Ref. No. : Ex/CE/PE/B/T/422B/2024(S)

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

Subject : ADVANCED STRUCTURAL ANALYSIS AND DESIGN **Time : 3 hours** **Full Marks : 100**

Part I

Instructions : Use Separate Answer scripts for each Part

Q 1 Consider a problem described by the Poisson equation

$$-\nabla^2 u = f_0 \quad in\ \Omega$$

in a square region (Fig 1) with

$$\Omega = \{(x, y): 0 < x < 1, 0 < y < 1\} .$$

Where *u(x,y)* is the dependent unknown and f_0 is the uniformly distributed source. Discretizing the domain using a 2 x 2 uniform mesh of linear rectangular Lagrangian finite element obtain the solution to the problem with the boundary conditions shown in the Figure. Show clearly the development of a typical element matrix based on weak variational principle and the assembling process. (25)

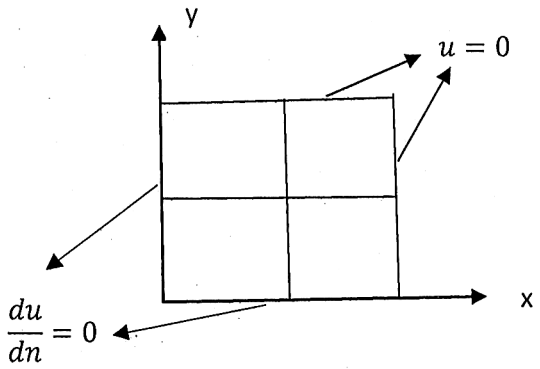

Fig 1

Q 2 For the problem shown in Fig 2 show that the process of minimizing the total potential leads to the variational form B(u, w) – l(w) = 0. (15)

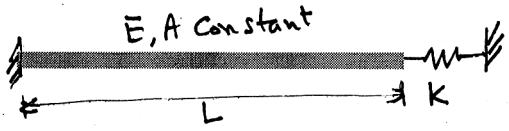

Fig 2

Q 3 Obtain the Hermite cubic interpolation functions for an Euler-Bernoulli beam element. (10)

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

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)	Derive the expression of nominal safety factor of single load case.	10
2	2) A Fe 250 steel section made of Fe 250 steel is suggested to carry an applied deterministic bending moment of 40 kNm. The nominal yield stress F_y of the steel is 250 MPa, and the nominal plastic modulus of the section Zp=496.77cm^3. Consider that the distributions of these random variables are unknown; only the means, standard deviations, and COVs are known: $\mu_{F_y} = 30O\ MPa.$, $\sigma_{F_y} = 30\ MPa.$ μ_z = 500 cm^3, 6_z =25 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 110 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)	A simply supported steel beam with a 4.5 m span has been designed to carry a dead load of 3 kN/m and a live load of 2.5 kN/m UDL. The beams are spaced 3.5 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, Zp=496.77cm^3. Assume any other suitable data.	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 M20 grade of concrete and Fe 500 steel.	20
6)	Analyze a rectangular silo having 16m length and 8m width supported on columns, height of vertical portion is 4m and hopper portion is 4m for storing cement having density 20kN/m^3.	20