Unit 10 - Week 7: Two dimensional Scalar field problems

Assignment-7

The due date for submitting this assignment has passed. Due on 2020-11-04, 23:59 IST.
As per our records you have not submitted this assignment.

Read the following and answer the question as follows (Q1-Q20)

Solve the steady state heat conduction problem given by Equation (1) in the triangular domain, ABC, shown in Figure 1. The coordinates of point A, B, C are shown in the left figure. The boundary conditions are as follows: (i) along AC, $u = 0$, (ii) along AB, the normal heat flux $q_n = 1$, and (iii) edge BC is completely insulated. The domain has been discretized (refer the right figure) using two linear triangular elements (1) and (2). The local node numbers are illustrated in red and global node numbers are shown in blue colors. The local shape functions, element stiffness and element force entries are represented using $N_i^{(e)}$, $k_{ij}^{(e)}$ and $f_i^{(e)}$ respectively. Here, subscript i, j refer local node numbers and superscript (e) denote the corresponding element number. The temperature field u is expressed in terms of the global shape functions N_i as, $u = \sum_{i=1}^{5} \alpha_i N_i$, where α_i represent the nodal temperature. Assume all the units to be consistent and answer the following questions.

$$-\nabla \cdot (\nabla u) = g \qquad \text{Equation (1)}$$

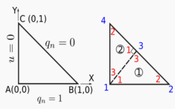

Figure 1: Triangular Domain

1) In the discrete form of the problem, the expression for stiffness entry, K_{ij} , is obtained as, *2 points*

(a) $\int_A N_{i,x} N_{j,x} + N_{i,y} N_{j,y}\, dA$

(b) $\int_A N_{i,x} N_{i,x} + N_{j,y} N_{j,y}\, dA$

(c) $\int_A N_{i,x} N_{j,x} + N_{i,y} N_{i,y}\, dA$

(d) $\int_A N_{i,x} N_{j,y} + N_{i,y} N_{j,y}\, dA$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) $\int_A N_{i,x} N_{j,x} + N_{i,y} N_{i,y}\, dA$

2) In the discrete form of the problem, the expression for force entry, f_i , is obtained as, *2 points*

(a) $\int_A g N_i\, dA$

(b) $\int_A g N_i\, dA - \int_{BC_{q_n}} q_n N_i\, ds$

(c) $-\int_{BC} q_n N_i\, ds$

(d) $\int_A g N_i\, dA + \int_{BC_{q_n}} q_n N_i\, ds$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) $\int_A g N_i\, dA - \int_{BC_{q_n}} q_n N_i\, ds$

3) Choose the correct connectivity matrix for the above mesh *(bold numbers (L no.) represent local number and E_1 and E_2 refer Element (1) and (2), respectively)* *2 points*

(a)

L no.	**1**	**2**	**3**
E1	1	2	3
E2	3	4	1

(b)

L no.	**1**	**2**	**3**
E1	1	2	3
E2	1	4	3

(c)

L no.	**1**	**2**	**3**
E1	2	1	3
E2	3	1	4

(d)

L no.	**1**	**2**	**3**
E1	2	3	1
E2	4	1	3

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a)

L no.	**1**	**2**	**3**
E1	1	2	3
E2	3	4	1

4) The Shape function $N_1^{(1)}$ can be expressed in the physical coordinate as, *2 points*

(a) $x - y$

(b) $2y$

(c) $2xy$

(d) $1 - x - y$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) $1 - x - y$

5) The Shape function $N_2^{(1)}$ can be expressed in the physical coordinate as, *2 points*

(a) x-y
(b) 2y
(c) 2xy
(d) 2x

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) x-y

6) The Shape function $N_1^{(1)}$ can be expressed in the physical coordinate as, *2 points*

(a) x-y
(b) 2y
(c) 2xy
(d) 2x

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) 2y

7) The Shape function $N_1^{(2)}$ can be expressed in the physical coordinate as, *2 points*

(a) y-x
(b) 2y
(c) 1-x-y
(d) 2x

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) 2x

8) The Shape function $N_2^{(2)}$ can be expressed in the physical coordinate as, *2 points*

(a) y-x
(b) 2y
(c) 1-x-y
(d) 2x

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) y-x

9) The Shape function $N_3^{(2)}$ can be expressed in the physical coordinate as, *2 points*

(a) y-x
(b) 2y
(c) 1-x-y
(d) 2x

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) 1-x-y

10) If the nodal temperature is denoted using α_i, where i = 1, 2, . . . , 5, represents the global node number, then the Dirichlet Boundary condition for this problem can be expressed as, *2 points*

(a) $\alpha_1 - \alpha_2 = 0$

(b) $\alpha_1 - \alpha_4 = 0$

(c) $\alpha_3 - \alpha_5 = 0$

(d) $\alpha_1 - \alpha_3 = 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) $\alpha_1 - \alpha_4 = 0$

11) The value of the element stiffness entry $K_{11}^{(1)}$ is *2 points*

(a) 1/4
(b) 1/2
(c) 1/3
(d) 1

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) 1/2

12) The value of the element stiffness entry $K_{12}^{(1)}$ is *2 points*

(a) -1/4
(b) 1/2
(c) -1/2
(d) 1/3

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) -1/2

13) The value of the element stiffness entry $K_{22}^{(1)}$ is *2 points*

(a) 1/4
(b) 1/5
(c) 1/3
(d) 1

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) 1

14) The value of the element stiffness entry $K_{11}^{(2)}$ is *2 points*

(a) 1
(b) 1/2
(c) 1/3
(d) 1/6

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) 1

15) The value of the element stiffness entry $K_{13}^{(2)}$ is *2 points*

(a) 1/4
(b) 0
(c) 1/3
(d) 1

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) 0

16) The value of the element force entry $f_2^{(1)}$ is *2 points*

(a) 4/114
(b) 5/12
(c) -5/12
(d) 1

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) -5/12

17) The value of the element force entry $f_3^{(1)}$ is *2 points*

(a) 3/12
(b) 1/12
(c) -1/12
(d) 5/12

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) 1/12

18) The value of the element force entry $f_1^{(2)}$ is *2 points*

(a) 4/12
(b) 5/12
(c) -5/11
(d) 1/12

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) 1/12

19) After solving the system of equations, the temperature at node-3, i.e., α_3 is *2 points*

(a) 2/14
(b) 1/6
(c) -1/6
(d) 1/15

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) -1/6

20) After solving the system of equations, the temperature at node-2, i.e., α_2 is *2 points*

(a) 1.1265
(b) -1
(c) -2.12
(d) 1/3

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) -1