Muhammad Ahmed Qazi
CS-24045

Week #01

Reporting on tasks assigned

Question 01: Implement a 32-bit Adder

Code: Adder32

Output:

```
VCD info: dumpfile adder_32.vcd
opened for output.

----- Starting 32-bit Adder Self-
Checking Testbench -----

TEST 1 PASS: a=00000000 b=00000000
cin=0 sum=00000000 cout=0

TEST 2 PASS: a=ffffffff b=ffffffff
cin=0 sum=fffffffe cout=1

TEST 3 PASS: a=80000000 b=80000000
cin=0 sum=00000000 cout=1

TEST 4 PASS: a=12345678 b=87654321
cin=1 sum=9999999a cout=0

TEST 5 PASS: a=12153524 b=c0895e81
cin=1 sum=d29e93a6 cout=0

TEST 6 PASS: a=b1f05663 b=06b97b0d
cin=1 sum=b8a9d171 cout=0

TEST 7 PASS: a=b2c28465 b=89375212
cin=1 sum=3bf9d678 cout=1

TEST 8 PASS: a=06d7cd0d b=3b23f176
cin=1 sum=41fbbe84 cout=0

TEST 9 PASS: a=76d457ed b=462df78c
cin=1 sum=bd024f7a cout=0

TEST 10 PASS: a=e33724c6 b=e2f784c5
cin=0 sum=c62ea98b cout=1

TEST 11 PASS: a=72aff7e5 b=bbd27277
cin=0 sum=2e826a5c cout=1

TEST 12 PASS: a=47ecdb8f b=793069f2
cin=0 sum=c11d4581 cout=0

TEST 13 PASS: a=f4007ae8 b=e2ca4ec5
cin=0 sum=d6cac9ad cout=1

TEST 14 PASS: a=de8e28bd b=96ab582d
cin=1 sum=753980eb cout=1

TEST 15 PASS: a=b1ef6263 b=0573870a
cin=0 sum=b762e96d cout=0

TEST 16 PASS: a=10642120 b=557845aa
cin=1 sum=65dc66cb cout=0

TEST 17 PASS: a=cb203e96 b=8983b813
cin=1 sum=54a3f6aa cout=1

TEST 18 PASS: a=a9a7d653 b=359fdd6b
cin=1 sum=df47b3bf cout=0

TEST 19 PASS: a=81174a02 b=d7563eae
cin=1 sum=586d88b1 cout=1

TEST 20 PASS: a=e7c572cf b=11844923
cin=0 sum=f949bbf2 cout=0

TEST 21 PASS: a=e5730aca b=9e314c3c
cin=0 sum=83a45706 cout=1

TEST 22 PASS: a=452e618a b=20c4b341
cin=0 sum=65f314cb cout=0

TEST 23 PASS: a=3c20f378 b=c48a1289
cin=1 sum=00ab0602 cout=1

TEST 24 PASS: a=5b0265b6 b=634bf9c6
cin=0 sum=be4e5f7c cout=0

TEST 25 PASS: a=de7502bc b=150fdd2a
cin=1 sum=f384dfe7 cout=0

TEST 26 PASS: a=b897be71 b=42f24185
cin=1 sum=fb89fff7 cout=0
```

Muhammad Ahmed Qazi
CS-24045

```
TEST 27 PASS: a=9dcc603b b=1d06333a cin=0 sum=bad29375 cout=0

TEST 28 PASS: a=0aaa4b15 b=78d99bf1 cin=1 sum=8383e707 cout=0

TEST 29 PASS: a=31230762 b=2635fb4c cin=1 sum=575902af cout=0

TEST 30 PASS: a=47b9a18f b=7c6da9f8 cin=1 sum=c4274b88 cout=0

TEST 31 PASS: a=cfc4569f b=ae7d945c cin=1 sum=7e41eafc cout=1

TEST 32 PASS: a=44de3789 b=a4ae3249 cin=0 sum=e98c69d2 cout=0

TEST 33 PASS: a=ebfec0d7 b=a8c7fc51 cin=0 sum=94c6bd28 cout=1

TEST 34 PASS: a=061d7f0c b=e12ccec2 cin=0 sum=e74a4dce cout=0

TEST 35 PASS: a=bb825a77 b=1ef2ed3d cin=0 sum=da7547b4 cout=0

TEST 36 PASS: a=bf05007e b=36e5816d cin=1 sum=f5ea81ec cout=0

TEST 37 PASS: a=0fd28f1f b=e9ebf6d3 cin=1 sum=f9be85f3 cout=0

TEST 38 PASS: a=bc148878 b=2dda595b cin=1 sum=e9eee1d4 cout=0

TEST 39 PASS: a=9ff2ae3f b=150caf2a cin=0 sum=b4ff5d69 cout=0

TEST 40 PASS: a=c33f3886 b=c71a0c8e cin=0 sum=8a594514 cout=1

TEST 41 PASS: a=7d3599fa b=937dbc26 cin=1 sum=10b35621 cout=1

TEST 42 PASS: a=d18bb4a3 b=9799a82f cin=1 sum=69255cd3 cout=1

TEST 43 PASS: a=afd8565f b=22290d44 cin=1 sum=d20163a4 cout=0

TEST 44 PASS: a=e59b36cb b=f3091ae6 cin=0 sum=d8a451b1 cout=1

TEST 45 PASS: a=14cfc129 b=f682e2ed cin=0 sum=0b52a416 cout=1

TEST 46 PASS: a=b29fb665 b=da8ae2b5 cin=1 sum=8d2a991b cout=1

TEST 47 PASS: a=3cf11979 b=2231ff44 cin=0 sum=5f2318bd cout=0

TEST 48 PASS: a=15090b2a b=55f6adab cin=0 sum=6affb8d5 cout=0

TEST 49 PASS: a=6e5daddc b=cd5ebc9a cin=1 sum=3bbc6a77 cout=1

TEST 50 PASS: a=e1f102c3 b=2b0eed56 cin=0 sum=0cfff019 cout=1

TEST 51 PASS: a=b3d97667 b=8531340a cin=0 sum=390aaa71 cout=1

TEST 52 PASS: a=9c0e8a38 b=3cd18779 cin=0 sum=d8e011b1 cout=0

TEST 53 PASS: a=4a74bf94 b=49c65d93 cin=0 sum=943b1d27 cout=0

TEST 54 PASS: a=acb7ca59 b=6dcb69db cin=1 sum=1a833435 cout=1

----- Testbench Summary -----

Total tests run : 54

Tests passed    : 54

Tests failed    : 0
```

Waveform: [Adder32 Waveform PDF]

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CS-24045

Question 02: Implement a 8-to-3 Encoder

Code: Encoder_8to3

Output:

```
VCD info: dumpfile encoder_8to3.vcd
opened for output.

----- Starting 8-to-3 Encoder Self-
Checking Testbench -----

TEST 1 PASS: in=00000001 en=1
out=000 gs=1 e0=0

TEST 2 PASS: in=00000010 en=1
out=001 gs=1 e0=0

TEST 3 PASS: in=00000100 en=1
out=010 gs=1 e0=0

TEST 4 PASS: in=00001000 en=1
out=011 gs=1 e0=0

TEST 5 PASS: in=00010000 en=1
out=100 gs=1 e0=0

TEST 6 PASS: in=00100000 en=1
out=101 gs=1 e0=0

TEST 7 PASS: in=01000000 en=1
out=110 gs=1 e0=0

TEST 8 PASS: in=10000000 en=1
out=111 gs=1 e0=0

TEST 9 PASS: in=00000000 en=1
out=000 gs=0 e0=1

TEST 10 PASS: in=11111111 en=0
out=000 gs=0 e0=0

TEST 11 PASS: in=00100100 en=1
out=101 gs=1 e0=0

TEST 12 PASS: in=10000001 en=1
out=111 gs=1 e0=0

TEST 13 PASS: in=00001001 en=1
out=011 gs=1 e0=0

TEST 14 PASS: in=01100011 en=1
out=110 gs=1 e0=0

TEST 15 PASS: in=00001101 en=1
out=011 gs=1 e0=0

TEST 16 PASS: in=10001101 en=1
out=111 gs=1 e0=0

TEST 17 PASS: in=01100101 en=1
out=110 gs=1 e0=0

TEST 18 PASS: in=00010010 en=1
out=100 gs=1 e0=0

TEST 19 PASS: in=00000001 en=1
out=000 gs=1 e0=0

TEST 20 PASS: in=00001101 en=1
out=011 gs=1 e0=0

TEST 21 PASS: in=01110110 en=1
out=110 gs=1 e0=0

TEST 22 PASS: in=00111101 en=1
out=101 gs=1 e0=0

TEST 23 PASS: in=11101101 en=1
out=111 gs=1 e0=0

TEST 24 PASS: in=10001100 en=1
out=111 gs=1 e0=0

TEST 25 PASS: in=11111001 en=1
out=111 gs=1 e0=0

TEST 26 PASS: in=11000110 en=1
out=111 gs=1 e0=0

TEST 27 PASS: in=11000101 en=1
out=111 gs=1 e0=0

TEST 28 PASS: in=10101010 en=1
out=111 gs=1 e0=0

TEST 29 PASS: in=11100101 en=1
out=111 gs=1 e0=0

TEST 30 PASS: in=01110111 en=1
out=110 gs=1 e0=0
```

Muhammad Ahmed Qazi
CS-24045

```
----- Testbench Summary -----

Total tests run : 30

Tests passed    : 30

Tests failed    : 0

encoder_tb.sv:111: $finish called
at 30000 (1ps)
```

Waveform: [Encoder 8to3 Waveform PDF]

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CS-24045

Question 03: Implement a 32-bit Barrel Shifter

Code: [Barrel Shifter]

Output:

```
VCD info: dumpfile
barrel_shifter.vcd opened for
output.

----- Starting 32-bit Barrel
Shifter Self-Checking Testbench ---
--

TEST 1 PASS: data_in=00000001
shift=1 dir=0 data_out=00000000

TEST 2 PASS: data_in=00000001
shift=1 dir=1 data_out=00000002

TEST 3 PASS: data_in=80000000
shift=31 dir=0 data_out=00000001

TEST 4 PASS: data_in=00000001
shift=31 dir=1 data_out=80000000

TEST 5 PASS: data_in=ffffffff
shift=16 dir=0 data_out=0000ffff

TEST 6 PASS: data_in=ffffffff
shift=16 dir=1 data_out=ffff0000

TEST 7 PASS: data_in=12345678
shift=4 dir=0 data_out=01234567

TEST 8 PASS: data_in=12345678
shift=4 dir=1 data_out=23456780

TEST 9 PASS: data_in=12153524
shift=1 dir=1 data_out=242a6a48

TEST 10 PASS: data_in=b1f05663
shift=13 dir=1 data_out=0acc6000

TEST 11 PASS: data_in=b2c28465
shift=18 dir=1 data_out=11940000

TEST 12 PASS: data_in=06d7cd0d
shift=22 dir=1 data_out=43400000

TEST 13 PASS: data_in=76d457ed
shift=12 dir=1 data_out=457ed000

TEST 14 PASS: data_in=e33724c6
shift=5 dir=0 data_out=0719b926

TEST 15 PASS: data_in=72aff7e5
shift=23 dir=0 data_out=000000e5

TEST 16 PASS: data_in=47ecdb8f
shift=18 dir=0 data_out=000011fb

TEST 17 PASS: data_in=f4007ae8
shift=5 dir=0 data_out=07a003d7

TEST 18 PASS: data_in=de8e28bd
shift=13 dir=1 data_out=c517a000

TEST 19 PASS: data_in=b1ef6263
shift=10 dir=0 data_out=002c7bd8

TEST 20 PASS: data_in=10642120
shift=10 dir=1 data_out=90848000

TEST 21 PASS: data_in=cb203e96
shift=19 dir=1 data_out=f4b00000

TEST 22 PASS: data_in=a9a7d653
shift=11 dir=1 data_out=3eb29800

TEST 23 PASS: data_in=81174a02
shift=14 dir=1 data_out=d2808000

TEST 24 PASS: data_in=e7c572cf
shift=3 dir=0 data_out=1cf8ae59

TEST 25 PASS: data_in=e5730aca
shift=28 dir=0 data_out=0000000e

TEST 26 PASS: data_in=452e618a
shift=1 dir=0 data_out=229730c5

TEST 27 PASS: data_in=3c20f378
shift=9 dir=1 data_out=41e6f000

TEST 28 PASS: data_in=5b0265b6
shift=6 dir=0 data_out=016c0996

TEST 29 PASS: data_in=de7502bc
shift=10 dir=1 data_out=d40af000
```

```
TEST 30 PASS: data_in=b897be71
shift=5 dir=1 data_out=12f7ce20

TEST 31 PASS: data_in=9dcc603b
shift=26 dir=0 data_out=00000027

TEST 32 PASS: data_in=0aaa4b15
shift=17 dir=1 data_out=962a0000

TEST 33 PASS: data_in=31230762
shift=12 dir=1 data_out=30762000

TEST 34 PASS: data_in=47b9a18f
shift=24 dir=1 data_out=8f000000

TEST 35 PASS: data_in=cfc4569f
shift=28 dir=1 data_out=f0000000

TEST 36 PASS: data_in=44de3789
shift=9 dir=0 data_out=00226f1b

TEST 37 PASS: data_in=ebfec0d7
shift=17 dir=0 data_out=000075ff

TEST 38 PASS: data_in=061d7f0c
shift=2 dir=0 data_out=01875fc3

TEST 39 PASS: data_in=bb825a77
shift=29 dir=0 data_out=00000005

TEST 40 PASS: data_in=bf05007e
shift=13 dir=1 data_out=a00fc000

TEST 41 PASS: data_in=0fd28f1f
shift=19 dir=1 data_out=78f80000

TEST 42 PASS: data_in=bc148878
shift=27 dir=1 data_out=c0000000

TEST 43 PASS: data_in=9ff2ae3f
shift=10 dir=0 data_out=0027fcab

TEST 44 PASS: data_in=c33f3886
shift=14 dir=0 data_out=00030cfc

TEST 45 PASS: data_in=7d3599fa
shift=6 dir=1 data_out=4d667e80

TEST 46 PASS: data_in=d18bb4a3
shift=15 dir=1 data_out=da518000

TEST 47 PASS: data_in=afd8565f
shift=4 dir=1 data_out=fd8565f0

TEST 48 PASS: data_in=e59b36cb
shift=6 dir=0 data_out=03966cdb

TEST 49 PASS: data_in=14cfc129
shift=13 dir=0 data_out=0000a67e

TEST 50 PASS: data_in=b29fb665
shift=21 dir=1 data_out=cca00000

TEST 51 PASS: data_in=3cf11979
shift=4 dir=0 data_out=03cf1197

TEST 52 PASS: data_in=15090b2a
shift=11 dir=0 data_out=0002a121

TEST 53 PASS: data_in=6e5daddc
shift=26 dir=1 data_out=70000000

TEST 54 PASS: data_in=e1f102c3
shift=22 dir=0 data_out=00000387

TEST 55 PASS: data_in=b3d97667
shift=10 dir=0 data_out=002cf65d

TEST 56 PASS: data_in=9c0e8a38
shift=25 dir=0 data_out=0000004e

TEST 57 PASS: data_in=4a74bf94
shift=19 dir=0 data_out=0000094e

TEST 58 PASS: data_in=acb7ca59
shift=27 dir=1 data_out=c8000000

----- Testbench Summary -----

Total tests run : 58

Tests passed    : 58

Tests failed    : 0

barrel_shifter_tb.sv:99: $finish
called at 58000 (1ps)
```

Waveform: [Barrel Shifter Waveform PDF]