Unit 11 - Week 8: Two dimensional Scalar field problems

Assignment 8

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

Due on 2020-11-11, 23:59 IST.

Read the following and answer Q1-Q20.

Consider the steady state heat conduction problem for the trapezoidal domain in Fig.1(a). Edge A-D is kept at a constant temperature $T_0 = 10^{\circ}C$; whereas constant and linear heat flux boundary conditions are applied along edges B-C and C-D, respectively. The edge A-B is completely insulated. The corresponding boundary conditions are mentioned in Fig. 1(a). The square domain (A-E-C-D) is having uniform thermal conductivity $\kappa_1 = 1W^{\circ}C^{-1}$ and for the rest of the domain (E-B-C), $\kappa_2 = 2W^{\circ}C^{-1}$. Consider a heat source term, in the square portion of the domain (A-E-C-D) as $g_1 = 10Wm^{-2}$, whereas in the triangular portion (E-B-C), $g_2 = 0$. The domain has been discretized using one quadrilateral and one triangular elements as shown in Fig. 1(b). 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. Answer the following questions.

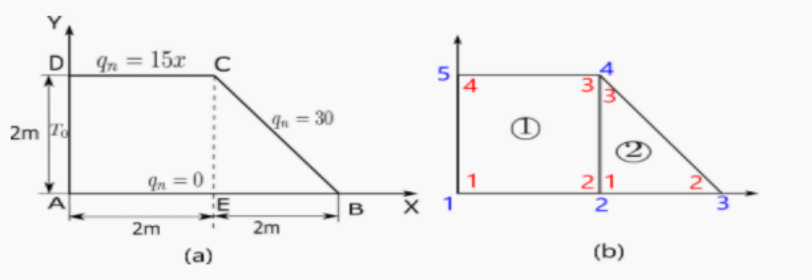

Figure 1: Domain with rectangular and triangular element.

1) The global stiffness entry K_{22} can be written in terms of the local stiffness entries $k_{ij}^{(e)}$ for the given mesh (refer Fig. 1(b)) as, *2 points*

(a) $K_{22}^{(1)} + K_{11}^{(2)}$
(b) $K_{22}^{(2)} + K_{11}^{(1)}$
(c) $K_{12}^{(1)} + K_{22}^{(2)}$
(d) $K_{23}^{(1)} + K_{13}^{(2)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) $K_{22}^{(1)} + K_{11}^{(2)}$

2) The global stiffness entry K_{33} can be written in terms of the local stiffness entries $k_{ij}^{(e)}$ for the given mesh (refer Fig. 1(b)) as, *2 points*

(a) $K_{22}^{(1)} + K_{22}^{(2)}$
(b) $K_{22}^{(1)}$
(c) $K_{13}^{(1)} + K_{21}^{(2)}$
(d) $K_{22}^{(2)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) $K_{22}^{(2)}$

3) The global stiffness entry K_{44} can be written in terms of the local stiffness entries $k_{ij}^{(e)}$ for the given mesh (refer Fig. 1(b)) as, *2 points*

(a) $K_{23}^{(1)} + K_{32}^{(2)}$
(b) $K_{21}^{(1)} + K_{31}^{(2)}$
(c) $K_{33}^{(1)} + K_{33}^{(2)}$
(d) $K_{23}^{(2)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) $K_{33}^{(1)} + K_{33}^{(2)}$

4) After applying the Dirichlet Boundary Conditions, one is left with three equations with three unknowns. The first force term (F_1) is obtained as, *2 points*

(a) $f_1^{(1)} + f_2^{(2)}$
(b) $f_1^{(1)} + f_2^{(2)} - \alpha_1 K_{22}^{(1)} + \alpha_5 K_{34}^{(1)}$
(c) $f_2^{(1)} + f_1^{(2)} - \alpha_1 K_{12}^{(1)} - \alpha_5 K_{24}^{(1)}$
(d) $f_2^{(1)} + f_1^{(2)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) $f_2^{(1)} + f_1^{(2)} - \alpha_1 K_{12}^{(1)} - \alpha_5 K_{24}^{(1)}$

5) After applying the Dirichlet Boundary Conditions, one is left with three equations with three unknowns. The second force term (F_2) is obtained as, *2 points*

(a) $f_2^{(1)} + f_3^{(2)}$
(b) $f_1^{(1)} + f_2^{(2)} + \alpha_1 K_{22}^{(1)} + \alpha_5 K_{34}^{(1)}$
(c) $f_2^{(1)} + f_1^{(2)} - \alpha_1 K_{12}^{(1)} + \alpha_5 K_{14}^{(1)}$
(d) $f_2^{(2)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) $f_2^{(2)}$

6) After applying the Dirichlet Boundary Conditions, one is left with three equations with three unknowns. The third force term (F_3) is obtained as, *2 points*

(a) $f_2^{(1)} + f_3^{(2)}$
(b) $f_3^{(1)} + f_3^{(2)} - \alpha_1 K_{13}^{(1)} - \alpha_5 K_{34}^{(1)}$
(c) $f_3^{(1)} + f_1^{(2)} + \alpha_1 K_{32}^{(1)} + \alpha_5 K_{44}^{(2)}$
(d) $f_2^{(2)} - \alpha_1 K_{13}^{(1)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) $f_3^{(1)} + f_3^{(2)} - \alpha_1 K_{13}^{(1)} - \alpha_5 K_{34}^{(1)}$

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

(a) $\frac{1}{4}(2-x)(2-y)$
(b) $\frac{1}{4}(2+x)(2-y)$
(c) $\frac{1}{2}(2-x)(2-y)$
(d) $\frac{1}{2}(2+x)(2-y)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) $\frac{1}{4}(2-x)(2-y)$

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

(a) $\frac{1}{4}(x)(2+y)$
(b) $\frac{1}{2}(2+x)(y)$
(c) $\frac{1}{2}(2-x)(y)$
(d) $\frac{1}{4}(x)(2-y)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(d) $\frac{1}{4}(x)(2-y)$

9) The Shape function $N_3^{(1)}$ can be expressed in the physical coordinate as, *2 points*

(a) $\frac{1}{4}(2-x)(y)$
(b) $\frac{1}{2}(x)(y)$
(c) $\frac{1}{4}(x)(y)$
(d) $\frac{1}{4}(x)(2-y)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) $\frac{1}{4}(x)(y)$

10) The Shape function $N_4^{(1)}$ can be expressed in the physical coordinate as, *2 points*

(a) $\frac{1}{4}(2-x)(y)$
(b) $\frac{1}{2}(2-x)(y)$
(c) $\frac{1}{2}(2+x)(y)$
(d) $\frac{1}{4}(2+x)(y)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) $\frac{1}{4}(2-x)(y)$

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

(a) $\frac{1}{4}(4-x+y)$
(b) $\frac{1}{2}(4-x-y)$
(c) $\frac{1}{2}(2-x-y)$
(d) $\frac{1}{4}(x+2-y)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) $\frac{1}{2}(4-x-y)$

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

(a) $\frac{1}{4}(4-y)$
(b) $\frac{1}{2}(x-2)$
(c) $\frac{1}{2}(2-y)$
(d) $\frac{1}{4}(x+2)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(b) $\frac{1}{2}(x-2)$

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

(a) $\frac{1}{4}(x)$
(b) $\frac{1}{2}(x)$
(c) $\frac{1}{2}(y)$
(d) $\frac{1}{4}(y)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) $\frac{1}{2}(y)$

14) The value of element stiffness entry $K_{22}^{(1)}$ is found to be, *2 points*

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

No, the answer is incorrect.
Score: 0
Accepted Answers:
b) 2/3

15) The value of element stiffness entry $K_{23}^{(1)}$ is found to be, *2 points*

a) 1/3
b) 1/6
c) −1/6
d) 1

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

16) The value of element stiffness entry $K_{24}^{(1)}$ is found to be, *2 points*

a) −1/3
b) 2/3
c) 3
d) 3/2

No, the answer is incorrect.
Score: 0
Accepted Answers:
a) −1/3

17) The value of element stiffness entry $K_{33}^{(1)}$ is found to be, *2 points*

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

No, the answer is incorrect.
Score: 0
Accepted Answers:
b) 2/3

18) The value of element stiffness entry $K_{11}^{(2)}$ is found to be, *2 points*

a) 1/3
b) −2/3
c) 2
d) −1

No, the answer is incorrect.
Score: 0
Accepted Answers:
c) 2

19) The value of element force entry $f_3^{(1)}$ is found to be . *2 points*

a) 15
b) −10
c) 10
d) −15

No, the answer is incorrect.
Score: 0
Accepted Answers:
b) −10

20) The value of element force entry $f_2^{(2)}$ is found to be, *2 points*

(a) $20\sqrt{3}$
(b) $30\sqrt{3}$
(c) $-30\sqrt{2}$
(d) $-20\sqrt{2}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) $-30\sqrt{2}$