Assignment 4: QFT

MATLAB exercise.

% Solved with circuit

% --H------R2------------|--

% |I> |A> | |B> |C> | |Q>

% ---------x-------H-----|--

Let |I> be identity (2x2), H be Hadamard, R2 be controlled rotation (note where I marked the control)

|A>, |B>, |C> are intermediate quantum states.

|Q> is the final state (assuming measurement)

Example 1:

Let’s derive the following

%|A> = U1|I>

%|B> = U2|A>

%|C> = U3|B>

%|Q> = U4|C>

U1 = Tensor(Hgate,Ident);

U2 = rGate(2);

U3 = Tensor(Ident,Hgate);

U4 = swapGate;

Where

function out=rGate(p)

out = [1,0,0,0;0,1,0,0;0,0,1,0;0,0,0,exp(2\*pi\*i/(2^p))];

end

% swap

swapGate = [1 0 0 0;0 0 1 0;0 1 0 0;0 0 0 1];

Q = U1\*U2\*U3\*U4;

Example 2:

% 2-qubit QFT

% Solved equation |x1 x2>

% |x1> --H--R2-----|-- 1/sqrt(2) \* (|0> + exp (2\*i\*pi\* (x1/2+x2/4))|1>)

% | |

% |x2> -----x---H--|-- 1/sqrt(2) \* (|0> + exp (2\*i\*pi\* (x2/2))|1>)

% |00>

a1=1/sqrt(2)\*(bloch0+exp(2\*i\*pi\*(0/2+0/4))\*bloch1);

a2=1/sqrt(2)\*(bloch0+exp(2\*i\*pi\*(0/2))\*bloch1);

% |01>

a3=1/sqrt(2)\*(bloch0+exp(2\*pi\*i\*(0/2+1/4))\*bloch1);

a4=1/sqrt(2)\*(bloch0+exp(2\*pi\*i\*1/2)\*bloch1);

% |10>

a5=1/sqrt(2)\*(bloch0+exp(2\*pi\*i\*(1/2+0/4))\*bloch1);

a6=1/sqrt(2)\*(bloch0+exp(2\*i\*pi\*(0/2))\*bloch1);

% |11>

a7=1/sqrt(2)\*(bloch0+exp(2\*pi\*i\*(1/2 + 1/4))\*bloch1);

a8=1/sqrt(2)\*(bloch0+exp(2\*pi\*i\*1/2)\*bloch1);

my2QFT = [Tensor(a2,a1),Tensor(a4,a3),Tensor(a6,a5),Tensor(a8,a7)];

FourierMatrix(4)

Where

bloch0 = [1;0];

bloch1 = [0;1];

Exercise 3:

% Solved with circuit

% --H------R2-----R3--------------------------------|--

% |I> |A> | |B> | | |Q>

% ---------x------|---------H-------R2--------------|--

% | |C> |D> | |E> |F> |

% ----------------x-----------------x-------H-------|--

%|A> = U1|I>

%|B> = U2|A>

%|C> = U3|B>

%|D> = U4|C>

%|E> = U5|D>

%|F> = U6|E>

%|Q> = U7|F>

U1 = Tensor(myHgate,ident);

U2 = rGate(2);

U3 = rGate(3);

Can you finish the rest?