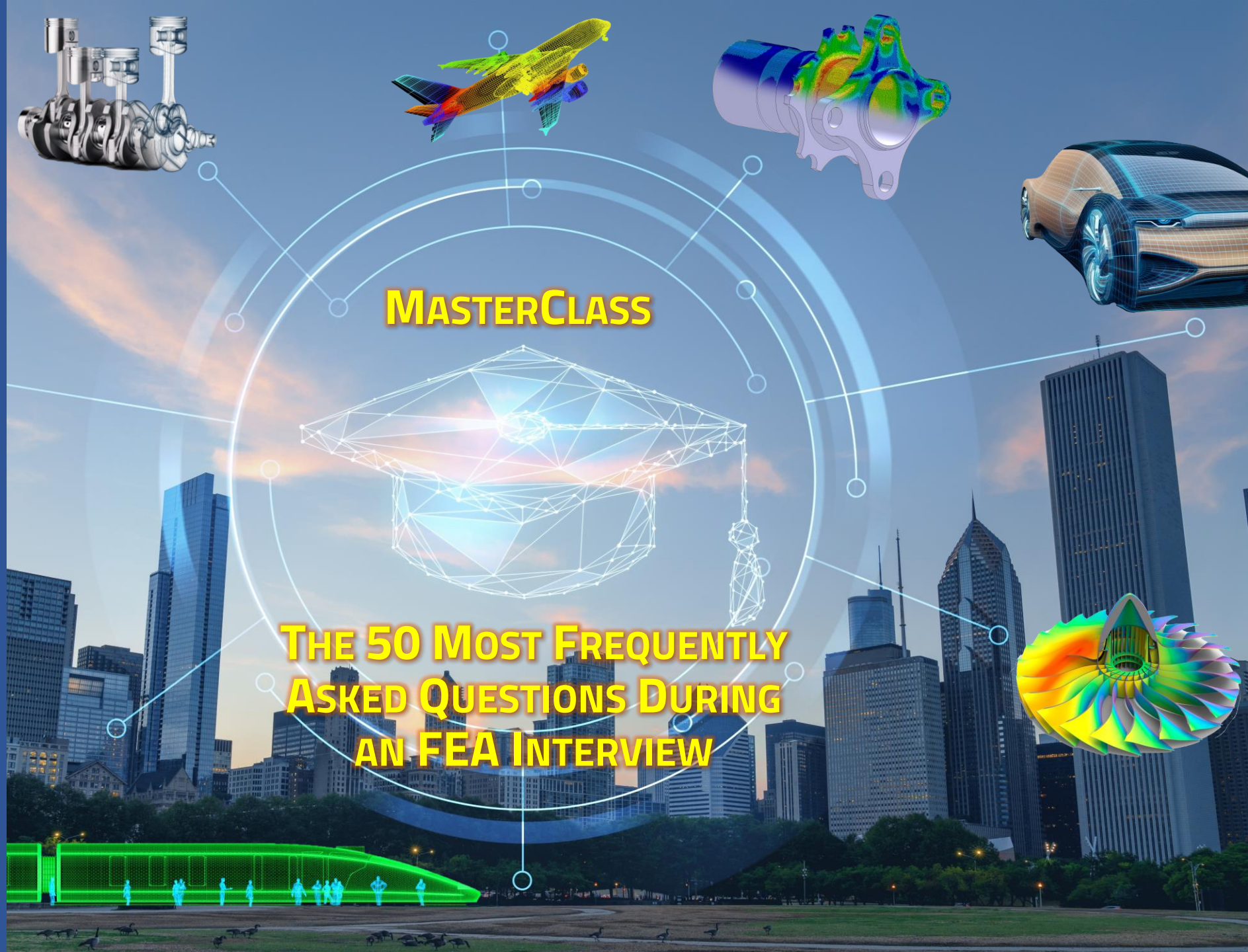


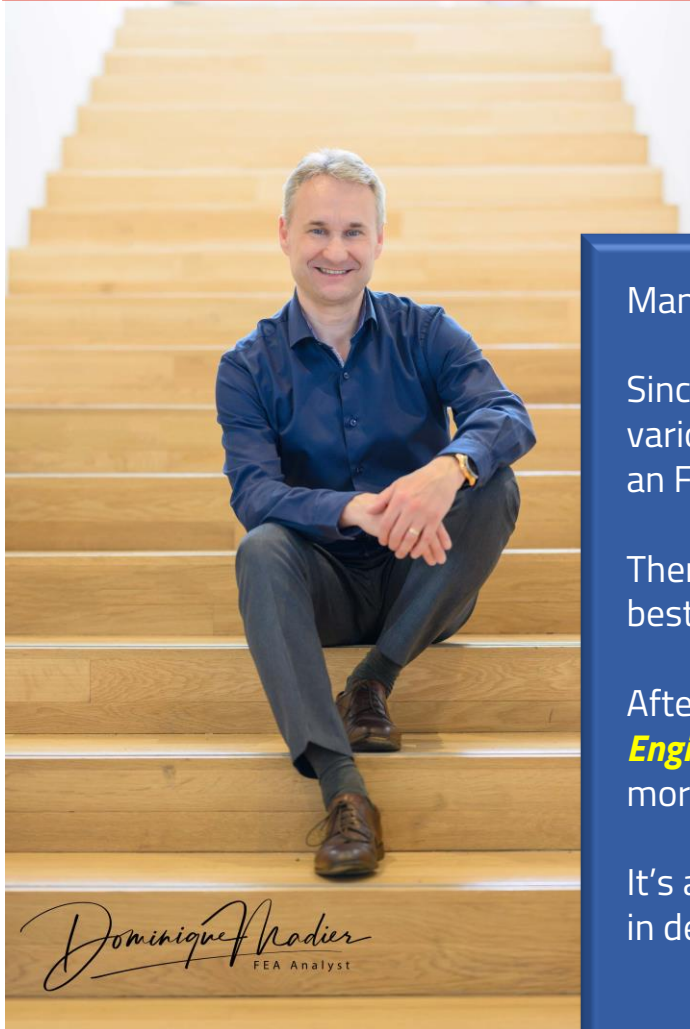


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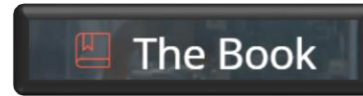
PREPARING AN FEA INTERVIEW

Dominique Nadier
FEA Analyst





Dominique Nadier
FEA Analyst



Many students, all over the world, regularly contact me asking ***"how to prepare an FEA interview?"***

Since I am not a job interviewer, I contacted people around me who are involved in such a role from various industries, and I asked them which questions they ask to the candidates they interview for an FEA position.

Then, I selected the ***50 most frequently asked questions***. In this document I am going to give you the best answers. I mean ***the answers that an interviewer wishes to hear***.

After each answer I refer to the chapter of my book ***"Practical Finite Element Analysis for Mechanical Engineers"*** in which you can find more details related to the question. If you wish, you can also learn more in the online FEA Academy courses.

It's always good to give a short answer to the questions but it is good also to be prepared to answer in detail if the interviewer asks for more details.

Dominique Nadier

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

QUESTION #1

DEFINE FINITE ELEMENT METHOD (FEM)

Answer: FEM is a numerical technique for finding approximate solutions of partial differential equations by solving boundary value problems in which a large domain is divided into smaller pieces called elements.

The solution is determined by assuming certain polynomials. The small pieces are called finite elements and the polynomials are called shape functions.



Chapter 1: Defining Finite Element Analysis

Chapter 2: Working with FEA





QUESTION #2

LIST OUT THREE ADVANTAGES OF FINITE ELEMENT ANALYSIS

Answer:

1. FEA allows for modeling of complex geometrical and irregular shapes with complex load conditions that we cannot solve using classical methods.
2. Many different types of boundary conditions can be considered.
3. Since the properties of each element are evaluated separately, different material properties can be considered for each element.



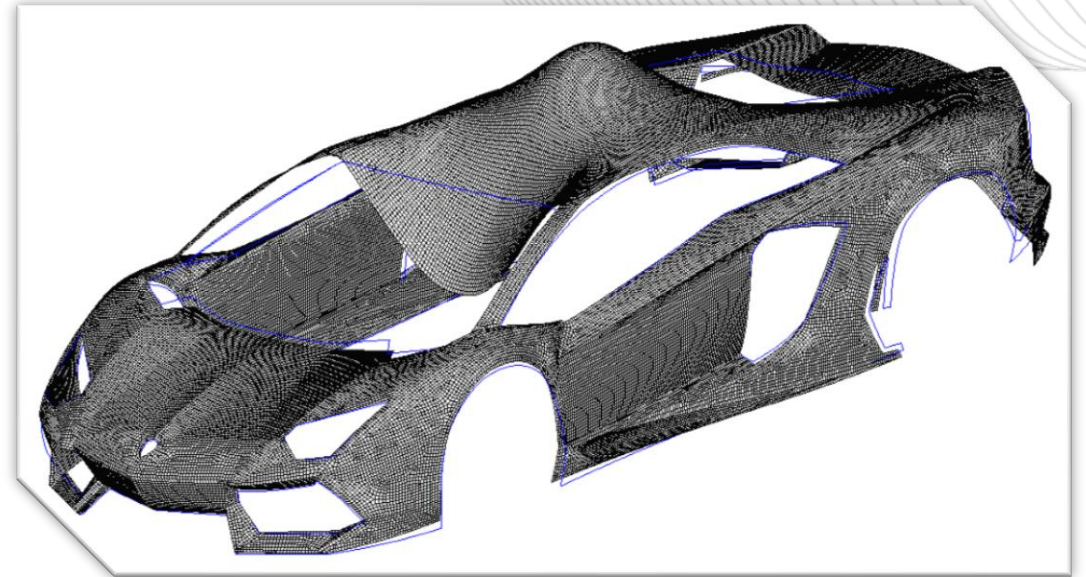
Chapter 2: Working with FEA

QUESTION #3

WHAT ARE THE BASIC STEPS FOR BUILDING AN FEA?

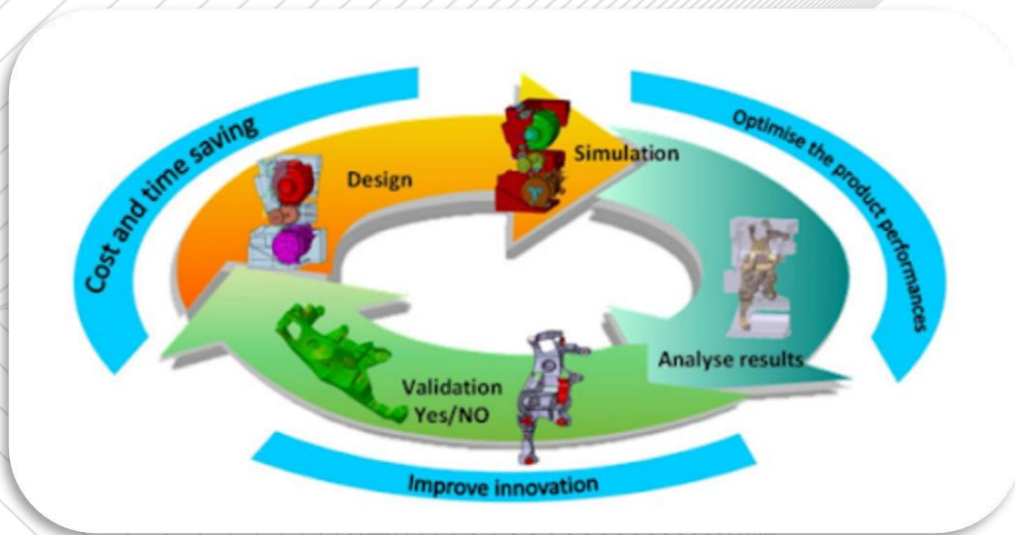
Answer:

1. Cleanup of geometry
2. Discretization of the structure (meshing)
3. Applying the element properties
4. Applying the boundary conditions (restraints and loading)
5. Setting the solution
6. Solving
7. Verification and Post-processing

*Chapter 2: Working with FEA*

QUESTION #4

WHY TO DO FEA?



Answer: We do FEA because this kind of analysis uses mathematical models to understand and quantify the effects of real-world conditions at the three stages of the product lifecycle:

- *Before, to define the product*, to help the engineers create a feasible design.
- *After the product is designed*, to permit the validation of the defined design.
- *After the product is released*, to investigate product failures.



Chapter 2: Working with FEA

QUESTION #5

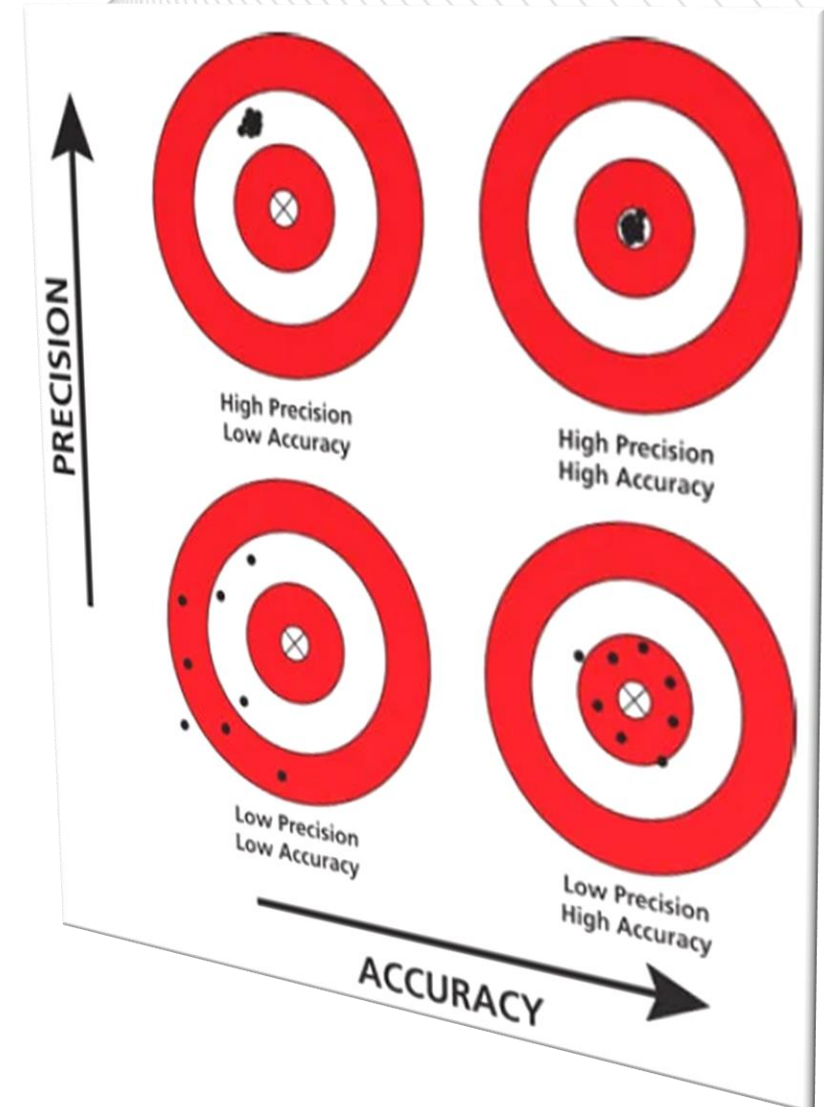
HOW ACCURATE IS FEA?

Answer: FEA can yield spectacularly accurate results when compared with physical test results. However, in a complex FEA, it is still not possible to obtain an error of less than 1% in the whole model. Generally, a target of $\pm 10\%$ global error allows for very good predictions, but this target does not prevent the occurrence of better accuracy in some local regions of the FEA.

An FEA will give accurate results if the analyst pay attention to many parameters like geometrical and material properties, mesh quality, loading conditions, boundary condition, to name a few. But at the end it is not possible to obtain a better accuracy than the input data permits.



Chapter 2: Working with FEA



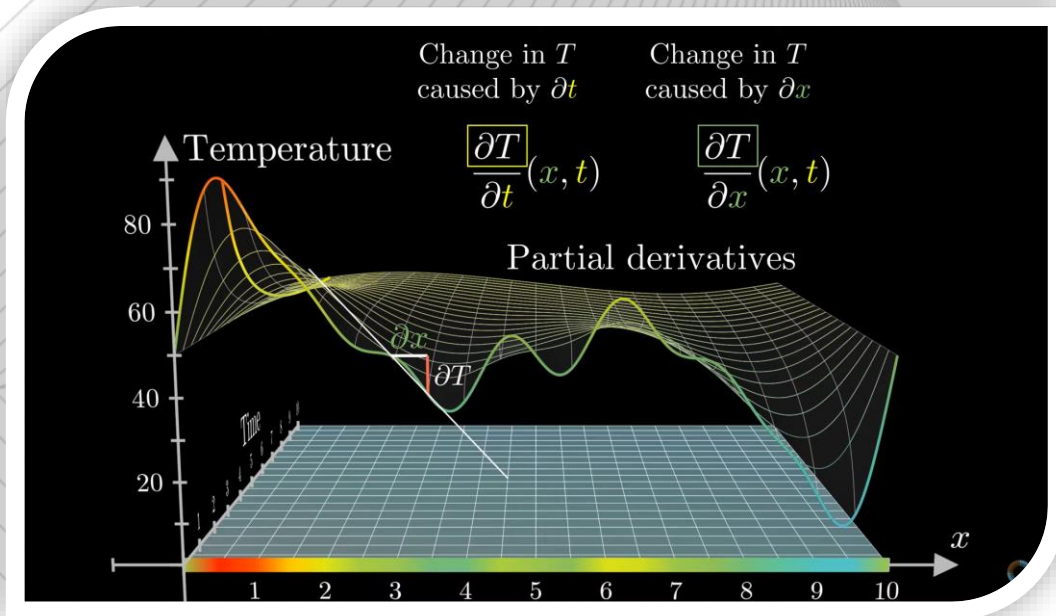
QUESTION #6

WHAT IS THE DIFFERENCE BETWEEN THE FINITE DISPLACEMENT METHOD (FDM) AND THE FINITE ELEMENT METHOD (FEM)?

Answer:

FDM is a numerical method for solving differential equations by approximating derivatives while FEM is a numerical method for finding approximate solutions to boundary value problems for partial differential equations.

FDM is an older method than FEM that requires less computational power but is also less accurate in some cases where higher-order accuracy is required. FEM permits to get a higher order of accuracy but requires more computational power and is also more exigent on the quality of the mesh.



QUESTION #7

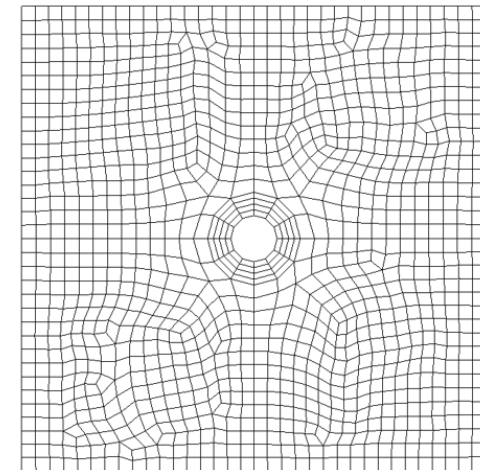
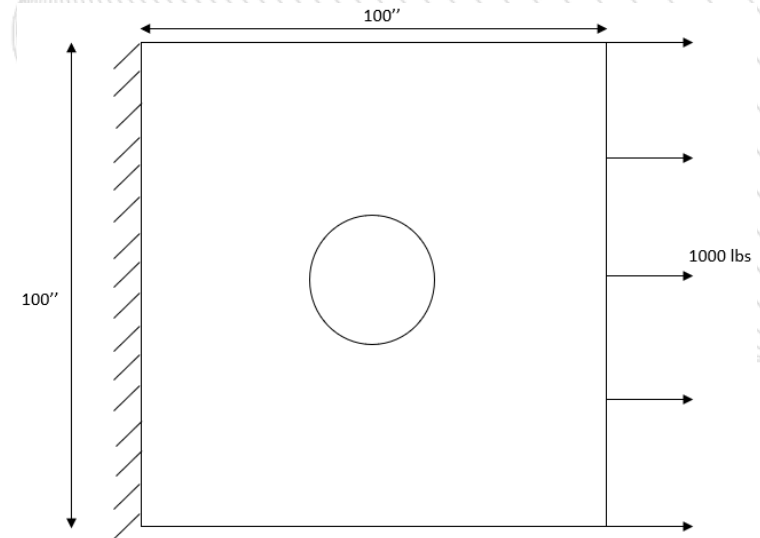
WHAT IS MEANT BY DISCRETIZATION?

WHAT IS MEANT BY MESHING?

Answer: Discretization (or meshing) is the process of subdividing the components into a number of elements which results in a system of equivalent finite elements.



Chapter 1: Defining FEA
Chapter 8: Meshing



QUESTION #8

WHAT ARE THE FACTORS GOVERNING THE
SELECTION OF ELEMENT TYPES?

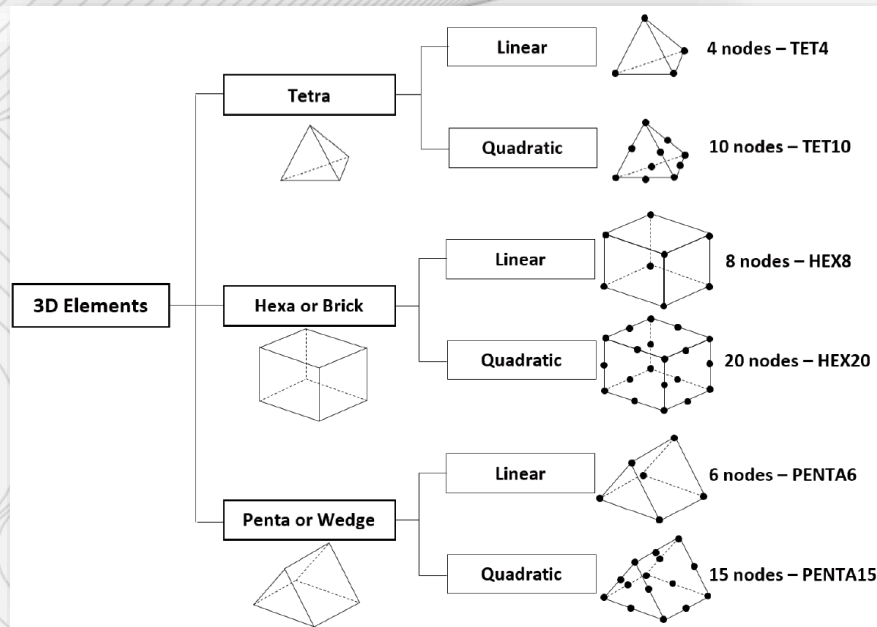
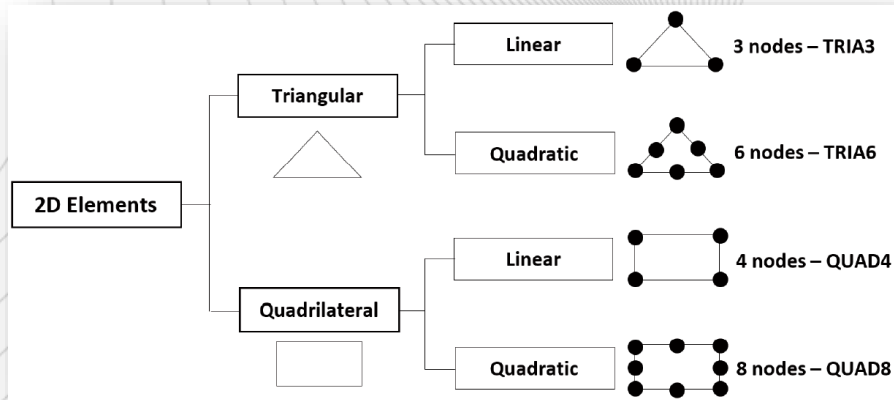
Answer:

1. The geometry of the parts I want to analyze
2. The behaviors I wish to capture

Mention that the knowledge of the Library of Elements related to the FEA package we are using to do our models is fundamental for a good selection of elements.



Chapter 7: The Library of Elements



QUESTION #9

WHAT IS MEANT BY STIFFNESS MATRIX?

Answer: In order to find a solution to the governing partial differential equations, the finite element method is used as the numerical method to find the solution.

In the process, the stiffness matrix represents the system of linear equations that must be solved in order to find an approximate solution to the differential equations.



Chapter 5: Basis of FEM Theory

$$[k]_{\text{Element 1}} = \begin{matrix} & \begin{matrix} \text{Node 1} & & \text{Node 4} & & \text{Node 5} \end{matrix} & \\ & \begin{matrix} u_1 & v_1 & u_4 & v_4 & u_5 & v_5 \end{matrix} & \\ \begin{bmatrix} k_{11x} & k_{11xy} \\ k_{11yx} & k_{11y} \end{bmatrix} & \begin{bmatrix} k_{14x} & k_{14xy} \\ k_{14yx} & k_{14y} \end{bmatrix} & \begin{bmatrix} k_{15x} & k_{15xy} \\ k_{15yx} & k_{15y} \end{bmatrix} & \begin{matrix} u_1 \\ v_1 \end{matrix} \\ \begin{bmatrix} k_{41x} & k_{41xy} \\ k_{41yx} & k_{41y} \end{bmatrix} & \begin{bmatrix} k_{44x} & k_{44xy} \\ k_{44yx} & k_{44y} \end{bmatrix} & \begin{bmatrix} k_{45x} & k_{45xy} \\ k_{45yx} & k_{45y} \end{bmatrix} & \begin{matrix} u_4 \\ v_4 \end{matrix} \\ \begin{bmatrix} k_{51x} & k_{51xy} \\ k_{51yx} & k_{51y} \end{bmatrix} & \begin{bmatrix} k_{54x} & k_{54xy} \\ k_{54yx} & k_{54y} \end{bmatrix} & \begin{bmatrix} k_{55x} & k_{55xy} \\ k_{55yx} & k_{55y} \end{bmatrix} & \begin{matrix} u_5 \\ v_5 \end{matrix} \end{matrix}$$

QUESTION #10

GIVE THE MAIN PROPERTIES OF THE GLOBAL STIFFNESS MATRIX
OF A SYSTEM MODELED BY FEM

$$\begin{bmatrix} f_{x1} \\ f_{y1} \\ f_{x2} \\ f_{y2} \\ f_{x3} \\ f_{y3} \end{bmatrix} = \begin{bmatrix} k_{x1x1} & k_{x1y1} & k_{x1x2} & k_{x1y2} & k_{x1x3} & k_{x1y3} \\ k_{y1x1} & k_{y1y1} & k_{y1x2} & k_{y1y2} & k_{y1x3} & k_{y1y3} \\ k_{x2x1} & k_{x2y1} & k_{x2x2} & k_{x2y2} & k_{x2x3} & k_{x2y3} \\ k_{y2x1} & k_{y2y1} & k_{y2x2} & k_{y2y2} & k_{y2x3} & k_{y2y3} \\ k_{x3x1} & k_{x3y1} & k_{x3x2} & k_{x3y2} & k_{x3x3} & k_{x3y3} \\ k_{y3x1} & k_{y3y1} & k_{y3x2} & k_{y3y2} & k_{y3x3} & k_{y3y3} \end{bmatrix} \begin{bmatrix} u_{x1} \\ u_{y1} \\ u_{x2} \\ u_{y2} \\ u_{x3} \\ u_{y3} \end{bmatrix}$$

f = Ku

Answer:

1. The order of the global stiffness matrix corresponds to the total number of degrees of freedom
2. The global stiffness matrix is singular (needs boundary conditions to solve the system)
3. Each column of the stiffness matrix is an equilibrium set of nodal force required to produce unit respective degree of freedom
4. The global stiffness matrix of a system is a square matrix, is symmetric and sparse (most of the terms are null)



Chapter 5: Basis of FEM Theory

QUESTION #11

DEFINE THE TERM SHAPE FUNCTION

Answer: The shape function is the function which interpolates the solution between the discrete values obtained at the nodes of a mesh. Low order polynomials are typically chosen as shape functions.



Chapter 5: Basis of FEM Theory



QUESTION #12

WHY ARE POLYNOMIALS GENERALLY USED AS
SHAPE FUNCTION?

Answer: Polynomials are generally used as shape function due to the following reasons.

1. Differentiation and integration of polynomials are quite easy.
2. The accuracy of the results can be improved by increasing the order of the polynomial.
3. It is easy to formulate and solve the finite element equations using polynomials with a computer.



Chapter 5: Basis of FEM Theory

QUESTION #13

WHAT ARE THE DIFFERENT TYPES OF ELEMENTS
USED IN FEA? GIVE EXAMPLES.

Answer: The various elements used in FEA are classified as:

- One dimensional elements (truss, beam, spring)
- Two dimensional elements (shell)
- Three dimensional elements (tetrahedron, hexahedron)

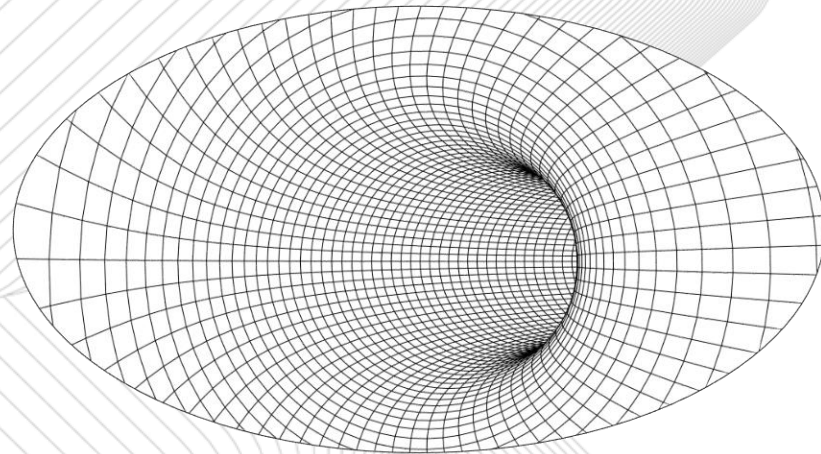


Chapter 7: The Library of Elements



QUESTION #14

GIVE FOUR POSSIBLE LOCATIONS FOR NODES?



Answer:

1. Point of application of a concentrated load.
2. Location where there is a change in intensity of loads.
3. Locations where there are discontinuities in the geometry of the structure.
4. Interfaces between materials of different properties.



Chapter 7: The Library of Elements
Chapter 8: Meshing

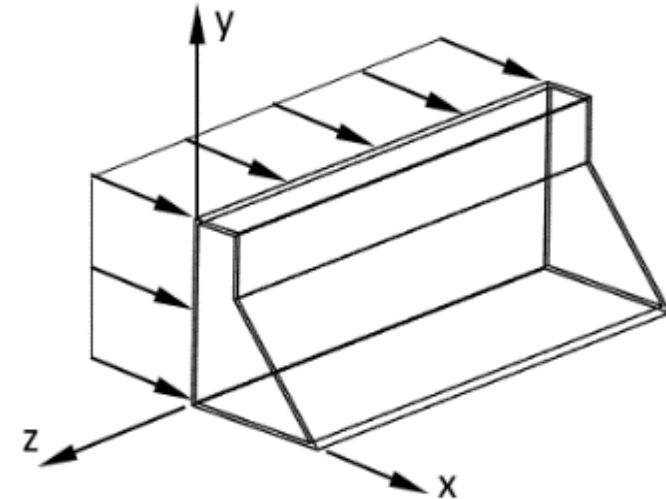
QUESTION #15

WHAT IS MEANT BY PLANE STRAIN CONDITION?

GIVE AN EXAMPLE.

Answer: Plane strain is a state of strain in which normal strain and shear strain directed perpendicular to the plane of the body are zero.

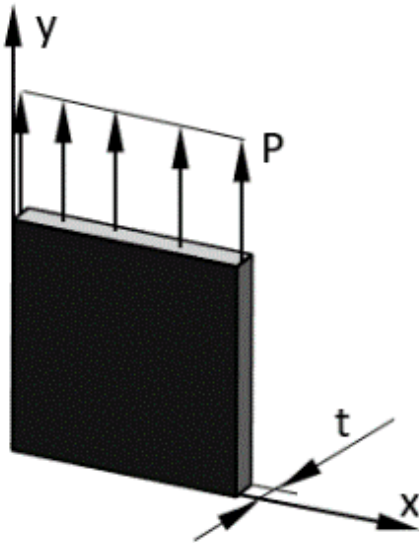
The plane strain assumption is used for long bodies in the normal direction with a constant cross section, subjected to loads acting only in the xy-plane. A dam is a good example.

*Chapter 7: The Library of Elements*

QUESTION #16

WHAT IS MEANT BY PLANE STRESS CONDITION?

GIVE AN EXAMPLE.



Answer: Plane stress is a state of stress in which the normal stress and shear stress perpendicular to the plane are zero.

A thin member, with a small normal dimension compared to the in-plane x and y dimensions, on which loads act only in the xy -plane can be considered to be under plane stress.

*Chapter 7: The Library of Elements*

QUESTION #17

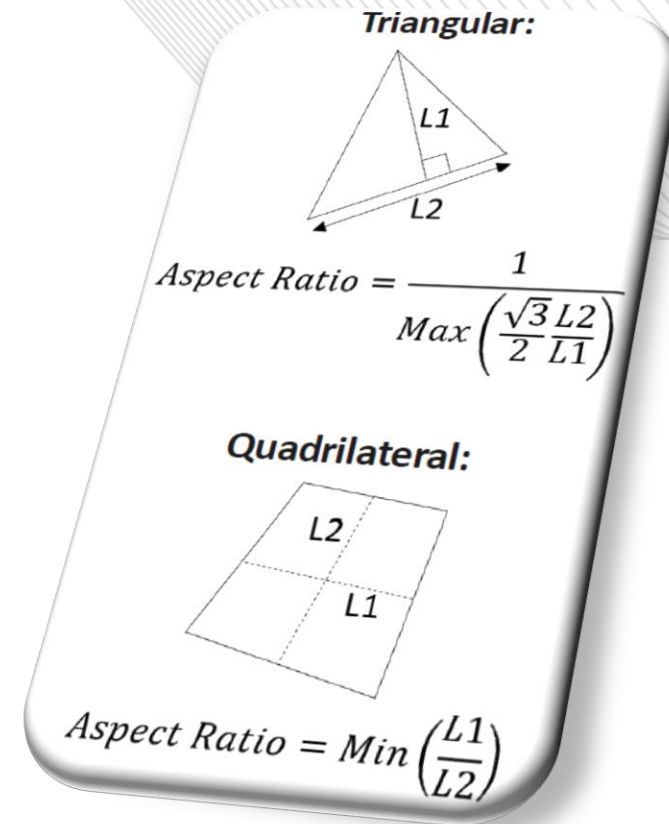
WHAT IS ASPECT RATIO?

Answer: Aspect ratio is defined as the ratio of the largest dimension of the element to the smallest dimension.

In many cases, as the aspect ratio increases, the inaccuracy of the solution increases. The aspect ratio should be close to unity as possible.

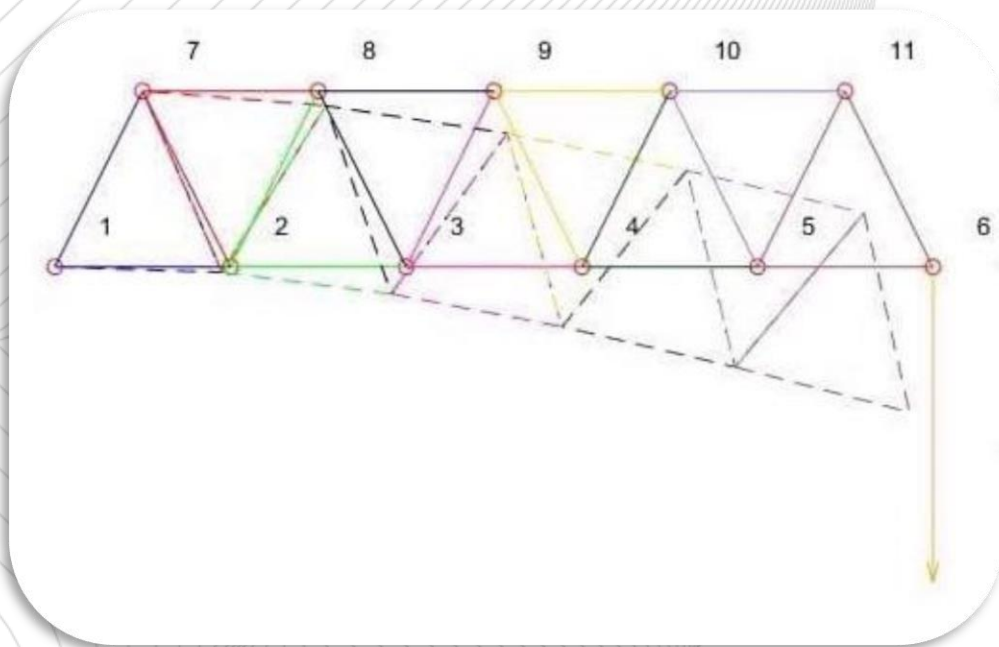


Chapter 8: Meshing



QUESTION #18

WHAT IS A TRUSS ELEMENT?



Answer: The truss elements are the part of a truss structure linked together by point joints, which transmit only axial force to the elements.



Chapter 7: The Library of Elements

QUESTION #19

THE FINITE ELEMENT METHOD IS AN APPROXIMATE METHOD (TRUE OR FALSE)? JUSTIFY YOUR ANSWER.

Answer: True, because the finite element method is a mathematical procedure used to calculate approximate solutions to differential equations.

During the process, the differential equations governing the modeled behavior are transformed into a set of linear equations obtained by discretization. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem.

The finite element method then uses techniques based on the calculus of variations to approximate a solution by minimizing an associated error function.



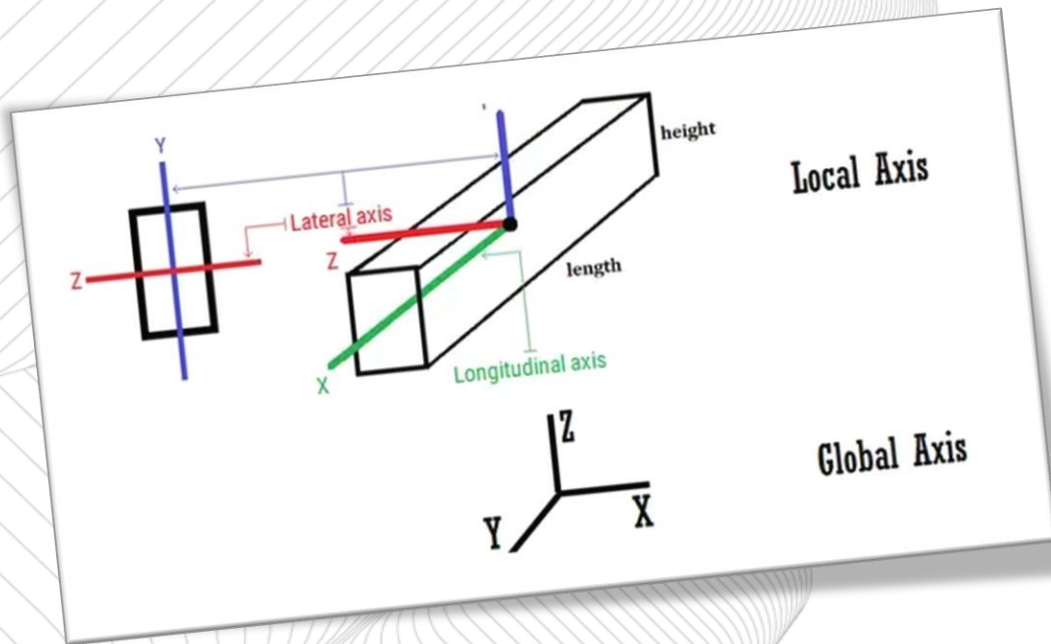
Chapter 1: Defining FEA

Chapter 5: Basis of FEM Theory

	CLASSICAL METHODS	NUMERICAL METHODS
EQUATIONS	Exact	Exact
SOLUTIONS	Exact	Approximate
NUMBER OF SOLUTIONS	A few standard cases	All problems
SHAPES BOUNDARY CONDITIONS LOADING	Simplifying assumptions	No assumptions Treated as they are
MATERIAL	Only isotropic Only one material	All types of property Unlimited number of materials

QUESTION #20

GIVE THE DIFFERENCE BETWEEN GLOBAL AND LOCAL AXES.



Answer: **Local axes** are established in an element. Since it is in the element level, they change with the change in orientation of the element. The direction differs from element to element.

Global axes are defined for the entire model. They are same in direction for all the elements even though the elements are differently oriented.



Chapter 7: The Library of Elements
Chapter 8: Meshing

QUESTION #21

HOW DO YOU CALCULATE THE SIZE OF THE GLOBAL STIFFNESS MATRIX?

Answer:

Global stiffness matrix size =
Number of nodes * Number of DOFs



Chapter 5: Basis of FEM Theory



QUESTION #22

GIVE THE GENERAL EXPRESSION FOR AN ELEMENT STIFFNESS MATRIX.

Answer:

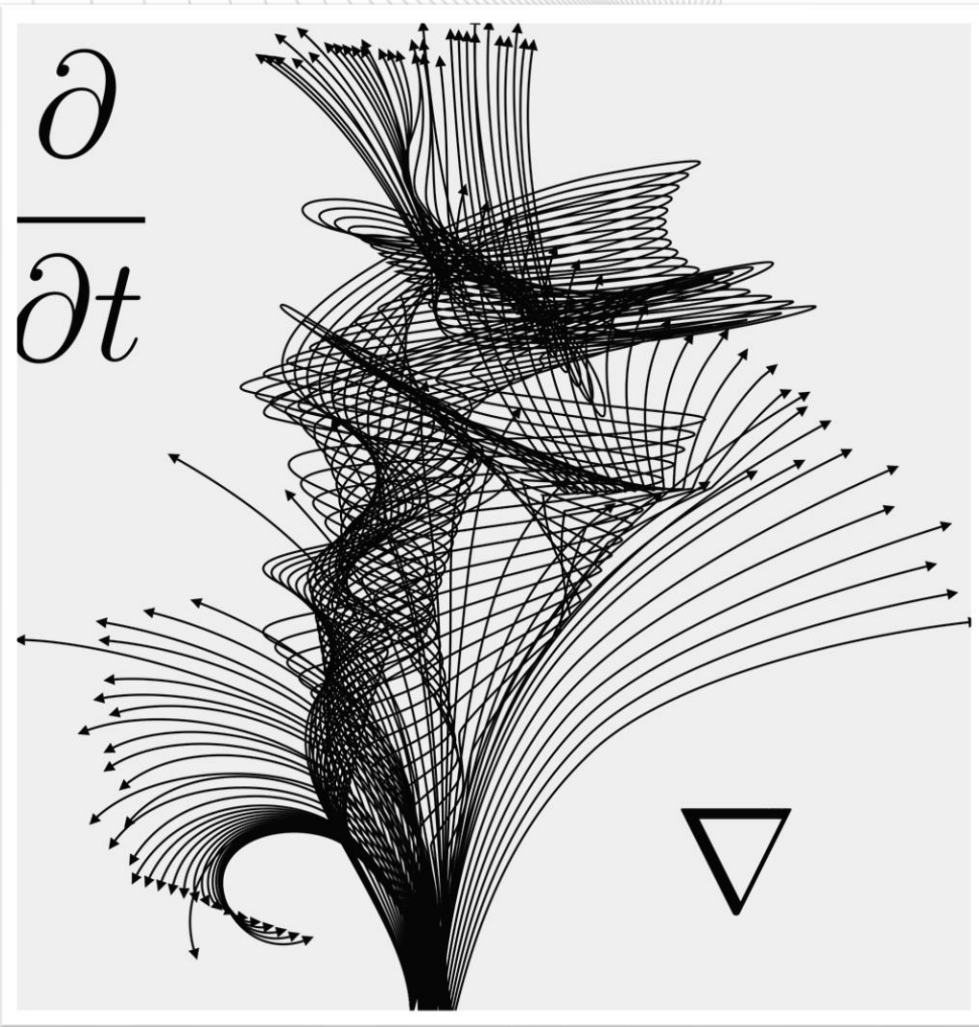
$$[k] = \int [B]^T [D] [B] dv$$

[B] – Strain displacement matrix. Formed by the global derivatives of the shape functions associated with the type of elements being considered.

[D] – The constitutive matrix. Formed by the material properties.



Chapter 5: Basis of FEM Theory



QUESTION #23

WRITE DOWN THE EQUILIBRIUM EQUATION USED
TO SOLVE DIFFERENT TYPES OF STRUCTURAL
PROBLEMS.

A)

$$[M]\{\ddot{u}\} + [B]\{\dot{u}\} + [K]\{u\} = P(t)$$

[M] Mass Matrix

[B] Damping Matrix

[K] Stiffness Matrix

 $\{\ddot{u}\}$ Acceleration Vector $\{\dot{u}\}$ Velocity Vector $\{u\}$ Displacement Vector

P(t) Applied Load

Keep in your mind the variations of the general equilibrium equation

GENERAL EQUILIBRIUM EQUATION

$$[M]\{\ddot{u}\} + [B]\{\dot{u}\} + [K]\{u\} = P(t)$$

STATIC ANALYSIS

$$[K]\{u\} = P$$

BUCKLING ANALYSIS

$$([K] + \lambda [K_d])\{\phi\} = \lambda P$$

VIBRATION ANALYSIS

$$([K] - \lambda [M])\{\phi\} = 0$$

TRANSIENT AND FREQUENCY
RESPONSE ANALYSIS

$$[M]\{\ddot{u}\} + [B]\{\dot{u}\} + [K]\{u\} = P(t)$$

λ is the i^{th} eigenvalue.

$\{\phi\}$ is the i^{th} eigenvector.

$[K_d]$ is the differential stiffness matrix (also called geometric stiffness).



Chapter 5: Basis of FEM Theory

QUESTION #24

WHAT IS CST ELEMENT?

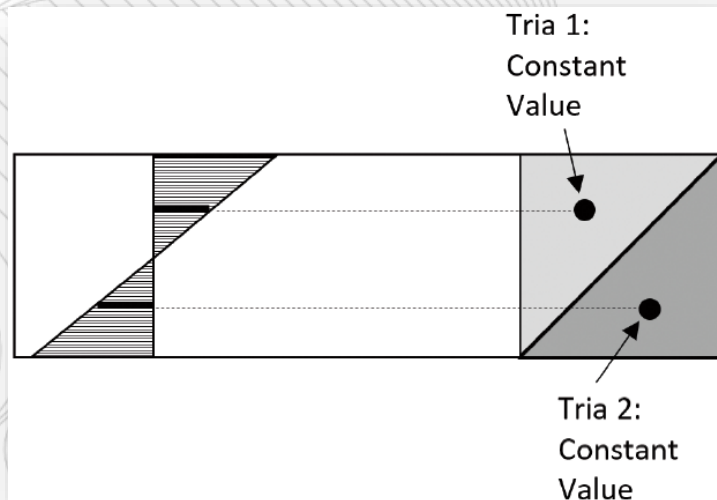
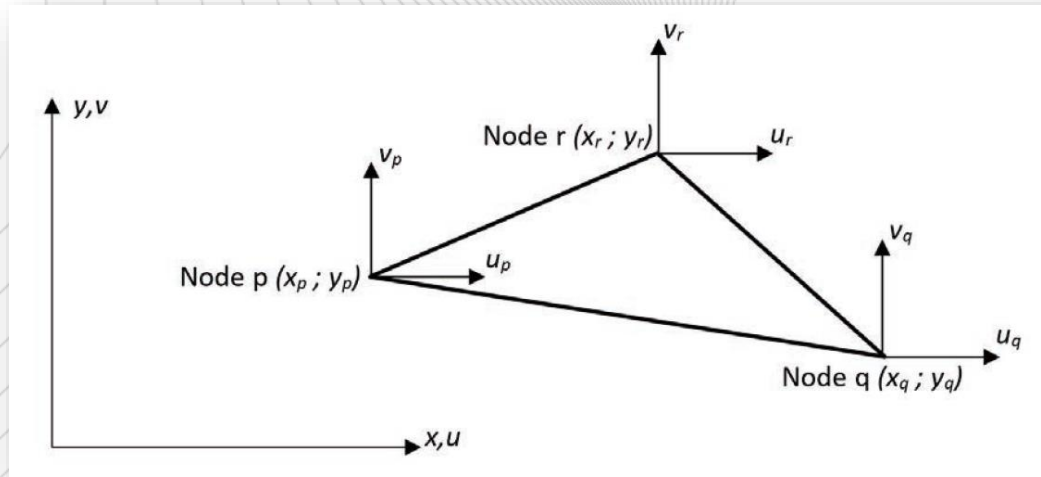
Answer: The three-node triangular element is known as Constant Strain Triangle (CST). It has six unknown displacement degrees of freedom ($u_1, v_1, u_2, v_2, u_3, v_3$).

The element is called CST because it has a constant strain through it. It explains also why the CST elements are stiffer than quadrilateral elements.



Chapter 5: Basis of FEM Theory

Chapter 7: The Library of Elements



QUESTION #25

WHAT IS A SINGULARITY? GIVE EXAMPLES.

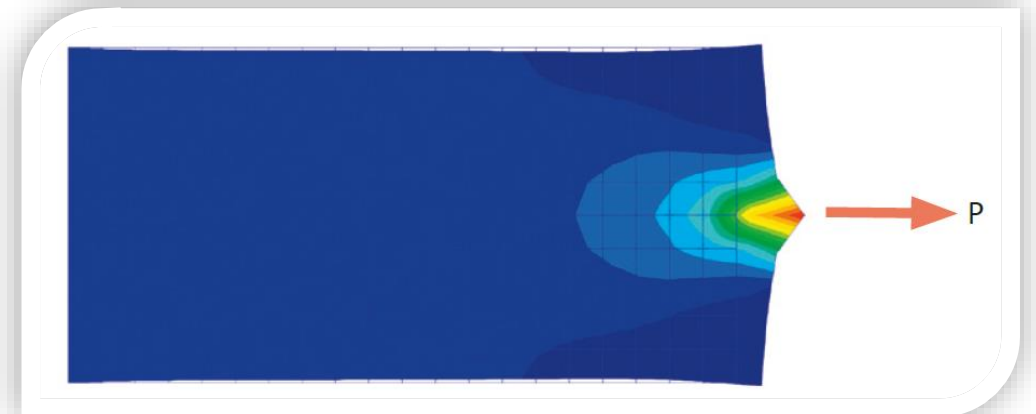
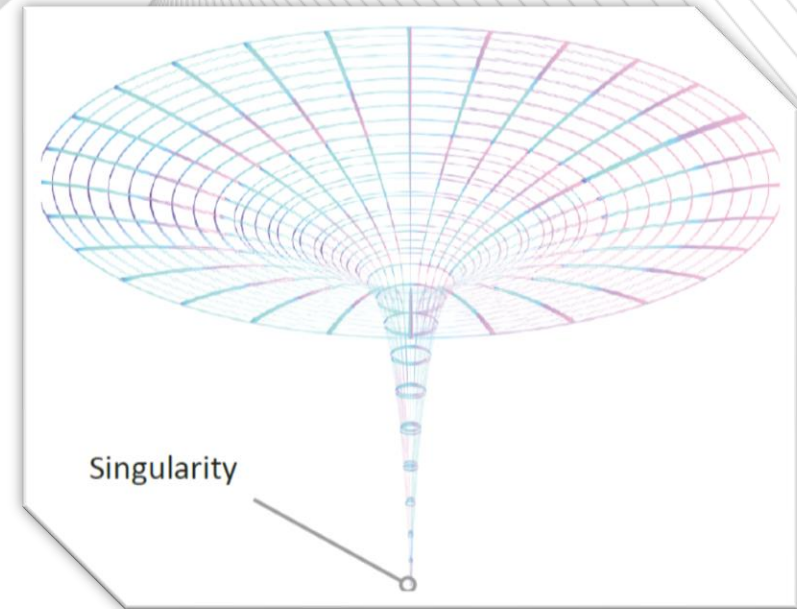
Answer: Point in a model where values tend toward an infinite value. A typical example is an infinite stress in a small region of the model.

Usually, it is caused by wrong boundary conditions like local infinite stiffness or a force applied on a very small surface.



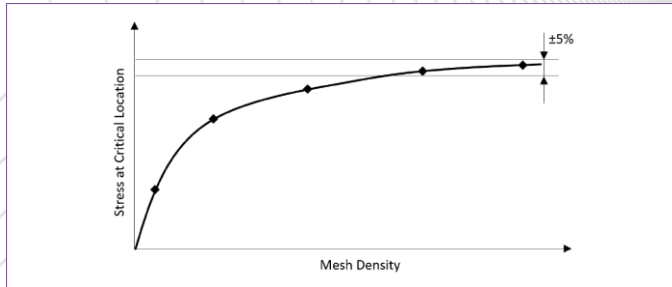
Chapter 11: Defining Loads and Boundary Conditions

Chapter 16: Validating and Correlating your FEA



QUESTION #26

WHAT IS MEANT BY STRESS CONCENTRATION & HOW
WILL YOU MESH FOR SUCH REGIONS?



Answer: A stress concentration is a place of the mesh where the stress raises above the applied nominal stress.

It behaves in a similar fashion than stress singularities, but the stress will converge towards a finite value, not infinite, given that the mesh is sufficiently refined.

The convergence study is the method uses to find the appropriate mesh size in a region experimenting a stress concentration.

QUESTION #27

WHAT IS SHEAR LOCKING? HOW CAN WE AVOID IT? HOW IT AFFECTS THE FEA RESULTS.

Answer: Shear locking is a numerical problem which produces bending displacements that are smaller than they should be in an element.

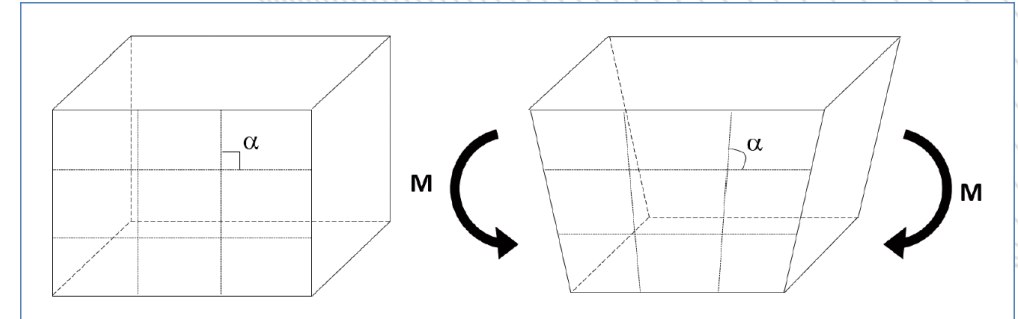
Consequently, the element becomes over-stiff, or locked, when subjected to a bending moment. The shear locking effect ultimately induces incorrect displacements, stresses, and natural frequencies.

To prevent shear locking, the suggested solutions are :

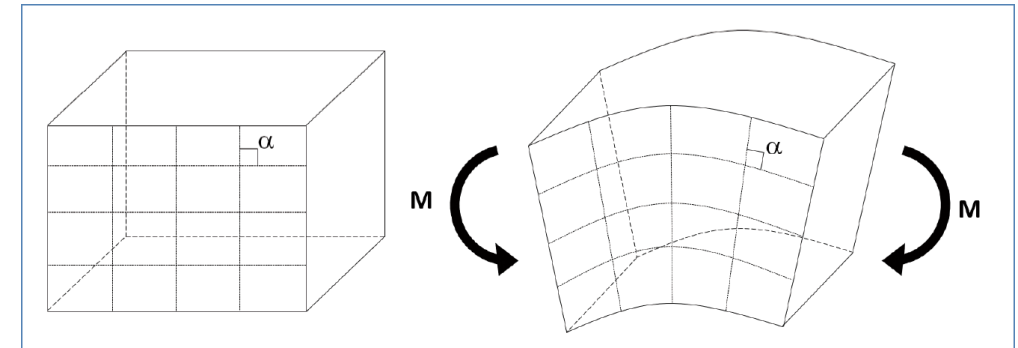
- Refine the mesh
- Use first order elements with a reduced integration



Chapter 7: The Library of Elements

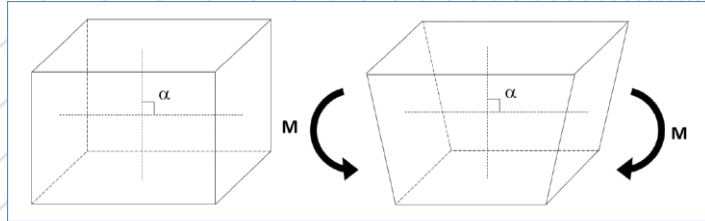


VS



QUESTION #28

WHAT IS HOURGLASSING? HOW CAN WE AVOID IT? HOW IT AFFECTS THE FEA RESULTS.



Answer: Hourglassing is a spurious deformation mode of a Finite Element mesh, resulting from the excitation of zero-energy degrees of freedom.

It typically manifests as a patchwork of hourglass like element shapes, where individual elements are severely deformed, while the overall mesh section is undeformed.

This is a non-physical mode that produces incorrect results because of excessively flexible behavior. To avoid hourglassing, the two suggested solutions are:

- Refining the mesh
- Using fully integrated elements

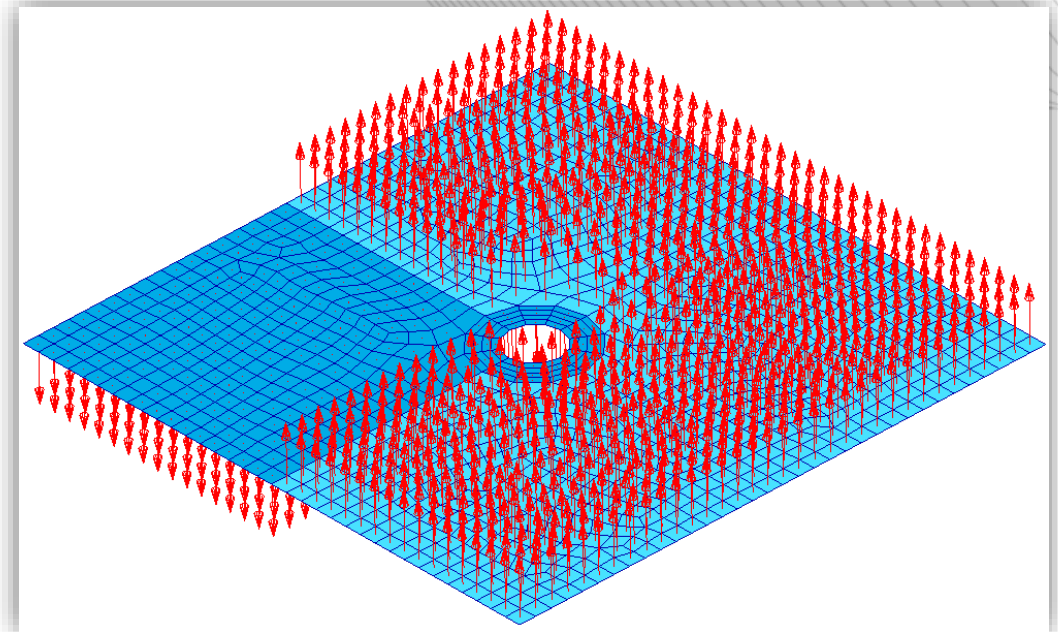


Chapter 7: The Library of Elements

QUESTION #29

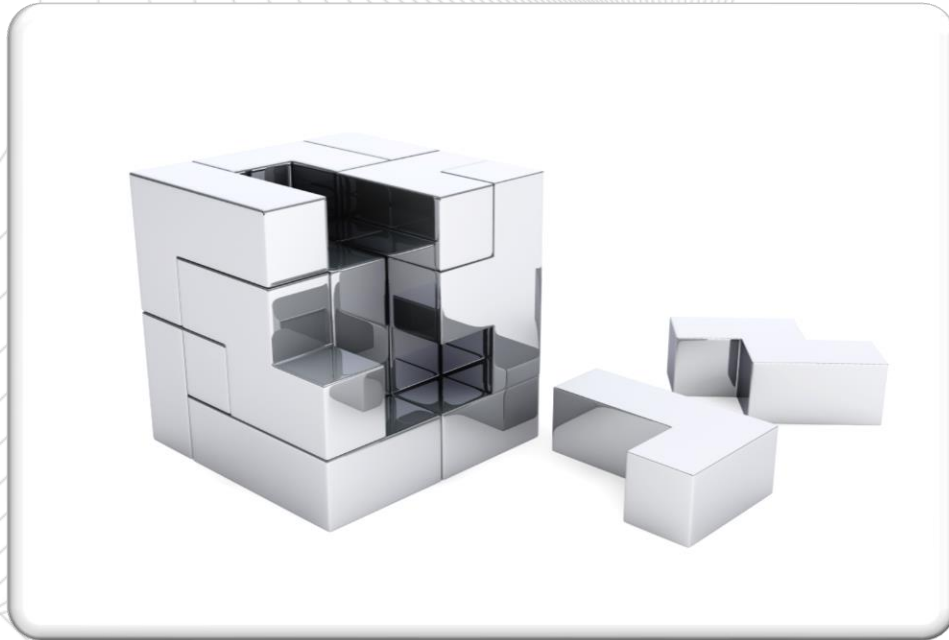
GIVE TWO CONSEQUENCES OF A WRONG SHELL
NORMAL SETTINGAnswer:

1. Wrong pressure loading (positive pressure is considered by the solvers to be pressure acting in the same direction as the normal)
2. Shell offset considered at the wrong location

*Chapter 8: Meshing*

QUESTION #30

WHAT IS SUBMODELING?



Answer: Submodeling is a technique used to compute a refined solution from a previous coarse analysis that employs two separate models: a coarse model and one that is more refined.

The results from the coarse model are used as boundary conditions and mapped onto the refined model.

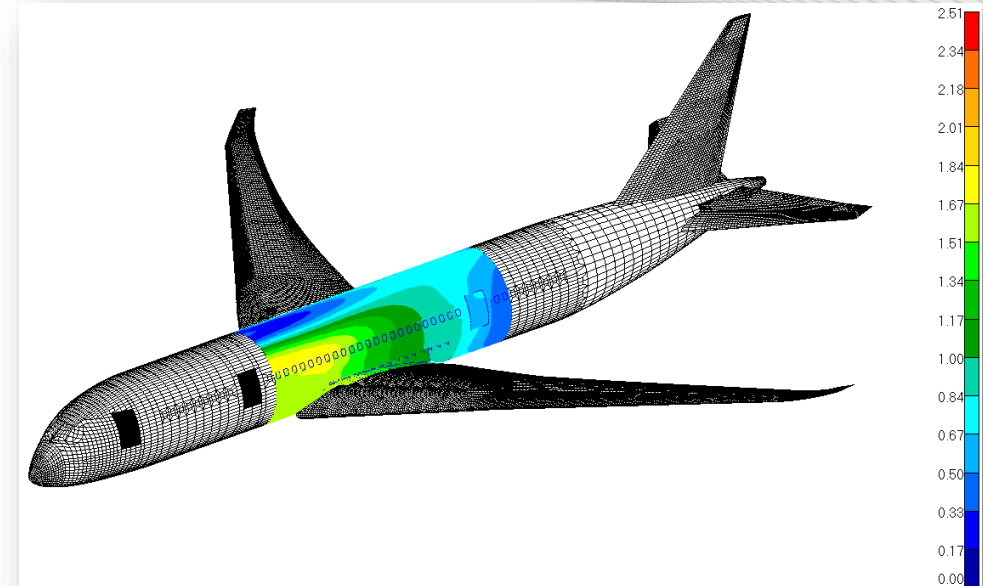
*Chapter 15: Submodeling*

QUESTION #31

GIVE TWO SUBMODELING METHODS.

Answer:

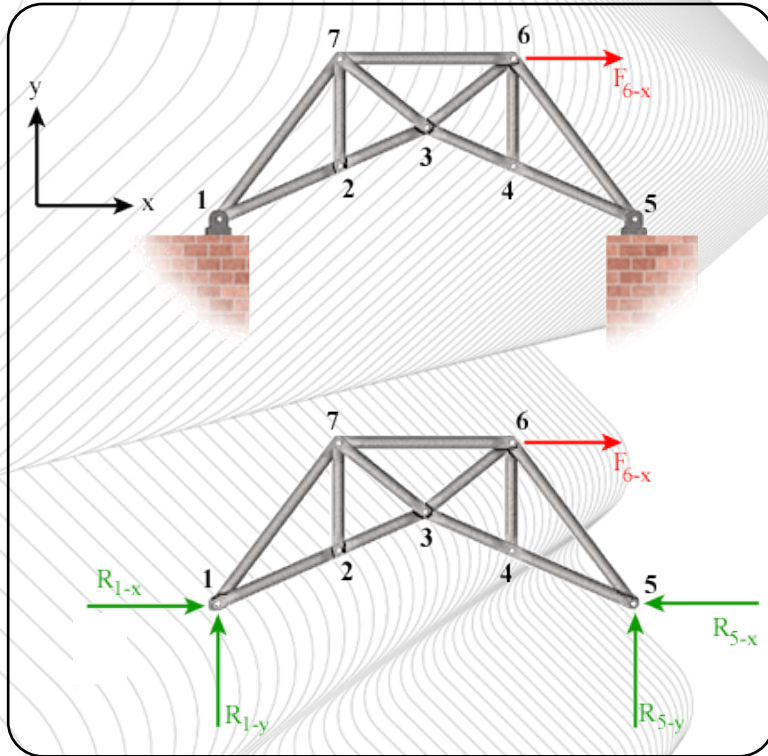
1. A first submodeling approach involves refining a critical region of the global model and creating a transition mesh between the refined region and the global model. The original global model loading is directly applied to the local model.
2. Another submodeling approach involves extracting the region of interest from the global model and refining it as needed. Then, the displacement/load fields are extracted from the global model and applied to the standalone local model as boundary conditions.



QUESTION #32

WHAT IS A STATICALLY INDETERMINATE STRUCTURE?

Answer: A structure is statically indeterminate when the static equilibrium equations - force and moment equilibrium conditions - are insufficient for determining the internal forces and reactions on that structure.



Chapter 11: Defining Loads and Boundary Conditions

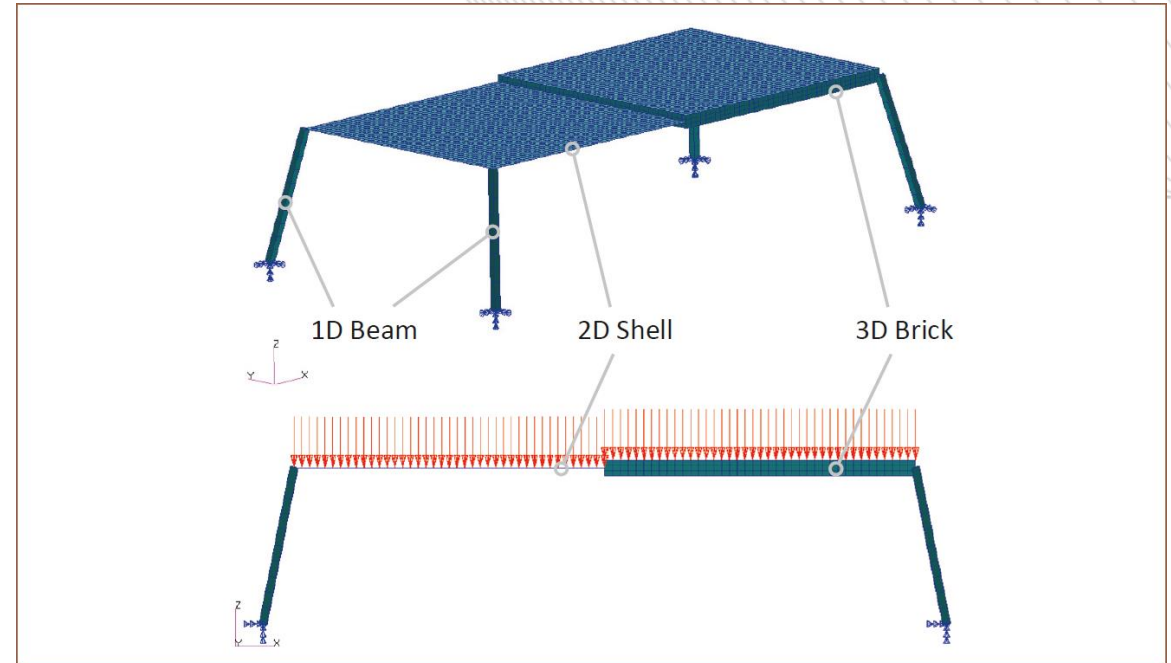
QUESTION #33

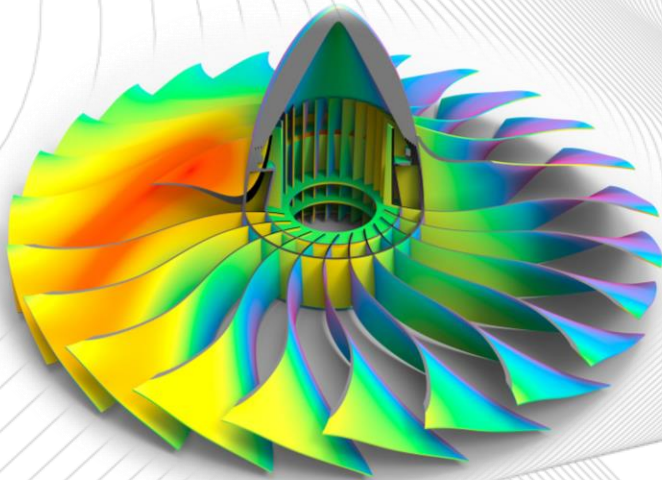
HOW DO YOU SOLVE THE PROBLEM OF
INCOMPATIBLE DEGREES OF FREEDOM
BETWEEN ELEMENTS?

Answer: The problem of incompatibility of DOFs between elements is solved by using specific multi-point constraints (MPC) elements like interpolation elements (called RBE3 or distributing coupling).



*Chapter 12: Rigid Body Elements and
Multi-Point Constraints*





QUESTION #34

WHAT IS RESIDUAL STRESS? GIVE TWO EXAMPLES.

Answer: Residual stresses are stresses that remain in a component even in the absence of external loading or thermal gradients.

In some cases, residual stresses result in significant plastic deformation, leading to warping and distortion of a body. Residual stresses can affect the susceptibility to fracture and fatigue.

Examples: Residual stresses can occur:

- In a welded component
- After a gap has been closed in a bolted joint

QUESTION #35

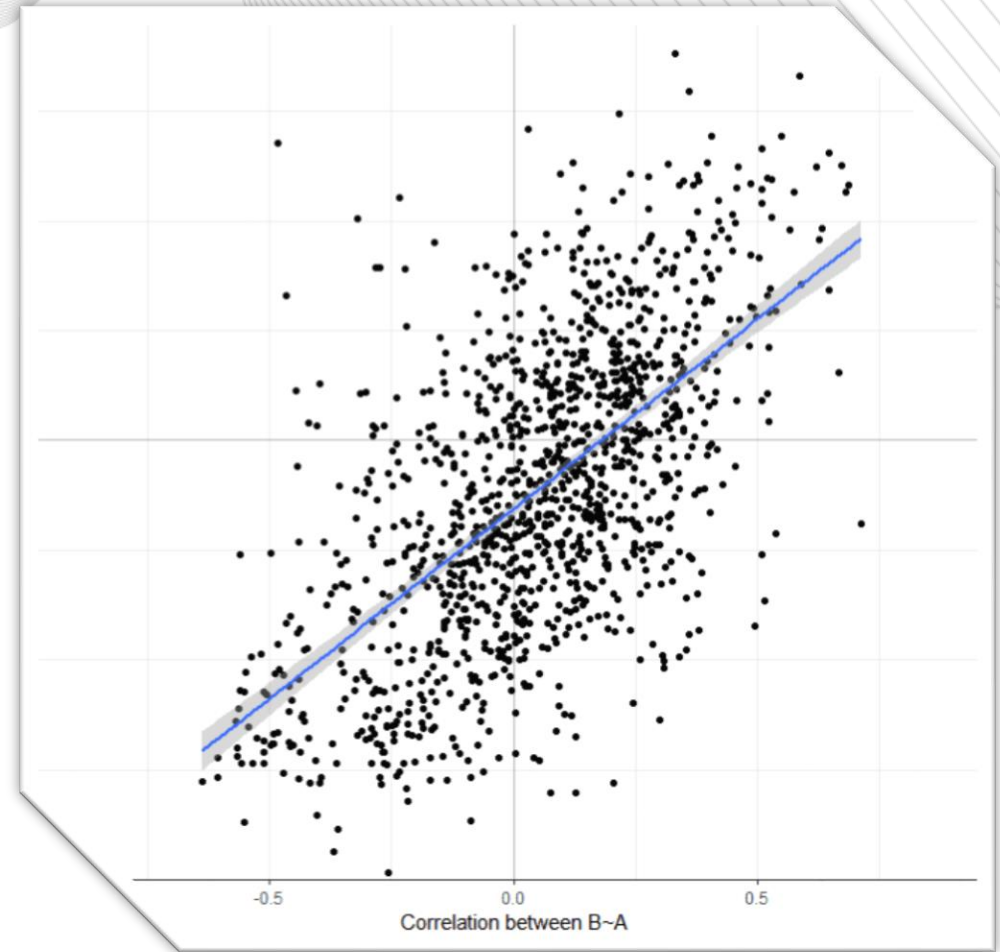
GIVE EXAMPLES OF ASSUMPTIONS WHICH CAN INFLUENCE THE ACCURACY OF AN FEA PREDICTION.

Answer:

1. The boundary conditions (restraints and loadings)
2. The simplifications of the CAD geometry
3. The discretization (meshing)
4. The assumptions made for the modeling of joints
5. The material models

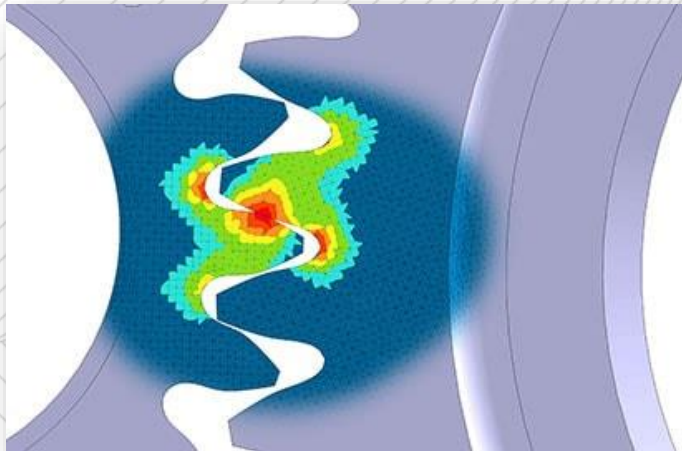


Chapter 6: Defining Your FEA Strategy



QUESTION #36

GIVE TWO TYPES OF CONTACT INTERACTION, WITH THEIR PROPERTIES, AVAILABLE IN COMMERCIAL FEA PACKAGES.

Answer:

- **Glued contact:** Glued contact allows two bodies to be fixed at the contact surface, even if they do not have the same mesh on both sides of the bodies.
- **Touching contact:** The bodies involved in a touching contact can move relative to one another, with the additional condition that one body is not allowed to penetrate the other.



Chapter 14: Modeling Contacts

QUESTION #37

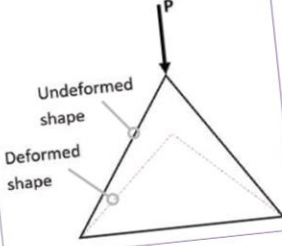
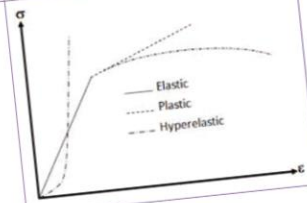
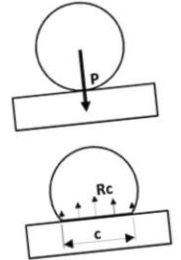
GIVE THE THREE TYPES OF NONLINEARITY
ENCOUNTERED IN MECHANICAL STRUCTURAL
ANALYSIS.

Answer:

1. Geometric nonlinearity (large displacements)
2. Material nonlinearity (the material behavior does not follow the Hooke's law)
3. Boundary nonlinearity (contact problem)



Chapter 21: Nonlinear Static Analysis

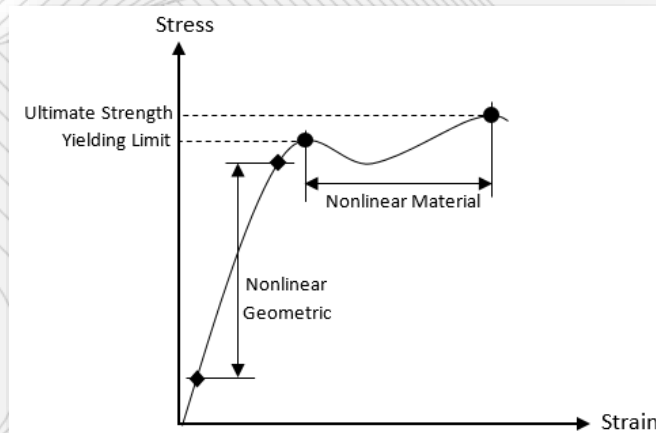
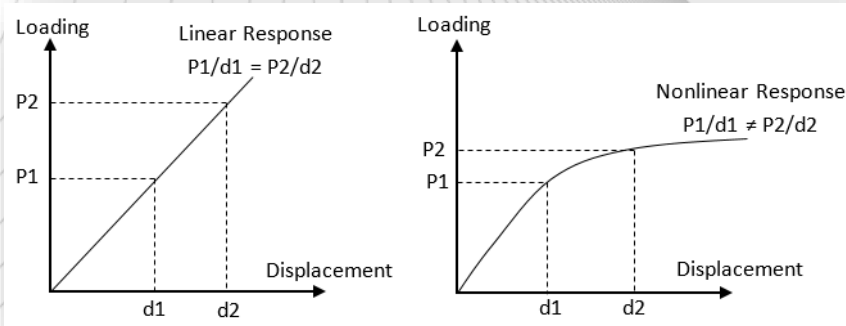
GEOMETRIC		Under large deformation, the deformed structure has a different geometry, implying a changing stiffness. The stiffness matrix $[K]$ is a function of displacements $\{u\}$.	$\{P\} = [K(u)] \{u\}$
MATERIAL		The stiffness response depends on deformation. The stiffness matrix $[K]$ is a function of displacements $\{u\}$.	$\{P\} = [K(u)] \{u\}$
CONTACT		Boundary conditions changing with deformation: the size c of the contact surface and the contact load Rc depend on deformation and load. The stiffness matrix $[K]$ and loading $\{P\}$ are functions of displacements $\{u\}$.	$\{P(u)\} = [K(u)] \{u\}$

QUESTION #38

WHAT ARE THE CHARACTERISTICS OF A NONLINEAR STATIC SOLUTION?

Answer:

1. The displacements are not related to the original stiffness of the structure
2. The stiffness of the analyzed structure is not constant and varies with the applied loads
3. Stresses and strains are not related to a linear function
4. The results cannot be scaled
5. The principle of superposition cannot be applied
6. The initial state of stress (residual stresses, temperature, pre-stressing) may be extremely important in the overall response
7. The structure's response is related to the load history
8. The deformation of the structure is not fully recovered once the applied loads are removed



QUESTION #39

WHAT ARE THE MAIN ALGORITHMS USED TO SOLVE
NONLINEAR PROBLEMS?

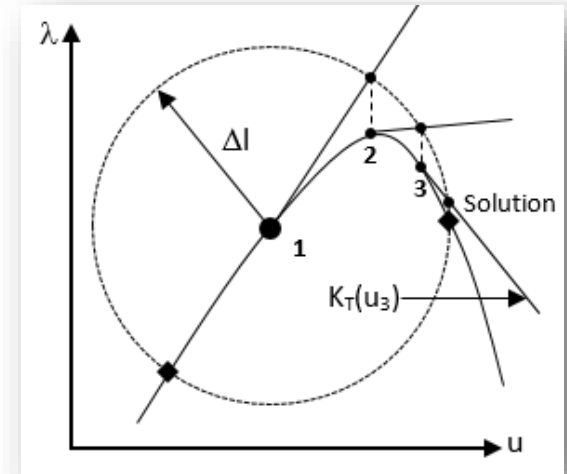
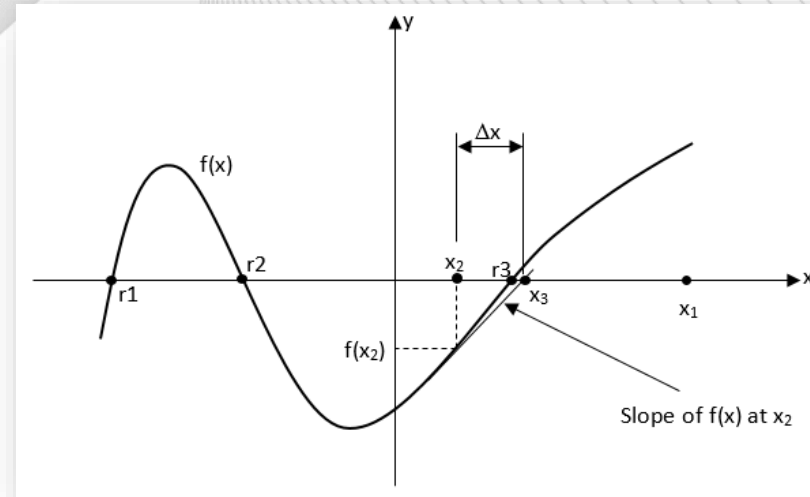
Answer:

1. The Newton-Raphson method
2. The Modified Newton-Raphson method
3. The Arc-Length methods mainly used for buckling problems (Crisfield and Riks Methods)



Chapter 21: Nonlinear Static Analysis

Chapter 23: Nonlinear Buckling Analysis

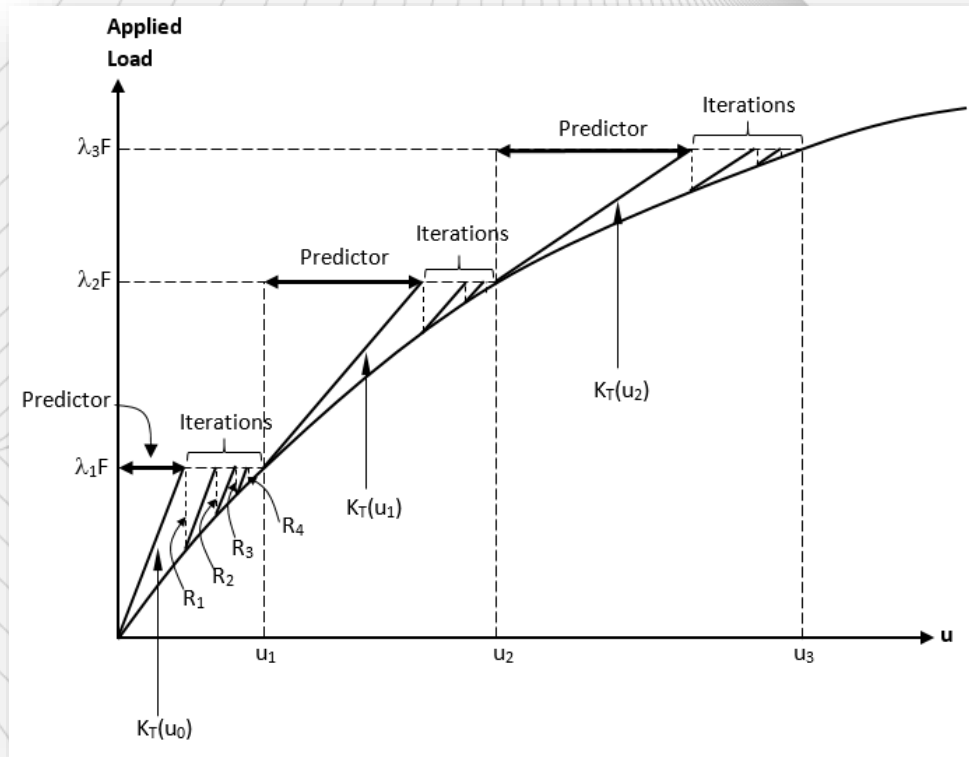


QUESTION #40

GIVE THE THREE BASIC OPERATIONS EMPLOYED TO SOLVE A NONLINEAR PROBLEM.

Answer:

1. Gradual loading
2. Iterations with convergence test for equilibrium
3. Stiffness matrix update

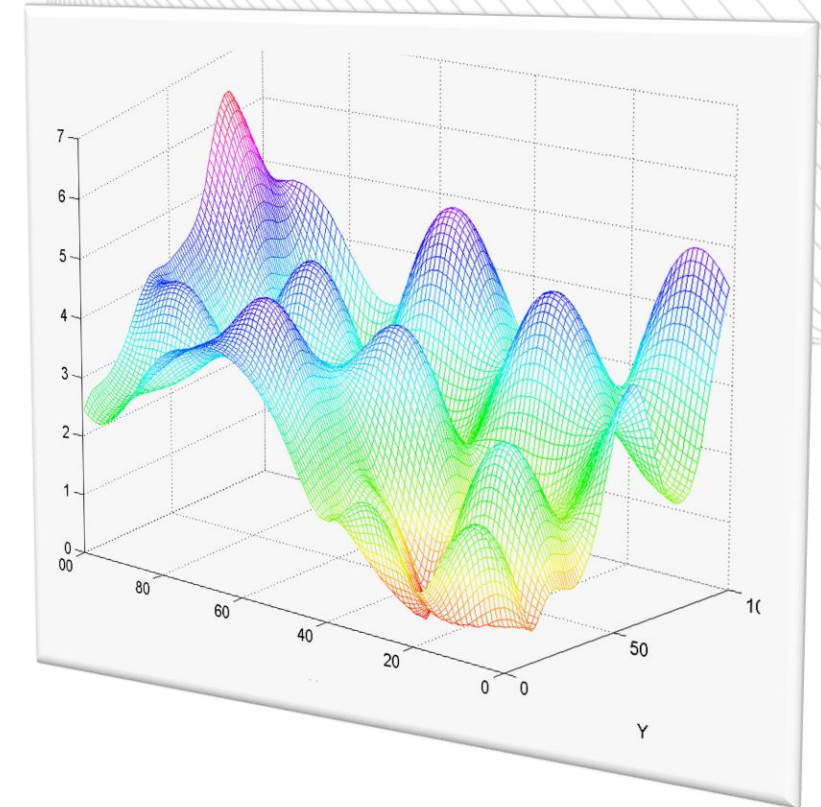


Chapter 21: Nonlinear Static Analysis

QUESTION #41

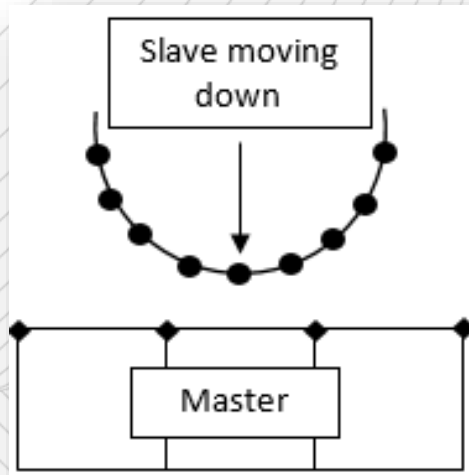
HOW DO YOU DECIDE IF YOUR PROBLEM IS A LINEAR STATIC
OR A NONLINEAR STATIC PROBLEM?Answer:

1. If the stiffness of the structure does not change when a loading is applied, it is a linear problem, otherwise it is a nonlinear problem.
2. If the strains in the model are less than 5%, it is a linear problem, otherwise it is a nonlinear problem.
3. If the strains or stresses of the model do not exceed the proportional limit, it is a linear problem, otherwise it is a nonlinear problem.

[Chapter 20: Linear Static Analysis](#)[Chapter 21: Nonlinear Static Analysis](#)

QUESTION #42

IN A CONTACT PROBLEM, HOW TO DECIDE THE MASTER AND SLAVE SURFACE? GIVE ONE RECOMMENDATION FOR MESHING.



Answer:

1. The master surface is on the touched body
2. The slave surface is on the touching body

Meshing recommendation: The slave body should have a finer mesh than the master body



Chapter 14: Modeling Contacts

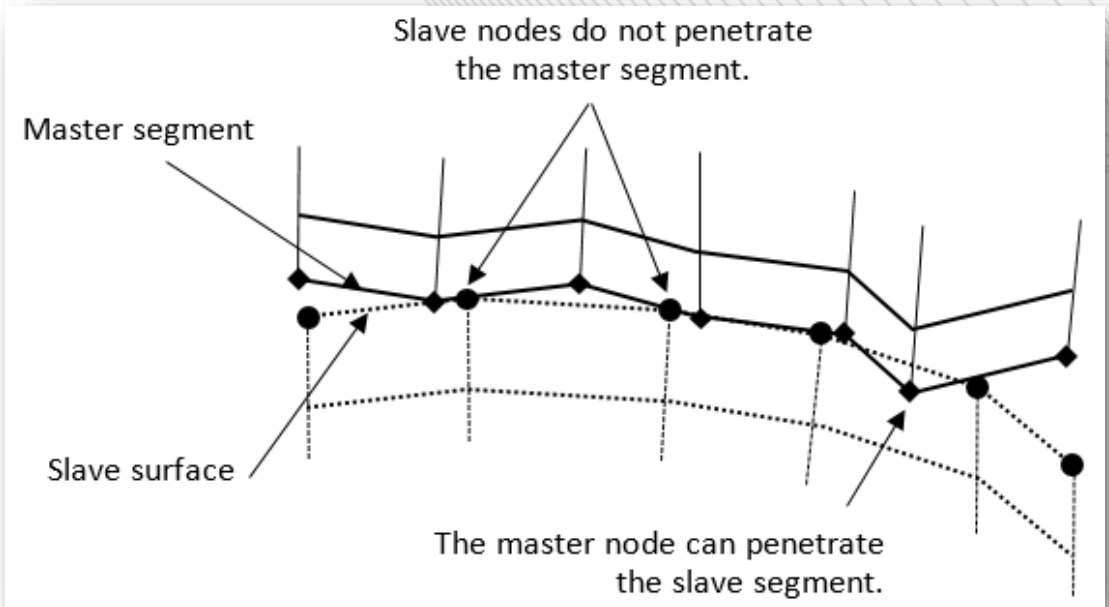
QUESTION #43

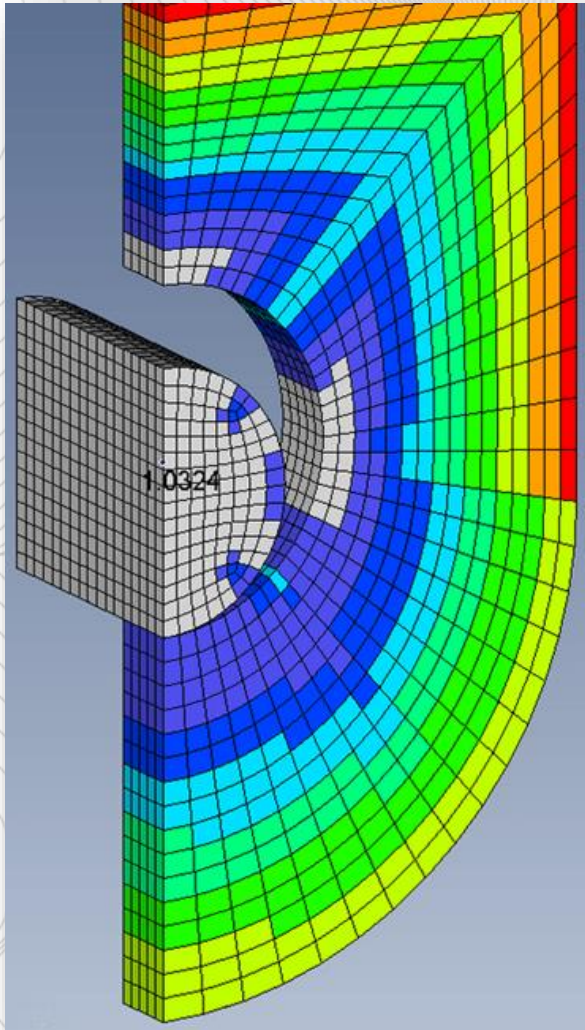
WHAT ARE THE RULES APPLYING TO THE NODES
OF THE SLAVE AND MASTER BODIES?Answer:

1. The node of the slave body CANNOT penetrate a segment of the master body
2. A node of the master body CAN penetrate a segment of a slave body



Chapter 14: Modeling Contacts





QUESTION #44

WHAT IS STABILIZATION IN CONTACT ANALYSIS?

Answer: The FEA packages offer contact stabilization to help automatically control rigid body motion in static problems before contact closure and friction restrain such motion.

However, it is recommended to try to stabilize rigid body motion first through modeling techniques (modifying geometry, imposing boundary conditions, etc.).



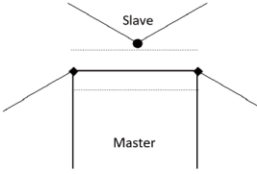
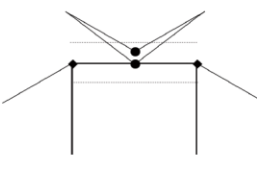
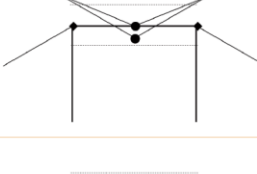
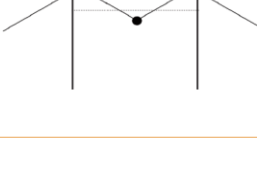
Chapter 14: Modeling Contacts

QUESTION #45

IN A CONTACT PROBLEM, EXPLAIN HOW THE SETTING OF THE CONTACT TOLERANCE INFLUENCES THE SOLUTION IN TERM OF COMPUTATIONAL COST AND ACCURACY.

Answer: Two scenarios:

1. The contact tolerance is too small:
 - Detection of the contact is difficult.
 - More nodes can potentially be considered penetrating.
 - Increment splitting increases.
 - The computational time increases.
2. The contact tolerance is too large:
 - The nodes are considered to be in contact prematurely.
 - A large number of nodes are detected as penetrated.
 - A loss of accuracy occurs in the final solution.

1. The slave node is outside the patch and outside the tolerance.		The bodies are not in contact. The contacting node remains in its current location.
2. The slave node is outside the patch but inside the tolerance.		An MPC is imposed to close the gap between the contacting node and the patch. The contact is effective while the normal tensile force is less than the separation force.
3. The slave node is inside the patch and inside the tolerance.		An MPC is imposed to resolve the penetration of the contacting node into the patch.
4. The slave node is inside the patch but outside the tolerance.		The slave node has penetrated the master body, leading to increment splitting. If this situation occurs at the beginning of the load increment, the contact will not be found.



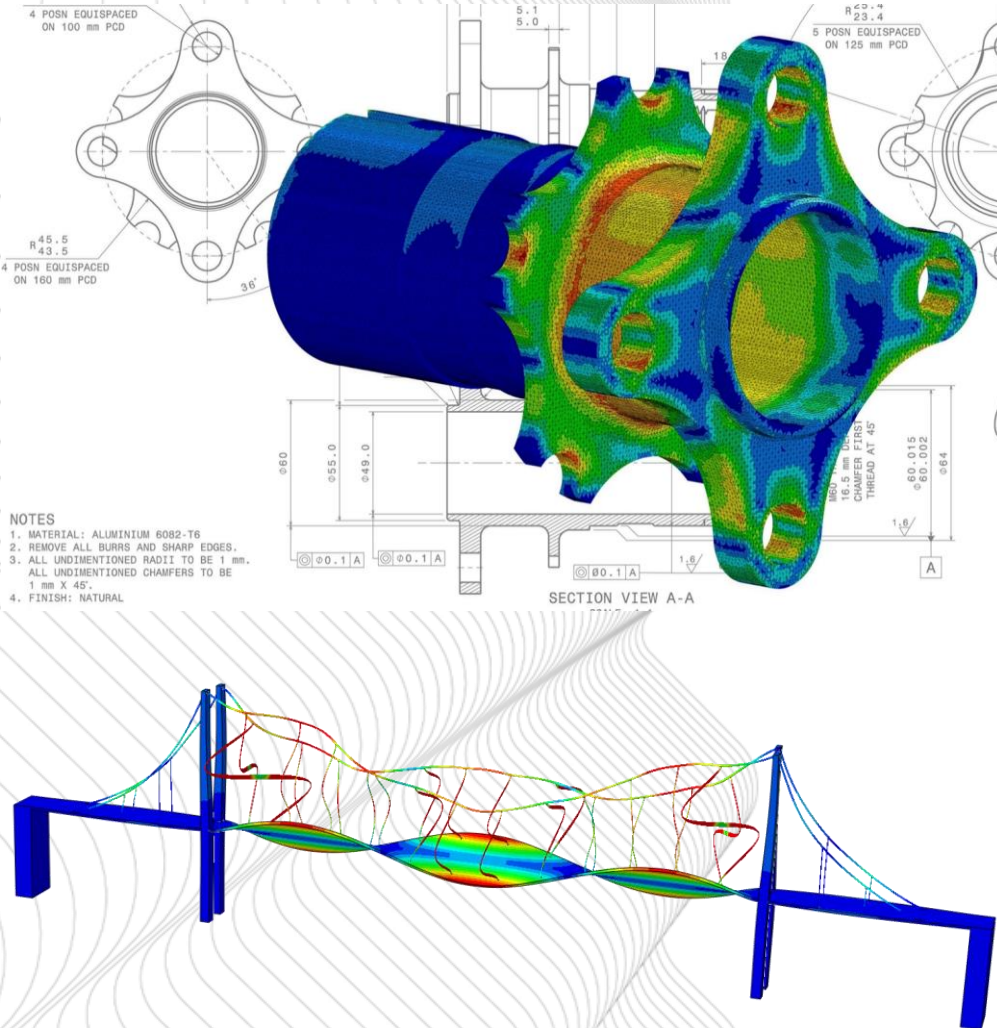
QUESTION #46

HOW TO DO YOU DETERMINE IF YOUR PROBLEM
NEEDS A STATIC OR A DYNAMIC ANALYSIS?Answer:

1. If the loading is constant over a relatively long period of time, it is a static problem, otherwise it is a dynamic problem.
2. If the inertial and damping effects are negligible, it is a static problem, otherwise it is a dynamic problem.
3. If the structure is subjected to vibrations, and the excitation frequency is less than one third of the structure's lowest natural frequency, it is a static problem, otherwise it is a dynamic problem.



Chapter 20: Linear Static Analysis



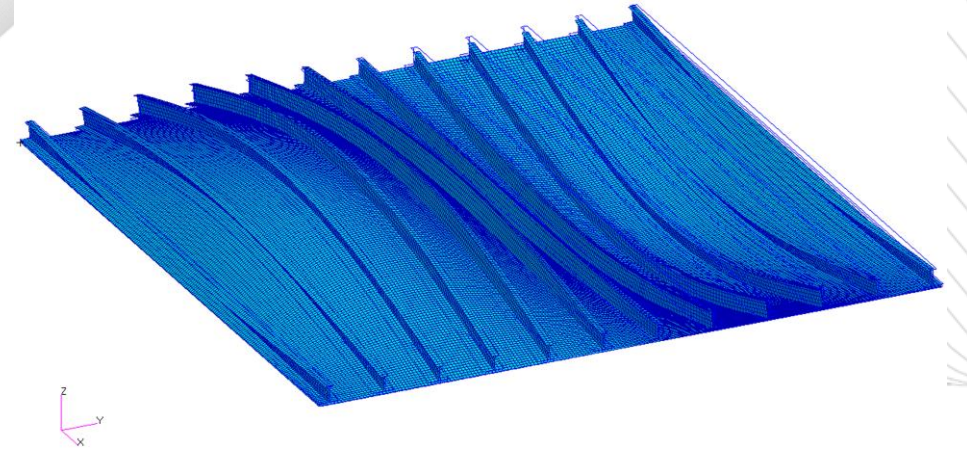
QUESTION #47

WHICH FE SOLUTION IS USED TO DETERMINE
NATURAL FREQUENCY?

Answer: Modal analysis is used to compute the natural frequencies and the associated mode shapes of a system.



Chapter 24: Normal Mode Analysis





QUESTION #48

WHICH ALGORITHM DO YOU SUGGEST FOR COMPUTING THE NATURAL FREQUENCIES OF A STRUCTURE? JUSTIFY YOUR RECOMMENDATION.

Answer: The recommended algorithm for computing the natural frequencies and mode shapes of a structure is the Lanczos method because, unlike the inverse power method, the Lanczos method does not require the analyst estimates the range of frequencies.

Moreover, this algorithm is proven to be efficient, accurate and fast in all situations. It gives good correlation with the natural frequencies measured during a tap test.



Chapter 24: Normal Mode Analysis

QUESTION #49

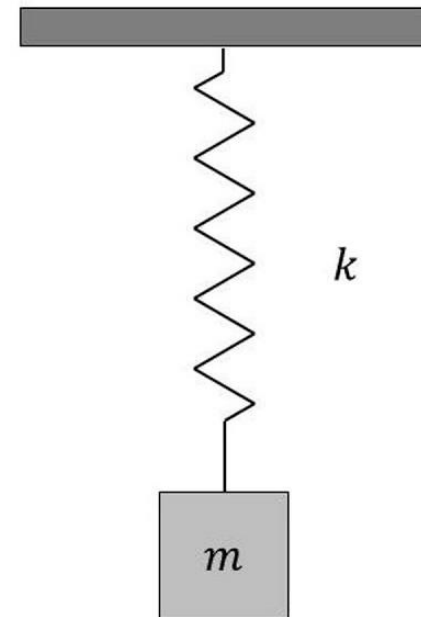
IN MODAL ANALYSIS, HOW THE STIFFNESS AND THE MASS INFLUENCE THE NATURAL FREQUENCIES?

Answer: If the stiffness K of the structure increases, the natural frequencies f_n increase, while if the mass M of the structure increases, the natural frequencies f_n decrease.



Chapter 24: Normal Mode Analysis

Spring-Mass System



$$f_n = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

QUESTION #50

GIVE THE 3 GROUPS OF ERRORS IN FEA

Answer:

1. Modeling error due to simplifications
2. Discretization error (wrong mesh)
3. Numerical error of the solution

Here are few tips and hints for you related to the interview itself

- **Start by researching the company and your interviewers.** Understanding key information about the company you are interviewing with can help you go into your interview with confidence. Using the company's website, social media posts and recent press releases will provide a solid understanding of the company's goals and how your background makes you a great fit.
- **Take at least five copies** of your printed resume on clean paper in case of multiple interviewers. Highlight specific accomplishments on your copy that you can easily refer to and discuss.
- **Bring a pen and a small notebook.** Prepare to take notes, but not on your smartphone or another electronic device. Write information down so that you can refer to these details in your follow-up thank-you notes. Maintain eye contact as much as possible
- **If it is a phone call, control your environment:** it is better to have the call in a quiet environment so that you and the other person can hear each other speak. In the same vein, if, during the call, communication gets difficult, agree with the person to call them back as soon as possible.
- **During the conversation, do not hesitate to restate your interest and enthusiasm for the position.** You want to make a good impression, so make sure to answer questions well. Take your time, be precise, control your delivery, articulate and do not forget to smile. If you do not understand something, do not hesitate to ask questions, and ask the person to repeat themselves if needed. The interviewer always appreciates when the candidate asks a clarification instead of answering a question she/he did not understand.

Here are few tips and hints for you related to the interview itself

- **Make sure to sell yourself well.** End the conversation by thanking the person for their time. An important detail is to remember to ask about the next steps in the hiring process. If you think it is appropriate, do a follow-up by email or by phone in the days following the call or the interview. This shows that you are interested and serious in your approach.
- **You are interviewing the company too.** Ask questions to learn more about the job and the company. This will help you figure out if it is a good fit for you.
- **Plan your schedule so that you can arrive 10–15 minutes early.** Map out your route to the interview location so you can be sure to arrive on time. Consider doing a practice run. If you are taking public transportation, identify a backup plan if there are delays or closures. When you arrive early, use the extra minutes to observe workplace dynamics.
- **Make a great first impression.** Do not forget the little things—shine your shoes, make sure your nails are clean and tidy, and check your clothes for holes, stains, pet hair and loose threads. Display confident body language and a smile throughout.
- **Treat everyone you encounter with respect.** This includes people on the road and in the parking lot, security personnel and front desk staff. Treat everyone you do not know as though they are the hiring manager. Even if they are not, your potential employer might ask for their feedback.
- **Practice good manners and body language.** Practice confident, accessible body language from the moment you enter the building. Sit or stand tall with your shoulders back. Before the interview, take a deep breath and exhale slowly to manage feelings of anxiety and encourage self-confidence. The interviewer should extend their hand first to initiate a handshake. Look the person in the eye and smile. A good handshake should be firm but not crush the other person's fingers.

Here are few tips and hints for you related to the interview itself

- **Win them over with your authenticity and positivity.** Being genuine during interview conversations can help employers easily relate to you. Showing positivity with a smile and upbeat body language can help keep the interview light and constructive.
- **Respond truthfully to the questions asked.** While it can seem tempting to embellish on your skills and accomplishments, interviewers find honesty refreshing and respectable. Focus on your key strengths and why your background makes you uniquely qualified for the position.
- **Tie your answers back to your skills and accomplishments.** With any question you answer, it is important that you tie your background to the job by providing examples of solutions and results you have achieved. Use every opportunity to address the requirements listed in the job description.
- **Keep your answers concise and focused.** Your time with each interviewer is limited so be mindful of rambling. Practicing your answers beforehand can help keep you focused. Use this PDF to practice the interview with a friend or a member of your family. You will find you gain confidence as you get used to saying the words.
- **Do not speak negatively about your previous employers.** Companies want to hire problem solvers who overcome tough situations. If you are feeling discouraged about your current job, focus on talking about what you have gained from that experience and what you want to do next.



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