

Multiple-Choice Test

Chapter 08.03

Runge-Kutta 2nd Order Method

1. To solve the ordinary differential equation

$$3 \frac{dy}{dx} + xy^2 = \sin x, y(0) = 5$$

by the Runge-Kutta 2nd order method, you need to rewrite the equation as

- (A) $\frac{dy}{dx} = \sin x - xy^2, y(0) = 5$
(B) $\frac{dy}{dx} = \frac{1}{3}(\sin x - xy^2), y(0) = 5$
(C) $\frac{dy}{dx} = \frac{1}{3}\left(-\cos x - \frac{xy^3}{3}\right), y(0) = 5$
(D) $\frac{dy}{dx} = \frac{1}{3}\sin x, y(0) = 5$

2. Given

$$3 \frac{dy}{dx} + 5y^2 = \sin x, y(0.3) = 5$$

and using a step size of $h = 0.3$, the value of $y(0.9)$ using the Runge-Kutta 2nd order Heun method is most nearly

- (A) -4297.4
(B) -4936.7
(C) -0.21336×10^{14}
(D) -0.24489×10^{14}

3. Given

$$3 \frac{dy}{dx} + 5\sqrt{y} = e^{0.1x}, y(0.3) = 5$$

and using a step size of $h = 0.3$, the best estimate of $\frac{dy}{dx}(0.9)$ using the Runge-Kutta

2nd order midpoint method most nearly is

- (A) -2.2473
(B) -2.2543
(C) -2.6188
(D) -3.2045

4. The velocity (m/s) of a body is given as a function of time (seconds) by

$$v(t) = 200 \ln(1+t) - t, \quad t \geq 0$$
 Using the Runge-Kutta 2nd order Ralston method with a step size of 5 seconds, the distance in meters traveled by the body from $t = 2$ to $t = 12$ seconds is estimated most nearly as
- (A) 3904.9
 - (B) 3939.7
 - (C) 6556.3
 - (D) 39397

5. The Runge-Kutta 2nd order method can be derived by using the first three terms of the Taylor series of writing the value of y_{i+1} (that is the value of y at x_{i+1}) in terms of y_i (that is the value of y at x_i) and all the derivatives of y at x_i . If $h = x_{i+1} - x_i$, the explicit expression for y_{i+1} if the first three terms of the Taylor series are chosen for solving the ordinary differential equation

$$\frac{dy}{dx} + 5y = 3e^{-2x}, \quad y(0) = 7$$

would be

- (A) $y_{i+1} = y_i + (3e^{-2x_i} - 5y_i)h + 5\frac{h^2}{2}$
- (B) $y_{i+1} = y_i + (3e^{-2x_i} - 5y_i)h + (-21e^{-2x_i} + 25y_i)\frac{h^2}{2}$
- (C) $y_{i+1} = y_i + (3e^{-2x_i} - 5y_i)h + (-6e^{-2x_i})\frac{h^2}{2}$
- (D) $y_{i+1} = y_i + (3e^{-2x_i} - 5y_i)h + (-6e^{-2x_i} + 5)\frac{h^2}{2}$

6. A spherical ball is taken out of a furnace at 1200 K and is allowed to cool in air. You are given the following

radius of ball = 2 cm

specific heat of ball = 420 J/kg · K

density of ball = 7800 kg/m³

convection coefficient = 350 J/s · m² · K

ambient temperature = 300 K

The ordinary differential equation that is given for the temperature θ of the ball is

$$\frac{d\theta}{dt} = -2.20673 \times 10^{-13} (\theta^4 - 81 \times 10^8)$$

if only radiation is accounted for. The ordinary differential equation if convection is accounted for in addition to radiation is

(A) $\frac{d\theta}{dt} = -2.20673 \times 10^{-13} (\theta^4 - 81 \times 10^8) - 1.6026 \times 10^{-2} (\theta - 300)$

(B) $\frac{d\theta}{dt} = -2.20673 \times 10^{-13} (\theta^4 - 81 \times 10^8) - 4.3982 \times 10^{-2} (\theta - 300)$

(C) $\frac{d\theta}{dt} = -1.6026 \times 10^{-2} (\theta - 300)$

(D) $\frac{d\theta}{dt} = -4.3982 \times 10^{-2} (\theta - 300)$

[Complete Solution](#)