CE525 Fall 2024
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.