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Department of Physics

**Introduction to Computational Physics (Phys3111)**

1. Determine initial estimates for the zeros of the function f(x) = x sin x −$\sqrt{x}$

between 0 and 10.

1. *To determine a root of a continuous function f*(*x*) *between zero and one, given that f*(0)*f*(1) *˂*0 *to within* 1*×*10-4*requires n ˃*ln(104)*/* ln 2 *≈* 13*.*28*: in other words fourteen iterations.*
2. *Consider the function f*(*x*) = *xn−a where a ˃*0*. The roots of this equation are* $\sqrt[m]{a}$*or, written another way, a*1 / m*. Then write its Newton–Raphson scheme.*
3. *Find the value of the function at x* = 4*.*5. *Where thedata points are* (1*,-*3)*,* (3*,* 4)*,* (5*,* 5)*,* (7*,-*8)*,* (9*,-*3) *and* (11*,* 0)*, using linearinterpolation.*
4. *Using the data in the previous example now calculate the valueof the interpolating polynomial at x* = 4*.*5 *using cubic interpolation*
5. *Fit a cubic spline to the data x* = (1*,* 2*,* 3*,* 5)*T, f* = (4*,* 2*,* 0*,* 3)*T*

*and plot the interpolated function on a grid z* = 0*,* 0*.*1*,* 0*.*2*, · · · ,* 5*.*

1. *Given that a set of data is of the form y* = *ax* + *b*e*-x*+ *c state.*

*How one would determine the constants a, b and c.*

1. *Determine the eigenvalues and eigenvectors of the matrix*

$$\begin{matrix}1&2\\3&2\end{matrix}$$

*and comment on the effect of the matrix.*

1. *Solve the equation*

$\ddot{y}$+ *y* = 0

*subject to the initial conditions y*(0) = 0 *and* $\dot{y}$(0) = 1*. We introduce the*

*quantitiesx* 1(*t*) = *y*(*t*) *and x*2(*t*) = $\dot{y}$(*t*)*. As such this system can be rewritten as*

$\dot{x}$ *=* $\begin{matrix}0&1\\-1&0\end{matrix}$x

*with***x**0 = (0*,* 1)*T. This has the solution*

**x**(*t*) = exp(**A***t*)**x**0*.*

1. *Construct the matrix* exp(**A**) *where*

*A =* $\begin{matrix}1&2\\0&-1\end{matrix}$

1. *Consider the differential equation*

$\frac{dy}{dt}$= y

*subject to the initial condition that y*(0) = 0 *from 0 to 2. Integrate this*

*equation directly to give y*(*t*) = *t*2*/*2*. Or [ Hint: use the explicit Euler method]*

1. *Solve the differential equation*

$\frac{dy}{dt}$ = (1-t) y

*subject to the initial condition y*(0) = 1 *from t* = 0 *to t* = 5*.*

1. *Solve the differential equation*

$\frac{dy}{dt}$ = y

*subject to the initial condition y*(0) = 1*.*

1. *Solve the equation*

$\frac{dy}{dt}$+ y = sin t

*subject to the initial condition y*(0) = 1 *for the range* [0*,* 1] *in steps of 0.1 using*

*the Crank–Nicolson technique.*