Unit 7 - Week 4: Structural Elements in One Dimensional FEM

Assignment 4

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

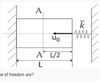
Due on 2020-10-14, 23:59 IST.

Answer the following question (q 1 to 10) with the help of below statement:

A bar has fixed support at one end and it is connected to a linear spring at the other end as shown in Fig. Length L, Area of the bar are 0.2 m and 0.2 m^2 respectively. Bar material has Young's modulus of 70 MPa. The spring has a spring constant of $\bar{k} = 10$ kN/mm. The connecting point between the bar and the spring is given a displacement of $u_0 = 5$ mm towards left. Consider the left end as node 1, section AA as node 2 and spring-bar junction point as node 3. Use one quadratic element for the bar for which element stiffness matrix can be expressed as,

$$\frac{AE}{6L}\begin{bmatrix} 7 & -8 & 1 \\ -8 & 16 & -8 \\ 1 & -8 & 7 \end{bmatrix},$$

where A, E, L are Area, Young's modulus and Element length respectively for the element.



1) Total number of degree of freedom are? *1 point*

- A. 3
- B. 2
- C. 4
- D. 5

No, the answer is incorrect.
Score: 0
Accepted Answers:
A. 3

2) What is the global stiffness matrix for the problem before imposition of boundary condition? (Let $\frac{AE}{L} = c$, spring constant = $\bar{k}$) *2 points*

A. $\begin{bmatrix} 7c+\bar{k} & -8c & 1c \\ -8c & 16c & -8c \\ 1c & -8c & 7c \end{bmatrix}$

B. $\begin{bmatrix} 7c & -8c & 1c \\ -8c & 16c+\bar{k} & -8c \\ 1c & -8c & 7c \end{bmatrix}$

C. $\begin{bmatrix} 7c & -8c & 1c \\ -8c & 16c & -8c \\ 1c & -8c & 7c+\bar{k} \end{bmatrix}$

D. $\begin{bmatrix} 7c & -8c & 1c \\ -8c & 16c & -8c \\ 1c & -8c & 7c+2\bar{k} \end{bmatrix}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. $\begin{bmatrix} 7c & -8c & 1c \\ -8c & 16c & -8c \\ 1c & -8c & 7c+\bar{k} \end{bmatrix}$

3) After imposing the suitable boundary condition and the displacement of the section AA is. *3 points*

- A. -3.5 mm
- B. -2.5 mm
- C. -7 mm
- D. -4.5 mm

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. -2.5 mm

4) The reaction force at the left fixed support (Node 1) is. *2 points*

- A. 75.25 kN
- B. 200 kN
- C. 449.95 kN
- D. 349.95 kN

No, the answer is incorrect.
Score: 0
Accepted Answers:
D. 349.95 kN

5) The reaction force at the spring-bar junction point (Node 3) is. *2 points*

- A. -85.09 kN
- B. -400 kN
- C. -699.95 kN
- D. -399.95 kN

No, the answer is incorrect.
Score: 0
Accepted Answers:
D. -399.95 kN

6) If the same problem is refined using three quadratic bar elements, what will be the size of global stiffness matrix before imposition of boundary conditions? *1 point*

- A. 6 × 6
- B. 7 × 7
- C. 8 × 8
- D. 9 × 9

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. 7 × 7

7) If the same problem is refined using three quadratic bar elements, what will be the size of global stiffness after imposition of boundary conditions? *1 point*

- A. 3 × 3
- B. 4 × 4
- C. 5 × 5
- D. 6 × 6

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. 5 × 5

8) If spring is eliminated from the stated problem setup then, the displacement of section AA will *2 points*

- A. Increase
- B. Remains same
- C. Decrease

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. Remains same

9) If the spring constant ($\bar{k}$) is doubled then, what will be reaction at the left end? *3 points*

- A. 75.25 kN
- B. 200 kN
- C. 449.95 kN
- D. 349.95 kN

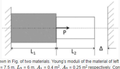
No, the answer is incorrect.
Score: 0
Accepted Answers:
A. 75.25 kN

10) If the spring constant ($\bar{k}$) is doubled then, what will be reaction at the right end? *3 points*

- A. -449.95 kN
- B. -400 kN
- C. -699.95 kN
- D. -399.95 kN

No, the answer is incorrect.
Score: 0
Accepted Answers:
A. -449.95 kN

Answer the following question from "a to b"(i.e 11 to 24) with the help of below statement:



Let us consider a stepped bar as shown in Fig. of two materials. Young's modulli of the material of left and right portions are 70 MPa and 200 MPa respectively. Length and area of the parts are $L_1 = 7.5$ m, $L_2 = 6$ m, $A_1 = 4$ m^2, $A_2 = 0.25$ m^2 respectively. Consider origin at the left end and x-direction along the axial direction of the stepped bar. Use the data given in Table 1 and Table 2. You may use Matlab for solving the problem.

Table 1: Nodal co-ordinates (in m)

Node	x	y
1	0	0
2	$\frac{L_1}{2}$	0
3	L_1	0
4	$L_1 + \frac{L_2}{2}$	0
5	$L_1 + L_2$	0

Table 2: Element connectivity

Element	Node 1	Node 2	Node
1	1	2	3
2	3	4	5

If the gap between right end of the bar and the right support is $\Delta = 4$ mm, load $P = 10$ kN and solved using two quadratic bar elements then,

(a) If $\boldsymbol{K}$, represent an element stiffness matrix for element e and component of the respective element stiffness matrix are given by $K_e(i, j)$ where $i = 1, 2, \ldots$ number of rows and $j = 1, 2, \ldots$ number of columns.

11) The $K_1(1,1)^{th}$ component of element stiffness matrix (in N/m) is *1 point*

- A. 1.99×10^7
- B. 8.7×10^6
- C. -9.95×10^6
- D. 1.24×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. 8.7×10^6

12) The $K_1(3,3)^{th}$ component of element stiffness matrix (in N/m) is *1 point*

- A. 1.99×10^7
- B. 8.7×10^6
- C. -9.95×10^6
- D. 1.24×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. -9.95×10^6

13) The $K_1(2,2)^{th}$ component of element stiffness matrix (in N/m) is *1 point*

- A. 1.99×10^7
- B. 8.7×10^6
- C. -9.95×10^6
- D. 1.24×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
A. 1.99×10^7

14) The $K_2(2,2)^{th}$ component of element stiffness matrix (in N/m) is *1 point*

- A. 1.94×10^7
- B. 4.44×10^7
- C. -2.22×10^7
- D. 2.77×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. -2.22×10^7

15) The $K_2(3,3)^{th}$ component of element stiffness matrix (in N/m) is *1 point*

- A. 1.94×10^7
- B. 4.44×10^7
- C. -2.22×10^7
- D. 2.77×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
A. 1.94×10^7

(b) If $\boldsymbol{K}$ represent a global stiffness matrix and $K(i, j)$ are the components of the global stiffness matrix (i = row and j = column), then

16) The $K(1,1)^{th}$ component of global stiffness matrix (in N/m) is *2 points*

- A. 1.99×10^7
- B. 8.7×10^6
- C. -9.95×10^6
- D. 1.24×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. 8.7×10^6

17) The $K(3,3)^{th}$ component of global stiffness matrix (in N/m) is *2 points*

- A. 1.99×10^7
- B. 8.7×10^6
- C. -9.95×10^6
- D. 1.24×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
A. 1.99×10^7

18) The $K(5,5)^{th}$ component of global stiffness matrix (in N/m) is *2 points*

- A. 4.44×10^7
- B. -2.22×10^7
- C. 2.77×10^6
- D. 1.94×10^7

No, the answer is incorrect.
Score: 0
Accepted Answers:
D. 1.94×10^7

19) The $K(3,3)^{th}$ component of global stiffness matrix (in N/m) is *2 points*

- A. 4.44×10^7
- B. 2.81×10^7
- C. -2.22×10^7
- D. 2.77×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. 2.81×10^7

20) The $K(3,4)^{th}$ component of global stiffness matrix (in N/m) is *2 points*

- A. 4.44×10^7
- B. 2.81×10^7
- C. -2.22×10^7
- D. 2.77×10^6

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. -2.22×10^7

21) The displacement at material junction is *2 points*

- A. 2.7 mm
- B. 4.4 mm
- C. 5.2 mm
- D. 1.1 mm

No, the answer is incorrect.
Score: 0
Accepted Answers:
A. 2.7 mm

22) The displacement at right end is *2 points*

- A. 3.7 mm
- B. 2.7 mm
- C. 5 mm
- D. 6.2 mm

No, the answer is incorrect.
Score: 0
Accepted Answers:
B. 2.7 mm

23) The reaction force at left end is *2 points*

- A. -15 kN
- B. -1 kN
- C. -10 kN
- D. -13 kN

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. -10 kN

24) What should be load P such that the gap is just filled without any reaction at the other end? *2 points*

- A. 18.052 kN
- B. 20 kN
- C. 14.933 kN
- D. 8.871 kN

No, the answer is incorrect.
Score: 0
Accepted Answers:
C. 14.933 kN