K L University
Pre-Ph.D Examination
FINITE ELEMENT ANALYSIS
SYLLABUS

Basic Principles
Equilibrium equations; Strain-displacement relations; linear constitutive relations; Principle virtual work; Principle of stationary potential energy
Element Properties

Different types of elements; Displacement models; Relation between nodal degrees of freedom and generalized coordinates; Convergence requirements; Compatibility requirement; Geometric invariance; Natural coordinate systems; Shape functions; Element strains and stresses; Element stiffness matrix; Element nodal load vector. Isoparametric elements – Definition, Two-dimensional isoparametric elements – Jacobian transformation, Numerical integration
Direct Stiffness method and Solution Technique

Assemblage of elements–Obtaining Global stiffness matrix and Global load vector; Governing equilibrium equation for static problems; Storage of Global stiffness matrix in banded and skyline form; Incorporation of boundary conditions; Solution to resulting simultaneous equations by Gauss elimination method
Plane-stress and Plane-strain analysis

Solving plane stress and plane-strain problems using constant strain triangle and four nodded isoparametric element

Text Book:

1. Introduction to Finite Elements in Engineering by R.T. Chandrupatla and A.D. Belegundu, Prentice Hall of India, 1997.

References:

1. Finite Element Analysis by Abel and Desai, New Age Publishers, 2007.
2. Finite Element Analysis: Theory and Programming by C. S. Krishnamoorthy, Tata McGraw-Hill, 1995
3. Finite Element Procedures in Engineering Analysis by K. J. Bathe, Prentice Hall Inc., 1996.
4. The Finite Element Method by O.C. Zienkiewicz, and R.L.Taylor, McGraw – Hill, 1987.

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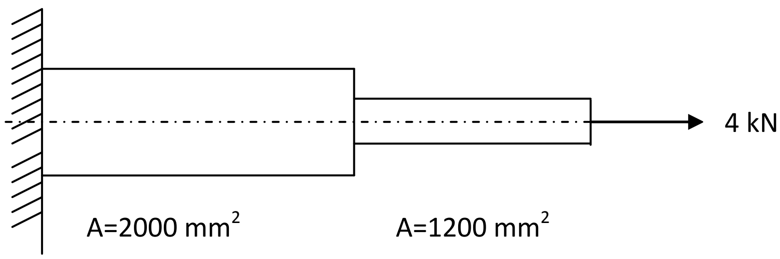
Model Paper

Time: 3.00 hrs. **Max Marks: 100**

Answer any FIVE questions. All questions carry equal marks

1. (a). Explain the various steps in a sequence to be followed in Finite Element Analysis.
   (b). What is a shape function? Derive the shape function of a line element.
2. (a). What are the various components of forces acting in a body due to external load.
   (b). Derive the strain-displacement matrix of a line element.
3. (a). What are the properties of a stiffness matrix?
   (b) Derive the stiffness matrix of a line element.
4. (a). Derive the stiffness matrix of a truss element

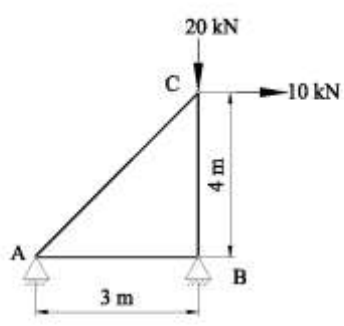
   (b). What is meant by Isoparametric representation?
5. For the bar shown in fig. Find the reaction force, using penalty approach.



A=2000 mm^2	A=1200 mm^2
E= $70x10^9$ N/mm^2	E= $70x10^9$ N/mm^2
L=400 mm	L=300 mm

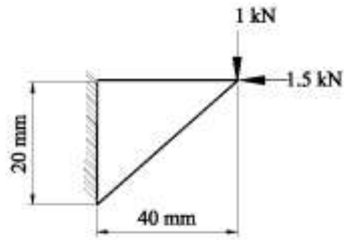
6. For the 3-bar truss shown in figure below, calculate the stresses in each member. Use elimination approach.

A=800 mm^2
E= $2x10^5$ N/mm^2



7. (a). Differentiate between plane stress and plane strain analysis.

   (b). For the configuration shown in figure below, determine the deflection at the point of load application using a one-element model.



Given

t= 10mm

ν=0.3

E= $2x10^5$ N/mm^2

8. (a). Derive the stiffness matrix for a constant strain triangle.

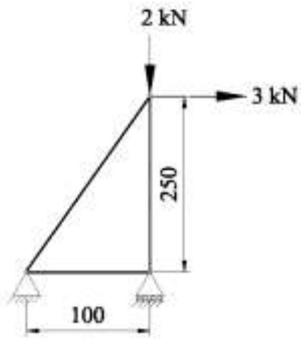
(b).For the plate shown in figure below, calculate stress

Given

t= 10mm

ν=0.3

E= $2x10^5$ N/mm^2



K L University
Pre-PhD Examination
STRUCTURAL DYNAMICS
SYLLABUS

Equation of Motions, Problem Statement, Solution Methods of Single Degree of Freedom Systems (SDOF)

Basic concepts of structural dynamics; single degree of freedom system, force displacement relationship, damping force, equation of motion, mass-spring-damper system, methods of solution of differential equation.

Free Vibration (SDOF):

Undamped free vibration, viscously damped free vibration, energy in free vibration.

Response to Harmonic and Periodic Excitations (SDOF)

Harmonic vibration of undamped systems, Harmonic vibration with viscous damping, response to vibration generator, natural frequency and damping from harmonic test, force transmission and vibration isolation, vibration measuring instruments, energy dissipated in viscous damping. Response to periodic force.

Response to Arbitrary, Step And Pulse Excitations (SDOF)

Response to unit impuse, response to arbitrary force, step force, ramp force, response to pulse excitations, solution methods, effects of viscous damping.

Numerical Evaluation of Dynamic Response (SDOF)

Time stepping methods, methods based on interpolation of excitation, central difference method, newmark’s method, stability and computational error, analysis of nonlinear response by newmark’s method.

Earthquake Response to Linear Systems (SDOF)

Earthquake excitation, equation of motion, response quantities, response history, response spectrum concept, deformation, pseudo-velocity and pseudo acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics, elastic design spectrum, comparison and distinction between design and response spectra.

Generalised Single Degree of Freedom Systems

Generalised SDOF systems, rigid body assemblages, systems with distributed mass and elasticity, lumped mass system-shear building, natural vibration frequency by Rayleigh’s method.

Multi -degree of freedom systems (MDOF)

Equation of motions: simple system-two storey shear building, general approach for linear systems, static condensation, symmetric plan systems: ground motion. Multiple support excitation, methods of solving the equation of motions.

Free Vibration (MDOF)

Natural frequencies and modes: systems without damping, modal and spectral matrices, orthogonality of modes, normalization of modes. Solution of undamped free vibration systems, solution methods for eigenvalue problem.

Recommended Text Books:

1. Dynamics of structures by Anil K Chopra; Prentice-Hall of India Limited, New Delhi.3rd edition 2006.
2. Dynamics of Structures by R.W. Clough and P.E. Penzien, McGraw-Hill. 1st edition 1975

Reference Books

1. Structural Dynamics for Structural Engineers by G. C. Hart & K. Wang; John Wiley & Sons. 1st edition 1991
2. Structural Dynamics by Mario Paz, CBS Publishers.1st edition 1991.

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Model Paper

Time: 3.00 hrs. **Max Marks: 100**

Answer any FIVE questions. All questions carry equal marks

1) a) solve the equation of undamped free vibration. 5 M

b) In a SDOF system displacement u(0)=15 cm and acceleration ù(0) = 30cm/sec at t = 0. The Stiffness of the system is 50KN/cm and the mass of the body 10kgs. Find maximum amplitude of free vibration. 5 M

1. a) Solve the equation of damped free vibration. 7M
   b) what do you understand by logarithmic decrement? 3M

2. a) Solve the equation of viscously damped harmonic motion. 6 M
   b) Derive the relationship between the Dynamic response factors. 4 M

3. a) Write a short notes Transmissibility and vibration measuring instruments. 4 M
   b) An automobile travels along a multi span elevated roadway supported every 30meters. Long term creep has resulted in a 15cm deflection at the middle of each span. The roadway profiles can be approximated as sinusoidal with amplitude of 7.5cms and period of 30m. The SDOF system is sample idealization of an automobile approximate for a first approximation "Study of ride quality of the vehicle when fully loaded the weight of the automobile is 120KN. The system of the automobile suspension system is 60 KN/cm and it's viscously damping co efficient in such a way that damping ratio of the system is 40% Determine

   a) The amplitude u_0^t of vertical motion $u_{(t)}{}^{t}$ when the automobile is travelling at 60KMPH and

   b) The speed of the vehicle that would produce a resonant condition for u_0^t. 6 M

4. a) Derive a expression for the unit impulse response function for the damped and undamped vibration. Hence deduce Duhamel integral for the same. 6 M
   b) Differentiate between Step force and Ramp force in SDOF. 4 M

5. a) List out the numerical methods used in evolution of dynamics response. Explain any one of the method. 5 M
   b) What do you understand about the generalized SDOF? Describe with examples.5 M

6. a) Write a short note on Harmonic Vibrations of Undamped system. 4 M
   b) Write a short note on Damping 3 M

   c) Write a short note on Multi degree of freedom systems 3 M

7. a) what do you understand by static condensation. 4 M
   b) Describe Natural Vibration Frequency and Modes for two degree freedom systems

   (MDOF). 6 M