



(An Autonomous Institution) Coimbatore–35

#### **DEPARTMENT OF MATHEMATICS**

UNIT-V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

FOURTH ORDER RUNGE KUTTA METHOD FOR SOLVING FIRST AND SECOND ORDER EQUATIONS! SECOND ORDER RK METHOD : -- 141.20 p If the initial values of (a, y) for the differential egn dy = f(x,y) then the first increment in y namely sy is calculated from the formula k, = hz(x,y)  $k_{2} = h_{3} \left[ n + \frac{h}{2}, y + \frac{k_{1}}{2} \right]$  $\Delta y = k_{2} \text{ where } h = \Delta n$ Now y (n+h) = y(n)+ Ay (4) y1= y0+ Ay THIRD ORDER RK METHOD : you are a real  $\kappa_i = \hbar_{\lambda}(n, y)$ 

 $k_2 = h_{\mathcal{F}} \left[ n + \frac{h}{2} , y + \frac{k_1}{2} \right]$ 

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$$K_{3} = Th \frac{1}{7} [n+th, y+2k_{2}-k_{1}]$$

$$Ay = \frac{1}{6} [k_{1}+4k_{2}+k_{3}]$$

$$Now \quad y_{1} = y_{0} + \Delta y$$

$$JoukTH \quad ORDER \quad Rk \quad METHOD:$$

$$k_{1} = fh \frac{1}{7} [n+\frac{f}{2}, y+\frac{k_{1}}{2}]$$

$$k_{3} = fh \frac{1}{7} [n+\frac{f}{2}, y+\frac{k_{2}}{2}]$$

$$k_{4} = fh \frac{1}{7} [n+f_{2}, y+\frac{k_{2}}{2}]$$

$$k_{4} = fh \frac{1}{7} [n+f_{2}+2k_{3}+k_{4}]$$

$$Ay = \frac{1}{6} [k_{1}+2k_{2}+2k_{3}+k_{4}]$$

$$Now \quad y_{1} = y_{0} + \Delta y$$

$$() \quad Given \quad \frac{dy}{dn} = 2^{3} + y , \quad y_{0}(n) = 2, \quad Compute \quad y(\tilde{0}, 2), \quad y(0, \frac{f}{4}) \neq y(0, 6)$$

$$by \quad Rk \quad method \quad q \quad Jouth \quad order \quad .$$

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Soln: Gin y'=28+4 20:0; 40=2. h=0.2. and 0= (a) and to a Now Ki= h: J. (max yo;) = 0:2 [na3+yo]= 02(0+2)=0.4 k2 = h 2 [20+ 1/2, yot k1-] = 02 - [0+ 0:2, 2+ 0.4. ] = 0.2 = [[0.1, 2.2] = 0 2 [(0.1)34 2.27 = 0.4402. k3=h2[not \$, yot \$= ]= 0.2 3[0.1, 2.2201]  $= 0.2 \left[ (0.1)^3 + 2.22017 = 0.4442. \right]$ k4 = thz [no+th, yotk3] = 0.2 2 [0.2, 2.4442] = 0.2 [ (0.1)3+ 2.44427 = 0.4904 P2P1.1 122  $Ay = \frac{1}{6} [K_1 + 2K_2 + 2K_3 + K_4]$  $= \frac{1}{6} \left[ 0.4 + (0.4402) 2 + (0.4442) 2 + 0.4904 \right]$ - 0.4432 NAL TOTAL REAL YI = Yo+ Ay = 2+0.4432 = 2.4432 -

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Now RK righted for 
$$(y_{1}, y_{1})$$
  
 $k_{1} = \frac{\hbar}{4}(y_{1}, y_{1}) = 0.4902$ .  
 $k_{2} = \frac{\hbar}{2}[x_{1} + \frac{\hbar}{2}, y_{1} + \frac{k_{1}}{2}] = 0.5430$   
 $k_{3} = \frac{\hbar}{3}[x_{1} + \frac{\hbar}{2}, y_{1} + \frac{k_{2}}{2}] = 0.5483$   
 $k_{4} = \frac{\hbar}{3}[x_{1} + \frac{\hbar}{2}, y_{1} + \frac{k_{2}}{2}] = 0.6111$   
 $\Delta y = 0.5473$ .  
 $y_{2} = y_{1} + \Delta y$   
 $= 2.4432 + 0.5473$   
 $= 2.9905$ 

Now KK neethod for (2, y2) where 2=0.4, y2 = 2.9905



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$$k_{1} = h_{1}^{2} (n_{2}, y_{2}) = 0.6108$$

$$k_{2} = h_{1}^{2} (n_{2} + \frac{h}{2}, y_{2} + \frac{k_{1}}{2}) = 0.6841$$

$$k_{3} = h_{1}^{2} (n_{2} + \frac{h}{2}, y_{2} + \frac{k_{2}}{2}) = 0.6914$$

$$k_{4} = h_{1}^{2} (n_{2} + h, y_{2} + k_{3}) = 0.7795$$

$$\Delta y = 0.6902$$

$$y_{3} = y_{2} + \Delta y = 2.9905 + 0.6902 = 3.6807$$

$$(2) Uung kk method og 21 th order, solve  $y'_{2} = \frac{y^{2} - n^{2}}{y^{2} + n^{2}}$ 

$$y_{1}(0) = 1 \text{ at } n = 0.2$$

$$\frac{Soln:}{1.1959}$$

$$(3) Find y(0.8) y_{1} + that y' = y - n^{2}, y(0.6) = 1.7379 \text{ by}$$

$$u_{1}ng Rk method og 4th order. Take h = 0.1$$

$$\frac{Soln:}{y_{1}} = y(0.7) = 1.8762$$

$$y_{2} = y(0.8) = 2.0142$$$$

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