FACULTY OF MECHANICAL ENGINEERING
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COMPUTATIONAL METHODS FOR ENGINEERS — Semester II 2011-2012
Test 1 — 90 minutes

1. Consider the function $v(t) = \frac{gm}{c} - e^{-(c/m)t}$. Use a first order error analysis to estimate the error of v at $t = 6$, if $g = 9.8$ and $m = 50$ but $c = 12.5 \pm 1.5$.

2. In combustion, the dissociation of CO_2 at 2500K results in the following expression for the equilibrium constant K;

$$K = \frac{z}{(1-z)}\left(\frac{z}{2+z}\right)^{1/2}\left(\frac{P}{P_{ref}}\right)^{1/2}$$

where z is what is called the *progress variable*. Given $P_{ref} = 1$ atm and $P = 10$ atm, $K = 0.0363$, find z using the secant method with initial guesses of 0.8 and 0.5. Do only four iterations. What is the error if the answer is 0.0621? If you are given the choice between the Newton-Raphson and the Secant methods for this problem, which would you choose and why? Write a short Matlab code to find the answer above using `fzero` along with a user-defined function.

3. Consider the following set of equations:

$$\begin{aligned} x_1 + 0x_2 + 3x_3 &= 11 \\ x_1 - 2x_2 - x_3 &= -6 \\ 0x_1 + 2x_2 + x_3 &= 7 \end{aligned}$$

This system will not converge as written above. State the reason. State the step that should be done to ensure convergence. Perform the step and solve it using the Gauss-Seidel technique using $x_{1,2,3} = 1$ or your initial guesses. Perform three iterations only.

4. Given the matrix $\begin{bmatrix} 2-\lambda & 8 & 10 \\ 8 & 4-\lambda & 5 \\ 10 & 5 & 7-\lambda \end{bmatrix}$
   a. Using the power method, determine the largest eigenvalue to an accuracy of ±0.01 and the associated eigenvector.
   b. Find the characteristic equation of **A**.