Birla Institute of Technology & Science, Pilani
First Semester 2022-2023
Mid-Semester Exam

Course No.	: ME G512
Course Title	: Finite Element Methods
Nature of Exam	: Open Book
Weightage	: 25%
Duration	: 90 minutes
Date of Exam	: 03/11/2022

No. of Pages = 2
No. of Questions = 4

Note to Students:
1. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
2. Assumptions made if any, should be stated clearly at the beginning of your answer.

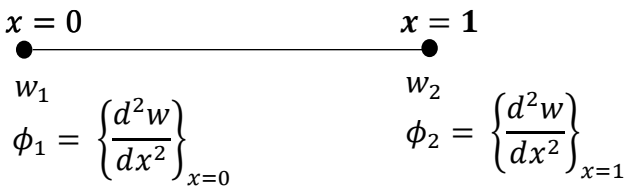
Q.1. The governing equation and boundary conditions for a physical phenomenon are as follows:

$$\frac{d^4y}{dx^4} - 2\frac{d^2y}{dx^2} + 4y = 0 \qquad 0 \le x \le 1;$$

(a) Derive the weak form of the governing equation.
(b) Identify primary and secondary variables

[3 + 3 = 6]

Q.2. Consider the two-noded element with two degrees of freedom $\left(w, \frac{d^2w}{dx^2}\right)$ per node. Derive the interpolation functions for the element in terms of the coordinate '*x*'.



[5]

Fig 2

Q.3. Consider the assembly of rigid and flexible members as shown in the **Fig 2** below. The material properties and cross-sectional areas are as follows:
Steel members: E = 200GPa, A = 300 mm^2
Aluminium member: E = 70 GPa, A = 600 mm^2

Use 2-noded bar elements and
(a) Determine global stiffness matrix
(b) Determine the global load vector
(c) Determine the displacement of the rigid member.
(d) Determine the reaction forces at points A and C.

[3 + 2 + 3 + 2 = 10]

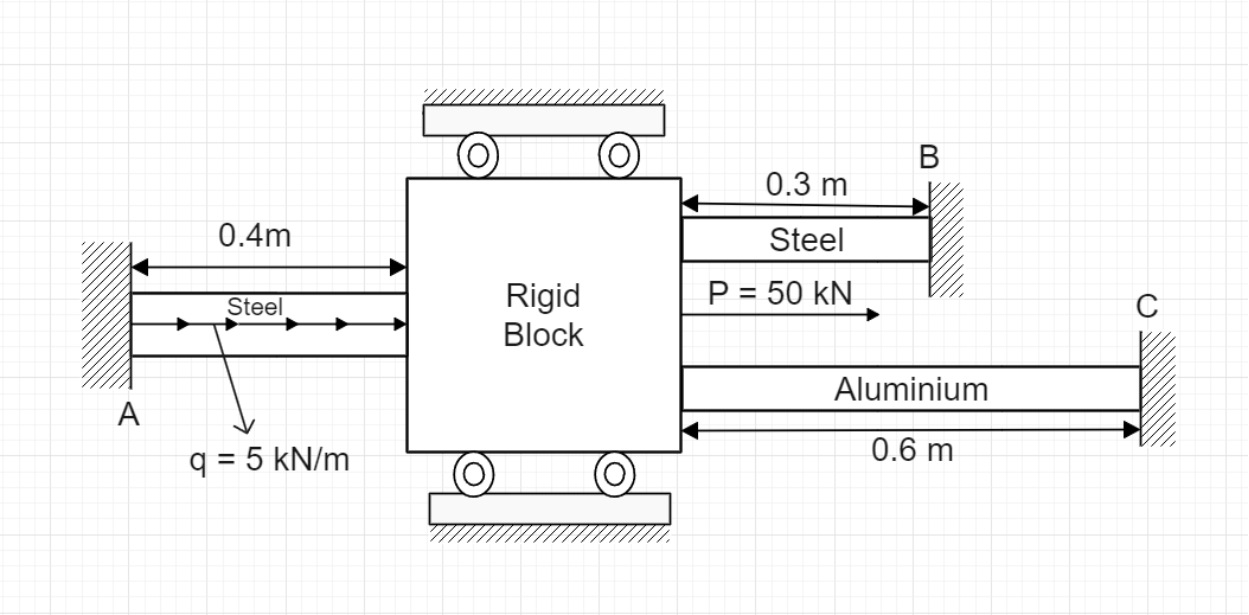


Fig 3

Q.4. Use **minimum** number of **2-noded beam/frame elements** to discretize the structure and write the global load vectors for the structures shown below:

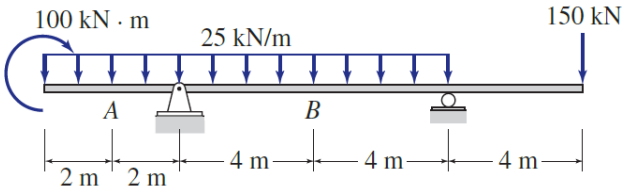


Fig 4a

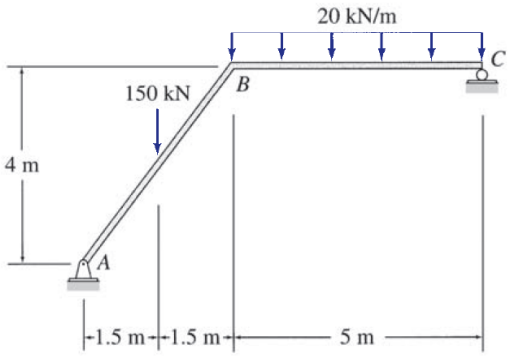


Fig 4b

[2 + 2 = 4]