FACULTY OF ENGINEERING, ARCHITECTURE & BUILT ENVIRONMENT

EE305 NUMERICAL ANALYSIS

ASSIGNMENT

Student ID : 

Student Name : 

Subject Code & Name : EE305 Numerical Analysis

Semester : January – April 2009

Instructor/Examiner/Lecturer : Mr. Dawood

Due date : 25 March 2009 (11:30am)

• Answer All The Questions.
• Cross out your unwanted calculations. Papers edited (with “liquid paper” etc) or with answers written with pencil will not be entertained for request of remarking.
• Show full workings/explanations for all your answers.
• Total Mark is 100 (10%)

Warning:
The University Examination Board of UCSI regards cheating as a most serious offence and will not hesitate to mete out severe punitive actions appropriate with the offence committed, and in accordance with the clauses stipulated in the Students’ Policies, up to and including expulsion from UCSI.

Grading - For Administrative Use Only

<table>
<thead>
<tr>
<th>Question</th>
<th>Point</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Question 2</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Question 3</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Question 4</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Question 5</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Attach this cover page with answer sheets
Question 1
The steady-state distribution of temperature on a heated plate can be modeled by the Laplace equation,

\[ 0 = \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} \]

If the plate is represented by a series of nodes (Fig.1), centered finite-divided differences can be substituted for the second derivatives, which results in a system of linear algebraic equations as follows:

\[
\begin{bmatrix}
4 & -1 & -1 & 0 \\
-1 & 4 & 0 & -1 \\
-1 & 0 & 4 & -1 \\
0 & -1 & -1 & 4
\end{bmatrix}
\begin{bmatrix}
T_{11} \\
T_{12} \\
T_{21} \\
T_{22}
\end{bmatrix}
= \begin{bmatrix}
175 \\
125 \\
75 \\
25
\end{bmatrix}
\]

Use the Gauss-Seidel method to solve for the temperatures of the nodes in Fig.1. Perform the computation until \( \epsilon_a \) is less than \( \epsilon_s = 0.5\% \).

![Fig 1](image)

(20 marks)

Question 2
Fig. 2a shows a uniform beam subject to a linearly increasing distributed load. The equation for the resulting elastic curve is (see Fig. 2b)

\[ y = \frac{a_0}{120EIL} (-x^5 + 2L^2x^3 - L^4x) \]

Use Bisection to determine the point of maximum deflection (that is, the value of \( x \) where \( dy/dx = 0 \)) with initial guess 0 and 500m and \( \epsilon_s = 6\% \). Use the following parameters in your
computation: L = 600cm, E = 50,000kN/cm², I = 30,000cm⁴, and ω₀ = 2.5kN/cm.

**Question 3**

Water exerts pressure on the upstream face of a dam as shown in Fig. 3. The pressure can be characterized by

\[ p(z) = \rho g (D - z) \]

where \( p(z) \) = pressure in pascals (or N/m²) exerted at an elevation \( z \) meters above the reservoir bottom; \( \rho \) = density of water, which for this problem is assumed to be a constant \( 10^3 \) kg/m³; \( g \) = acceleration due to gravity (9.8 m/s²); and \( D \) = elevation (in m) of the water surface above the reservoir bottom. According to above mentioned equation, pressure increases linearly with depth, as depicted in Fig. 3(a). Omitting atmospheric pressure (because it works against both sides of the dam face and essentially cancels out), the total force \( f_t \) can be determined by multiplying pressure times the area of the dam face (as shown in Fig. 3b). Because both pressure and area vary with elevation, the total force is obtained by evaluating

\[ f_t = \int_0^D \rho g w(z)(D - z)dz \]

where \( w(z) \) = width of the dam face (m) at elevation \( z \) (Fig. 3b). The line of action can also be obtained by evaluating
\[
\begin{align*}
    d &= \frac{\int_0^D \rho g w(z)(D - z) \, dz}{\int_0^D \rho g w(z)(D - z) \, dz} \\
\end{align*}
\]

Use the six-segments Simpson’s 1/3 rule to compute \(d\).

![Water exerting pressure on the upstream face of a dam](image)

**Fig 3:** Water exerting pressure on the upstream face of a dam: (a) side view showing force increasing linearly with depth; (b) front view showing width of dam in meters

(20 marks)

**Question 4**

A jet fighter’s position on an aircraft carrier’s runway was timed during landing:

<table>
<thead>
<tr>
<th>(t) (s)</th>
<th>0</th>
<th>0.52</th>
<th>1.04</th>
<th>1.75</th>
<th>2.37</th>
<th>3.25</th>
<th>3.83</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x) (m)</td>
<td>153</td>
<td>185</td>
<td>210</td>
<td>249</td>
<td>261</td>
<td>271</td>
<td>273</td>
</tr>
</tbody>
</table>

where \(x\) is the distance from the end of the carrier. Estimate (a) velocity \(\frac{dx}{dt}\) and (b) acceleration \(\frac{dv}{dt}\) using numerical differentiation.

(20 marks)

**Question 5**

The voltage drop \(V\) was measured across a resistor for a number of different values of current \(i\). The results are

<table>
<thead>
<tr>
<th>(i)</th>
<th>0.25</th>
<th>0.75</th>
<th>1.25</th>
<th>1.5</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V)</td>
<td>-0.45</td>
<td>-0.6</td>
<td>0.7</td>
<td>1.88</td>
<td>6</td>
</tr>
</tbody>
</table>

Use first-through fourth-order polynomial interpolation to estimate the voltage drop for \(i = 1.15\). Interpret your results.

(20 marks)