Middle East Technical University
Department of Mechanical Engineering

ME 310 – Numerical Methods
Fall 2014

Study Problems-I*

Assigned on 30.10.2014
Prepared by İlteriş Berke Harmancı – Eren Demircan
*Will not be collected/graded.

1. Use zero- through third order Taylor series expansions to predict the value of the function given below at $x = 3.2$ around the base point $x = 1.5$ and compute the true percent relative error, ε_t for each approximation. Calculate the truncated error for the first order expansion, R_1 using the Taylor series method.

$$f(x) = ln(3x) \cdot (6x^4 - 18.5x^2 + 3.2x - 10)$$

2. Given the function

$$f(x) = -12x^5 - 6.4x^3 + 12$$

Use bisection method to determine the real root of this function. Employ initial guesses of $x_l = 0$ and $x_u = 1$, and perform iterations until the approximate relative error is below 5%. Also check your answer by plotting the function. *(Answer: 0.9045)*

[Adapted from Applied Numerical Methods for Engineers, Steven Chapra]

3. Determine the positive real root of

$$f(x) = \ln(x^6) - 0.7$$

(a) Analytically
(b) Graphically
(c) False position method with initial guesses of $x_l = 0.5$ and $x_u = 2$

(Answer: 1.1237)

[Adapted from Applied Numerical Methods for Engineers, Steven Chapra]

4. Determine the lowest positive root of $f(x) = 8\sin(x)e^{-x} - 1$;

(a) Graphically
(b) Using the Newton-Raphson method (five iterations, $x_i = 0.3$)
(c) Using the Secant method (five iterations, $x_{i-1} = 0.5$ and $x_i = 0.4$)
(d) Using the Modified Secant Method (use equation 6.8 from the textbook Chapra & Canale with three iterations, $x_i = 0.3$ $\delta = 0.01$)

(Answer: 0.1450)

[Adapted from Applied Numerical Methods for Engineers, Steven Chapra]

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5. Determine the roots of the following simultaneous non-linear equations using the Newton-Raphson method:

$$y = -x^2 + x + 0.75$$

$$y + 5xy = x^2$$

Employ initial guesses of $x = y = 1.2$ and discuss the results. *(Answer: x = 1.372, y = 0.239 Note that there exists 2 other x & y solution pairs for the problem)*

[Adapted from Applied Numerical Methods for Engineers, Steven Chapra]