

Unit 9 - Unit 6: Brief Background of Tensor Calculus

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Live session: Dr. Atanu Banerjee, Date : 16/12/2020 Time : 3:15:00 PM

Assignment 6

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

Due on 2020-10-28, 23:59 IST.

Answer the following question A from "a to b" (i.e 1 to 13) with the help of figure shown.

A.

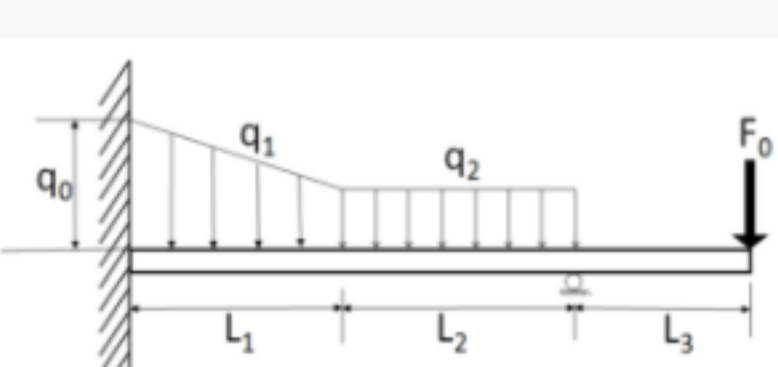


Figure above represent a cantilever beam subjected to distributed load and it is also supported by a roller in the middle. Different dimensions are $L_1 = 0.2\text{ m}$, $L_2 = 0.24\text{ m}$ and $L_3 = 0.16\text{ m}$. Beam has area moment of inertia of $8.24 \times 10^{-6}\text{ m}^4$ and Young's modulus E of 90 MPa . It is subjected to end point load of 5 kN and distributed load with parameters $q_1 = 300\text{ N/m}$ and $q_2 = 200\text{ N/m}$. For one horizontal beam element we have stiffness matrix \mathbf{K}_{beam} and load vector \mathbf{f}_{beam} beam for uniformly distributed load q as

$$\mathbf{K}_{\text{beam}} = \frac{EI}{L^3} \begin{bmatrix} 12 & 6L_e & -12 & 6L_e \\ 6L_e & 4L_e^2 & -6L_e & 2L_e^2 \\ -12 & -6L_e & 12 & -6L_e \\ 6L_e & 2L_e^2 & -6L_e & 4L_e^2 \end{bmatrix}, \mathbf{f}_{\text{beam}} = \begin{bmatrix} \frac{qL^2}{2} \\ qL_e \\ \frac{qL^2}{2} \\ -qL_e \end{bmatrix}$$

where I , E , L_e , L_e are area moment of inertia, Young's modulus and element length respectively for the element.

(a) If the domain is discretized with three elements then answer the following:

1) The rotation (θ) at the fixed end of the propped cantilever beam is 1 point

- 0
- 0.5
- 2
- 2.5

No, the answer is incorrect. Score: 0

Accepted Answers: 0

2) What is the size of the global stiffness matrix?

- 4×4
- 5×5
- 8×8
- 6×6

No, the answer is incorrect. Score: 0

Accepted Answers: 8×8

3) The size of the reduced stiffness matrix is 1 point

- 6×6
- 4×4
- 3×3
- 5×5

No, the answer is incorrect. Score: 0

Accepted Answers: 5×5

4) The size of the global load vector is 1 point

- 5×1
- 4×1
- 3×1
- 8×1

No, the answer is incorrect. Score: 0

Accepted Answers: 8×1

5) The size of the reduced global load vector is 1 point

- 6×1
- 4×1
- 3×1
- 5×1

No, the answer is incorrect. Score: 0

Accepted Answers: 5×1

(b) The finite element equation is given as $[\mathbf{K}]\{\mathbf{u}\} = \{\mathbf{F}\}$. After the boundary conditions are applied, the reduced stiffness matrix is $[\mathbf{K}^*]$ and reduced force vector is $\{\mathbf{F}^*\}$ then answer the following:

6) What is the value of element $\mathbf{K}(1, 1)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 174500000;175000000

2 points

7) What is the value of element $\mathbf{K}(2, 2)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 2520000;2780000

2 points

8) What is the value of element $\mathbf{K}(3, 3)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 3050000;3150000

2 points

9) What is the value of element $\mathbf{K}(4, 4)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 212000000;225000000

2 points

10) The bending moment expression at the node located on the roller support can be given as

- $-\frac{qL^2}{12}$
- $\frac{qL^2}{12}$
- $-\frac{qL^2}{12}$
- $\frac{qL^2}{12}$

No, the answer is incorrect. Score: 0

Accepted Answers: $-\frac{qL^2}{12}$

1 point

11) Bending moment at free end of the beam is

- 3.0 N-m
- 2.0 N-m
- 1.0 N-m
- 0 N-m

No, the answer is incorrect. Score: 0

Accepted Answers: 0 N-m

1 point

12) The values of rotation (θ) (in radians) at roller support are

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 0.0009;0.0014

2 points

13) What is the value of rotation (θ) at the free end?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 0.0017;0.0023

2 points

Answer the following question B from "a to b" (i.e 14 to 28) with the help of figure shown.

B.



Figure above represent a cantilever beam subjected to quadratic distributed load. Different dimensions are $L_1 = 0.8\text{ m}$, $L_2 = 0.6\text{ m}$. Beam has area moment of inertia of $8.1 \times 10^{-6}\text{ m}^4$ and Young's modulus E of 70 GPa . It is subjected to end point load of $F_0 = 1\text{ kN}$ and distributed load with parameters $q_0 = 1000\text{ N/m}$.

(a) The domain is discretized with two elements; length of the first element is L_1 and length of the second element is L_2 then answer the following:

14) The rotation (θ) at the fixed end of the cantilever beam is 1 point

- 0
- 1
- 2
- 3

No, the answer is incorrect. Score: 0

Accepted Answers: 0

15) The deflection (y) at the fixed support of the beam is 1 point

- 0
- 0
- 2
- 3

No, the answer is incorrect. Score: 0

Accepted Answers: 0

16) In the expression $q(x) = a(x - L_1)^2$ constant a can be given as 2 points

- 0
- 90
- $\frac{30}{L_1^2}$
- $\frac{30}{L_1^3}$
- $\frac{30}{L_1^4}$

No, the answer is incorrect. Score: 0

Accepted Answers: $\frac{30}{L_1^4}$

17) What is the size of the global force vector?

- 4×1
- 5×1
- 8×1
- 6×1

No, the answer is incorrect. Score: 0

Accepted Answers: 6×1

18) The size of the global stiffness matrix after boundary conditions are applied is 1 point

- 6×6
- 4×4
- 3×3
- 5×5

No, the answer is incorrect. Score: 0

Accepted Answers: 4×4

19) The size of the reduced load vector is 1 point

- 5×1
- 2×1
- 4×1
- 3×1

No, the answer is incorrect. Score: 0

Accepted Answers: 4×1

20) What is the value of q at $x = 0$? 2 points

- 0
- 0.2 N/m
- $aL_1\text{ N/m}$
- $q_0\text{ N/m}$
- $q_0L_1\text{ N/m}$

No, the answer is incorrect. Score: 0

Accepted Answers: $q_0\text{ N/m}$

(b) The finite element equation is given as $[\mathbf{K}]\{\mathbf{u}\} = \{\mathbf{F}\}$. After the boundary conditions are applied, the reduced stiffness matrix is $[\mathbf{K}^*]$ and reduced force vector is $\{\mathbf{F}^*\}$ then answer the following:

21) What is the value of element $\mathbf{K}(1, 1)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 44780000;44790000

2 points

22) What is the value of element $\mathbf{K}(2, 2)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 6614000;6615500

2 points

23) What is the value of element $\mathbf{K}(3, 3)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 31000000;31800000

2 points

24) What is the value of element $\mathbf{K}(4, 4)$ of the reduced stiffness matrix in N/m?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 3740000;3820000

2 points

25) What is the value of $\mathbf{F}(3)$?

- 0 N
- 1000 N
- 0 N-m
- 1000 N-m

No, the answer is incorrect. Score: 0

Accepted Answers: 1000 N

2 points

26) The value of deflection (in mm) at free end of the beam?

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 1.58;1.67

2 points

27) The bending moment at free end of the beam is 2 points

- 0 N-m
- 0.54 N-m
- 0.44 N-m
- 0.54 N-m

No, the answer is incorrect. Score: 0

Accepted Answers: 0 N-m

28) The value of rotation at $x = L_1$ is 2 points

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 0.0014;0.00144

2 points