Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	FINITE ELEMENT ANALYSIS
COURSE CODE	:	BFS41003
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	6 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 A bar that fully constraint at the left side is shown in **Figure Q1**. The bar is made from steel with Young's modulus, E = 207 GPa and Poisson's ration, v = 0.30. The bar has effective length, L_{eft} = 1500 mm and cross-sectional area, A = 900 mm^2. An axial force, P = 100 kN is imposed at the bar.

(a) Briefly discuss **FOUR (4)** factors that govern the derivation of partial differential equation of the bar.

(8 marks)

(b) Identify the essential and natural boundary conditions of the bar. External force acting on the bar can be taken as 2 kN/m.

(4 marks)

(c) If the bar is divided into three elements, establish the simultaneous equations and treat in the matrix form.

(13 marks)

Q2 (a) Explain **THREE (3)** differences between constant-strain (CST) and linear-strain (LST) triangular elements.

(6 marks)

(b) **Figure Q2** shows an aluminium plate that divided into three elements using triangular mesh. The dimension of plate is 400 mm length, 300 mm width and 10 mm thickness. The plate is constraint at all nodes.

(i) Determine the constitutive matrix, [D] and gradient matrix, [B] for all elements. Use Young's modulus, E = 70 GPa and Poisson's ration, v = 0.20.

(15 marks)

(ii) By considering the refinement using four elements, propose **TWO (2)** mesh configurations and coordinate the nodes sequentially.

(4 marks)

Q3 (a) An indeterminate beam, as shown in **Figure Q3**, has a fixed support at node 1, a roller support at node 2 and a spring support at node 3. Given the following specifications:

Point load, P	= 50 kN
Spring stiffness, k	= 200 kN/m
Young's modulus, E	= 210 GPa
Moment of inertia, I	= 2 x 10^{-4} mm^4

(i) Discretize the beam into suitable element and indicate the degree-of-freedom.

(4 marks)

(ii) Determine the displacement at all supports.

(17 marks)

(b) Evaluate the effects of spring support on the reaction force and displacement of beam.

(4 marks)

Q4 A steel I-beam of 305 x 165 x 54 with single web-opening, as shown in **Figure Q4**, is experimented under three-point bending test to obtain the ultimate carrying capacity and mid-span deflection. During the test, the steel I-beam yields the common structural behaviour and experience localised failure.

(a) By adopting the polygonal mesh, explain the strategies to conduct the modelling of steel I-beam.

(12 marks)

(b) If von Mises is used as a constitutive law, define the compulsory and additional material properties to establish the non-linear model.

(9 marks)

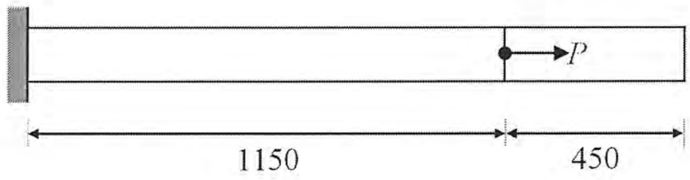
(c) Identify **TWO (2)** discrepancies that may occur if the steel I-beam is simulated using different sizes and types of mesh.

(4 marks)

– END OF QUESTIONS –

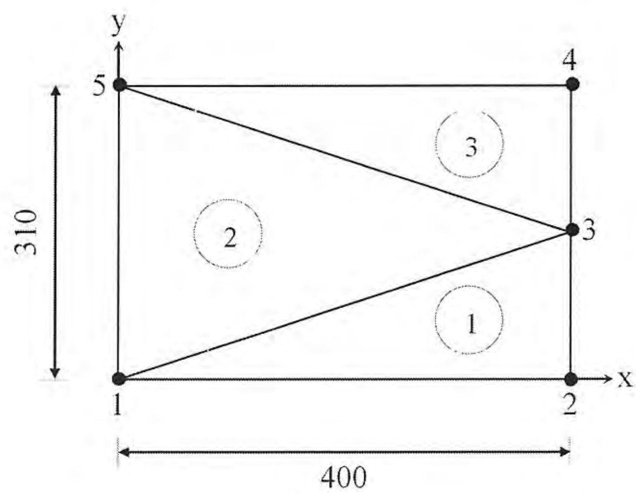
FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2019/2020 PROGRAMME CODE : 4 BFF
COURSE NAME : FINITE ELEMENT ANALYSIS COURSE CODE : BFS41003



All units in mm

FIGURE Q1



All units in mm

FIGURE Q2

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2020/2021
COURSE NAME : FINITE ELEMENT ANALYSIS
PROGRAMME CODE : 4 BFF
COURSE CODE : BFS41003

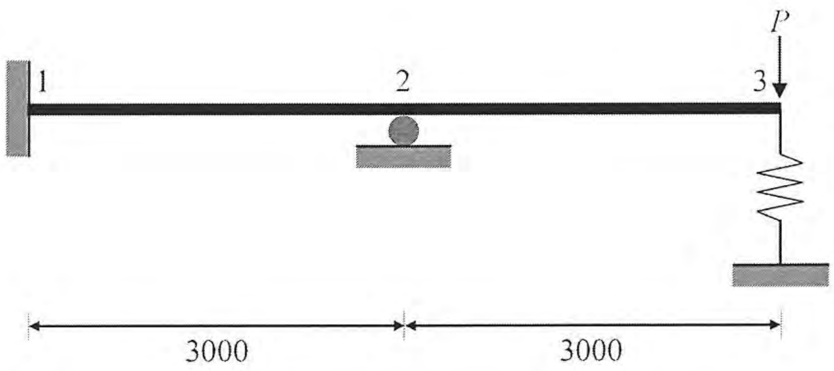


FIGURE Q3

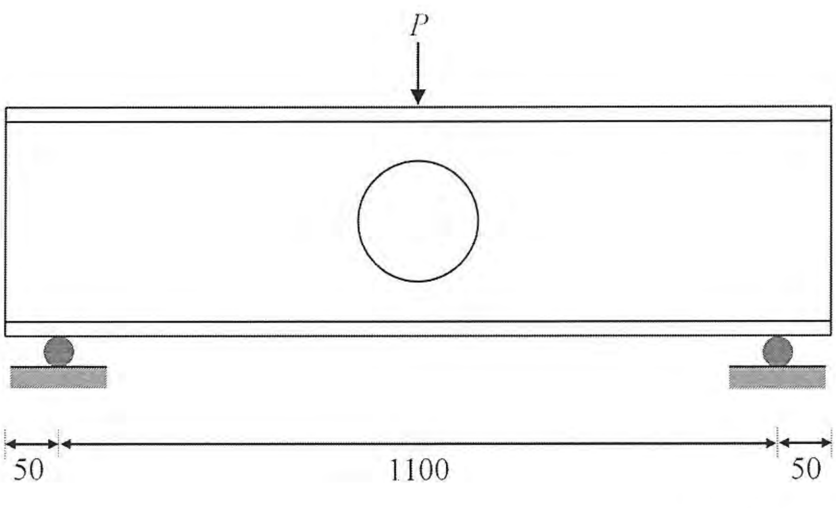


FIGURE Q4