Assignment 1- Answers

Please post in the forum if you need further explanations for any of the answers

1. Imagine that you wish to design the air conditioning system for a car and you want to determine where to put the air conditioner vents through which cold air would be coming. For this problem, which of the following statements is true?

(a) you expect CFD to give you reasonably correct solution.
(b) you expect CFD would not be of much use.
(c) you would look for an analytical solution
(d) you would rather do experiments.

2. A client would want you to check for the mileage for a new formulation of biodiesel for use in a car compared to that of normal diesel sold at the petrol bunk. For this problem, which of the following statements is true?

(a) you expect CFD to give you reasonably correct solution.
(b) you expect CFD would not be of much use.
(c) you would look for an analytical solution
(d) you would rather do experiments

Fuel economy depends on the efficiency of driver, road conditions etc., that can’t be modeled using CFD

3. Which of the following statements is NOT TRUE about the use of finite difference methods for solving CFD problems?

(a) Finite difference methods can be applied to problems described in cylindrical coordinate system.
(b) Finite difference methods do not require boundary conditions.
(c) Finite difference methods convert a partial or ordinary differential equation into a set of algebraic equations.
(d) None of the above.

4. Consider the Laplace equation describing steady state heat conduction in a two dimensional rectangular domain. If the equation is discretized using finite difference approximations with uniform grid spacing in both directions, and if the resulting equations are arranged and written in the form of a matrix equation, then the non-zero coefficients in the coefficient matrix will

(a) have a tridiagonal structure with three adjacent diagonals including the main diagonal.
(b) have a pentadiagonal structure with five adjacent diagonals including the main diagonal.
(c) have a pentadiagonal structure with zero diagonals in between some of the non-zero diagonals.
(d) be the sum of two tridiagonal matrices each containing three adjacent diagonals.

5. You wish to solve the Poisson equation in a two-dimensional domain spanning a length $L$ in the x-direction and width $W$ in the y-direction. You have divided the length $L$ into 20 equal intervals, and the width $W$ into 30 equal intervals. You have Dirichlet boundary conditions on all sides. You discretize the Poisson equation using central difference approximation. The source term is a constant. You wish to solve the resulting set of linear algebraic equations, which you express as $Ax = b$. For this problem, the number of equations to be solved will be

(a) $600 \pm 5$  (b) $550 \pm 5$  (c) $650 \pm 5$  (d) $50 \pm 5$

6. You wish to solve the set of equations from the above using the Gauss-Seidel method. This method will converge if which of the following condition(s) is satisfied:

(a) matrix $A$ is non-singular  (b) the spectral radius of $A$ must be less than one  (c) matrix $A$ is irreducible and diagonally dominant  (d) none of the above.

7. For the problem in question #6, identify the correct statements about the initial guess:

(a) Initial guess is not required  
(b) initial guess for one variable is sufficient to find the final solution  
(c) one would start with guess values for all the variables  
(d) none of the above

8. For the problem in question #6, identify the correct statements about the initial guess:

(a) starting values must always be zero  
(b) all starting values must be the same  
(c) only some starting values may give the correct solution  
(d) initial guess does not affect the final solution so any starting values are okay
9. You wish to do the problem in one dimension, i.e., you wish to solve the equation \( \frac{d^2w}{dx^2} = C \) over the domain \( 0 \leq x \leq L \) with the boundary conditions that \( w|_{x=0} = w_0 \) and \( w|_{x=L} = w_L \). If you divide the domain into 20 equal intervals, then how many equations will you need to solve?

(a) 18  (b) 19  (c) 20  (d) 21

10. If you use second order-accurate approximations for the derivative, how many of the equations in problem #9 will have either \( w_0 \) or \( w_L \)?

(a) 0  (b) 1  (c) 2  (d) all

**In the first and last equations**

11. If you put the equations from problem #9 in proper order, you can get a coefficient matrix which

(a) is tridiagonal with three adjacent diagonals having non-zero coefficients
(b) is tridigonal but the non-zero diagonals have zero diagonals in between
(c) is penta-diagonal with five adjacent diagonals having non-zero coefficients
(d) is penta-diagonal but some non-zero diagonals have zero diagonals in between

12. Do you expect the Gauss-Seidel method will work for problem #9?

(a) Yes, because the diagonal dominance condition will be satisfied
(b) No, because the diagonal dominance condition will not be satisfied
(c) Can’t say as the satisfaction of the diagonal dominance condition depends on the specific values of \( w_0 \) and \( w_L \)
(d) Gauss-Seidel method cannot be applied for tri-diagonal matrices.