CE 525 Fall 2024

Study Guide for Exam II

1. **Matrix Displacement Method (MDM) for beams** (Lectures 10-14)

   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 4x4 BEBT member stiffness matrix [k] *using mechanics of material approach.*
   f. Derivation of the elements of the 4x4 BEBT member stiffness matrix [k] using the *finite element formulation* based on virtual work.
   g. Derivation of fixed end forces/moments using *principle of superposition*.
   h. Determining fixed end forces/moments using *finite element shape functions*.
   i. MDM implementation of support displacements.
   j. Assembly of [S], $\{P_f\}$ from member [k], $\{Q_f\}$ using:
      I. Code Number Method
   k. Solution of $\{P\}=\{P_f\}+[S]\{d\}$ to obtain $\{d\}$.
   l. For each member, use compatibility to get $\{u\}$ in terms of the elements of $\{d\}$.
   m. Calculation of member end forces using $\{Q\}=\{Q_f\}+[k]\{u\}$.
   n. Use of member end forces to obtain reactions and verify equilibrium and compatibility.
   o. Draw shear force and bending moment diagrams. Calculate shear and bending stresses.

2. **Matrix Displacement Method (MDM) for 2D Frames** (Lectures 15-16)

   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. Calculation of fixed-end forces/moments on inclined members.
   d. Member Level Superposition in local coordinates to construct: $\{Q\}=\{Q_f\}+[k]\{u\}$.
   e. Using the transformation matrix [T] to construct member system of equations in global coordinates: $\{F\}=\{F_f\}+[K]\{v\}$, where $\{F_f\}=[T]^T\{Q_f\}$ and $[K]=[T]^T[k][T]$.
   f. Assembly of [S], $\{P_f\}$ from member [K], $\{F_f\}$ using:
      I. Code Number Method
   g. Solution of $\{P\}=\{P_f\}+[S]\{d\}$ 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: $\{F\}=\{F_f\}+[K]\{v\}$.
   j. Calculate local member end forces using: $\{Q\}=[T]\{F\}$
   k. Use member end forces to obtain reactions and verify overall equilibrium.
   l. Draw axial force, shear force, and bending moment diagrams.
   m. Calculate shear and normal (axial + bending) stresses.

3. Matrix Displacement Method (MDM) for Grids (Lectures 17-18)

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. Calculation of fixed-end forces for torsional moments.
d. Member Level Superposition in local coordinates to construct: $\{Q\}=\{Q_f\}+[k]\{u\}$.
e. Using the transformation matrix [T] to construct member system of equations in global coordinates: $\{F\}=\{F_f\}+[K]\{v\}$, where $\{F_f\}=[T]^T\{Q_f\}$ and $[K]=[T]^T[k][T]$.
f. Assembly of [S], $\{P_f\}$ from member [K], $\{F_f\}$ using:
   I. Code Number Method
g. Solution of $\{P\}=\{P_f\}+[S]\{d\}$ 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: $\{F\}=\{F_f\}+[K]\{v\}$.
j. Calculate local member end forces using: $\{Q\}=[T]\{F\}$
k. Use member end forces to obtain reactions and verify overall equilibrium.
l. Draw torsion, shear force, and bending moment diagrams.
m. Calculate shear (torsion + shear force) and bending stresses.