**COMPUTER ARCHITECTURE & ASSEMBLY LANGUAGE**

**14:332:331**

**Rutgers University**

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

1. Global CPI = sum off all CPI \* percent:
   1. P1 = (0.2×1)+(0.3×4)+(0.2×3)+(0.3×2) = **2.6**  **counts / instruction**
   2. P2 = (0.2×2)+(0.3×3)+(0.2×2)+(0.3×3) = **2.6 counts / instruction**
2. Total clock cycles = (Global CPI \* Instructions) / Clock rate:
   1. P1 = 10E6 \* 2.6 / 2.5E9 = **1040 cycles**
   2. P2 = 10E6 \* 2.6 / 3E9 = **670 cycles**

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

1. Improving CPI of FP instructions (to halve program run time, halve total cycles of the tasks. Original total cycles= 5.7E8):
   1. 80E6 \* New CPI + INT + L/S + branch instructions = (5.7E8)/2. **New CPI =-1.56**
2. L/S instructions:
   1. Same formula but solving for 60E6\***New CPI = -0.75**
3. Execution time = sum of all instructions \* CPI / clock rate. Original clock rate = 0.1425 seconds.
   1. 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:
   1. Location: Lawrence Livermore National Laboratory
   2. Servers/cores: 11,039,616
   3. FLOPS: 2,746.38 PetaFLOPS
   4. Instructions per second: 1.74E18
   5. Power Usage: 35 MW
   6. Power density per square foot: 4.6 KW/ft^2
   7. Processor technology: AMD
2. Frontier:
   1. Location: Oak Ridge National Laboratory
   2. Servers/cores: 9,066,176
   3. FLOPS: 2,055.72 PetaFLOPS
   4. Instructions per second: 1.34E18
   5. Power Usage: 21 MW
   6. Power density per square foot: 2.87 KW/ft^2
   7. Processor technology: AMD
3. Aurora:
   1. Location: Argonne National Laboratory
   2. Servers/cores: 9,264,128
   3. FLOPS: 1,980.01 PetaFLOPS
   4. Instructions per second: 1E18
   5. Power Usage: 60 MW
   6. Power density per square foot: 6 KW/ft^2
   7. Processor technology: Intel

**Data Centers:**

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