COMPUTER ARCHITECTURE & ASSEMBLY LANGUAGE

14:332:331

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Problem 1: (6 pts, 3 pts each sub-part)

A) Global CPI = sum off all CPI * percent:
   - **a.** P1 = (0.2×1)+(0.3×4)+(0.2×3)+(0.3×2) = **2.6 counts / instruction**
   - b. P2 = (0.2×2)+(0.3×3)+(0.2×2)+(0.3×3) = **2.6 counts / instruction**

B) Total clock cycles = (Global CPI * Instructions) / Clock rate:
   - a. P1 = 10E6 * 2.6 / 2.5E9 = **1040 cycles**
   - **b.** P2 = 10E6 * 2.6 / 3E9 = **670 cycles**

Problem 2: (6 pts, 2pts each sub-part)

A) Improving CPI of FP instructions (to halve program run time, halve total cycles of the tasks. Original total cycles= 5.7E8):
   - a. 80E6 * New CPI + INT + L/S + branch instructions = (5.7E8)/2. **New CPI =-1.56**

B) L/S instructions:
   - a. Same formula but solving for 60E6***New CPI = -0.75**

C) Execution time = sum of all instructions * CPI / clock rate. Original clock rate = 0.1425 seconds.
   - **a.** Execution time after reducing CPI of each instruction = 0.1425 – 0.107 = **0.0355 seconds.**

Problem 3: (6 pts) [Research Question for Fun]

Supercomputers:

1. El Capitan:
   a. Location: Lawrence Livermore National Laboratory
   b. Servers/cores: 11,039,616
   c. FLOPS: 2,746.38 PetaFLOPS
   d. Instructions per second: 1.74E18
   e. Power Usage: 35 MW
   f. Power density per square foot: 4.6 KW/ft^2
   g. Processor technology: AMD
2. Frontier:

    a. Location: Oak Ridge National Laboratory
    b. Servers/cores: 9,066,176
    c. FLOPS: 2,055.72 PetaFLOPS
    d. Instructions per second: 1.34E18
    e. Power Usage: 21 MW
    f. Power density per square foot: 2.87 KW/ft^2
    g. Processor technology: AMD
3. Aurora:
    a. Location: Argonne National Laboratory
    b. Servers/cores: 9,264,128
    c. FLOPS: 1,980.01 PetaFLOPS
    d. Instructions per second: 1E18
    e. Power Usage: 60 MW
    f. Power density per square foot: 6 KW/ft^2
    g. Processor technology: Intel

Data Centers:

1. China Telecom-Inner Mongolia Information Park:
    a. Location Hohhot, China
    b. Servers/cores: 50,000
    c. Power Usage: 150 MW
    d. Power density per square foot: 3.3 W/ft^2
2. The Citadel – Switch:
    a. Location: Tahoe Reno, Nevada, USA
    b. Servers/cores: 15,000
    c. Power Usage: 650 MW
    d. Power density per square foot: 89 W/ft^2
3. Yotta NM1:
    a. Location: Panvel, India
    b. Servers/cores: 7200
    c. Power Usage: 61 MW
    d. Power density per square foot: 6 W/ft^2