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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	FINITE ELEMENT METHOD
COURSE CODE	:	BDA 31003
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 A two-dimensional truss structure is illustrated in **Figure Q1**. The cross-sectional area, A of all bars is 0.01 m^2 and the modulus elasticity, $E = 100$ GPa. The span length $L = 2$ m and the applied horizontal force, $F = 1$ kN. By following the node and element definitions as seen in **Figure Q1**, and letting node 3 as origin (0, 0);

(a) Answer the following question:

i. How many degrees of freedoms per node

ii. How many nodes in the structure

iii. What is the order of the global stiffness matrix of the structure (for example: 5x5)

(5 Marks)

(b) Label the coordinate for each node and load clearly.

(4 Marks)

(c) Construct the finite element table to calculate the stiffness of each element.

(8 Marks)

(d) Then evaluate the stiffness matrix of element **3** and **4 ONLY**

(8 Marks)

Q2 A beam structure supported by an axial spring is shown in **Figure Q2**. The length of the beam is 3 m and supported by a spring with a stiffness constant of 1000 N/m at half length of the beam. The beam square cross section profile 10 cm × 12 cm. Along the span from node 1 to node 3 a distributed loading of 12 kN/m is applied. The modulus elasticity of the beam material $E = 200$ GPa. Other information can be found from **Figure Q2**. By following the node and element definitions as seen in **Figure Q2**:

(a) Generate the stiffness matrix of every element and the elemental force vector.

(6 marks)

(b) Assemble the global stiffness matrix and the global force vector before considering any constraints.

(4 marks)

(c) By considering all the boundary conditions (constraints), solve for displacement matrix $\{U\}$.

(6 marks)

(d) Evaluate the reaction forces and reaction moment of the nodes.

(9 marks)

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Q3 A rectangular fin shown in Figure Q2 is made of aluminium alloy, are installed at an exhaust to remove heat whose temperature is 80 °C. The temperature of the ambient air is 25 °C andthermal conductivity of the aluminium alloy is 168 W/m. °C. The natural convective heat transfercoefficient associated with the surrounding air is28 W/m^2 °C while the fins are 40 mm long, 8 mm wide, and 1 mm thick.

(a) Determine the temperature distribution along the fin using only two elements

(15 marks)

(b) Examine the heat loss, Q of the fin.

(10 marks)

Q4 A two dimensional structure is isolated in two edges; edge 1-3-5 and edge 2-4. The edge 5-6-7-4 is exposed to the air with temperature of T_f= 20°C and the convection coefficient h = 20 W/m^{2}C. The bottom edge is maintained at temperature T = 80 °C. The conductivity of the material is uniform, k = 80W/mC.

(a) Identify the coordinates for each node for every 3 elements

(6 marks)

(b) Calculate the conductance matrix and the thermal load vector of each element

(12 marks)

(c) Distinguish the global system matrix equation [Kc] {T} = {F} before and after considering all constraints.

(7 marks)

You do not required to calculate the exact value for the temperature distribution.

Q5 **Figure Q5** shows a two-dimensional plate structure made of triangular elements. The plate thickness is 1mm and is made of aluminium alloy with Young's modulus E = 70GPa and Poisson's ration v = 0.3. After the structure has been loaded, the displacement measurement records for element A are shown in **Table Q5**:

Table Q5: Recorded displacement measurement

Node	u (mm)	v (mm)
1	0	0
2	0.1	0.1
3	0.1	0.1

Based on the experimental displacement data shown in **Table Q5**, find the elemental stress of element A.

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Hints: You have to decide whether the problem is plane stress or plane strain. You also have to calculate the strain displacement matrix [B] and the stiffness matrix [k] of the element, prior to analyzing the elemental stress.

(a) Based on the plate condition, explain briefly the *plane* case of the plate?

(4 marks)

(b) Evaluate the stress lever σ_{xx}, σ_{yy} and σ_{xy} of element A.

(21 marks)

-END OF QUESTIONS–

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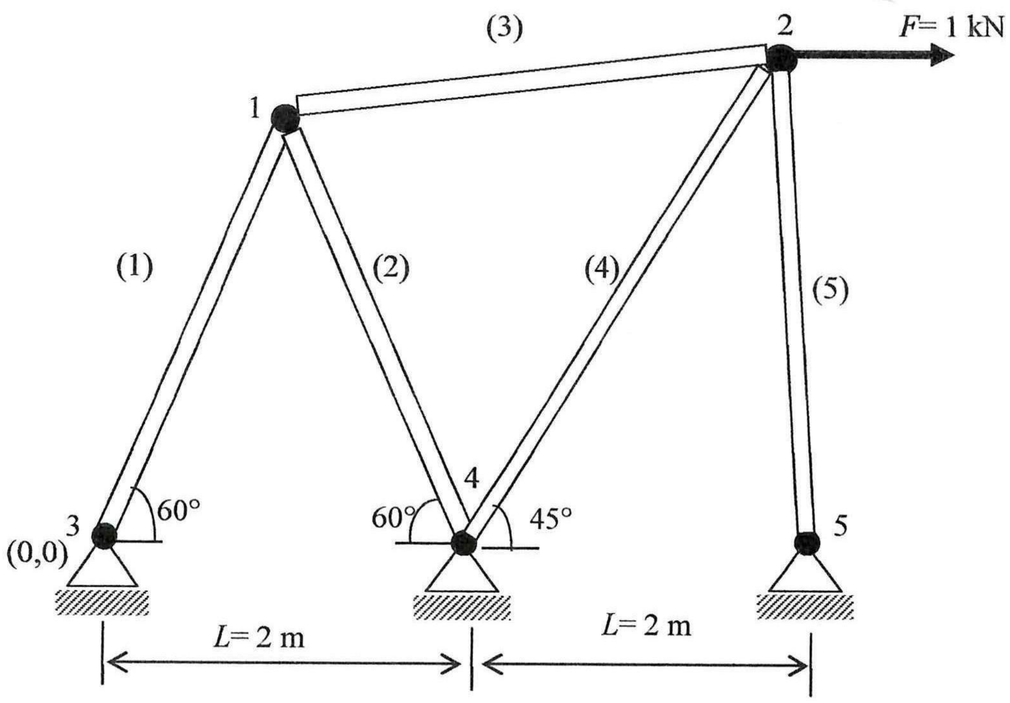
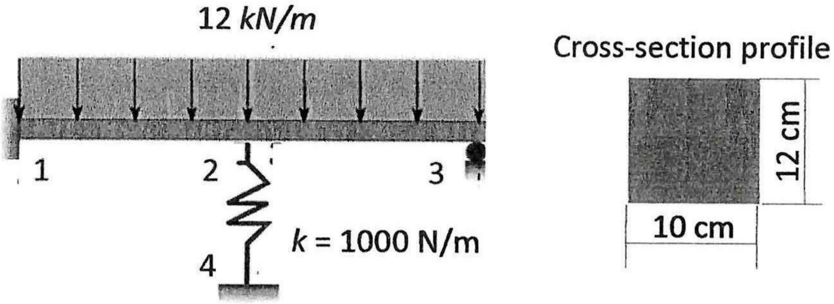


Figure Q1



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

Figure Q2

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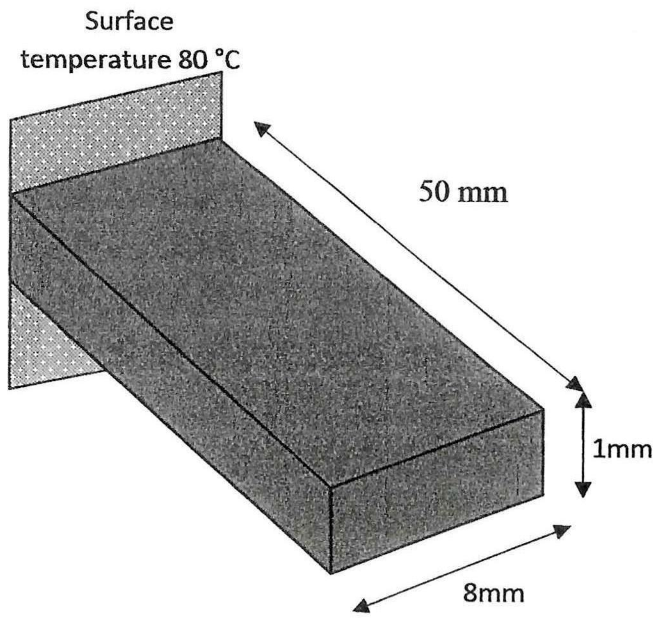

Figure Q3

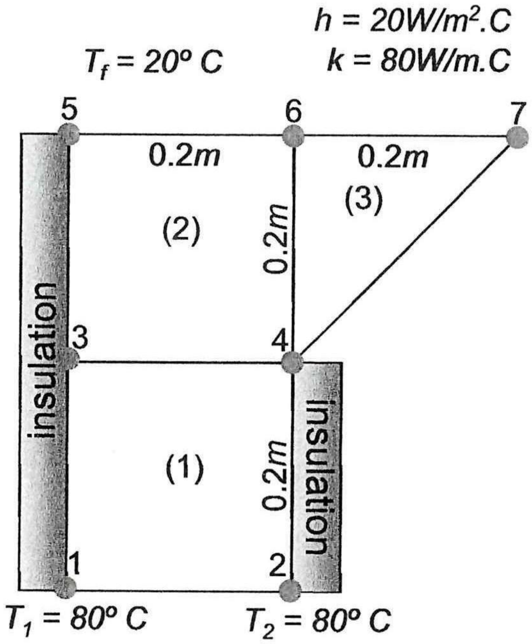

Figure Q4

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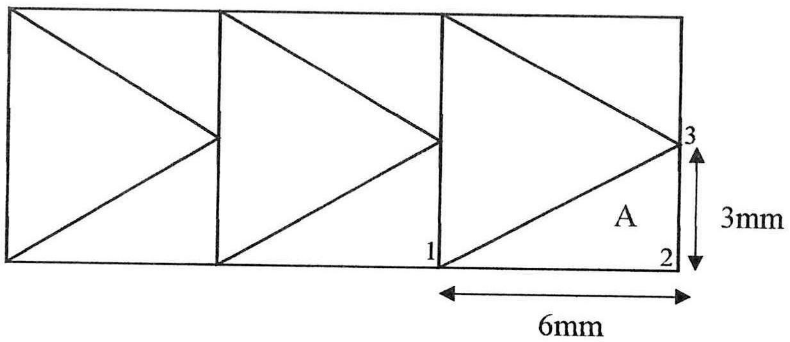

Figure Q5

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