A6_Q3

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```
In [7]: using LinearAlgebra

        function HMat(J,N,B)
            Ham = zeros(Float32, 2^N, 2^N)
            for Ket = 0:(2^N - 1) # Loop over the kets
                Diagonal::Float32 = 0
                for SpinIndex = 0:N-2 # loop through the indices
                    Spin1 = 2*((Ket>>SpinIndex) & 1)-1
                    Spin2 = 2*((Ket>>(SpinIndex+1)) & 1) - 1
                    Diagonal = Diagonal - 0.25*Spin1*Spin2
                end
                Ham[Ket+1,Ket+1] = J*Diagonal # Fill the diagonal component
                # Adding in the Bra component
                for SpinIndex = 0:N-1
                    bit = 2^SpinIndex
                    Bra = Ket  bit # Define our Bra for each Ket
                    Ham[Ket+1,Bra+1] = -0.5*B # Fill the off-diagonal components
                    #println(Ket, " ", Bra)
                end
            end
            return Ham
        end

        # Q3 a)
        # (J=1,N=2,B=0.5)
        Ham = HMat(1,2,0.5)
        display(Ham)
        print("Min Eigenvalue: ")
        println(eigen(Ham).values[1])
        print("Groundstate Eigenvector: ")
        println(eigen(Ham).vectors[1:4])
```

```
4×4 Array{Float32,2}:
 -0.25  -0.25  -0.25   0.0
 -0.25   0.25   0.0   -0.25
 -0.25   0.0    0.25  -0.25
  0.0   -0.25  -0.25  -0.25
```

```
Min Eigenvalue: -0.5590167
Groundstate Eigenvector: Float32[-0.601501, -0.371748, -0.371748, -0.601501]
```

```
In [18]: # Q3 b)
         Ham = HMat(1,6,0)
         eigenvalues = eigen(Ham).values
         m = 0
         for i = 1:2^6
             m = m + eigenvalues[i]
         end
         print("Magnetization: ")
         println(m/6)
```

```
Magnetization: 0.0
```

```
In [19]: Ham = HMat(0,6,1)
         eigenvalues = eigen(Ham).values
         m = 0
         for i = 1:2^6
             m = m + eigenvalues[i]
         end
         print("Magnetization: ")
         println(m/6)
```

```
Magnetization: 2.5828679e-6
```

```
In [20]: Ham = HMat(1,6,0.5)
         eigenvalues = eigen(Ham).values
         m = 0
         for i = 1:2^6
             m = m + eigenvalues[i]
         end
         print("Magnetization: ")
         println(m/6)
```

```
Magnetization: -1.1920929e-7
```