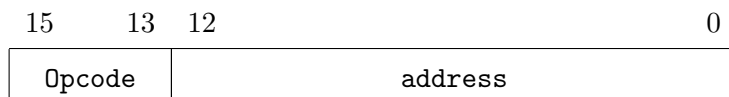


Question 3 (20 points):

You are participating in the Computing Science Industrial Internship Program and your placement is with *Tiny Inc.*, a company that produces *TinyProc* — a new processor developed for the automobile industry. All instructions in *TinyProc* have 16 bits. *TinyProc* also works with 16-bit addresses. The format of a jump instruction in *TinyProc* is as shown below:



where the address of the target of a jump instruction is computed using the same mechanism used in the MIPS processor with the adjustments necessary for it to work with a 16-bit address: first the Program Counter (PC) is incremented by **two**, then the **two** most-significant bits of the PC are concatenated with the thirteen bits of the address field from the instruction shifted to the left by one. The OpCode for a jump instruction in *TinyProc* is 100. Based on this information, answer the following questions:

1. **(5 points)** Assume that a *TinyProc* instruction is at memory address 0xFF00 and that its target is at address 0xC0A8, What is the binary representation, expressed in hexadecimal of this instruction?
2. **(5 points)** Assume that a *TinyProc* jump instruction is at address 0xBFFE. What is the farthest jump forward and the farthest jump backward that this instruction could execute? In other words, what is the lowest address to which this instruction could jump and what is the highest address to which this instruction could jump — express the lowest and highest target addresses in hexadecimal?

3. (**5 points**) For the jump instruction in question 1.b above, what is the binary format, expressed in hexadecimal for the jump instructions that will jump to the lowest and to the highest targets?
4. (**5 points**) The *range* of a jump instruction is the address distance between the target of the jump instruction and the jump instruction itself. For example if a jump instruction is at the address 0x0010 and the target is at address 0x0030, then the range of this branch instruction is $0x0020 = 32_{10}$. Assume that a jump instruction is at address 0xBF00. What is the maximum range for this jump instruction, expressed as a decimal number, in *TinyProc*?