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TP6

1) Instruction field identification: A machine instruction is structured as three parts: [Mode | Opcode | Operand]. For each instruction below, identify what is stored in each field:
   a) LOAD A
   b) ADD R1, B
   c) MUL R1, R2, R3
2) Given the following instructions, identify whether each is zero-, one-, two-, or three-address format:
   a) PUSH A
   b) LOAD B
   c) ADD R1, R2
   d) MUL R1, R2, R3
   e) POP X
3) Using zero-address (stack): Evaluate the expression $Y = (A * B) + (C * D)$ using zero-address instructions. Show the full instruction sequence and the stack state (TOP value) after each instruction.
4) Using one-address (accumulator): Evaluate the expression $Y = (A * B) + (C * D)$ using one-address instructions. Use AC as the accumulator and M[T] as a temporary memory location. Show the instruction and the resulting accumulator value after each step.
5) Using two-address instructions: Evaluate $Y = (A - B) * (C + D)$ using two-address instructions. Use registers R1 and R2, and show the memory/register state after each instruction.
6) Using three-address instructions: Evaluate $Z = (A + B) * (C - D) + E$ using three-address instructions. Use registers R1, R2, R3, and temporary memory locations as needed. Show each instruction and briefly describe what it does.

Solution

1) Identify what is stored in each field:
   a) LOAD A ⇒ One-Address
   b) ADD R1, B ⇒ Two-Address
   c) MUL R1, R2, R3 ⇒ Three-Address
2) Identify whether each is zero-, one-, two-, or three-address format:
   a) PUSH A ⇒ Zero-Address
   b) LOAD B ⇒ One-Address
   c) ADD R1, R2 ⇒ Two-Address
   d) MUL R1, R2, R3 ⇒ Three-Address
   e) POP X ⇒ Zero-Address
3) Evaluate the expression $Y = (A * B) + (C * D)$ using zero-address instruction.

Instruction	Stake
PUSH A	TOP = A

PUSH B	TOP = B
MUL	TOP = A * B
PUSH C	TOP = C
PUSH D	TOP = D
MUL	TOP = C * D
ADD	TOP = (C * D) + (A * B)
POP Y	M[Y] = TOP

4) Evaluate the expression $Y = (A * B) + (C * D)$ using one-address instructions.

Instruction	Stake
LOAD A	AC = M[A]
MUL B	AC = AC * M[A]
STORE T	M[T] = AC
LOAD C	AC = M[C]
MUL D	AC = AC * M[D]
ADD T	AC = AC + M[T]
STORE Y	M[Y] = AC

5) Evaluate $Y = (A - B) * (C + D)$ using two-address instructions. Use registers R1 and R2.

Instruction	Stake
MOV R1, A	R1 = M[A]
SUB R1, B	R1 = R1 – M[B]
MOV R2, C	R2 = M[C]
ADD R2, D	R2 = R2 + M[D]
MUL R1, R2	R1 = R1 * R2
MOV Y,R1	M[Y] = R1

6) Evaluate $Z = (A + B) * (C - D) + E$ using three-address instructions.

Instruction	Stake
ADD R1, A, B	R1 = M[A] + M[B]
SUB R2, C, D	R2 = M[C] – M[D]
MUL R3, R1, R2	R3 = R1 * R2
ADD R1, R3, E	R1 = R3 + M[E]
MOV Z, R1	M[Z] = R1