1) Multiple Choice Questions: Please select the best answer from the given list for the following statements/questions. **(1 point each)**

A) Each byte of a memory has a unique address.
   i) True
   ii) False

B) Replacing a processor in a computer with a faster processor will increase response time.
   i) True
   ii) False

C) ADD instruction uses _____ instruction format.
   i) R
   ii) D
   iii) I
   iv) B

D) LEGv8 has 32 bit registers.
   i) True
   ii) False

E) The first register operand (left operand) for an R-type instruction is stored in bit position 0 to 4.
   i) True
   ii) False

F) _____ means that the number is too small to be represented and it may be reported as 0.
   i) Underflow
   ii) Overflow
   iii) Sideflow
   iv) Wideflow

G) One of the trade-offs of floating-point math is that many calculations produce results that are not exact and have to be rounded to the nearest value that the notation can represent.
   i) True
   ii) False

H) Compared with addition and subtraction, multiplication is a complex operation, whether performed in hardware or software.
   i) True
   ii) False

2) Please fill in the blanks in the following statements: **(1 point each)**

A) If we add two positive numbers and the result is a negative number then we have _____.

B) _____ is an example of using "Performance via Pipelining."

C) ADDEQ R1, R2, R3 ARM instruction will be executed if _____ flag is set.

D) LEGv8 has _____ registers.

E) LEGv8 uses _____ bit instructions.

F) If we are using 8 bit one's complement number system then the value of 11111111_2 in decimal is: _____.

G) If we are using IEEE floating point number then a binary number is normalized if it is in the form _____.

3) Match the situation with the closest analog of a great idea in computer architecture. **(4 points)**

Use abstraction to simplify design		A) A soccer player runs not to where the ball is, but to where the ball will be.
Make the common case fast		B) A customer talks to a phone agent. If there's a problem, he talks to the agent's supervisor.
Design for Moore's Law		C) A house architect first designs a house with 5 rooms, then designs room details like closets, windows, and flooring.
Hierarchy of memories		D) A college student rents an apartment closer to campus than to her favorite weekend beach spot.

4) Perform the following conversion (all numbers are positive): **(5 points each)**

   A) 1101011.1111 – Convert binary to decimal

   B) 129 – Convert decimal to binary

   C) ABCD4 - Convert hexadecimal to decimal

   D) 110101101.101 – Convert binary to hexadecimal

5) Complete the following table (assume 8-bit word):

(10 points)

Decimal	Ones Complement	Twos Complement
-45		

6) Convert the following twos complement number into decimal number: **(5 points)**
11110000

7) Express the following number in IEEE 32-bit floating point format: **(5 points)**
18

8) The following number uses the IEEE 32-bit floating-point format. What is the equivalent decimal value? **(5 points)**
0 10000001 11110000000000000000000

9) Consider two different processors P1 and P2 executing the same instruction set. P1 has a 4 GHz clock rate and a CPI of 2. P2 has a 3 GHz clock rate and a CPI of 1. Which processor has the highest performance expressed in instructions per second? **(10 points)**

10) Assume for arithmetic, load/store, and branch instructions, a processor has CPIs of 1, 12, and 5, respectively. Also assume that a program requires the execution of 2.56E9 arithmetic instructions, 1.28E9 load/store instructions, and 256 million branch instructions. Assume that the processor has a 2 GHz clock frequency. **(5 points each)**

A) Calculate the number of clock cycles required to execute the program.

B) Calculate the global (average) CPI.

C) Calculate the CPU time for the execution of the program.

11) Provide the instruction type and binary representation of the following LEGv8 instructions. **(5 points each)**

A) ANDS R9, R10, R11

B) LSL R12, R13, #2

12) Provide the instruction type and assembly language instruction for the following binary value:
11111000010000000000000101101010 **(5 points)**

13) You have been hired by ACME Corporation which makes 16-bit microcontroller for embedded system. You have been assigned the task of coming up with a way to represent a floating point number using a system similar to IEEE floating point standard. Note that IEEE floating point standard is defined for 32 bit and 64 bit systems. You decided to use the following fields to store a floating point number using 16 bit word:
1 bit is used for sign
5 bits are use for storing exponent and
10 bits are used for storing fraction.

A) What will be an optimum value for the bias so that you can store about equal number of negative and positive exponents. You must show your work and provide justification for your answer to get full credit. **(5 points)**

B) How will you represent 0 in the floating point number system that you designed. You must show your work and provide justification for your answer to get full credit. **(5 points)**

C) What is the smallest positive number that you can store in the floating point number system that you designed. You must show your work and provide justification for your answer to get full credit. **(5 points)**

D) What is the largest positive number that you can store in the floating point number system that you designed. You must show your work and provide justification for your answer to get full credit. **(5 points)**