Theory of Structure I

Course objectives:
The purpose of this course is to provide concept and knowledge of structural analysis with the emphasis of statically determinate structure. By the end of this course, it is expected that the students will be able to perform analysis of determinate structures both by manual calculation as well as matrix method of analysis using computer application.

1. Introduction (4 hours)
    a. Types of Structures Based on Material Used
    b. Structural Mechanics
    c. Two Basic Approaches of Structural Analysis
    d. Linearly Elastic Structures
    e. Non-linearity in Structural Analysis
    f. Computer Based Methods
    g. Principle of Superposition

2. Analysis by the Strain Energy Method (4 hours)
    a. Strain Energy and Complementary Strain
    b. Strain Energy due to Gradually and Suddenly Applied Direct Load: Dynamic Multipliers
    c. Strain Energy due to Bending, shear and Torsion

3. Analysis by the Virtual Work Method (6 hours)
    a. Work and Complementary Work
    b. Displacement of Beams and Frames by Method of Real Work
    c. Calculation of Real Work from Bending
    d. Limitations of the Method of Real Work
    e. Displacements by the Methods of Virtual Work
    f. Direct Axial and Bending Effects
    g. Displacements in Beams due to Temperature Effects
    h. Adjustments and Misfits in Truss Elements and Temperature Effects
    i. Combination of Different Effects

4. Deflection of Beams (7 hours)
    a. Introduction
    b. Differential Equation of Flexure
    c. Double Integration method
    d. Theorems on Area Moment Method
    e. Macaulay's Method
    f. Deflection of Cantilever beams
    g. Deflections in Simply Supported Beams
    h. Mid-span Deflections
    i. Conjugate-Beam Method
    j. Deflections by the Method of Superposition

5. Influence Lines for Simple Structures (10 hours)
    a. Moving Static Loads and Influence Lines
    b. Influence Lines for Statically Determinate structures
    c. Moving Loads on Statically Determinate Beams
    d. Influence Lines for Statically Determinate Trusses

e. Influence Line Diagrams for the Case of Indirect Load Applications (Panel Loadings)
f. Influence Lines for Support Reactions
g. Influence Lines for support Moment
h. Influence Lines for Shear Force
i. Influence Lines for bending Moment
j. Determination of Reactions, bending Moments and Shear Forces from Influence Line Diagrams due to different loadings: Point Load, Distributed Load, Couple
k. Loading of Influence Line Diagrams using Standard Load Trains
l. Most Critical Position of a Load on a Beam Span

6. Statically Determinate Arches (7 hours)
   a. Types of Arches
   b. Three-Hinged Structures with Support at Same and different Level
   c. Determination of Support reactions, Shearing Forces, Normal Forces and Bending Moments by Numerical Methods
   d. Analysis of Three-Hinged Arches by the Graphical Method
   e. Influence Line Diagrams for Reactions, Bending Moments, Shearing Forces and Normal Forces in Three-Hinged Arches

7. Suspension Cable Systems (7 hours)
   a. Theory of Suspended Structures with Un-stiffened Cables
   b. Catenary and Parabolic Cables
   c. General Cases of Parabolic Cables
   d. Elements of a Simple suspension Bridges
   e. Stress Determination in Three-Hinged Stiffening Girder
   f. Influence Line Diagrams
   g. Tower structures, Wind Cables and Ties (Introduction only)

Practical:
1. Measurement of reactions in three-hinged arches under different loading arrangements
2. Deflection of Beam
3. Experimental analysis of suspension bridges
4. Simulation of Influence lines for beams and girders
5. Simulation of displacement measurement in statically determinate plane frame

Tutorials: 12 assignments, 2 seminar presentations

References:

1. C.H. Norris, J.B. Wilbur and S.Utku “Elementary structural Analysis”, 3rd Edition, New York: McGraw-Hill Book Co., 1977
2. Wong Y. Yang “Applied Numerical Methods using MATLAB”, , et.Al., John Willey & Sons, 2005
3. William Weaver, JR., james M. Gere “Matrix Analysis of Frames Structures”, , 2nd Edition, CBS Publishers and Distributers, India
4. A. Darkov and Kuznetsov “Structural Mechanics”, , Mir Publishers