BINF 690
Numerical Methods in Bioinformatics
Final Exam
Due 7:00 pm, Monday, December 12, 2005

For all problems turn any programs/scripts you use as well as any additional work to show exactly what you did. Please make sure all work is clearly explained and presented.

Problem 1

Find the global minimum of the following function using two optimization methods. For the first you should take the derivative and find the root of the resulting equation (calculus based method). For the second, you can choose any other method you like. You can use MATLAB functions or write your own MATLAB code. Please explain the method/algorithm used and justify why it was appropriate.

$$x^4 + 10x^3 + 28x^2 + 30x + 2 = 0$$

Problem 3

Solve the following integral using a numerical integration method. You can use MATLAB functions or write your own MATLAB code. Please explain the method/algorithm used and justify why it was appropriate.

$$\int_0^{10} \frac{2x + xe^{-x}}{x^{3/2}} dx$$

Problem 2

Solve the following system partial differential equations. You can use MATLAB functions or write your own MATLAB code. Please explain the method/algorithm used and justify why it was appropriate. Print and turn-in time course plots (graphs) for V and w for x = 25 cm, x = 50 cm, x = 75 cm.

Parameter	Value	Units
C	20.0	$\mu F\ cm^{-2}$
V_K	-84.0	mV
g_K	8.0	$mS\ cm^{-2}$
V_{Ca}	120.0	mV
g_{Ca}	4.4	$mS\ cm^{-2}$
V_{leak}	-60.0	mV
G_{leak}	2.0	$mS\ cm^{-2}$
v_1	-1.2	mV
v_2	18.0	mV
v_3	2.0	mV
v_4	30.0	mV
Ψ	0.04	ms^{-1}
I_{app}	60.0	$\mu A\ cm^{-2}$
D	1.0	$cm^2\ msec^{-1}$

Initial Conditions

$V(x,0) = -39.0$ mV for $0 \le x \le 2$

$w(x,0) = 0.08$ for $0 \le x \le 2$

$V(x,0) = 0.0$ mV for $2 < x \le 100$

$w(x,0) = 0.1$ for $2 < x \le 100$

Boundary Conditions

$V_x(0,t) = 0.0$, $V_x(100,t) = 0.0$

$w_x(0,t) = 0.0$, $w_x(100,t) = 0.0$

Equations

$$m_\infty = 0.5[1.0 + \tanh((V - v_1)/v_2)]$$

$$w_\infty = 0.5[1.0 + \tanh((V - v_3)/v_4)]$$

$$\tau = 1.0/[\cosh((V - v3)/(2.0\, v_4))]$$

$$I_{Ca} = g_{Ca} m_\infty (V - V_{Ca})$$

$$I_K = g_K w\ (V - V_K)$$

$$I_{leak} = g_{leak} (V - V_{leak})$$

$$C\frac{\partial V}{\partial t} = -I_{Ca} - I_K - I_{leak} + I_{app} + D\frac{\partial^2 V}{\partial x^2}$$

$$\frac{\partial w}{\partial t} = \Psi\ (w_\infty - w)/\tau$$