

Instructions

- ❖ No cell phones, calculators, etc.
- ❖ Use pencil, if you brought one.
- ❖ For multiple-choice questions, circle the letter of the *one best choice* unless the question specifically says to select “all” correct choices.
- ❖ There is no penalty for guessing, so answer all questions.
- ❖ Place drawings where indicated in the question; be sure to put the question number next to your drawing; use pencil rather than ink.
- ❖ Unless otherwise indicated, all questions count equally.

1. How many OR gates are there in a *decoder* with m inputs?
 - A. 0
 - B. 1
 - C. m
 - D. 2^m
 - E. 32

2. How many OR gates are there in a *multiplexer* with m inputs and one output?
 - A. 0
 - B. 1
 - C. m
 - D. 2^m
 - E. 123

3. What is the name of the datapath component that provides operands to the ALU and stores the result?
 - A. PC
 - B. Memory
 - C. Clock
 - D. Register File
 - E. Disk

4. How many *address* wires are there for an $m \times n$ memory?
 - A. m
 - B. n
 - C. $m \times n$
 - D. 2^m
 - E. $\log_2(m)$

5. How many *data* wires are there for an $m \times n$ memory?
 - A. m
 - B. n
 - C. $m \times n$
 - D. 2^m
 - E. $\log_2(m)$

6. Which sentence describes a memory *read* operation?
 - A. Given an address, the memory outputs the data at that address.
 - B. Given an address and data, the memory saves the data at that address.
 - C. Given some data, the memory outputs the corresponding address.
 - D. Given some data, the memory saves the address of the data.
 - E. Transfer data to disk from the CPU.

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7. Which sentence describes a memory *write* operation?
- A. Given an address, the memory outputs the data at that address.
 - B. Given an address and data, the memory saves the data at that address.
 - C. Given some data, the memory outputs the corresponding address.
 - D. Given some data, the memory saves the address of the data.
 - E. Transfer data from disk to the CPU.
8. How many wires are associated with *each* port of the full MIPS register file? _____
9. How many wires are associated with *each* port of the Assignment 5 register file? _____
10. How many *ports* does a MIPS register file have?
- A. 1 read port and 1 write port.
 - B. 1 port, which is used for both reading and writing.
 - C. 1 port for reading and 2 ports for writing.
 - D. 2 ports for reading and 1 port for writing.
 - E. 2 ports for reading and 2 ports for writing.
11. Which of the following is the set of inputs and outputs for *one* register from Assignment 5?
- A. DataIn[31..0], DataOut[31..0], Clock, Enable
 - B. DataIn[7..0], DataOut[7..0], Clock, Enable
 - C. DataIn[7..0], DataOut[7..1], Clock, Enable
 - D. DataIn[3..0], DataOut[3..0], Clock, Enable
 - E. DataIn[2..0], DataOut[3..0], Clock, Enable
12. On the back of an exam sheet, write this question number (that would be 12), and draw the gates to implement a decoder with three inputs, plus *enable*. Be sure to label the outputs meaningfully.
13. Which sentence describes the behavior of the circuit in Question 12?
- A. Any number of outputs can be true at once.
 - B. Exactly one output is true at a time.
 - C. No more than one output is true at a time.
 - D. One or more outputs can be true at the same time.
 - E. Either all the outputs are true, or all the outputs are false.
14. The circuit in Question 12 is used in Assignment 5. In that context, where do the inputs come from?
- A. RR1
 - B. RR2
 - C. WR
 - D. WD
 - E. RegWrite
15. And where do the outputs go?
- A. The *select* inputs of the multiplexers
 - B. The *data* inputs of the multiplexers
 - C. The *data* inputs of the registers
 - D. The *clock* inputs of the registers
 - E. The *enable* inputs of the registers
16. What are multiplexers used for in a MIPS register file?
- A. To store the data bits.
 - B. To select which registers are output from the register file.
 - C. To select which registers get written to.
 - D. To select which function the ALU is to perform.
 - E. There are no multiplexers in a MIPS register file.

17. To what do the RR1 and RR2 inputs of the register file connect?

- A. The decoder.
- B. The data inputs of the registers.
- C. The data outputs of the register.
- D. The data inputs of the multiplexers.
- E. The select inputs of the multiplexers.

18. How many outputs are there from each multiplexer in an $m \times n$ register file?

- A. m
- B. n
- C. $\log_2(m)$
- D. $\log_2(n)$
- E. 2^m

19. Describe what happens during one clock cycle of the MIPS datapath:

20. Which statement(s) describe the architecture of the MIPS main memory? Circle the letter(s) of *all* correct choices.

- A. It is byte addressable.
- B. It has 2^{32} bytes.
- C. There are 4 bytes per word.
- D. Addresses are 32 bits wide.
- E. There are 2^{30} words.

21. What is the name of the MIPS instruction that performs memory read operations?

- A. Load Word
- B. Store Word
- C. Input
- D. Output
- E. Jump

22. Which of the following *Verilog statements* describes the execution of the *add* instruction?

- A. `add r1, r2, r3;`
- B. `R[rd] = R[rs] + R[rt];`
- C. `rd = rs + rt;`
- D. `{rd,rs,rt};`
- E. `add(r1, r2, r3);`

23. Which of the following Verilog expressions describes the calculation of the Branch Target Address?

- A. `{16{immediate[15]},immediate}`
- B. `{14{immediate[15]},immediate,2'b0}`
- C. `PC+4+{16{immediate[15]},immediate}`
- D. `PC+4+{14{immediate[15]},immediate,2'b0}`
- E. `{PC+4[31:28],address}`

24. Name three uses of the I format in the MIPS Instruction Set:

A. _____

B. _____

C. _____

25. Describe in *English sentences, not Verilog*, what the *beq* instruction does:

26. How many bits are there in the *op code* field of MIPS instructions?

A. 0

B. 6

C. 16

D. 32

E. It depends on the instruction