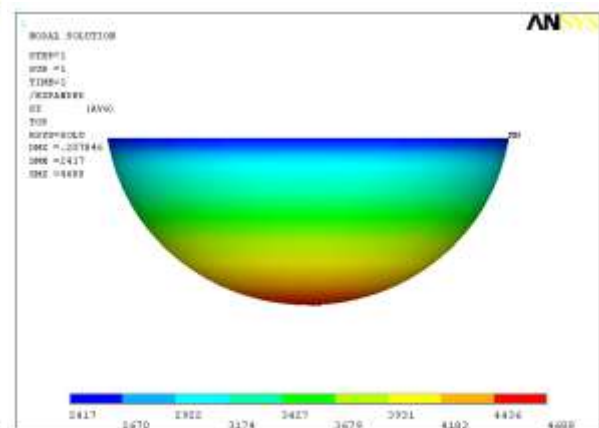
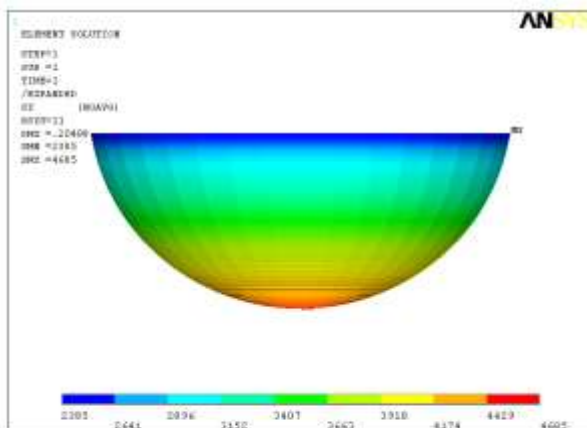


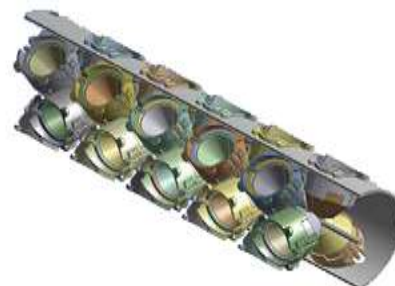
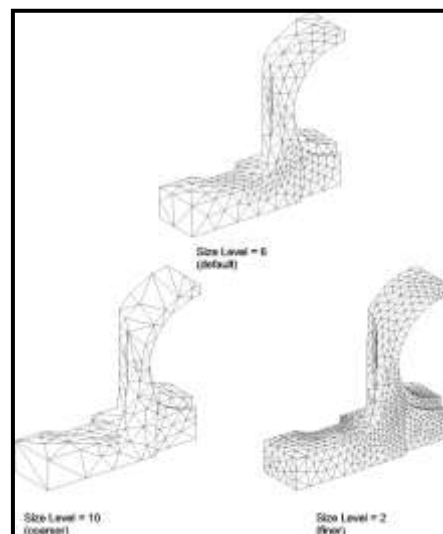
Syllabus [Structural Analyst Program] – Duration: 3 months [12 weeks]

Week 1 & 2: Simulation Tool Training

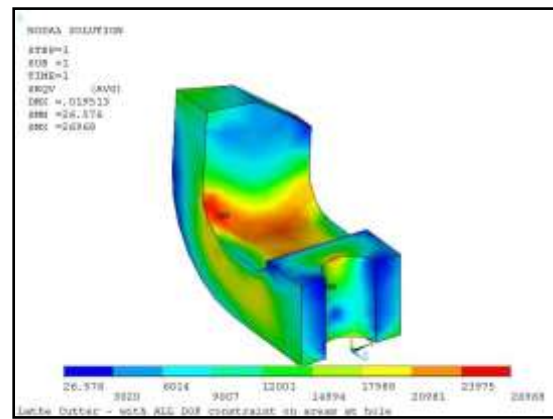
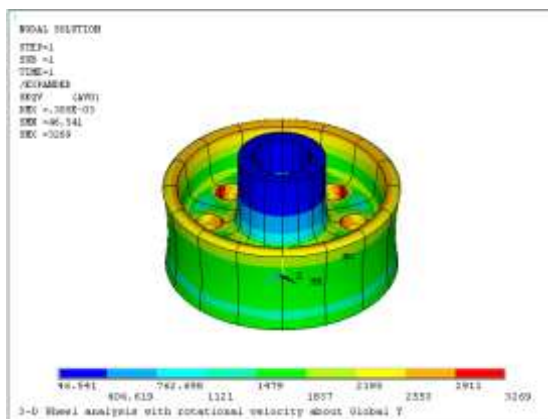
TOPIC	CONTENT	WORKSHOPS
FEA and ANSYS	About ANSYS, What is FEA?, Instructor Example	
Getting Started	Interactive Vs. Batch Mode, Starting ANSYS, Product Launcher, ANSYS Workbench, Memory, GUI, The Database and Files, Exiting ANSYS	1) Introductory Workshop 2) Getting Started Workshop
ANSYS Basics	Overview, Plotting, Picking, Coordinate Systems, Select Logic, Components	3) ANSYS Basics Workshop
General Analysis Procedure	Preliminary Decisions, Preprocessing, Create Solid Model, Create FEA Model, Define Material, Solution, Postprocessing, Review Results, Verification	



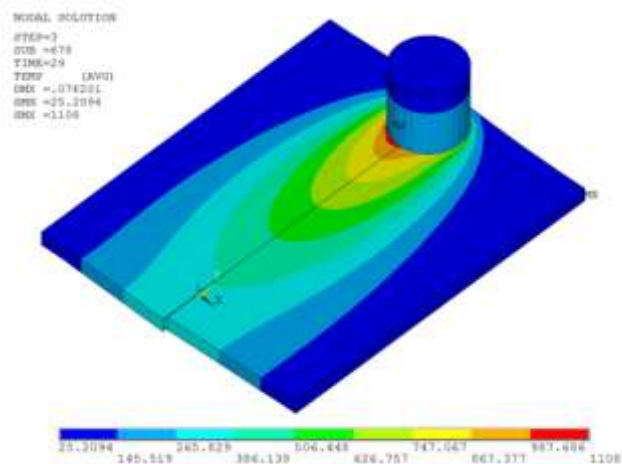
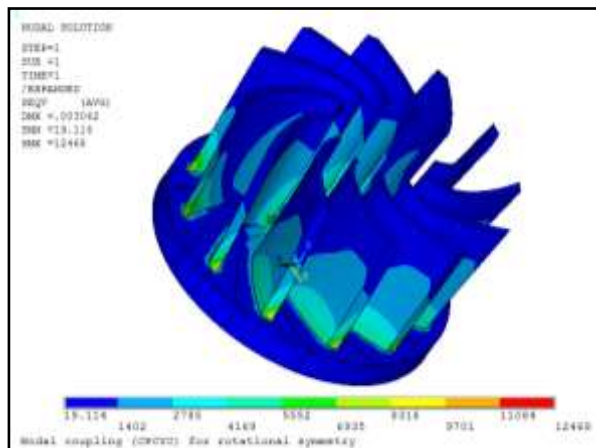
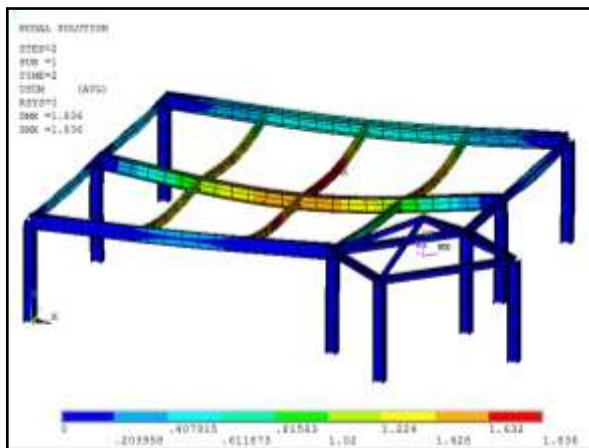
TOPIC	CONTENT	WORKSHOPS
Creating the Solid Model	What to Model?, Importing Geometry, IGES Import, Connection Products, ANSYS Native Commands, Definitions, ANSYS Native Geometry Creation, Working Plane, ANSYS Coordinate Systems and Working Plane Coord. System	<ol style="list-style-type: none"> 1) Importing Solid models- IGES, SAT, SAT Assembly, Parasolid, Parasolid Assembly 2) Pillow Block Modeling 3) Connecting Rod 4) Connecting Rod Import/Cleanup
Creating the Finite Element Model	Overview, Element Attributes, Multiple Element Attributes, Controlling Mesh Density, Mesh Order Control, Generating the Mesh, Hex-to-Tex Meshing, Mesh Extrusion, Sweep Meshing, F.E. Imports	<ol style="list-style-type: none"> 5) Silo 6) Pillow Block 7) Cotter Pin 8) Connecting Rod 9) Impeller Extrusion 10) Wheel



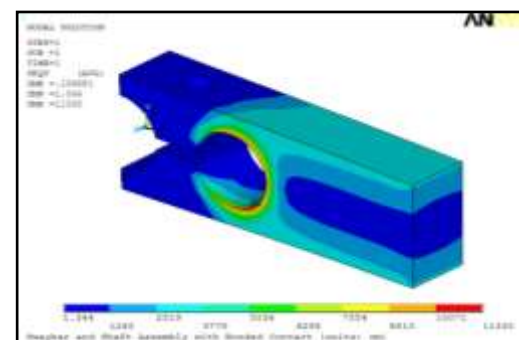
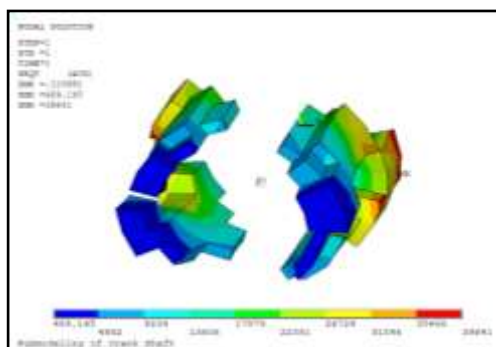
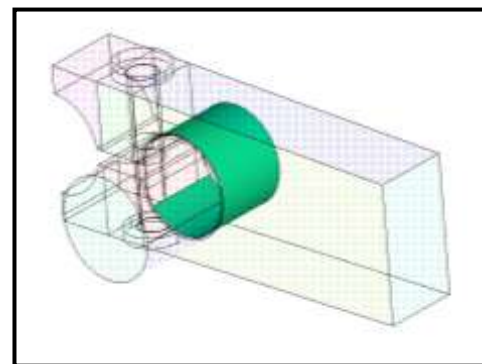
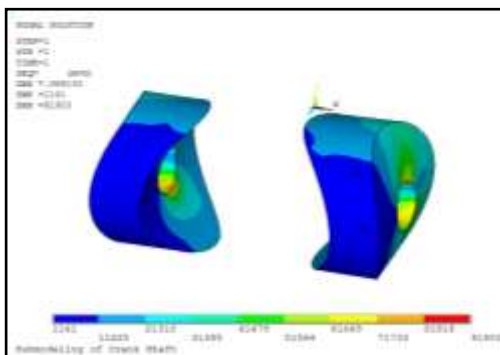
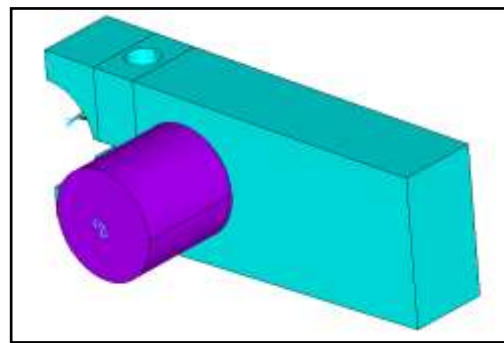
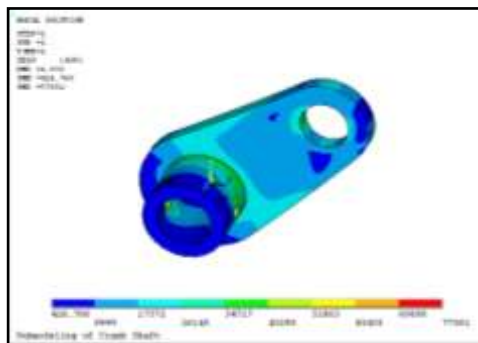
TOPIC	CONTENT	WORKSHOPS
Defining the Material	Units, ANSYS Defined Materials, Material Model GUI, Listing Defined Materials	1) User Input Material
Loading	Define Loads, Nodal Coordinate Systems, Displacement Constraint, Concentrated Forces, Verifying Loads	
Solution	Solvers, Definitions, Multiple Loadsteps	2) 3D Bracket 3) Connecting Rod 4) Wheel
Structural Analysis	Preprocessing, Solution, Postprocessing	5) Lathe Cutter 6) 2D Corner Bracket
Thermal Analysis	Preprocessing, Solution, Postprocessing	7) Axisymmetric Pipe with Fins
Postprocessing	Query Picking, Results Coordinate System, Path Operation, Error Estimation, Load Case Combinations, Results Viewer, Variable Viewer, Report Generator	8) Connecting Rod 9) Spherical Shell 10) Axisymmetric Fin with Multiple Load Steps



TOPIC	CONTENT	WORKSHOPS
Array Parameters	Types of Array Parameters, Retrieving Database Information, Array Operations	1) Axisymmetric Wheel
Coupling & Constraint Equations	Coupling, Constraint Equations	2) Impeller Blade (Coupling) 3) Turbine Blade (Constraint Equation) 4) Swaybar (Rigid Regions)
Working with Elements	Element Coordinate System, Surface Effect Elements, Element Table	5) Bolt Torque (Surface Effect Elements)
Beam Modeling	Beam Properties, Beam meshing, Loading, Solution and Results	6) Building Frame
Couple Field Analysis	Sequential method, direct method	7) Thermal Pipe



TOPIC	CONTENT	WORKSHOPS
Submodeling	General Procedure	1) Crank Shaft
Modal Analysis	Procedure	2) U-Bracket
Introduction to Nonlinear Analysis	Basic Concepts, Typical Procedure	3) Arched Beam
Bonded Contact	Definitions, Typical Procedure	4) Swaybar
Macro Basics Open forum discussion	Creating a Macro, Macro with Arguments, Branching, Looping, General Guidelines	5) Verifying Pressures



Batch Allocation [Total 4 batches] – Sample Week [from week 3 to 10]

Lecture and Practice Sessions			Self-learning Sessions		
Day	Contact Session	Practice session	Batch	Day	Work Definition
Day 1	Batch 1	Batch 3	Batch 1	3 & 6	CT* & SA**
Day 2	Batch 2	Batch 1			
Day 3	Batch 3	Batch 2	Batch 2	1 & 4	CT* & SA**
Day 4	Batch 1	Batch 3			
Day 5	Batch 2	Batch 1	Batch 3	2 & 5	CT* & SA**
Day 6	Batch 3	Batch 2			

* Critical Thinking; **Self-assessment

* **Critical thinking** is an innovative method of learning instead of a traditional method. Herein we take an applied situation which is real time and solve the same by systematic application of the concepts with out-of-the-box thinking. This gives a detailed understanding of the physics, but significantly improves problem solving skills.

Week 3: Mechanics

What does this session achieve?

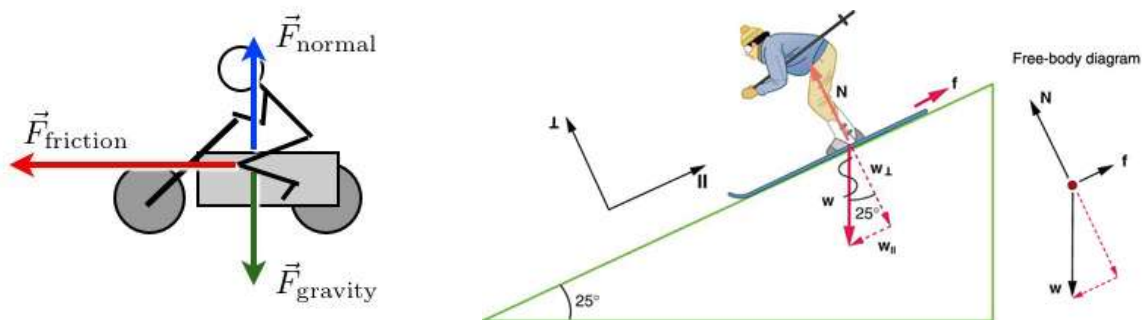
The concept of loads and load path is critical to the structural design, which is systematically understood, which helps to understand the loading of a component in a particular product. Friction is extremely important in many applications and this session gives a comprehensive understanding of the role of friction in critical areas such as fits and Joints. Further, concept of inertia is important not just in rigid body dynamics but also in vibration and Rotordynamics. Thus, this session helps conceive all possible loads, load path, friction and inertia relevant to real time components and also via simulation of the same.

FORENOON: **Critical Thinking Situations**

TOPIC	SITUATIONS
Mechanics – Free Body Diagram (FBD)	<ul style="list-style-type: none"> a) FBD of a Landing Gear b) 2 mass accelerating system c) Shaft and Bearing system
Mechanics – Friction and Inertia	<ul style="list-style-type: none"> a) Bolted Joint – Friction consumed during pre-torque b) Interference Fit – Load carrying capacity c) Equilibrium of a 2 mass system under external load d) Computation of MOI for a given system

AFTERNOON: Simulation Situations

TOPIC	SITUATIONS
Mechanics – Free Body Diagram (FBD)	a) Recapitulate Important Concepts of Simulation b) Landing Gear Analysis & Practice
Mechanics - Friction	a) Analysis of Bolted Joint Assembly & Practice b) Analysis of Interference Fit & Practice



Week 4: Mechanics & Solid Mechanics

What does this session achieve?

Modern day machinery runs on high power and speed necessitating the need for appreciating these systems comprehensively. This session focuses on idealized dynamics of system (CAR) and subsystems (gear train) and moderate mathematical treatment.

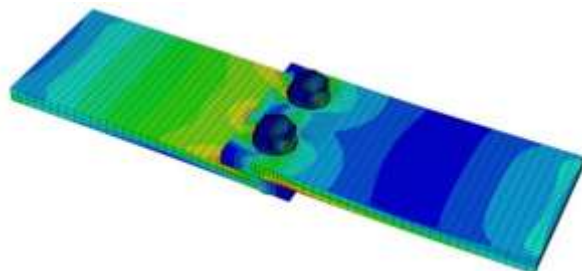
The second part of the session focusses on material modelling. This focusses on the role of material properties in the engineering applications. For example Poisson's ratio could bring about failure of a rotating bolted joint or joint of a pipe. From Stress-strain curve of a material lot of information could be derived about mechanics of the material. Material modelling for simulation is also effectively demonstrated.

FORENOON: **Critical Thinking Situations**

TOPIC	SITUATIONS
Mechanics – Dynamics	a) Rotating Rectangle (Bearing reactions) b) Mass & Spring System c) Negotiating a sine wave d) Analysis of a Gear Train
Solid Mechanics – Material Models	a) Role of Poisson’s Ratio b) Visco-elastic and Visco-plastic behaviour c) Fracture Toughness and Plasticity at Crack Tips d) Stress-Strain Curve

AFTERNOON: **Simulation Situations**

TOPIC	SITUATIONS
Mechanics – Dynamics	a) Analysis of 2 mass system on an inclined plane b) Analysis of a mass negotiating a sine wave c) Stress analysis of a Spur Gear
Solid Mechanics – Material Models	a) Introduction to material models in the simulation tool b) Bolted pressure vessel analysis c) Linear fracture analysis of a plate



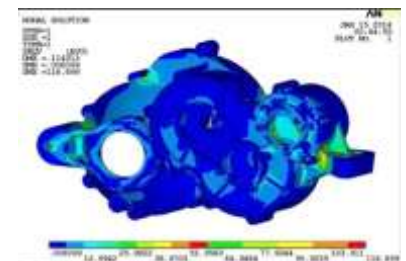
Week 5: Solid Mechanics

What does this session achieve?

The stress measure is crucial, whether it is a simple static analysis or fatigue lifeing, any inaccuracy or wrong stress measure can make a lot of difference to the prediction of the ANALYST about the structural health. Further the fundamental loads such as bending and torsion are emphasized through several trickier situations. Simulation uses many real-time components to understand the component vulnerabilities to the worst bending and torsional loads.

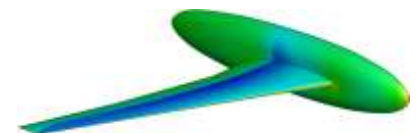
FORENOON: Critical Thinking Situations

TOPIC	SITUATIONS
Solid Mechanics – Stress & Strain	a) Limitations of Von Mises b) Concept of large deflection c) Stress dependence on Material d) Stress & Strain for a typical composite plate
Solid Mechanics – Transformation, SFD & BMD	a) Transformation for a Composite Plate b) BMD & SFD for a C-Beam c) Torsional Stiffness of a Beam d) BMD & SFD of an Aircraft Wing



AFTERNOON: Simulation Situations

TOPIC	SITUATIONS
Solid Mechanics – Stress & Strain	a) Stress concentration of a Hollow Cylinder with a Hole b) Large deflection analysis (Flexible gripper & Pneumatic Fingers) c) Stress analysis of a Gear Box
Solid Mechanics – Transformation, SFD & BMD	a) Combined non proportional loading of an axial and torsional loads b) Analysis of a C-Beam and a Bulk Head c) Torsional Rigidity of a Solid & Hollow Cylinder d) Analysis of an Aircraft Wing with various loads



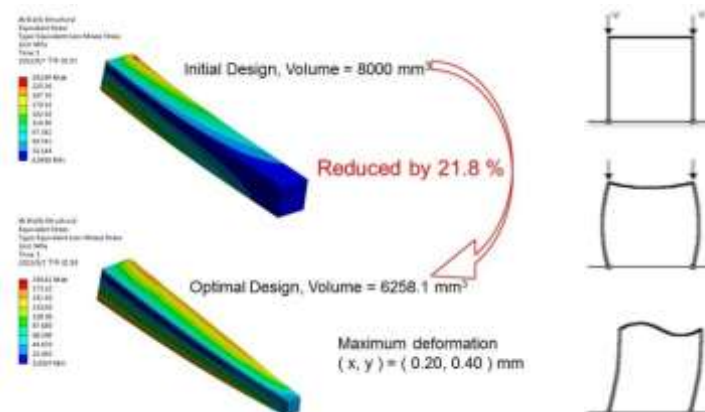
Week 6: Solid Mechanics

What does this session achieve?

The stiffness and strain energy are two more indices that are as important as stress. The stiffness tells us about the structural elastic stability. The strain energy distribution is also a measure of how the material is utilized or stressed. Modal strain energy is used to statically trim the components. This session focusses on failure modes related to stiffness and application of strain energy to analyze structures. Simulation considers good structures from aero domain to illustrate buckling analysis of various types of components and analysis of stiffeners that enhance the component stiffness.

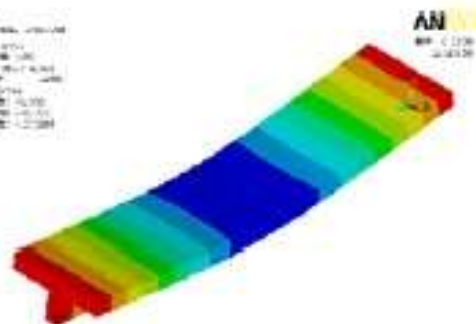
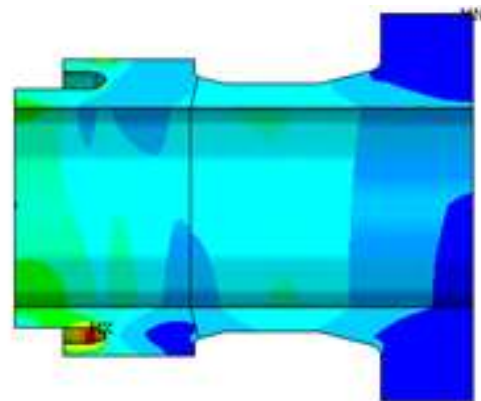
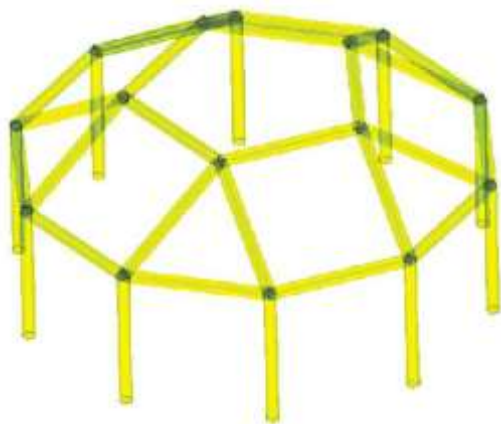
FORENOON: Critical Thinking Situations

TOPIC	SITUATIONS
Solid Mechanics – Stress & Stiffness for Basic Structures	<ul style="list-style-type: none"> a) Optimization of a Cantilever Beam b) Consequence of using Short Bolts c) Finding the Effective Stiffness of a Bearing System d) Finding Deflection of a Curved Beam e) Torsion of a Solid Elliptical Shaft f) Why Shell is more Efficient than a Plate & Stress Discontinuity in a Pressure Vessel
Solid Mechanics – Buckling & Asymmetric Bending	<ul style="list-style-type: none"> a) C-Frame Buckling b) Hat & T Stiffeners for a Shell c) Limit Post Buckling d) Finding the Neutral Axis of an L-Section & Max Stresses



AFTERNOON: Simulation Situations

TOPIC	SITUATIONS
Solid Mechanics – Stress & Stiffness for Basic Structures	<ul style="list-style-type: none"> a) Design Optimization of a Truss b) Analyzing the Effective Stiffness of a Bearing System c) Analysis of a Curved Beam d) Torsion of a Solid Elliptical Shaft e) Comparison of Stress Level for a Shell & Plate of same weight
Solid Mechanics – Buckling & Asymmetric Bending	<ul style="list-style-type: none"> a) Eigen Buckling Analysis of a C-Frame b) Eigen Buckling Analysis of a Plate with T & Hat Stiffeners c) Limit Post Buckling Analysis of a Beam d) Bending analysis of a C, L & T Sections



Week 7: Vibration

What does this session achieve?

One of the fundamental margins that is established for a component is vibration margin apart from stress margin. Vibratory stress is perhaps the most difficult parameter to assess in a multiaxial loading situation. Further the damping, say material damping is very difficult to measure. The concept of resonance, use of Campbell diagram, effect of temperature, friction and other parameters are theoretically understood and also via simulation.

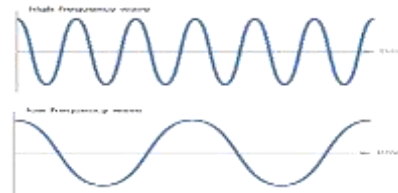
FORENOON: Critical Thinking Situations

TOPIC	SITUATIONS
Vibration – Free Vibration	<ul style="list-style-type: none"> a) Quantifying Natural Frequency b) 2 mass system with Springs c) Torsional Vibration of 2 Discs d) Vibration Margin for Steel or Titanium and use of Campbell Chart
Vibration – Damped Free Vibration	<ul style="list-style-type: none"> a) Material Damping & Limitations b) Complex Eigen Values & Negative Damping c) Gyroscopic Couple Calculation & Natural Frequency of a Overhung Rotor

AFTERNOON: Simulation Situations

TOPIC	SITUATIONS
Vibration – Free Vibration	<ul style="list-style-type: none"> a) Vibration analysis of a two mass system with and without Springs b) Nodal diameters of a cyclic symmetric disc with and without temperature load c) Torsional Vibration of a 2 Disc system d) Validating the Vibration Margin for a hollow shaft with stiffener

<p>Vibration – Damped Free Vibration</p>	<p>a) Damping modeling and introduction to basic rotordynamics in simulation tool</p> <p>b) Rotor Dynamic analysis of an overhung shaft with and without bearing flexibility</p>
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Week 8: Vibration

What does this session achieve?

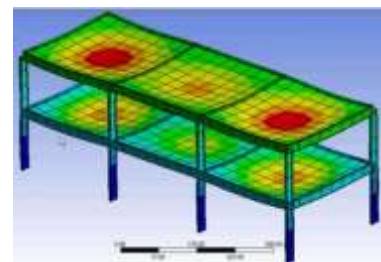
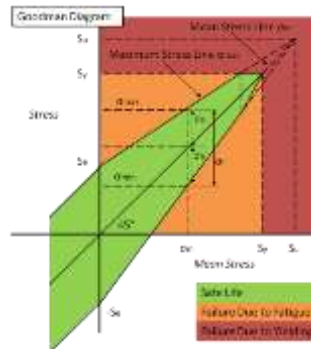
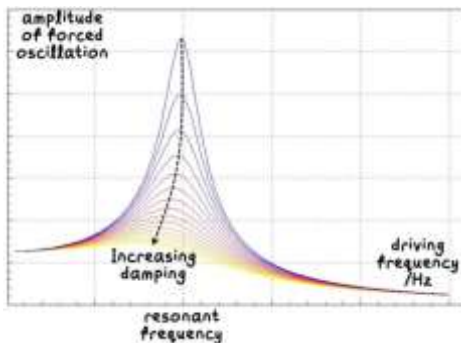
After a detailed exposure to free and forced vibration with damping, this session deals with capturing dynamic stress via various methods or standard practices at various OEMs. Further vibration measurement such as use of accelerometer is also given a detailed understanding. The transient dynamics and hence the concept of numerical damping is also focused and compared with physical damping. A few important factors that lead to bearing loading are also discussed. Simulation considers several examples from building response to unbalance response of a shaft, to reinforce vibration analysis.

FORENOON: Critical Thinking Situations

TOPIC	SITUATIONS
<p>Vibration – Forced Vibration</p>	<p>a) Selection of an accelerometer, location and faithfulness</p> <p>b) Bearing reactions due to an eccentric plate</p> <p>c) Unbalanced response of a shaft with bearing springs</p>
<p>Vibration – Dynamic Stress and Vibration Isolation</p>	<p>a) Role of Numerical Damping</p> <p>b) Dynamic stress in the presence stress concentration features</p> <p>c) Analysis of a 3D Aero foil for Vibratory Stresses</p> <p>d) Vibration Isolation of a Flexible Foundation</p>

AFTERNOON: Simulation Situations

TOPIC	SITUATIONS
Vibration – Forced Vibration	a) Plotting standard response curves for a harmonic analysis b) Harmonic analysis of a two storey building c) Response of a shaft due to unbalance
Vibration – Dynamic Stress and Vibration Isolation	a) Analysis of a Cylinder impacting a plank b) Dynamic stress capturing of an aero foil via amplification factor method / Goodman diagram approach



Week 9: Design

What does this session achieve?

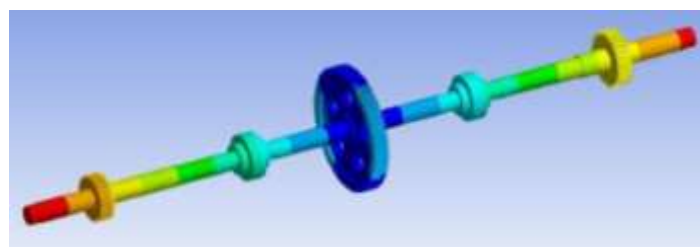
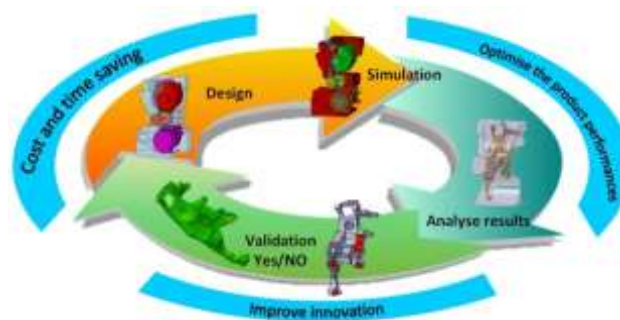
Design is all about sizing components, optimally, hence build an assembly optimally against all possible failure modes. The incidental requirement are to read the drawing carefully understand the component interaction, load path and joints. The latest trend in engineering materials is also crucial as industry wants to reduce every possible gram of weight without compromising on component and structural integrity. The session walks candidates through several design exercises including real time risk sessions. This gives a detailed idea about the design process that takes place in an industry.

FORENOON: Critical Thinking Situations

TOPIC	SITUATIONS
Design – Component Design	<ul style="list-style-type: none"> a) How do you design a shaft system? b) Failure modes for a Gear c) ASME Standards & Limitation d) Risk review for a Bolted Joint
Design – Ideas on Bearing, Shafts, Gears & Engineering materials	<ul style="list-style-type: none"> a) Why Bearing Lifting is different from Shaft Lifting? b) Single crystal materials, Ceramics & Metal Matrix Composites, Material Testing & Characterization c) Drawing Reading

AFTERNOON: Simulation Situations

TOPIC	SITUATIONS
Design – Component Design	<ul style="list-style-type: none"> a) Supervised Exercise – Design of Shaft – Stress, Vibration and Lifting
Design – Ideas on Bearing, Shafts, Gears & Engineering materials	<ul style="list-style-type: none"> a) Supervised Exercise – Dynamic stress analysis of a Blade-Disc assembly



Week 10: FEM

What does this session achieve?

Many successful analyst's in industry grip the commercial tool and engineering concepts well rather than the mathematical concepts of FEM. However the applied FEM facts are sometimes crucial to interpret results and appreciate the accuracy. The session focusses on some of the applied facts of FEM that directly influence convergence and the output.

Critical Thinking Situations

TOPIC	SITUATIONS
Simulation – FEM Facts	<ul style="list-style-type: none"> a) Designing a Shape Function & Properties of Stiffness Matrix b) Stiffness Matrix for Shells & Plates with and without Transverse Shear c) FEM Locking, error, convergence & Use of Quadra Point Elements

Week 11 & 12: Mock Interviews [150 select questions]



Component	Academic	Industry
Physics Fundamentals	10	20
Simulation	10	20
Applied FEM	30	0
Loads & Failures	10	20
Product Situations	0	30