FACULTY OF MECHANICAL ENGINEERING
UNIVERSITI TEKNOLOGI MALAYSIA

COMPUTATIONAL METHODS FOR ENGINEERS	Semester II 2011-2012
Test 1	90 minutes

1. Consider the function $f(x) = \sqrt{1 - x^3}$. If an approximate value $\tilde{x} = 0.998$ is used instead of the true value $x = 0.999$, determine the
   a. absolute error, and
   b. relative error (in %)

   involved in the computation of the function *f(x)*.

2. For a curved beam subjected to bending, such as a crane hook lifting a load, the location of the neutral axis r_n, is given by
$$4r_n(2R - \sqrt{4R^2 - d^2}) = d^2$$
   where *R* is the radius of the centroidal axis and *d* is the diameter of the cross section (assumed to be circular) of the curved beam.
   a. Using Newton-Raphson method, find the value of *d* for which $r_n = 4d$ when *R* = 10. Use an accuracy of ± 0.01.
   b. Write a short Matlab code to find the answer above using `fzero` along with a user-defined function.

3. For a DC bridge circuit driven by a single constant voltage source, the relationships between the node voltages are obtained by applying Kirchoff's current law, which says that the sum of the currents leaving each node must be zero. This yields the following system of equations;
$$\frac{V_1-E}{R_S} + \frac{V_1-V_2}{R_1} + \frac{V_1-V_3}{R_2} = 0 \text{ (node 1)}$$
$$\frac{V_2-V_1}{R_1} + \frac{V_2-V_3}{R_L} + \frac{V_2}{R_3} = 0 \text{ (node 2)}$$
$$\frac{V_3-V_1}{R_2} + \frac{V_3-V_2}{R_L} + \frac{V_3}{R_4} = 0 \text{ (node 3)}$$
   Find the voltage *V* of the circuits for the following data using the Gauss-Seidel iterations;
   R_S = 10Ω, R_L = 1000Ω, R_1 = 220Ω, R_2 = 330Ω, R_3 = 470Ω, R_4 = 560Ω, and *E* = 12*V*.
   Use $V_1 = V_2 = V_3 = 5V$ as the initial trial values and stop all calculations after three iterations. Determine the relative error for each iteration and comment on the trend obtained.

4. Given the coefficient matrix $A = \begin{bmatrix} 2 & -2 & 1 \\ -1 & 3 & -1 \\ 2 & -4 & 3 \end{bmatrix}$
   a. Using the power method, determine the largest eigenvalue and the associated eigenvector after the fourth iteration, starting with $\vec{X}_1 = [1 \quad 1 \quad 1]$
   b. Using the power method, determine the largest eigenvalue and the associated eigenvector after the fourth iteration, starting with $\vec{X}_1 = [1 \quad 0 \quad 0]$
   c. Comment on the answers you get in a. and b. above.
   d. Find the characteristic equation of **A**.