

Name of the Examinations: B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER - 2024

Subject : ADVANCED STRUCTURAL ANALYSIS AND DESIGN

Time : 3 hours

Full Marks : 100
(50 Marks for each Part)

Part I(50 Marks)

Instructions : Use Separate Answer scripts for each Part

Question 1. The governing differential equation of an Euler Bernoulli beam is given by

$$\frac{d^2}{dx^2} \left(EI \frac{d^2 w}{dx^2} \right) + C_f w = q(x) \quad \text{for } 0 < x < L$$

Where EI, C_f and q are functions of x.

Develop the weak variational form (Ritz) of the governing differential equation clearly identifying the boundary terms. (10)

Question 2. Applying Cubic Hermite polynomial functions develop the element stiffness matrix of the Euler – Bernoulli beam governed by the equation given in Question 1. Also generate the global stiffness matrix and the force vector for the problem shown in Figure 1 by discretizing the domain using four elements. (20)

Question 3. For an orthotropic medium the 2-D heat transfer in the medium is governed by the following equations where T(x,y) is the temperature anywhere in the domain

$$-\frac{\partial}{\partial x} \left(K_x \frac{\partial T}{\partial x} \right) - \frac{\partial}{\partial y} \left(K_y \frac{\partial T}{\partial y} \right) = f(x, y)$$

The discretized domain is shown in Figure 2. Obtain the finite element equation obtained using weak variational principle for the element no. 6 (20)

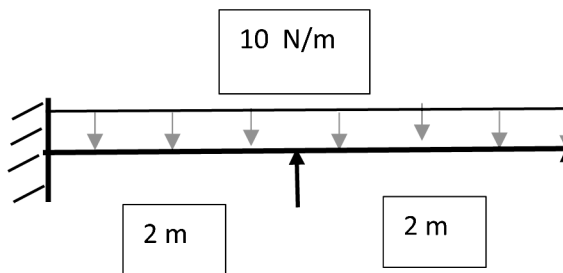
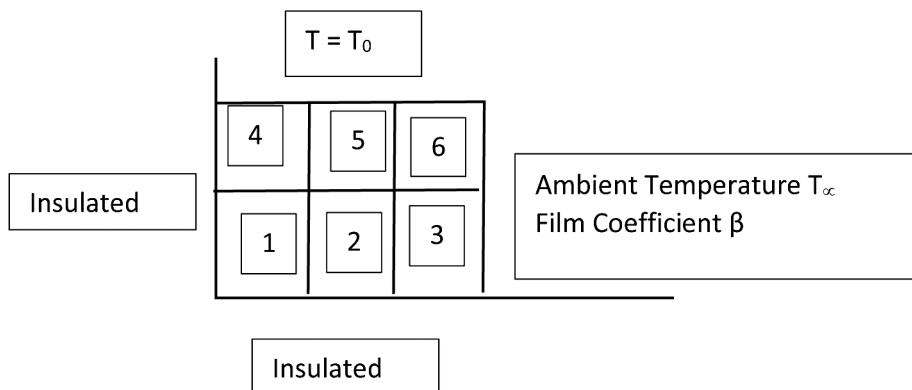


Figure 1



B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2024
ADVANCED STRUCTURAL ANALYSIS AND DESIGN

PART-II

(50 Marks)

Time: Three Hours

Full Marks 100
(50 marks for 2nd part)

Use a separate Answer-Script for each part
[Any IS codes or handbook are allowed]

No. of questions	Part I (any 3 from 1-4, and any one from 5-6)	Marks (50)
1)	A simply supported steel beam with a 4 m span has been designed to carry a dead load of 2 kN/m and a live load of 2.5 kN/m UDL. The beams are spaced 3 m apart and are continuously laterally supported by the concrete slab. Using Fe250 steel an engineer suggests a steel section of ISMB 250. Based on the preceding discussion, what will be the corresponding resistance and load factors? assume that the uncertainties in the dead load and live load in terms of COV are 0.13 and 0.37, respectively. The uncertainty in the resistance of the steel section, considering the uncertainties in material properties, fabrication, and modeling, is 0.13. These COVs are typical values reported in the literature. Consider first that all the variables are normal random variables, $Z_p=496.77\text{cm}^3$. Assume any other suitable data.	10
2)	A Fe 250 steel section made of Fe 250 steel is suggested to carry an applied deterministic bending moment of 50 kNm. The nominal yield stress F_y of the steel is 250 ksi, and the nominal plastic modulus of the section $Z_p=496.77\text{cm}^3$. Consider that the distributions of these random variables are unknown; only the means, standard deviations, and COVs are known: $\mu_{F_y} = 300 \text{ MPa.}$, $\sigma_{F_y} = 30 \text{ MPa.}$ $\mu_z = 500 \text{ cm}^3$, $\sigma_z = 25 \text{ cm}^3$, Assume that F, and Z are statistically independent. Determine reliability index by MVFOSM method.	10
3)	Suppose a cable of resistance R needs to carry a weight S. Assume both R and S are normal random variables with means of 120 kN and 50 kN, respectively, and corresponding standard deviations of 18 kN and 12 kN, respectively. The limit state equation can be assumed as $Z=R-S$. Prove that, the safety index according to the MVFOSM and the Hasofer-Lind methods will be the same.	10
4)	Derive the expression of nominal safety factor of single load case.	10
5)	Determine and design side walls of square bunker of storing 50 tons of cement having density 14kN/m^3 and angle of repose is 20° . Adopt M25 grade of concrete and Fe 500 steel.	20
6)	Analyze a rectangular bunker having 16m length and 8m width supported on columns, height of vertical portion is 4m and hopper portion is 4m.	20