

1.

$$\begin{aligned}
sw(c) &\equiv opc(c) = 101011 \\
lui(c) &\equiv opc(c) = 001111 \\
bgtz(c) &\equiv opc = 000001 \wedge rt(c) = 00000 \\
slt(i) &\equiv rtype(c) \wedge fun(c) = 101010 \\
jal(c) &\equiv opc(c) = 000011
\end{aligned}$$

- 2.
- 000000 00001 11111 10101 00000 100001  
 $rtype, addu, opc = 000000, rs = 1, rt = 31, rd = 21, fun = 100001$   
 $addu\$21\$1\$31, gpr(21) = gpr(1) + gpr(31)$
  - 000000 01010 10101 11000 00000 100111  
 $rtype, nor, opc=000000, rs=10, rt= 21, rd = 24, fun = 100111$   
 $nor\$24\$10\$21, gpr(24) = gpr(10) \text{ nor } gpr(21)$
  - 001110 10000 10111 1111111111111111  
 $itype, xori, opc=001110, rs= 16, rt=23, imm = 0b1111111111111111$   
 $xor\$23\$160b1111111111111111$   
 $gpr(23) = gpr(16) \text{ xor } 0b00000000000000001111111111111111$
  - 000000 10110 00001 00000 101010  
 not a proper instruction
  - 001000 00010 00000 1111111111111111  
 $imm = -1$

- 3.
- 100011 00001 00010 00000000000011011
  - 001000 00010 00010 00000000000000001
  - 101011 00001 00010 00000000000011011
  - 101011 00010 00000 00000000000011011

4.  $gpr(2) = m_4(gpr(1) + 27)$   
 $gpr(2) = gpr(2) + 1$   
 $m_4(gpr(1) + 27) = gpr(2)$   
 $m_4(gpr(1) + 27) = gpr(0)$

5.  $gpr(1) = 0b10101010101010100000000000000000$   
 $gpr(1) = gpr(1) \wedge 0b000000000000000001010101010101$   
 Effect:  
 $gpr(1) = 0b10101010101010100101010101010101$

6.

- |   |   |                                      |         |
|---|---|--------------------------------------|---------|
| 1 | – | $gpr(2) = gpr(1)$                    |         |
| 2 | – | if $gpr(1) == 0$ then jump to line 1 |         |
| 3 | – | $gpr(1) - = 1$                       |         |
| 4 | – | $gpr(2) + = gpr(1)$                  |         |
| 5 | – | jump to line 26                      | – no-op |

Effect:

$$gpr(1) = \frac{n(n+1)}{2}$$

where  $n$  is the starting value of  $gpr(1)$