BSE666: ASSIGNMENT

23 Jan 2026

1. Using Taylor series approximation, derive the zeroth, linear and quadratic representations of the function

$$f(x) = x^4 - 3x^3 + 2x^2 + 7$$

Choose x_0=2 as the base point. Thus, estimate the function and its derivative at x=3 using the three approximations.
Determine percentage errors with respect to the exact value. Perform all calculations in tabular form. [**5**]

2. *Hydraulic network*: Solve the following system of nonlinear algebraic equations using the Newton-Raphson method. Show four iterations. An initial guess of (1,1,1) can be used.
Show convergence in terms of roots as well as the functions in the root mean square norm.

$$f_1 :\ x_1 - x_2 - x_3 = 0$$
$$f_2 :\ 0 + x_2^2 - x_3^2 = 0$$
$$f_3 :\ x_1^2 + x_2^2 + 2x_3^2 = 7$$

[**5**]

3. *Radiating fin with an insulated tip*: Obtain the solution of the following boundary-value problem on an equally spaced grid of 5 points. Linearize the discretized form using the first order TSA. Express the system of linear algebraic equations in matrix form.
Solve this linearized system using internet sources or any other approach of your choice.
Show three iterations and present the extent of convergence achieved.
Start with a linear variation in the dependent variable as the initial guess.

[**5**]

$$\frac{d^2T}{dx^2} - 2T^4 = 0 \qquad T(0) = 1;\ \frac{dT}{dx}(x = 1) = 0$$

4. Consider the two-tank and two-tube arrangement shown schematically below. Establish the governing equations for the time-dependent water levels in the two tanks.
   Specialize the equations to the situation where external flows f_1 and f_2 are zero and the second tube is closed. The cross-sectional areas of the two tanks are equal, and equal to A; the loss coefficient of the connecting tube is C.
   Using the method given in * below, derive the time-marching scheme that will solve for the water levels in the two tanks as a function of time. The initial water levels in the two tanks are H_1 and H_2, respectively, with $H_1 > H_2$. Note that a clear steady state is possible. **[5]**

   * Implicit method followed by linearization with respect the guessed estimate
   Develop the required algorithm in the form of a flow chart.
   Distinguish between iterations within a time step and overall time marching.
   Discuss the choice of the time step that will adequately resolve transients.

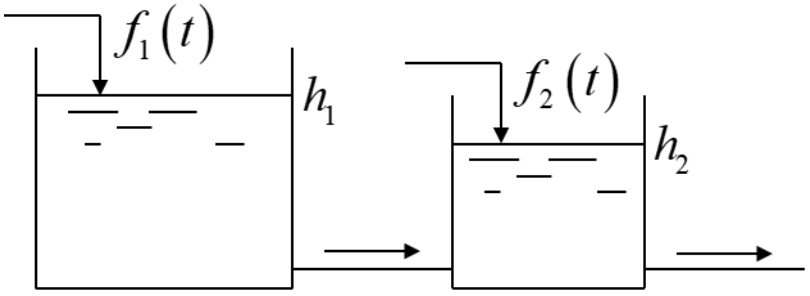

Figure for Problem 4: (two tanks and two tubes)