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| **State** | Finished |
| **Completed on** | Wednesday, 9 May 2018, 2:23 PM |
| **Time taken** | 22 mins 39 secs |
| **Grade** | **14.00** out of 20.00 (**70**%) |

Question **1**

Correct

Mark 2.00 out of 2.00

This method of solving boundary value problems "overshoots" the new value a little to reach convergence faster.

Select one:

- a. FTCS method
- b. Spectral method
- c. Gauss-Seidel method
- d. Overrelaxation method ✓

Your answer is correct.

The correct answer is: Overrelaxation method

Question **2**

Correct

Mark 2.00 out of 2.00

This method of solving initial value problems exploits the use of Fourier transforms.

Select one:

- a. Gauss-Seidel method
- b. Spectral method ✓
- c. Crank-Nicholson method
- d. FTCS method

Your answer is correct.

The correct answer is: Spectral method

Question 3

Correct

Mark 2.00 out of 2.00

In using the leapfrog method, what should α and β be in the equation below?

$$x(t+\frac{7}{2}h)=x(t+\frac{5}{2}h)+hf(\alpha,\beta)$$

Select one:

A. $\alpha = x(t+3h), \beta = t+3h$ ✓

B. $\alpha = x(t+6h), \beta = t+6h$

C. $\alpha = x(t+\frac{5}{2}h), \beta = t+\frac{5}{2}h$

D. $\alpha = x(t+\frac{1}{2}h), \beta = t+\frac{1}{2}h$

Your answer is correct.

To find the solution at the point $(x(t+\frac{7}{2}h), t+\frac{7}{2}h)$, we need the slope of the point between this point and the previous point $(x(t+\frac{5}{2}h), t+\frac{5}{2}h)$.

The correct answer is: $\alpha = x(t+3h), \beta = t+3h$

Question 4

Correct

Mark 2.00 out of 2.00

RK4 is by far the most common method for the numerical solution of ordinary differential equations, which is accurate to terms of order

Select one:

a. $h^3$

b. $h^5$

c. $h^2$

d. $h^4$ ✓

Your answer is correct.

The correct answer is: $h^4$

Question 5

Correct

Mark 2.00 out of 2.00

If we are given a system of $n$ differential equations, each of order $m$, we can simplify this into a system of ___________ simultaneous first order differential equations.

Select one:

- a. $m - n$
- b. $m + n$
- c. $m/n$
- d. $m \times n$

✓

Your answer is correct.

The correct answer is: $m \times n$

Question 6

Correct

Mark 2.00 out of 2.00

A simple example of using the shooting method for solving boundary value problems numerically is solving for the vertical position of a thrown ball as it travels until it reaches the ground. In this example, consider the code shown below in using the Shooting method for the ODE

$$\frac{d^2y}{dt^2} = -g$$

```
# Function for Runge-Kutta calculation
def f(r):
x = r[0]
y = r[1]
fx = y
fy = -g
return array([fx,fy],float)

def height(v):
r = array([0.0,v],float)
for t in arange(a,b,h):
k1 = h*f(r)
k2 = h*f(r+0.5*k1)
k3 = h*f(r+0.5*k2)
k4 = h*f(r+k3)
r += (k1+2*k2+2*k3+k4)/6
return r[0]
```

What is the output of the function height(v)?

Select one:

- (selected) A. Some floating point number representing the final height of the ball given an initial velocity v. ✓
- B. An array containing all possible values for the initial height given an initial velocity v.
- C. An array containing all points that represent the trajectory of the ball given an initial velocity v.
- D. Some floating point number representing the initial height of the ball given an initial velocity v.

Your answer is correct.

The correct answer is: Some floating point number representing the final height of the ball given an initial velocity v.

Question **7**

Incorrect

Mark 0.00 out of 2.00

$$\frac{\partial^2 \phi}{\partial t^2} = v^2 \frac{\partial^2 \phi}{\partial x^2}$$

The 1D wave equation shown above is used to find the solution for a wave traveling on a string. Suppose we want to find the solution to this initial value problem at time $t = 1 \times 10^{50}$ s with a reasonably small amount of running time. Which of the following methods of solving partial differential equations is best applicable to the problem?

Select one:

- A. Spectral Method
- B. Forward-time centered-space (FTCS) Method ❌ This method is numerically unstable and leads to divergent solutions when solving the wave equation. Also, it would require a very long running time to get an accurate result since we want the solution at a very large time t.
- C. Jacobi and Relaxation Method
- D. Gauss-Seidel Method

Your answer is incorrect.

The problem requires us to find the solution at some very large value of time t. So that the best method to use is the Spectral method since it does not require the solutions of the previous time steps to obtain the result at the desired time so that even with the very large value t, we can still arrive at an accurate result with a reasonably small amount of running time.

The correct answer is: Spectral Method

Question **8**

Incorrect

Mark 0.00 out of 2.00

In solving partial differential equations (PDEs) of Boundary Value Problems, which of the following is NOT true about the Jacobi method (square grid approach)?

Select one:

- A. The method can be extended to handle arbitrary shapes of boundaries without any further approximation.
- B. In general, decreasing the grid spacing yields more accurate results. ✗
- C. The method provides the solution only at the points on the grid and not in between.
- D. The solutions at the boundaries given as boundary conditions must remain constant.

Your answer is incorrect.

The correct answer is: The method can be extended to handle arbitrary shapes of boundaries without any further approximation.

Question **9**

Incorrect

Mark 0.00 out of 2.00

In solving ordinary differential equations (ODEs), which of the following statements is true?

Select one:

- A. The methods discussed in class are applicable only for linear ODEs.
- B. To solve a second order ODE with two dependent variables, you need at least four boundary conditions.
- C. In general, using larger step sizes gives more accurate results. ✗ To get more accurate results, we need smaller step sizes.
- D. The results obtained using the Runge-Kutta method in the 4th order are exact

Your answer is incorrect.

The correct answer is: To solve a second order ODE with two dependent variables, you need at least four boundary conditions.

Question **10**

Correct

Mark 2.00 out of 2.00

Most of the speed-up of the combined overrelaxation/Gauss-Seidel method comes from the overrelaxation.

Select one:

- (•) True ✓
- ( ) False

The correct answer is 'True'.