Homework 1, Comp. Modeling

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1 Problems

1. For the following recursion relation

$$F_n = F_{n-1} + F_{n-2}, F_1 = 1, F_0 = 0$$

Calculate the continued fraction

$$\frac{1}{2F_0 + \frac{1}{2F_1 + \frac{1}{2F_2 + \frac{1}{2F_3 + \ldots}}}} \tag{1}$$

2. Calculate the sequence of functions up to n = 10 for

$$\psi_n(u) = \frac{1}{\pi^{1/4}} \frac{1}{\sqrt{2^n n!}} H_n(u) e^{-u^2/2} \tag{2}$$

Where H are the Hermite Polynomials.

2 FORTRAN Code

Listing 1: Comp. Mod. HW.1 file

```
1
2
3  program HW_1
4
5      use numtype
6      implicit none
7              real(qp) :: u, umin, umax, du, w
8              integer :: imax, i, counter, qmin, qmax, &
9                  k, q, n
10             real(qp), dimension(2001,0:10) :: H, Psi
11
12             counter = 1
13             imax = 10
14             umin = -10
15             umax = 10
16             du = .01
17             qmin = -1000
18             qmax = 1000
19
20             u = umin
21             do q = qmin, qmax
22
23                 H(counter,0) = 1
24                 H(counter,1) = 2._qp*u
25                 do i = 1, imax-1
26                 H(counter,i+1) = 2._qp*u*H(counter,i) &
27                 -2*i*H(counter,i-1)
28                 end do
29
30                 w = exp(-((u**2._dp)/2))
31
32                 do n = 0,10
33                 Psi(counter,n) = (pi**(-(1._dp/4._dp)))&
34                 *(((2**n)*(product((/(k,k=1,n)/))))** &
35                 (-(1._dp/2._dp))) * H(counter,n)*w
36                 end do
```

```
37
38                  write(14,*) u, Psi(counter,0:10)
39                  counter = counter + 1
40                  u = u + du
41              end do
42
43      print *,'Problem 1 result :', prob1(10)
44
45
46
47      contains
48
49          function prob1(imax) result(C)
50              implicit none
51              integer :: imax, i
52              real(dp), dimension(imax) :: coeff, y
53              real(dp) :: C
54
55              coeff = 0
56              coeff(1) = 0._dp
57              coeff(2) = 1._dp
58
59              do i = 3, imax
60                  coeff(i) = coeff(i-1) + coeff(i-2)
61              end do
62
63              y = 0
64              y(imax) = coeff(imax)
65              do i = imax-1, 1, -1
66                  y(i) = 2**coeff(i) + (1/y(i+1))
67              end do
68
69              C = 1/y(1)
70
71
72          end function prob1
73
74  end program HW_1
```

3 Results

The result of the continued fraction is:

$$0.70980344286$$

The Graph of $\psi_n(u)$ for n from 1 to 10:

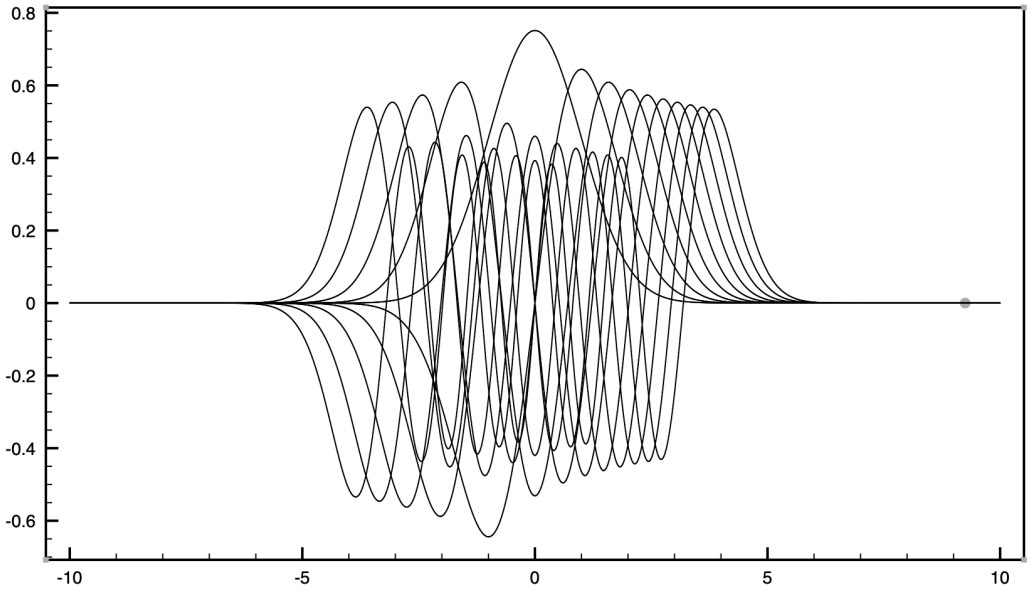

Figure 1: $\psi_n(u)$