SNS COLLEGE OF TECHNOLOGY

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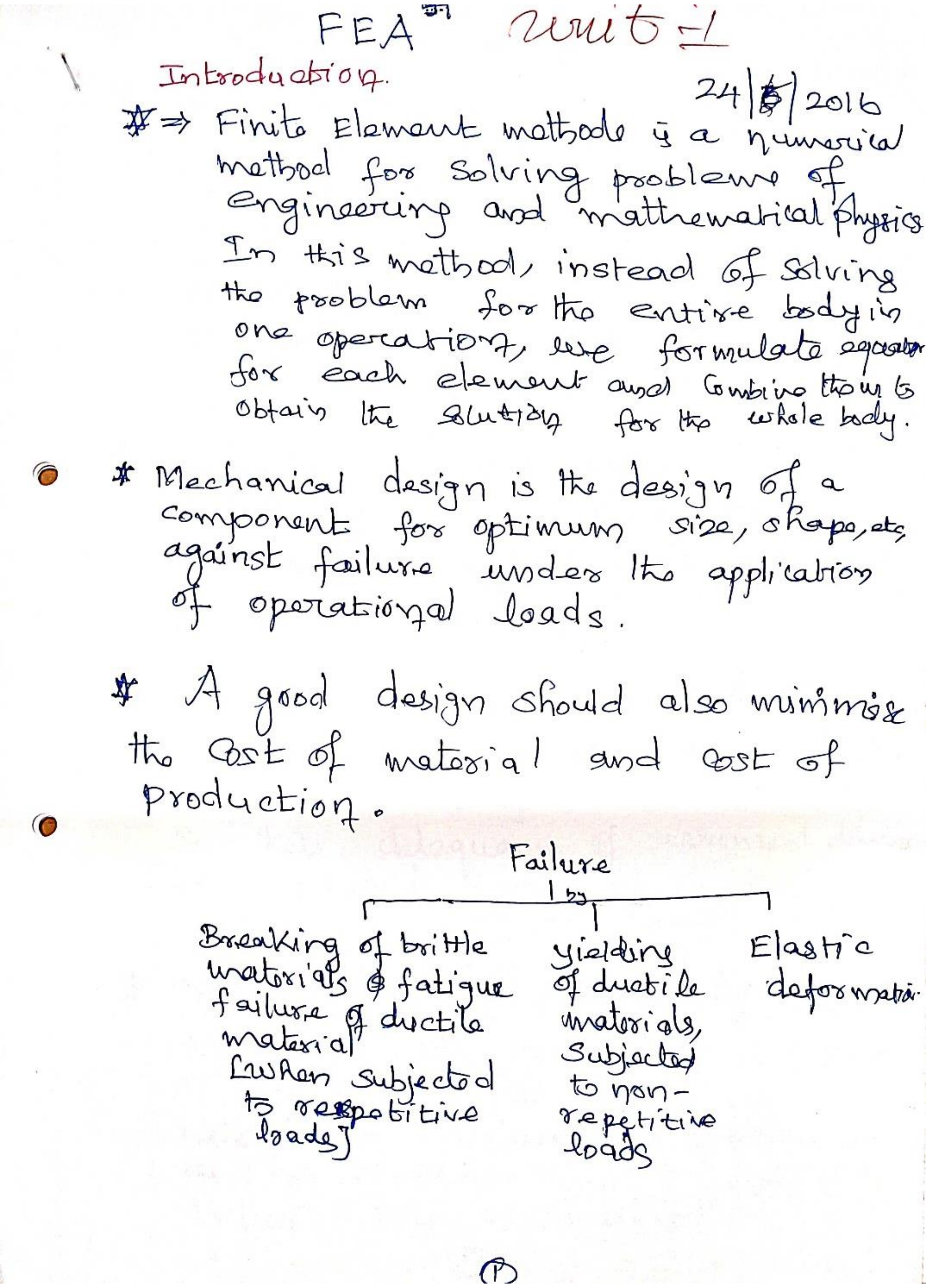
COIMBATORE-641 035, TAMIL NADU

DEPARTMENT OF AEROSPACE ENGINEERING

Faculty Name	:	**Dr.M.Subramanian, Prof & Head/ Aerospace**	Academic Year	:	**2024-2025 (Odd)**
Year & Branch	:	**III Aerospace**	Semester	:	**V**
Course	:	**19ASB302 – Finite Element Method for Aerospace**			

Unit:



FEA Unit -1

Introduction.

24/8/2016

- ⇒ Finite Element methods is a numerical method for solving problems of engineering and mathematical physics. In this method, instead of solving the problem for the entire body in one operation, we formulate equation for each element and combine them to obtain the solution for the whole body.

- Mechanical design is the design of a component for optimum size, shape, etc, against failure under the application of operational loads.

- A good design should also minimise the cost of material and cost of production.

Failure
by
- Breaking of brittle materials & fatigue failure of ductile material [when subjected to repetitive loads]
- yielding of ductile materials, subjected to non-repetitive loads
- Elastic deformation

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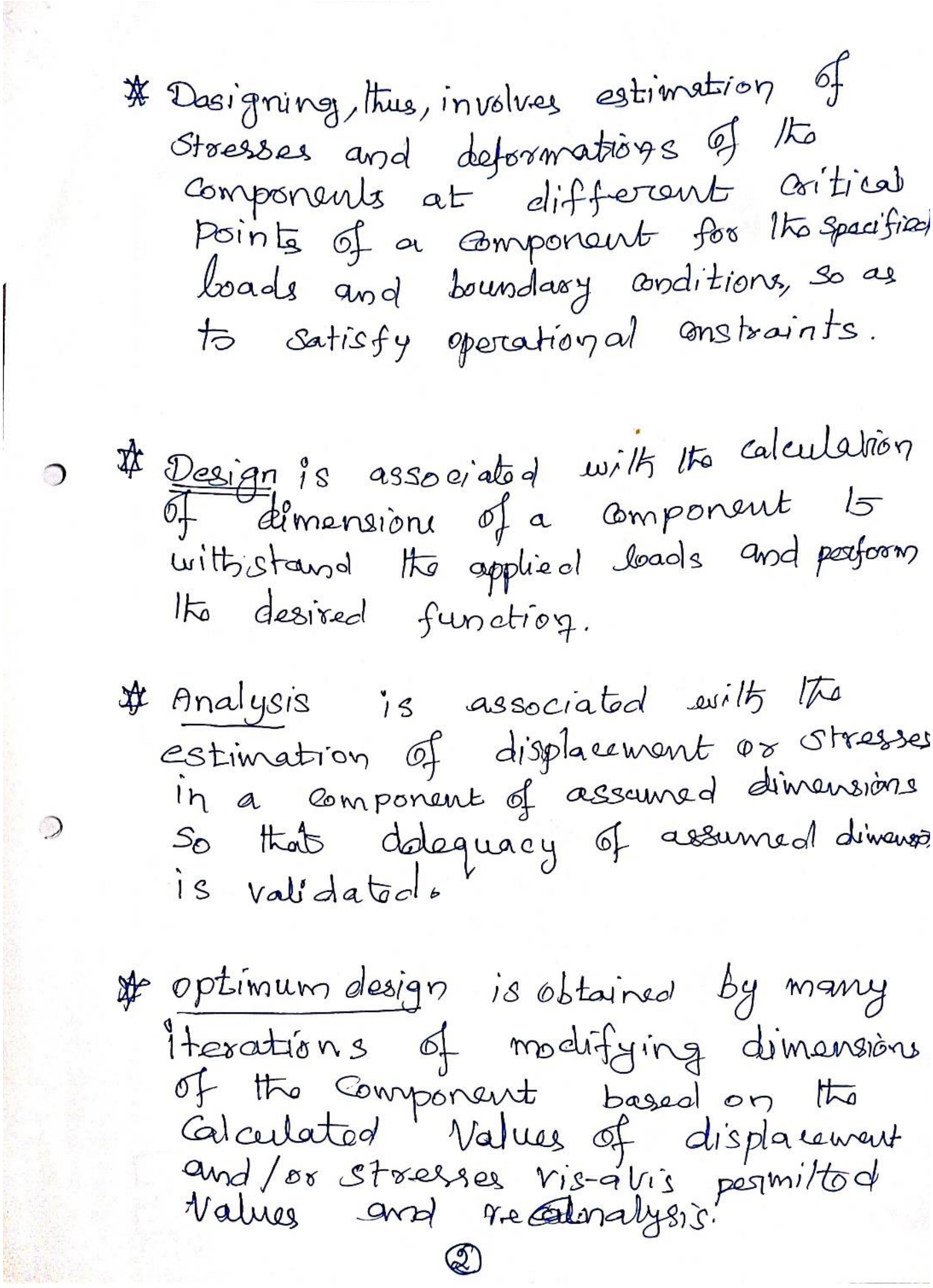

* Designing, thus, involves estimation of stresses and deformations of the components at different critical points of a component for the specified loads and boundary conditions, so as to satisfy operational constraints.

* Design is associated with the calculation of dimensions of a component to withstand the applied loads and perform the desired function.

* Analysis is associated with the estimation of displacement or stresses in a component of assumed dimensions so that adequacy of assumed dimensions is validated.

* optimum design is obtained by many iterations of modifying dimensions of the component based on the calculated values of displacement and/or stresses vis-a-vis permitted values and re-analysis.

②

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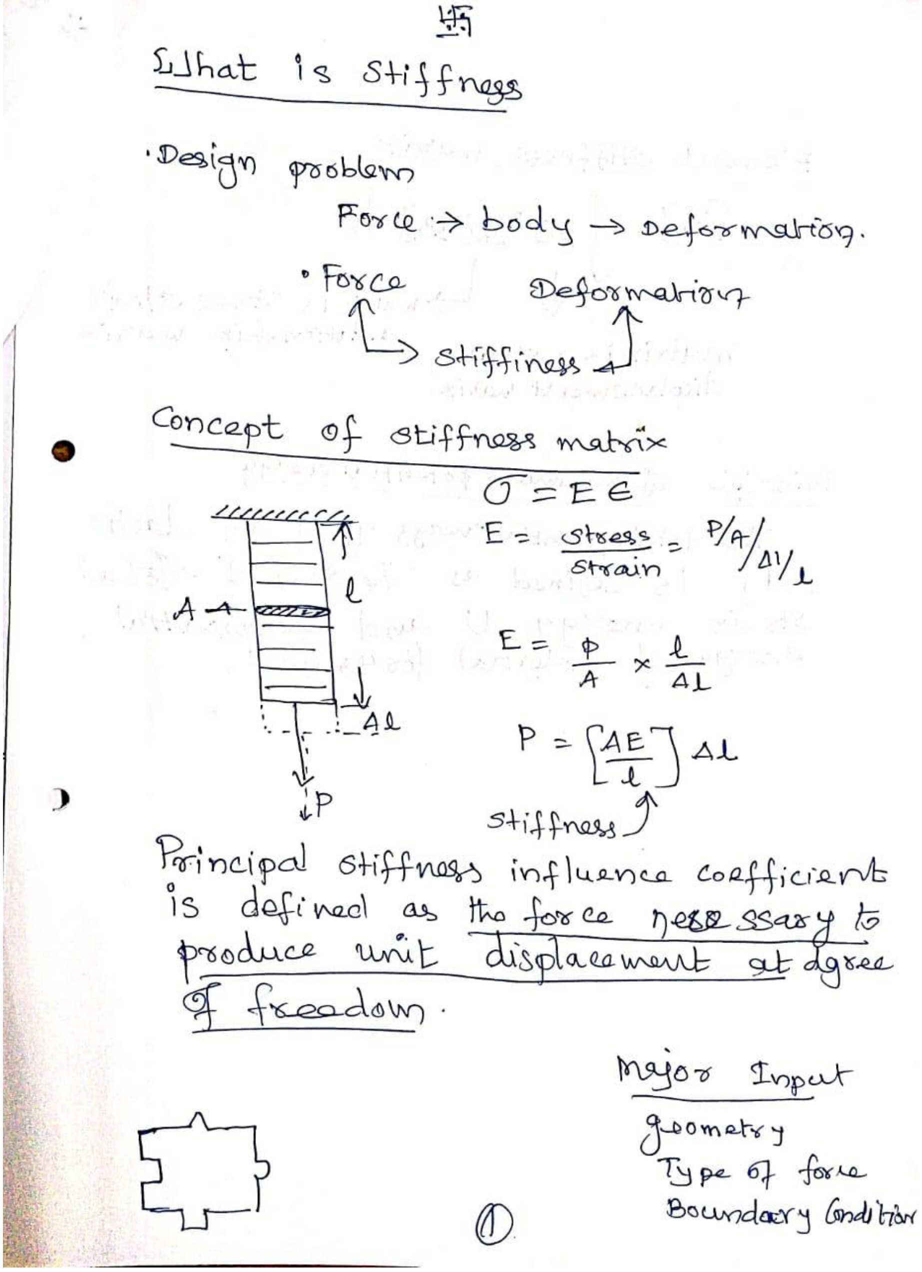


卐

What is Stiffness

- Design problem

Force → body → Deformation.

- Force

Deformation

Stiffness

Concept of stiffness matrix

$\sigma = E\epsilon$

$E = \frac{\text{stress}}{\text{strain}} = \frac{P/A}{\Delta l / l}$

$E = \frac{P}{A} \times \frac{l}{\Delta l}$

$P = \left[\frac{AE}{l}\right] \Delta l$

stiffness

Principal stiffness influence coefficient is defined as the force nessessary to produce unit displacement at dgree of freedom.

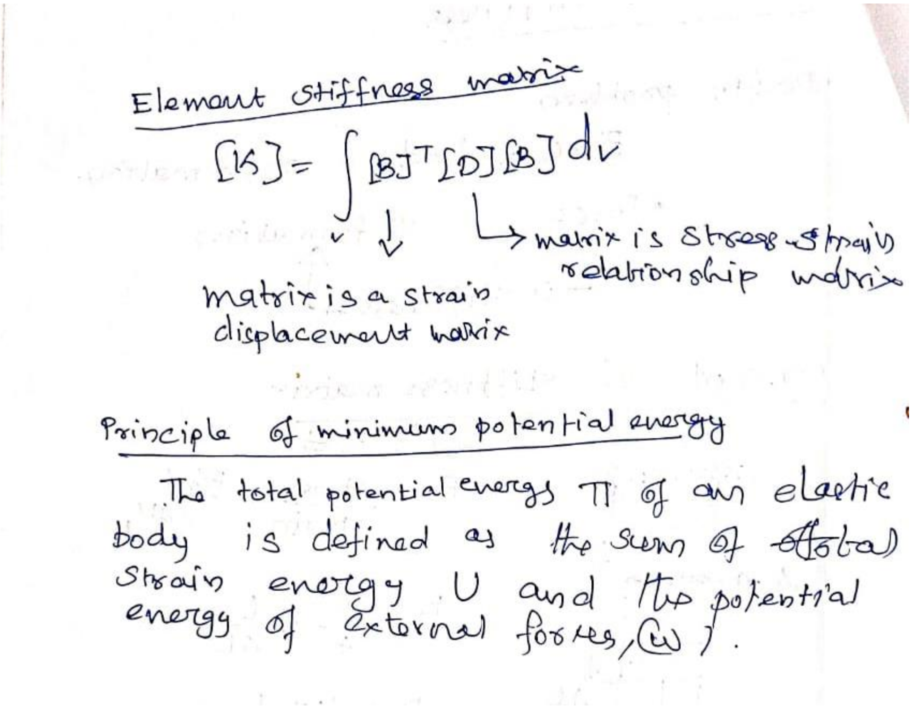
Major Input

geometry

Type of force

Boundary Condition

①



Element stiffness matrix

$$[K] = \int_v [B]^T [D] [B] \, dv$$

matrix is a strain displacement matrix

matrix is stress-strain relationship matrix

Principle of minimum potential energy

The total potential energy Π of an elastic body is defined as the sum of ~~o~~total strain energy U and the potential energy of external forces, (W).

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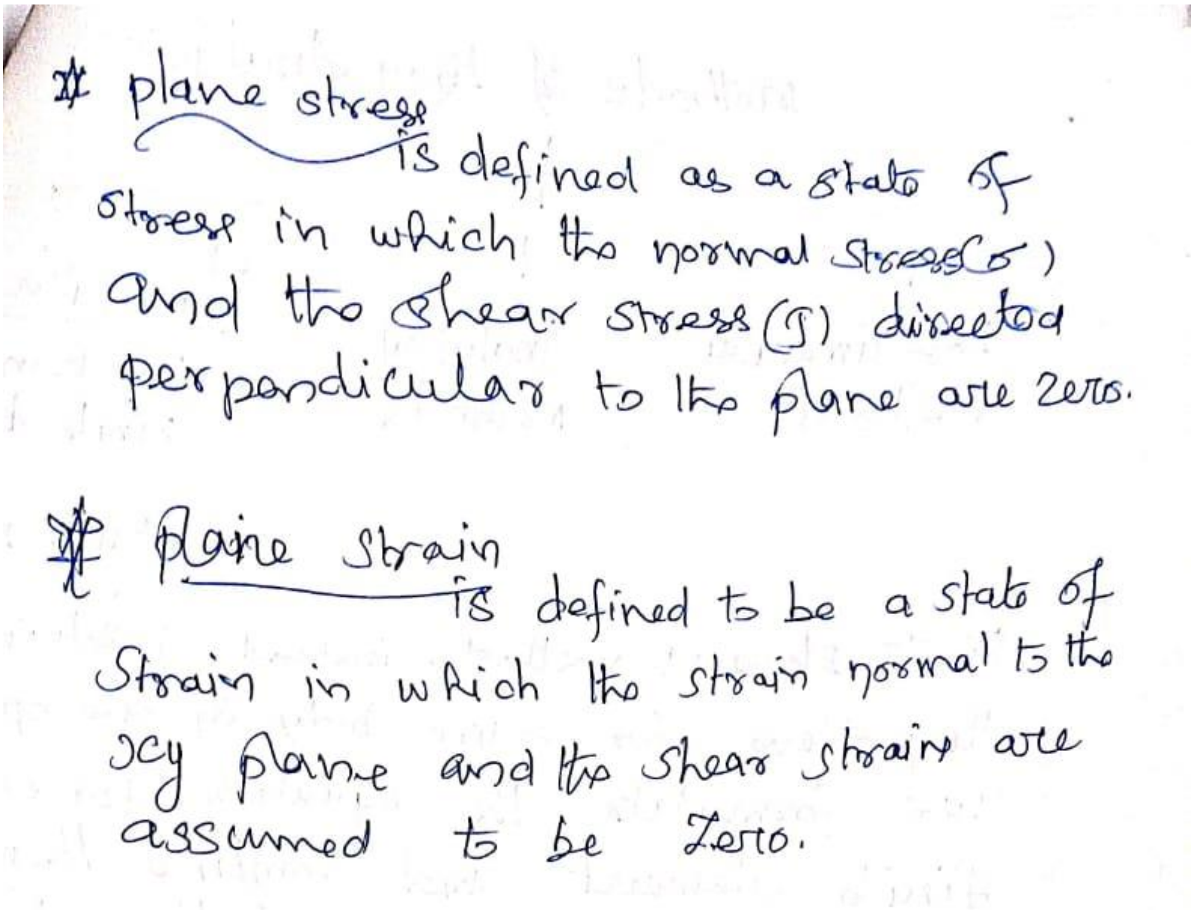

* plane stress

is defined as a state of stress in which the normal stress (σ) and the shear stress (τ) directed perpendicular to the plane are zero.

* plane strain

is defined to be a state of strain in which the strain normal to the xy plane and the shear strains are assumed to be zero.

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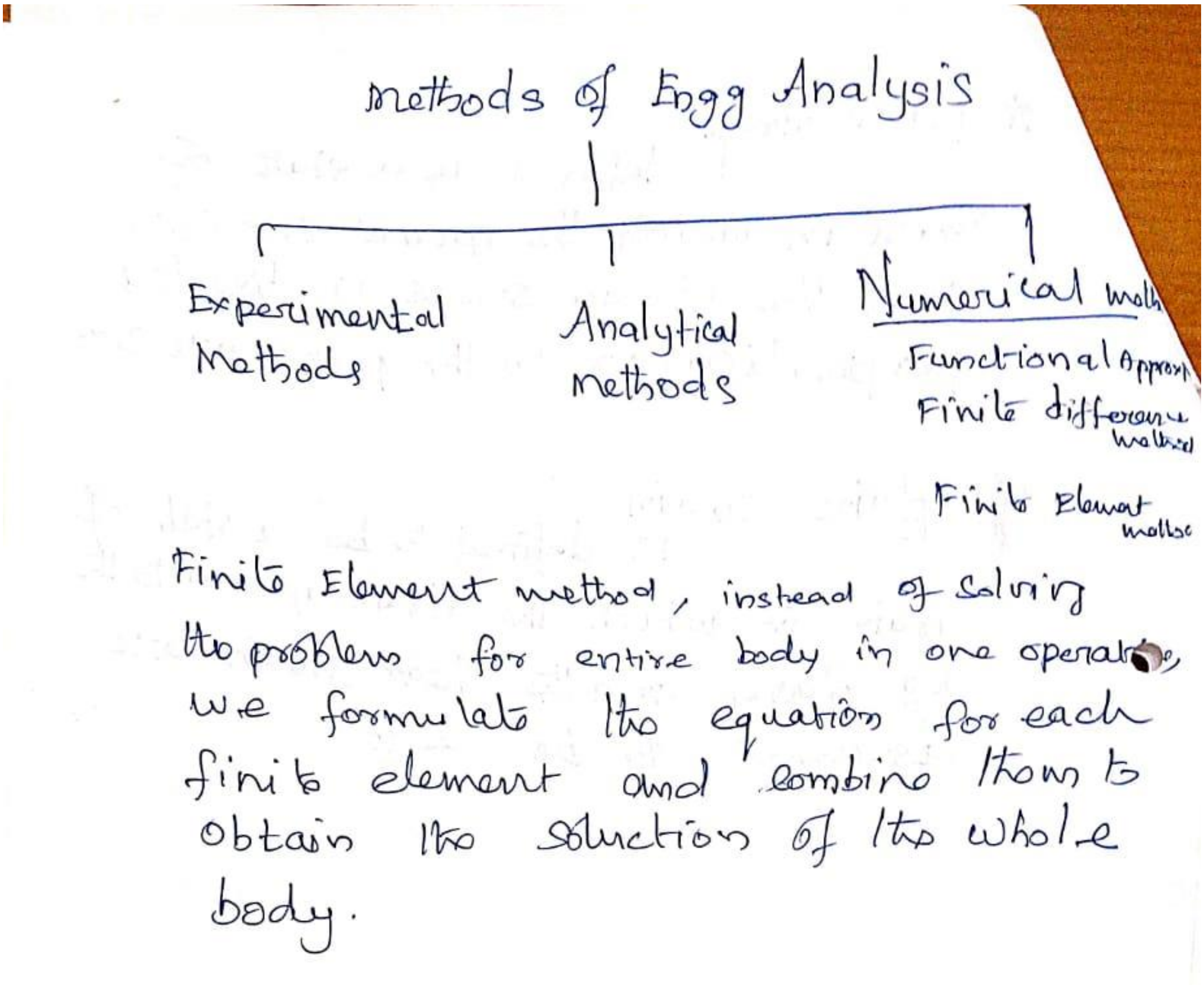

Finite Element method, instead of solving the problems for entire body in one operation, we formulate the equations for each finite element and combine them to obtain the solution of the whole body.

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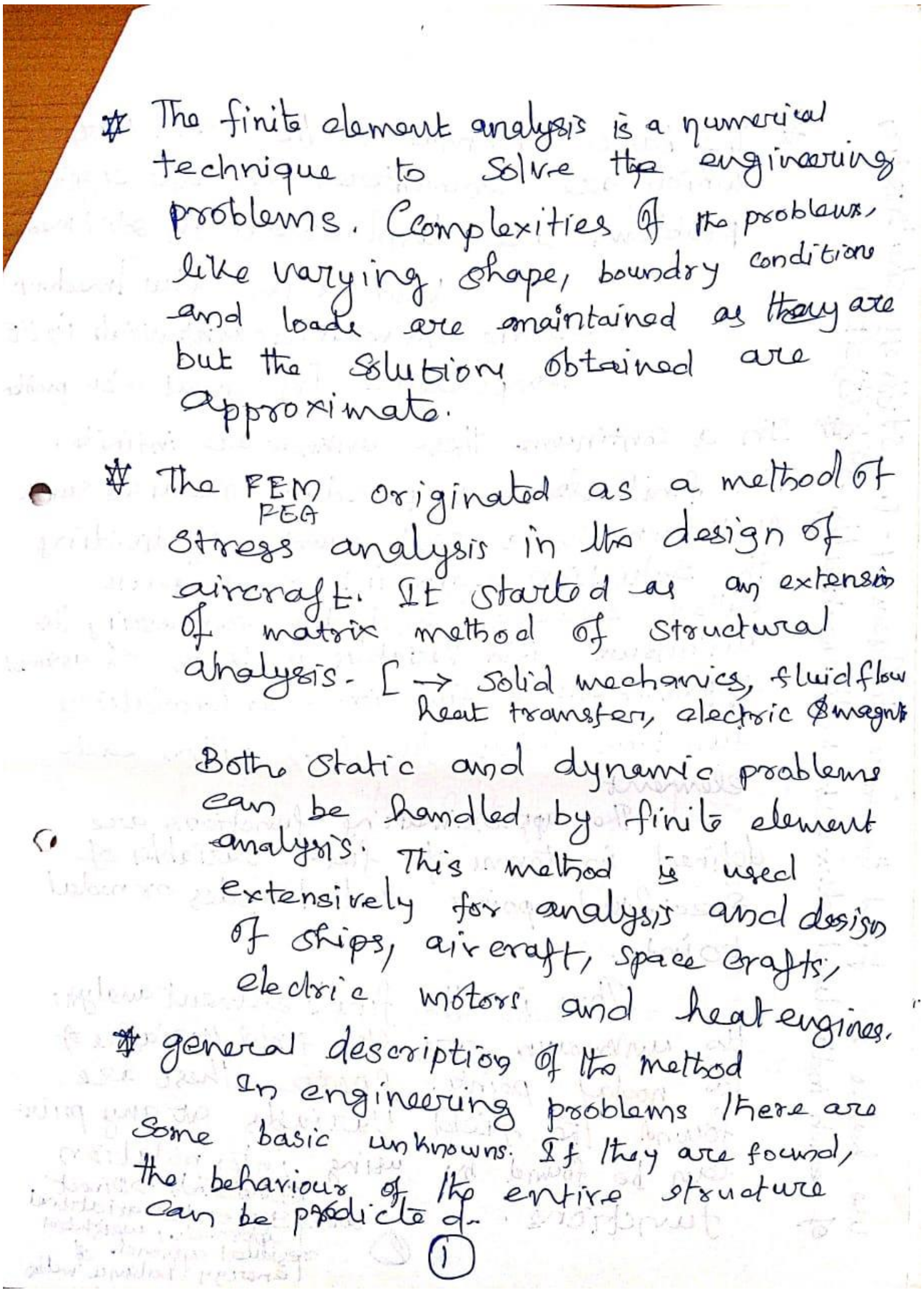

✡ The finite element analysis is a numerical technique to solve the engineering problems. Complexities of the problems, like varying shape, boundry conditions and loads are maintained as they are but the solution obtained are approximate.

✡ The $\underset{\text{FEA}}{\text{FEM}}$ originated as a method of stress analysis in the design of aircraft. It started as an extension of matrix method of structural analysis. [→ solid mechanics, fluid flow heat transfer, electric & magnt

Both static and dynamic problems can be handled by finite element analysis. This method is used extensively for analysis and design of ships, aircraft, space crafts, electric motors and heat engines.

✡ general description of the method

In engineering problems there are some basic unknowns. If they are found, the behaviour of the entire structure can be predicted.

The basic unknown or the field varia which are encountered in the engine problems are displacement in solid mech
Velocits in fluidmechani
electric and magnetic pontentials in El
Temperature in heat flow probl

In a Continum these unknow are infinite. The finite element procedure reduces such unknowns to a finite number by dividing the Soluction region into small parts called elements and by expressing the unknown field variables in term of assumed approximating functions (Interpolation function /shape function) within each element.

The approximating functions are defined in terms of field variables of specified points called nodes or nodal points.

Thus in the finite element analysis the unknowns are the field variables of the nodal points. Once these are found the field variables at any point can be found by using interpolation functions.

we have to find the force-displacement i.e stiffness charatoristics of each individual elements. mathematically → $(K)(\delta)=(F)$

② solit ④ methods → Direct approach, variational approach, weighted residual approach & energy balance metho

FEA Steps:

- Select suitable field Variables and the elements.
- Discritise the Continua
- Select interpolation function
- Find the element properties
- assemble element properties to get global properties
- Impose the boundary conditions
- Solve the System equation to get the nodal unknowns.
- make the additional calculations to get the required Values.