Questions 6–7 require the information in Figure 2.29. The cost of the microprocessor is a significant fraction of the cost of the machine, which in turn affects the price and hence price-performance.

Microprocessor	Wafer Cost	Defects/cm^2	Area (mm^2)	Package Cost	List price
486DX2	$1,200	1.0	81	$11	$245
PowerPC 601	$1,700	1.3	121	$3	$280
HP PA7100	$1,300	1.0	196	$35	$300
DEC Alpha	$1,500	1.2	234	$30	$1,231
Pentium	$1,500	1.5	296	$19	$965

FIGURE 2.29 Characteristics of microprocessors. List prices were quoted as of August 1993 at quantity 10000 purchases.

6 [15] <2.3> Use a spreadsheet and use the values found in Figure 2.29 above for yield parameters, and assume α is set to 3. How many good chips do you get per 6-inch (150 mm) wafer for each chip?

7[15/10/10/15/15] <2.3> Use a spreadsheet to answer all the questions about all the microprocessors from Figure 2.29. Use the assumptions on manufacturing found in Figure 2.29 and exercise 6 unless specifically mentioned otherwise.

a. [15] There are wide differences in defect densities between semiconductor manufacturers. What are the costs of untested dies assuming: (1) 2 defects per square cm; and (2) the defects in Figure 2.20.

b. [10] Assume that testing costs $150 per hour and the small chip takes 10 seconds for every 100 mm^2 of area, what is the cost of testing each die?

d. [15] What is the die final cost?

e. [15] Given the list price and the calculated cost from the questions above, calculate the gross margin. Assume the direct cost is 40% and average selling discount is 33%.

8 [15/15/10] <2.2> Your company has a benchmark which is considered to be representative of your typical applications. One of the older model workstations does not have a floating point unit and must emulate each floating point instruction by a sequence of integer instructions. This older model workstation is rated at 12 MIPS on this benchmark. A third party vendor offers an attached processor that is intended to give a "mid-life kicker" to your workstation. That attached processor executes each floating point instruction on a dedicated processor (i.e., no emulation is necessary). The workstation/attached processor rates 8 MIPS on the same benchmark.

The following symbols are used to answer the questions below:

I- Number of integer instructions executed on the benchmark;

F - Number of floating-point instructions executed on the benchmark;

Y - Number of integer instructions to emulate a floating point instruction;

W - Time to execute the benchmark on the workstation alone;

B - Time to execute the benchmark on the workstation/attached processor combination.

a. [15] Write an equation for the MIPS rating of each configuration using the symbols above. Document your equation.

b. [10] If F = $4*10^6$,Y = 10,W =4 seconds, then Find I.

c. [10] What is the value of B?

d. [12] What is the MFLOPS rating of the system with the attached processor board?

e. [10] Your technician wants to purchase the attached processor board even through the MIPS rating for the configuration using the board is less than that of the workstation alone. Is your technicians evaluation correct? Defend your answer?

252 Homework Number 3: Due Monday 9/12 @ Noon in 634 Soda Hall

Questions 1–5 require the following information.

The Whetstone benchmark contains 195,578 basic floating-point operations in a single iteration, divided as follows:

Add	82,014
Subtract	8,229
Multiply	73,220
Divide	21,399
Convert integer to fp	6,006
Compare	4,710
TOTAL	195,578

Whetstone was run on a Sun 3/75 using the F77 compiler with optimization turned on. The Sun 3/75 is based on a Motorola 68020 running at 16.67 MHz, and it includes a floating-point coprocessor. The Sun compiler allows the floating-point to be calculated with the coprocessor or using software routines, depending on compiler flags. A single iteration of Whetstone took 1.08 seconds using the coprocessor and 13.6 seconds using software. Assume that the CPI using the coprocessor was measured to be 10 while the CPI using software was measured to be 6.

1 [15] <2.2> What is the (native) MIPS rating for both runs?

2 [15] <2.2> What is the total number of instructions executed for both runs?

3 [8] <2.2> On the average, how many integer instructions does it take to perform a floating-point operation in software?

4 [18] <2.2> What is the native and normalized MFLOPS for the Sun 3/75 with the floating-point coprocessor running Whetstone? (Assume convert counts as a single floating-point operation and use Figure 2.3 for normalized operations.)

5 [20] <2.2> The Whetstone benchmark includes the following high level calculations:

- arctangent, invoked 640 times
- sine, invoked 640 times
- cosine, invoked 1920 times
- square root, invoked 930 times
- exponential, invoked 930 times
- and logarithm, invoked 930 times

If we remove the floating-point operations performed in each of the functions above, there are 79,550 floating point operations remaining, divided into the following categories:

Add	37,530
Subtract	3,520
Multiply	22,900
Divide	11,400
Convert integer to fp	4,200
TOTAL	79,550

Figure 2.3 on page 43 suggests how many floating-point operations it takes to perform the six functions above (arctangent, sine, and so on). From the data above you can calculate the average number of floating-point operations per high-level function from the SUN 3/75 for Whetstone. What is the ratio between the estimates in Figure 2.3 and the floating-point operation measurements for the Sun 3? (In case you were wondering, assume the coprocessor implements only Add, Subtract, Multiply, Divide, and Convert.)