Define stored-program concept. Give at least 3 advantages of this architecture, and corresponding applications/systems.
Suppose we have two implementations (Machine A and machine B, namely) of the same instruction set architecture. For some program which has 1 million instructions,

Machine A has a clock cycle time of 100ps and an average CPI of 4.0.

Machine B has a clock cycle time of 130ps and an average CPI of 3.0.

a. What machine is faster for this program, and by how much?

b. If overclocking (i.e., driving the given machine with faster clock speed) of the slower machine is possible, what clock rate should be used to execute the given program to achieve the same execution time of the faster machine?
Answer the following questions.

1. Name three different hazard types of pipelined processors.

2. For the five stage MIPS pipeline processor, indicate which of the following instructions will generate hazard, and what type of hazard?

   ADD R1, R3, R4
   ADD R5, R6, R7
   SUB R8, R1, R7
   OR R9, R7, R6

3. If there is a hazard in 2, could it be handled using forward path? If so, please indicate the forward path. If not, please explain why.
Below is a list of 32-bit memory address references, given as word addresses.

3, 180, 43, 2, 191, 88, 190, 14, 181, 44, 186, 253

For each of these references, identify the binary address, the tag, and the index given a direct-mapped cache with two-word blocks and a total size of 8 blocks. Also list if each reference is a hit or a miss, assuming the cache is initially empty.
Answer the following questions regarding combinational logic.

a) Determine the outputs functions A and B as sums of minterms. You may use any process to determine the result, but show your work.

b) The circuit shown in a) has the functionality of a commonly used arithmetic component. What does the circuit do and what are other names for A and B?
Design a circuit (combinational, not sequential) that takes an unsigned 2-bit number, \( X = X_1 X_0 \), and computes the square of that number, \( Y = X^2 \).

Answer the following questions.

a) How many outputs do you need?

b) Show the truth table for this combinational circuit. Name the outputs \( Y_n, \ldots, Y_2, Y_0 \) (with \( n \) depending on what you have determined in a).

c) Determine the minimized output functions.
Design a 2-bit up/down counter with rollover (i.e. counting up 0-1-2-3-0... and down 3-2-1-0-3...). The counter is controlled by signal C, where C = 0 means counting down and C = 1 means counting up. Use JK flip-flops in your design and show all steps for full credit.
Draw the 2-input NAND and 2-input NOR implementation of the following function: \( F(A, B, C) = \overline{A\overline{B}} + BC + A\overline{C} \).
Assume you are given an 8-bit timer. If 12MHz crystal clock frequency is used to drive the given timer and one timer tick is equivalent to 12 crystal clock periods, what would be an appropriate timer initialization value (i.e., 8-bit binary word) to achieve 1ms delay? Show your work clearly.
Assume that you have an 8051 microcontroller with a 12 MHz operation. Write an assembly language program to create a 83.3 kHz square wave on P1.0. Timers or interrupts are not required for this assembly language program. Show your work for the timing involved for: 1) executing each instruction and 2) generating the time delay associated with the 83.3 kHz square wave.
Low-level programming is still an important way to optimize performance in embedded devices. For this problem, fully explain how low-level instruction sets handle various required programming features found in high-level languages. When possible, use specific examples from instruction sets you may know. Include relevant architectural details when appropriate.

(a) arrays

(b) function calls

(c) conditionals
Problem: CM12  
Area: Embedded Computer Systems  

Answer the following:

a) What does the baud rate measure in serial communication?

b) Explain (a) what interrupts are and (b) what advantage they give us when designing a digital system.

c) A common function used in embedded systems programming is the DELAY subroutine. Calculate the number of machine cycles the following function consumes. Include overhead. (Note: MOV and NOP consume 1 cycle while the other instructions all consume 2. The DJNZ instruction will decrement the register and, if the register is not zero, jump to the indicated label.)

```
DELAY: MOV R3, #50
OUT:   MOV R2, #100
IN:    NOP
       DJNZ R2, IN
       DJNZ R3, OUT
RET
```

Answer = _____________________
Problem: CM14  Area: Computational Intelligence  Code #

Explain Particle Swarm Optimization. Cover the motivation, pseudocode or flowchart, and where and how it may be used.
Describe the use of alpha-cuts and defuzzification in Fuzzy Logic, and what this is good for.
Describe overfitting. Is it desirable or undesirable? Why? What does one do to achieve or prevent it? Give plenty of detail. A right answer without sufficient supporting details won’t get many points.