academic avenues including machine learning and AI (Interms of mathematical requirements). The young engineers who complete this course successfully would be equivalent to engineers with 2 years' experience in the new product development environment. The following are the course components.

- Structural physics with detailed understanding of loads and load path and detailed appreciation for stress and vibration with strong fundamental foundation on stress and vibration.
- 7 Design case-studies on engineering best practices and failures with 7 assignments on engineering hand-calculations.
- A detailed module on engineering design with 34 design situations of loads, load path and engineering failures, lifing and industrial perspective.
- A module on manufacture and assembly sensitising on all facets of component definition, integrity, and assembly.
- A module on holistic engineering finishing school visits the entire mechanical engineering followed by a few advanced concepts from senior graduate level caters to competitive exams like GATE/subject GRE/IES, higher order thinking and building research aptitude.
- Several stages of measurement and mapping of competency (critical thinking and problem solving), including Gamified assessments.

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	• 7 design case studies and best practices • 7 assignments on engineering hand-calculations	• Interpreting engineering failures • Campbell-diagram construction and interpretation. • Joint design for elevate temperature and RPM loads • Discontinuity stresses.
Module - 3	34 situations on engineering design covering all facets of structural design	• Loads and Load path • Engineering failures (spectrum not limited to strength failures and surface failures) • Component design best practices • Comprehensive case study on centrifugal loading. • Bearings, Gears, shafts and bearing support structure. • Criticality of clearances for product performance • Design best practices • Probabilistic design and sensitivity analysis.

PACKAGE DEFINITION

MODULE	What it contains?	Key Engineering takeaway
Module - 4	9 modules from quality to cost to tolerance to component integrity.	• What aspects designer must be sensitive to achieve the quality warranted by component drawing? • Process capability Challenges • Tolerancing and tolerance stackup and design failures • Effect of process on component integrity. • Optimising material utilisation
Module - 5	Holistic engineering finishing school with 12 submodules (entire mechanical engineering curriculum + concepts from senior graduate curriculum)	• Previous GATE situations with pen- less and innovative solutions (all concepts covered except repeated ones) • Higher order thinking situations • Research interview situations • Advanced concepts from senior graduate curriculum • Engineering hand-calculations
Module - 6	10 levels of assessments	• Concept registration • Gamified assessment • Summative assessment • Concept mapping (4 levels) • Designer's aptitude assessment • Manufacture assessment • Competitive thinking • Higher order thinking • Research aptitude • Simulation skill assessment
Free Module	Introduction to Basic Simulation Culture ANSYS Workbench/Spaceclaim	• 34 Workshops • 12 tests • 100 plus demonstration

Module 1: Structural physics for CAE

This lays the foundation for engineering design 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: Design case-studies

(7 design case-studies and 7 engineering hand-calculations)

This module is designed to sensitise the designer about various possible failures and best practices such as using and interpreting Campbell and Goodman diagram. This has a perfect continuity to module 1 and is built on the fundamentals achieved during module 1.

Salient features

- One design case-study for each sub-module of Module 1
- Comprehensive situations for engineering hand-calculations with detailed solutions chosen from various product industries.
- A detailed module on Construction and interpretation of Campbell diagram.
- Critical insights on unobvious failures, drawn from various industries.

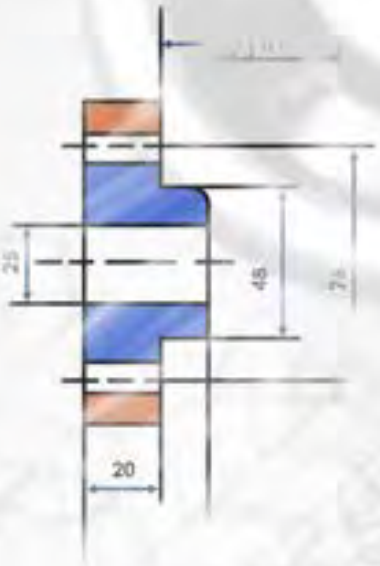
Module 3: Engineering Design

This module is designed to achieve component design and validation skill. It gives a detailed understanding of loads, load path and component failures (strength, surface, and performance). This module also focuses on best practices of engineering learning such as memory maps and engineering wheels. Topics on design best practices, probabilistic design and sensitivity analysis are highly useful even to practicing engineers.

Salient features

The course achieves the following:

- Understanding of contemporary definition of Engineering design
- Design and engineering practices
- Component design process
- Elements of Rotordynamics
- Corrosion failures
- Performance failures
- Rotating component design best practices
- Lifing philosophies
- Modern practices Probabilistic design and sensitivity analysis
- Gyro-loading and unobvious failures



Module 4: Manufacturing & Assembly

This module is designed to achieve sensitivity of designers and analysts towards various aspects of component definition and integrity. Hence this module not just focusses on process or method but also on heat treatment, assembly aspects, operating clearance and hence tolerance stackup and tolerancing. Incidental aspects such welding and casting defects, effect of microstructure are given effective discussions. Additive manufacture is compared with conventional manufacture.

Salient features

- Develops strong perception of quality.
- Develops detailed understanding on tolerancing and stackup.
- Gives exposure to heat treatment and surface engineering.
- Gives detailed exposure to component defects and Non-destructive testing.

Module 5: Holistic Engineering Finishing School

To build spontaneity and speed characterised by accuracy, preparation for competitive exams is a must. Though competitive thinking is the point of inception, the higher order thinking, problem solving via observation, approximation, and critical thinking, fundamentally driven by physics and mathematics is what is warranted by new product introduction (NPI). The course not only adopts multi-physics driven integrated approach to develop product design skill but also introduces a comprehensive module on manufacture and production management. Therefore, this is perhaps the most unique program that has every element build holistic mechanical design skill.

This course also provides a strong foundation in mathematics. Therefore, emphasis is not only physics (mechanical, thermal, fluid, elements of E-mag and control theory) but also on mathematics such that candidates could pursue machine-learning, AI, robotics, and other leading sciences.

Salient Features

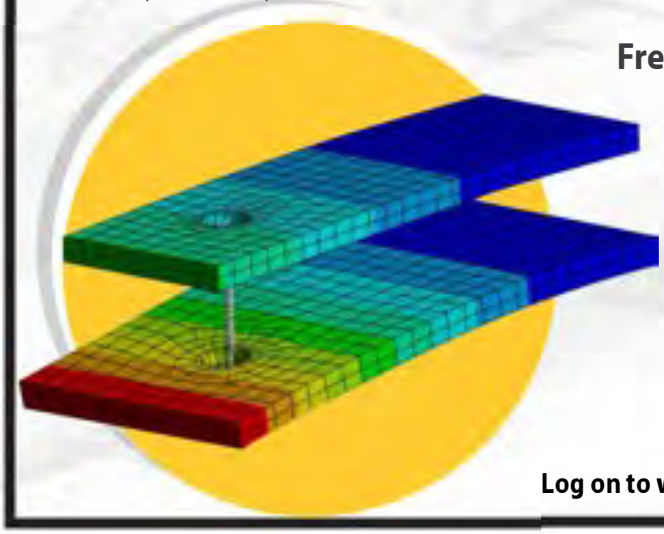
- The course is designed to build strong physics and maths culture for higher academic pursuits and engineering innovation.
- The course helps young engineer to inculcate critical thinking and spontaneity which is fundamental for competitive exams and research interviews.
- The curriculum followed is that of a 4-year undergraduate course in mechanical engineering plus advanced concepts from senior graduate course in mechanical engineering.
- The course equally addresses manufacture, assembly, and production management with several real time examples.
- The course also incorporates elements of electromagnetism and control theory considering current day industry requirements.

Module 6: 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. Designer's aptitude assessment	**This tests ability to conceive loads, load path, failures and material selection.**
6. Manufacture assessment	**This tests ability to choose the right method, GD and T and quality perception.**
7. Competitive thinking	**This tests spontaneity and application**
8. Higher order thinking	**This tests the ability to deal with non-routine situations**
9. Research aptitude	**This focusses on modelling, boundary conditions and result interpretation**
10. Simulation assessment	**This tests the ability to visualise unobvious facets and problem-solving**

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.



Free Module: Introduction to Basic Simulation Culture ANSYS Workbench/Spaceclaim

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.

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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