Innovent
PROPELLING ENGINEERING DREAMS

An Upskilling Program for New Product Design, Innovation & Research

CAE SKILLS in

STRUCTURAL MECHANICS, DESIGN & ANALYSIS

For Industries and Academic Avenues

Course evaluated by AICTE

implemented by

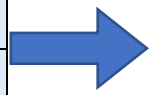
N·E·A·T

प्रौद्योगिकी के लिए राष्ट्रीय शैक्षणिक सहयोग

National Educational Alliance for Technology

Objective of the course is to achieve the competency to **16 Industry trades:**

OEM Industry trades	
1	Component design engineer
2	System design engineer
3	Structural analyst
4	Product integration engineer
5	Integrated product team lead
6	Process designer
7	Risk/FMEA facilitator
8	Design Laison engineer
9	Testing engineer
10	Quality control engineer
11	Methods/process engineer
12	Production engineer
13	Assembly engineer
14	Component/product definition engineer
15	Repair and concessions engineer
16	Technical documentation author



- Strong foundation in physics and mathematics relevant to mechanical engineering and data science
- A foundational understanding of electro-mechanical A strong foundation in manufacture, GD and T, buildability, tolerance-stackup quality control, heat –treatment and surface engineering.
- Many other incidentals such as quality control cost-modelling, repair/salvage, heat-treatment failures: left austenite , case-depth variation, NDT, CMM vs first principle measurement etc.
- Engineering design (accounting for fluid, thermal, mechanical and electromagnetic aspects), design liaison, Concessions, design best practices, design process and contemporary best practices such as probability approaches, sensitivity analysis etc.
- Strong simulation culture, material and geometric modelling, understanding and replicating idealised boundary conditions, engineering hand-calculations, conceiving worst performance and operating envelopes, interpreting results and conceiving scope for optimisation.

CAE in Structural Mechanics & Analysis

A. Stress, Vibration and Simulation
B. Engineering Design and Manufacture

A. Stress, Vibration and Simulation		
Modules	**Description**	**Assessments**
1) Free Body Diagram **Course Duration:** **1 hour 22 minutes**	Using FBD in Static and dynamic equilibrium situations, component loads, and load path of an assembly could be derived. The concept is useful in joint assessment (reactions). Concept of FBD could also be used in fluid mechanics, heat transfer, electromechanical situations, and others. Further FBD helps resolve the direction of friction which is not obvious in some situations.	• Formative Objective: 8 • Formative Gamified: 4 • Formative: 15 • Summative: 15
2) Rigid Body Diagram **Course Duration:** **2 hours 35 minutes**	Be it systems /mechanisms/ components, when subjected to dynamic loads, develop acceleration, velocities and hence stresses. These have to be computed to ensure the fundamental parameters such as durability (fatigue life), reliability, controllability, observability and performance. The first step is to idealize the component to be rigid and derive all the dynamic loads seen by it and via load path loads seen by other components in the assembly.	• Formative Objective: 33 • Formative Gamified: 4 • Formative: 20 • Summative: 15
3) Bending Moment & Shear Force Diagrams **Course Duration:** **2 hours 38 minutes**	This is extremely useful be it a civil structure (bridge), a mechanical structure (a lathe) or an aerostructure (fuselage). The BMD and SFD are used to assess stress, deflection and stiffness. If the bending loads are variable, it causes fatigue. The BMD is useful in Rotor dynamics such as matching slopes and deflections at the interface of multi rotor systems. The BMD and SFD is also used in locally stiffening structure.	• Formative Objective: 17 • Formative Gamified: 4 • Formative: 18 • Summative: 15
4) Stress Analysis **Course Duration:** **2 hours 35 minutes**	The stress margin is one of the fundamental margins for a structure, which also goes to determine the fatigue life/ damage tolerance of the structure depending on nature of the stresses. Generally, components are loaded multiaxially, hence, combining stresses to assess failures is a must. Pre-stress due to self-weight or joint or heat treatment must be accounted for, apart from other the obvious sources.	• Formative Objective: 52 • Formative Gamified: 4 • Formative: 12 • Summative: 15
5) Stiffness & Buckling **Course Duration:** **1 hour 6 minutes**	The buckling margin is one of the fundamental margins of safety. Buckling is a concern not just for structural elements in compression but also shafts subjected to shock loading and thermal stresses. The buckling margin must be traded with vibration and deflection requirements as these depend on the stiffness.	• Formative Objective: 16 • Formative Gamified: 4 • Formative: 12 • Summative: 15

Modules	Description	Assessments
6) Free Vibration and Elements of Shaft Dynamics **Course Duration: 1 hour 22 minutes**	The vibration margin is a fundamental design margin. The flexural and torsional vibration analysis is fundamental, be it, a shaft, a gear train or a seal. The design of bearing support structure is critical not only for critical speed and as a source of damping but also critical for weight and space constraint. The understanding of exciting agencies is critical to understand dynamic loading (HCF loading). Designing damping is critical to the life of several parts subject to vibration (designing the friction damping).	• Formative: 16 • Formative Gamified: 4 • Formative Objective: 13 • Summative: 15
7) Finite Element Method **Course Duration: 1 hour 23 minutes**	Today simulation forms the core of engineering design with simulation replacing physical testing to a significant extent. Therefore, with its effective use (be it an in-house code or a commercial code), simulation needs strong FEM fundamentals. The appreciation for modelling components with correct elements is fundamental to the accurate prediction of the system behavior. Trouble shooting and result interpretation requires physics background of FEM concepts.	• Formative: 16 • Formative Gamified: 4 • Formative Objective: 12 • Summative: 15
8) Simulation **Course Duration: 60 hours**	Ansys Design modular: • Total no of lecture slides - 140 • Total Demo videos - 55 • Total no of workshop -10 Ansys Meshing: • Total no of lecture slides - 148 • Total Demo videos - 50 • Total no of workshop – 5 Ansys Mechanical Solver: • Total no of lecture slides - 329 • Total Demo videos - 43 • Total no of workshop - 18 Ansys Space claim: • Total no of lecture slides - 150 • Total Demo videos - 19 • Total no of workshop – 6	Ansys Design modular: **Assessment: 50** Ansys Meshing: **Assessment: 50** Ansys Mechanical Solver: **Assessment: 70** Ansys Space claim: **Assessment: 40**
Textbook 9. Fundamentals of Stress and Vibration	The resource book on stress and vibration lays a strong foundation in mechanics and material mechanics from a product design perspective. The book aims to build higher order thinking on this solid foundation. The chapter introduces many advanced concepts in mechanics, such as Euler angles, to enable the candidates address higher challenges such as satellite dynamics. The book also attempts to address incidental aspects such as stability analysis, feedback control systems and disturbing agencies to provide a holistic picture.	The book has more than 100 challenging situations solved problems

B. Engineering Design and Manufacture		
Modules	**Description**	**Assessments**
1. 7 Physics webinars/Design case-studies **Course Duration:** **2 hours 20 minutes**	These 7 webinars discuss 7 unique situations in structural design addressing comprehensively static and dynamic aspects of component design, unobvious failures, design aids (say Campbell diagram) and design best practices. The module intends to elevate the structural physics knowledge, such that young engineers get a detailed idea about industry expectation and how to apply physics fundamentals to product situations. The module has 7 assignments descriptive taken from real time industry design challenges of space and aero industry!	7 Quizz Assessments
2. Engineering Design **Course Duration:** **3 hours 9 minutes**	This module designed to walk a young engineer through all the critical facets of product design. This module endeavors to define and exemplify all types of possible engineering failures be it strength, surface, performance, NVH or any other off design failure. Young engineers are presented with various situations derived from Gas turbine (next to rocket science) that build a broad understanding of loads, load path, vibration loading, cooling, failures (including assembly), lifing, heat treatment and host of other incidental issues of design. The module also details the process of design from concept to design space to component drawing /model-based definition.	Design Level 1: 15 Design Level 2: 10 Design Level 3: 15
3. Manufacture **Course Duration:** **1 hours 30 minutes**	The module is designed to sensitise young engineers about those aspects of manufacture and assembly that are critical to the success of design. The critical facets are component definition (GD and T), tolerance stackup, effect of process on component integrity, cost modelling (to optimize design cost), heat and surface treatment, important clearances etc. A brief discussion on defects and strength analysis of cast and welded components is also included. To make the discussion more relevant a discussion on additive manufacture is included.	Manufacture Level 1: 15 Manufacture Level 2: 25
Textbook 4. Engineering Critical Thinking	The book is intended towards the development of engineers who aspire to peruse product development. It resorts to numerical culture to explain concepts. The approach has multiple benefits such as sense of numbers, mathematical modelling of the situation and a detailed insight to which parameter has what influence. The book has more than 100 challenging situations solved step by step, providing every possible insight. The situations are well concluded with engineering facts that are crucial to a designer or an analyst. The situations presented are idealized product situations which lay the foundation for strong design culture.	The book has more than 100 challenging situations solved problems

Final Assessment for CAE in Structural Mechanics & Analysis		
Concept Mapping Assessment **(Mandatory)**	This is done to ensure all critical concept proficiency in structural physics. There are 39 critical concepts identified across 7 subjects of phase 1 of Proficiency course. Concept proficiency is evaluated by evaluating each of the 39 critical concepts in 4 steps: Understanding Application Analytics Critical thinking	Understanding: 39 Application: 39 Analytics: 39 Critical thinking: 39
Service Industry Assessments **(Mandatory)**	This section is devoted to test the real time traits needed at the industry to sustain the role of a component designer and analyst. The traits include basic aptitude to make engineering calculations, interpreting numbers, mechanical and abstract visualization and critical thinking skills.	Assessment: 70
OEM and Research Assessments **(Optional)**	The level difficulty increases as we move from Service Industry level to research lab. Service Industry questions are designed assuming the skill needed to work on design changes whereas OEM and research lab questions are designed from a new product introduction perspective that may include innovation and optimization of design considering complex constraints. The OEM and research levels are for the candidates who are eager to take up assignments in product development and research. This evaluation is not mandatory for certification.	OEM: 70 Research: 70