Question 1: (0 points)
Bank of Questions

Question 2: (8 points)
How long does it take to execute this program in this machine?

Clocks Per Instruction (CPI) (V10, V11)

The table below shows the number of instructions and the average number of cycles per instruction for each class of instructions executed by a program in a given machine. The clock frequency for this machine is 4 GHz (1 GHz = 10^9 Hz).

	FP Instr.	INT Instr.	L/S Instr.	Branch Instr.
# of instructions	100×10^6	500×10^6	200×10^6	250×10^6
Average cycles per instruction	10	1	5	4

Solution:

$$\text{Total Time} = \frac{\#\text{ clock cycles}}{\text{clock frequency}}$$

$$\text{Total Time} = \frac{[(10 \times 100) + 500 + (5 \times 200) + (4 \times 250)] \times 10^6}{4 \times 10^9}$$

$$\text{Total Time} = \frac{1000 + 500 + 1000 + 1000}{4 \times 10^3}$$

$$\text{Total Time} = \frac{3500}{4000} = 0.875s$$

Question 3: (8 points)
Both a compiler team and a hardware team are working on improving the performance of this program in this machine. The compiler team promises that it can produce a version that is 1.25 times faster than the original machine. They say that they will reduce the number of integer (INT) instructions executed by half and that the remainder of the performance improvement will come from reducing the number of floating-point (FP) instructions executed. How many FP instructions will be executed in this new version of the machine?

Solution:

$$
\begin{aligned}
\text{Total Time}_{\text{new}} &= \frac{\text{Total Time}_{\text{original}}}{1.25} = \frac{0.875}{1.25} = 0.7s \\
0.7 &= \frac{[(10 \times X) + 250 + (5 \times 200) + (4 \times 250)] \times 10^6}{4 \times 10^9} \\
0.7 \times 4000 &= 10 \times X + 250 + 1000 + 1000 \\
2800 - 2250 &= 10 \times X \\
X &= \frac{550}{10} = 55 \Rightarrow 55 \times 10^6 \text{ FP instructions}
\end{aligned}
$$

Question 4: (8 points)
The hardware team says that they can produce a machine that is 1.25 times faster than the original machine. They will reduce the average number of cycles needed to execute a floating point instructions (FP) to 5 cycles per instructions and they will also increase the frequency of the clock. What is the frequency of the clock for the machine proposed by the hardware team?

Solution:

$$
\begin{aligned}
\text{Total Time}_{\text{hardware}} &= \frac{[(5 \times 100) + 500 + (5 \times 200) + (4 \times 250)] \times 10^6}{F} \\
0.7 &= \frac{3 \times 10^9}{F} \\
F &= \frac{3 \times 10^9}{0.7} = 4.29 \text{ GHz}
\end{aligned}
$$