California State University, Sacramento
The College of Engineering and Computer Science

CPE 186 Computer Hardware Design

Midterm

Fall 2020

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   _____

1. [36 points] Each of the following questions only has one correct answer. Please select the correct answer.

1). With PCI Bus width of 64 bits and running at maximum 33MHz, the maximum data transfer rate is going to be
A. 132 MBps   B. 264 MBps   C. 512 MBps

2). When IRDY# gets asserted, it indicates which of the following agent is ready for transaction?
A. Initiator   B. Target   C. None

3). What is the functionality of C/BE[3:0]?
A. Defines the PCI command during address phase.
B. Indicate byte enable during address phase.
C. None of the above.

4). For PCI Express (PCIe) Transactions:
A.   Memory Read is Posted Transaction.
B.   IO Read is Non-Posted Transaction.
C.   Configuration Write is Posted Transaction.

5). Sequence Number is first added into the TLP packet by the PCIe transmitter at the
A.   Transaction Layer
B.   Data Link Layer
C.   PHY Layer

6). PCIe TLP maximum data payload transfer size is
A. 2 DW   B. 3 DW   C. 1024 DW

7). FRAME# is used to signal
A.   only start of a transaction   B. only end of a transaction
C.   the start and end of a transaction.

8). PCIe Type 0 configuration space has
A. 2 Base Address Registers   B. 4 Base Address Registers   C. 6 Base Address Registers

9). PCIe TLP header size is
A. 6 Words or 8 Words   B. 12 Bytes or 24 Bytes   C. 4 DW or 5 DW

10). PCIe replay buffer is located inside the
A.   Transaction Layer
B.   Data Link Layer
C.   PHY Layer

11). Suppose a legacy device ABC is restricted to the lower 16 bits of PCIe IO address space. This means, the device ABC supports
A.   64 GB IO address space
B.   64 MB IO address space
C.   64 KB IO address space

12). Which of the following statement about PCIe is correct?
A.   The transmitter uses a 2-bit Replay Number counter, referred to as the REPLAY_NUM counter, to keep track of the number of replay events.
B.   The transmitter uses a 8-bit Replay Number counter, referred to as the REPLAY_NUM counter, to keep track of the number of replay events.
C.   The transmitter uses a 12-bit Replay Number counter, referred to as the REPLAY_NUM counter, to keep track of the number of replay events.
D.   The transmitter uses a 20-bit Replay Number counter, referred to as the REPLAY_NUM counter, to keep track of the number of replay events.

2.   [24 points].

```verilog
`timescale 1 ns / 1 ns
module cir(a, b, f);
 input  a, b;
 output f;
 assign f =  ~( a & b);
endmodule
```

(1). Write a general verilog testbench for the above circuit without using any task. You must include all four testing cases for a and b.

```verilog
module cir_tb;


module cir_tb;
reg a,b;
wire f;

cir utt(a,b,f);

initial begin
a=0;
b=0;

#10;
a=1;
b=0;

#10;
a=0;
b=1;

#10;
a=1;
b=1;

#10 $stop;
```

```
end
endmodule
```

(2). Modify the above testbench by using task called "test" below to
rewrite your testbench.


```
`timescale 1 ns / 1 ns

module cir_tb;
 reg __a,b_____;
 wire f;
 cir g1 ( ____a____, ____b_____, f);

 initial  begin
   a = 0; b = 0;
   #10 test( f, 1 );
   a = 0; b = 1;
   #10 test( f, _____0_____ );
   a = 1; b = 0;
   #10 test( f, _____0_____ );
   a = 1; b = 1;
   #10 test( f, _____1_____ );
   #10 $stop;
 end

 task test;
// Write a task in Verilog of "test" which compares two input data
// values, one is from generated testing output result and another
// one is from expected testing result and find out if they are equal.
// If the two values are not equal, display the simulation time,
// the error massage, as well as the testing values of a and b.


Task check res;
input data;
input res;

begin
        if(data!=res)
                $display($time, "ns, Error: a=%b, b=%b, Expected value =
%d, Actual value = %d \n", a, b,  res, data);
end


endtask
endmodule
```
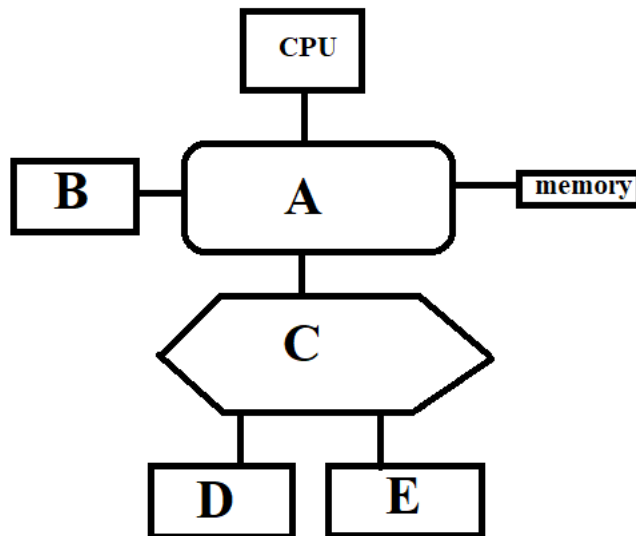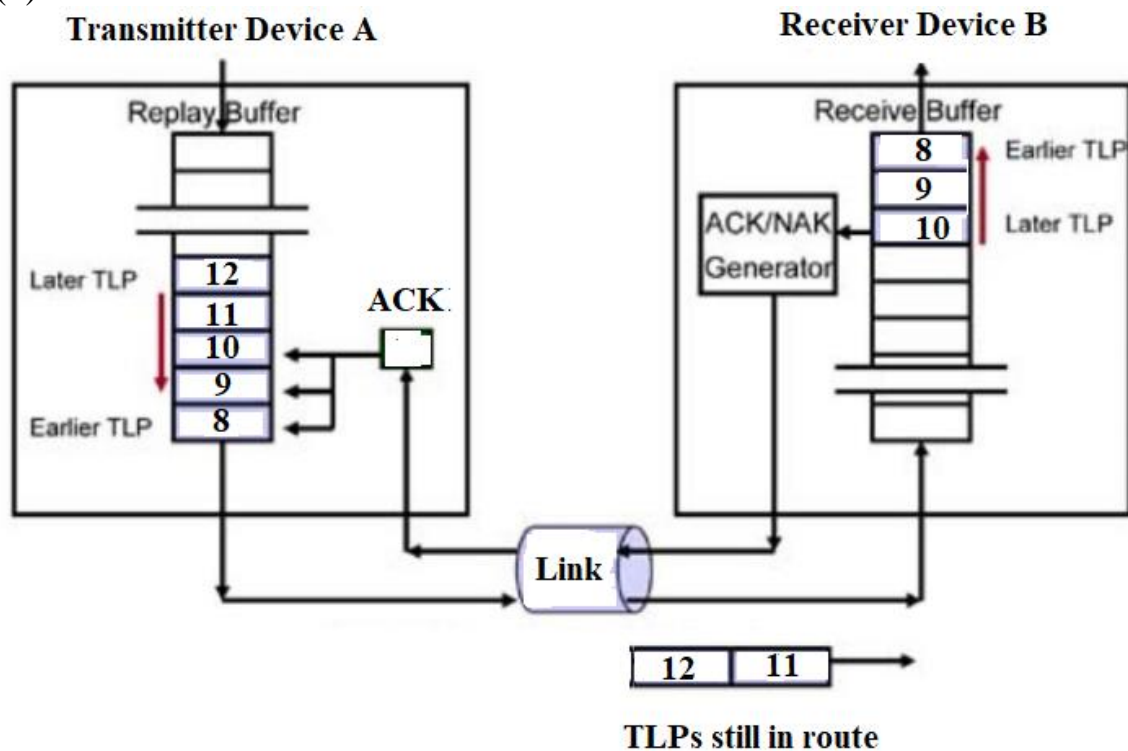
3. [40 points]

(1). Fill out 5 blanks with different PCIe hardware unit names of Endpoint (EP),   Switch, and Root Complex in the diagram below.

```
           ┌───────┐
           │  CPU  │
           └───────┘
               │
 ┌─────┐   ┌─────────────┐   ┌────────┐
 │  B  │───│      A      │───│ memory │
 └─────┘   └─────────────┘   └────────┘
                │
          ╱─────────────╲
         ⟨      C        ⟩
          ╲─────────────╱
             │      │
         ┌──────┐ ┌──────┐
         │  D   │ │  E   │
         └──────┘ └──────┘
```

A : __Root Complex_____ ,   B:__Legacy EndPoint_____,
C: _____Switch_____

D : _____PCI-XP Endpoint_____ ,   E:_PCI-XP Bridge to PCI___

(2).

Transmitter Device A

Receiver Device B

TLPs still in route

Device A transmits TLPs with Sequence Numbers 8, 9, 10, 11, 12 where TLP 8 is the first TLP sent and TLP 12 is the last TLP sent.

Device B receives TLPs with Sequence Numbers 8, 9, 10 in that order. TLP 11, 12 are still en route.

Device B performs the error checks and collectively acknowledges good receipt of TLPs 8, 9, 10.

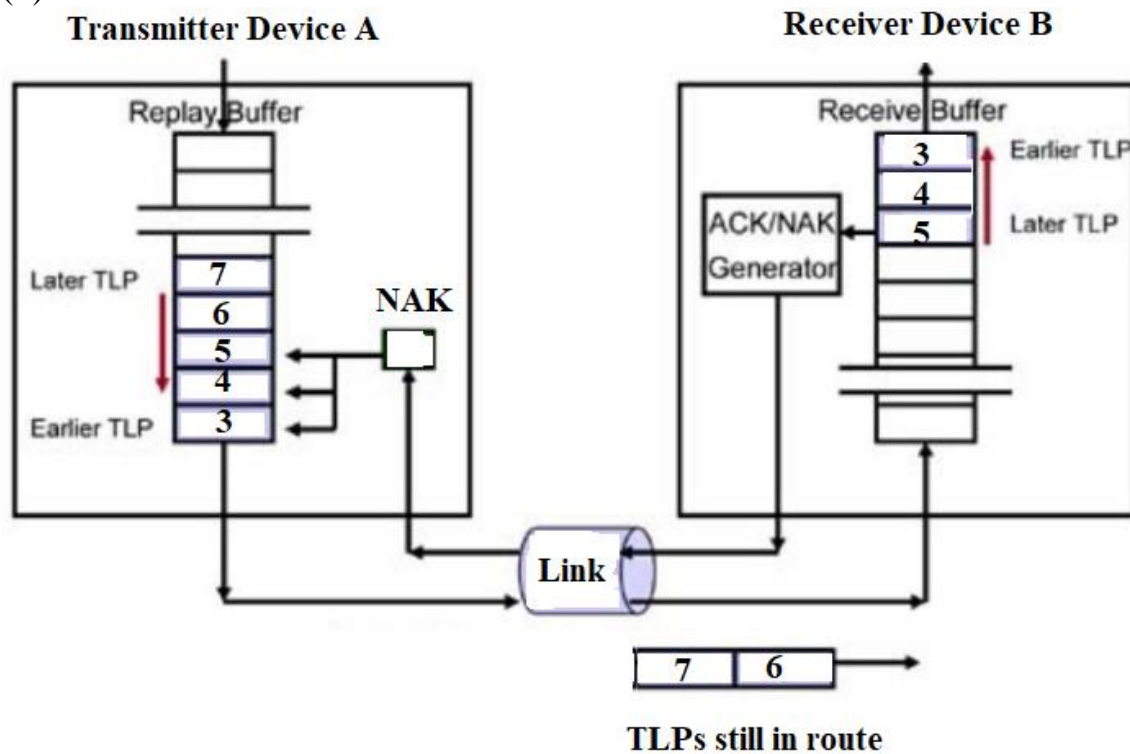i. What sequence number will Device B return with in its ACK DLLP packet?

Your Answer: sequence number _____11_____.

ii. What will Device A do with the TLP packets in its replay buffer after it receives the above ACK information successfully?

Your Answer:

A will clear 8,9,10 from its buffer and remain with 11, 12. It will then send sequence number 11 followed by sequence number 12.

(3).

Device A transmits TLPs with Sequence Numbers 3, 4, 5, 6, and 7. Device B receives TLP 3 with no error. However, it receives TLP 4 with a CRC error. Device B schedules the return of a NAK DLLP with a Sequence Number.

     i.   What sequence number will Device B send to Device A in its NAK DLLP packet?

          Your Answer: sequence number _____4_____.

     ii.   What will Device A do with the TLP packets 3, 4, 5, 6, and 7 in its replay buffer after it receives the above NAK information successfully?

<u>Your Answer</u>:
Buffer accepts all the packet which is send after 4 but it sends every time negative acknowledge until it will not get the correct packet of 4.
So, Device A has only packet 4 in Replay buffer.

(4). The receiver Device B returns an ACK/NAK DLLP to the Device A, but the remote transmitter Device A detects a CRC error in the DLLP. What will the transmitter Device A do after detecting CRC error in its received ACK/NAK DLLP?

<u>Your Answer</u>:

If DLLP CRC error is detected, the DLLP is discarded and an error is reported