UNIVERSITY OF CALIFORNIA, DAVIS
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

COURSE: WATER RESOURCES SIMULATION (ECI 146)

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Class: Tuesdays and Thursdays-10:30 to 11:50 PM (119 Wellman)
Computer lab: Fridays-11:00 AM to 2:00 PM (Ghausi Hall 2030)
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ASSIGNMENT 1: Solution of implicit algebraic equations and ODEs

Assigned on*: *Monday, January 29, 2018
Due on*: *Thursday, February 8, 2018

Please answer the following questions using the discussions we had in class and hand-outs.

Question 1: Please mention four uses of water in which you can apply numerical techniques to optimize the use (based on the examples we saw in the first two classes). Indicate the use (for example, "provide potable to a city"), the problem (for example, "calculate the friction factor of the pipes"), and how you will solve it (for example, "apply the Newton-Raphson method to obtain the friction factor iteratively"). Please base your answers on the examples we saw in class, and on the course handouts. Please formulate the answer as follows: a) Problem; b) which type of equation is obtained?; c) how to solve it.

Question 2: a) Please develop a flow chart for the method of **bisection** of a *general* implicit algebraic equation, considering all possible cases that may take place. (Recall that we discuss four cases in class which can be reduced to two.) Explain, after the chart, the rationale behind those cases. b) Please develop a flow chart for the method of **iteration of a point (fixed point)** for a *general* algebraic implicit equation as well. In both cases, obtain the error from successive guessed values of the root. c) How do the flow charts change if the "stopping criterion" is based on the value of the function "close to zero"?

Question 3: Please take the equation:

$$\frac{d\,u(t)}{dt} + K\ u(t) = 0$$

In class we used a forward method (approximation) to discretize it. Now, please use a "backward method" to discretize it (i.e., evaluate the second term at *j+1*) and obtain the "computational stencil." Call the time step as "h". Is the solution unstable in the backward method? Is the solution accurate? Under what conditions?

Question 4: Please explain what you understand by order of convergence in the case of an algebraic implicit equation. Is it there a similar concept in the solution of ODEs?

Question 5: Obtain the error for the forward approximation of the first derivative of a function.

Question 6: Please use the Theorem we discussed in class for the **fixed point** method to see if the alternative method you selected in Computer Problem 1 for the Colebrook-White equation can be shown to produce a convergent set of values in the iterative process.

Question 7: Please explain what you understand by consistency, stability and convergence of ODEs. You can use examples for this.

Question 8: Please develop a flow chart for the Newton-Raphson method.