PEPERIKSAAN IJAZAH SARJANA MUDA KEJURUTERAAN
EXAMINATION FOR THE DEGREE OF BACHELOR OF ENGINEERING

SESI AKADEMIK 2014/2015 : SEMESTER 2
ACADEMIC SESSION 2014/2015 : SEMESTER 2

ANALISA UNSUR TERHINGGA
FINITE ELEMENT ANALYSIS

Jun 2015 Masa: 2 jam
June 2015 Time: 2 hours

ARAHAN KEPADA CALON:
INSTRUCTIONS TO CANDIDATES:

1. Kertas peperiksaan ini mengandungi TIGA (3) soalan.
   This examination paper contains THREE (3) questions.

2. Jawab semua soalan.
   Answer ALL the questions.

(Kertas soalan ini mengandungi 3 soalan dalam 3 halaman yang dicetak serta 1 lampiran)
(This question paper consists of 3 questions on 3 printed pages with 1 attachment)
1. The FEA engineers should acquire sufficient knowledge of doing a numerical modeling.

   a) Describe general procedure in performing a finite element analysis.
      (10 markah/marks)

   b) Describe various sources of errors that can contribute to incorrect results.
      (10 markah/marks)

2. A mechanical system is subjected to a tension load $P$ of 2000 kN as shown in Figure Q2. Given $k = 200$ kN/mm; $L_1 = 200$ mm; $L_2 = 400$ mm; $E = 200,000$ MPa; $A_1 = 100$ mm$^2$, and $A_2 = 1000$ mm$^2$. Use the relevant formulae given in Appendix.

   (a) Using the finite element method, determine the support reactions at A, B, C and E, and the displacement at D.
      (30 markah/marks)

   (b) Using the analytical solutions, verify the solutions in (a). Discuss the findings.
      (10 markah/marks)

![Figure Q2.](image-url)
3. A vertical rod in a high-rise building is subjected to a wind loading that is linearly distributed of \( w = 4 \text{ kN/m} \) and a concentrated load of \( P = 2 \text{ kN} \) as shown in Figure Q3. Given \( E = 200,000 \text{ MPa} \); \( I = 0.5 \text{ m}^4 \); \( L = 5 \text{ m} \); \( A = 0.2 \text{ m}^2 \). Use the relevant formulae given in Appendix.

(a) Determine the support reactions at A, B and D, and the deflection at C.

(30 markah/marks)

(b) Verify the solutions in (a) with those by the method that utilizes the deflections formulae. Discuss the findings.

(10 markah/marks)

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**Figure Q3.**
Lampiran/ Attachment/ KCEC 3107

Stiffness matrix in a bar element:

\[
k = \begin{bmatrix}
k & -k \\
-k & k
\end{bmatrix} = \begin{bmatrix}
\frac{EA}{L} & -\frac{EA}{L} \\
-\frac{EA}{L} & \frac{EA}{L}
\end{bmatrix}
\]

Stiffness matrix in a beam element:

\[
k = \begin{bmatrix}
v_i & \theta_i & v_j & \theta_j \\
12 & 6L & -12 & 6L \\
6L & 4L^2 & -6L & 2L^2 \\
\frac{EI}{L^3} & -12 & -6L & 12 & -6L \\
6L & 2L^2 & -6L & 4L^2
\end{bmatrix}
\]

Deflection formulae

\[
y = \frac{Pa^2}{6EI} (3x - a) \text{ for } a < x < l
\]

Equivalent nodal loadings in beam

<table>
<thead>
<tr>
<th>Case</th>
<th>Nodal Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( \frac{wL}{2} )</td>
</tr>
<tr>
<td>2</td>
<td>( \frac{wL^2}{12} )</td>
</tr>
<tr>
<td>3</td>
<td>( \frac{3wL}{20} )</td>
</tr>
<tr>
<td>4</td>
<td>( \frac{wL^2}{30} )</td>
</tr>
</tbody>
</table>