

CE525 Fall 2026
Study Guide for Exam 1

1. Matrix Displacement Method (MDM) for uniaxial structures (Lectures 1-6)

- a. Identification of degrees of freedom (dof) in a structure with proper notation also for members, joints, forces, and reactions.
- b. Structural Level Superposition to construct system of equations: $\{P\} = \{P_f\} + [S]\{d\}$.
- c. Member Level Superposition to construct system of equations: $\{Q\} = \{Q_f\} + [k]\{u\}$.
- d. Definitions of S_{ij} , and k_{ij} .
- e. Derivation of the elements of the 2x2 member stiffness matrix $[k]$ using *mechanics of materials* approach
- f. Derivation of the elements of the 2x2 member stiffness matrix $[k]$ using the *finite element formulation* based on virtual work
- g. Assembly of $[S]$, $\{P_f\}$ from member $[k]$, $\{Q_f\}$ using:
 - I. *Rigorous Method*
 1. Use of joint **equilibrium** at a dof to get P's in terms of Q's.
 2. Use of member **force displacement** relation to get Q's in terms of k's and u's.
 3. Use of **compatibility** equations to get u's in terms of d's (and zeros for supports).
 4. Simplify resulting equations to get $[S]$ in terms of elements in member $[k]$ matrices and $\{P_f\}$ in terms of the elements in member $\{Q_f\}$ vectors.
 - II. *Code Number Method*
- h. Solution of $\{P\} = \{P_f\} + [S]\{d\}$ to obtain $\{d\}$.
- i. For each member, use compatibility to get $\{u\}$ in terms of the elements of $\{d\}$.
- j. Calculation of member end forces using $\{Q\} = \{Q_f\} + [k]\{u\}$.
- k. Use of member end forces to obtain reactions, verify equilibrium and compatibility.
- l. Draw axial force diagram and calculate axial stresses.

2. Matrix Displacement Method (MDM) for planar/spatial trusses (Lectures 7-9)

- a. Identification of degrees of freedom (dof) and local coordinate systems in a structure with proper notation also for members, joints, forces, and reactions.
- b. Structural Level Superposition to construct system of equations: $\{P\} = [S]\{d\}$.
- c. Member Level Superposition in local coordinates to construct: $\{Q\} = [k]\{u\}$.
- d. Derivation of the coordinate transformation matrix $[T]$ to construct member system of equations in global coordinates: $\{F\} = [K]\{v\}$, where $\{Q\} \equiv [T]\{F\}$ - $\{F\} \equiv [T]^T\{Q\}$.
- e. Derivation of $[K] = [T]^T[k][T]$
- f. Assembly of $[S]$ from global member $[K]$ using:
 - I. *Rigorous Method*.
 - II. *Code Number Method*
- g. Solution of $\{P\} = [S]\{d\}$ to obtain $\{d\}$.
- h. For each member, use compatibility to get $\{v\}$ in terms of the elements of $\{d\}$.
- i. Calculate global member end forces using $\{F\} = [K]\{v\}$.
- j. Calculate local axial bar forces using: (a) $\{Q\} = [T]\{F\}$ or (b) Pythagorean theorem with $\{F\}$
- k. Use of member forces to obtain reactions, and verify joint/overall equilibrium.
- l. Calculate axial stresses.