13 + 62 = 75

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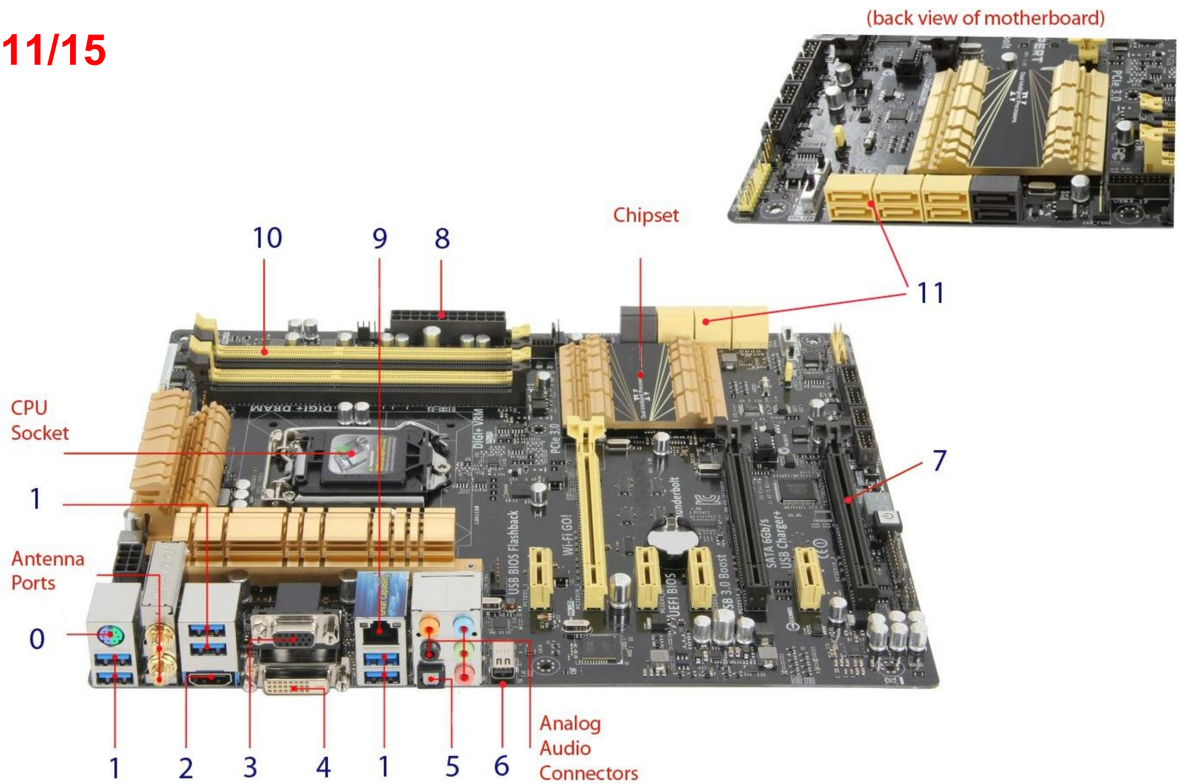
Course: COM219

HOMEWORK 1

Question 2:

11/15



Connector number	Name of connector	Function
0	PS/2 mouse/keyboard port	6-pin mini DIN connector used for connecting keyboard and mice to PC
1	USB 3.0 ports	Use for transferring data, with transfer time theoretically 10 times the predecessor USB 2.0
2	HDMI Port	19 pins connector used to transmit digital video and audio signals between devices.

			Support standard-definition, high-definition and Ultra HD video signals	
	3	VGA Port	15 pins connector used for computer video output	
	4	DVI-D Port	A video display interface is used to connect a video source (video display controller) to a display device (computer monitor)	
-1	5	DTS Support Optical S/PDIF	Support DTS sound system	interface for connecting digital audio
-1	6	Thunderbolt port Display Port	Hardware interface that connects peripherals to computers. Support high speed and high resolution media display	used to connect a video source to a display device (ex: monitor)
-1	7	GPU PCI slot	Specialized circuit used for rendering graphics on monitor	system to attach I/O cards to the motherboard
	8	Power cable main connector	Connect to the power cord, that temporarily connect the PC to electricity supply	
	9	Modem Ethernet (RJ-45 Gigabit LAN port)	Connect to Ethernet cables, that connects wired network	
-1	10	DDR3 Support Memory slot	A type of synchronous dynamic random-access memory (SDRAM). Able to transfer data at twice the rate, enabling higher bandwidth or peak data rates, compare to its predecessor	Connector to add memory sticks
	11	SATA 6Gb/s Ports	Interface that connect motherboard to mass storage devices	

<u>Question 5</u>:

e.g. Motherboard, power supply, CPU, RAM, chipset, disk, sound card, graphics, card, network

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	Chip/Device	Component Class	Approximate Price
	ASUS WS C422 SAGE/10G LGA2066 ECC DDR4 M.2 U	Motherboard	$650
	AMD Radeon Pro WX 9100 - 4096 Stream Processors, 16GB vRAM	Graphic card	$2000
	Intel Core i7 i7-7700K - Quad Core, 4.2GHz	CPU	$370 - $450
	MSI MEG X570 AMD SATA 6Gb/ USB 3.2	Motherboard	$360 - $530
	Intel Core i9-7980XE X-Series 2.6 GHz 18-Core LGA 2066	CPU	$1980 - $2000
-1	Cisco 32GB DDR4-2666-MHZ RDIMM PC4-21300 DUAL	RAM	$200 X $1280
	NVIDIA QUADRO RTX 8000	Graphic card	$5500
-1	AMD Ryzen Threadripper 1920X 12-Cores, Socket sTR4, 3.5GHz	CPU	$500 - $650 X $230
	Intel 10PK OPTANE 800P SERIES INT 120GB	SSD	$200
	Intel C246, 14 USB Ports, 24 PCI Express Lanes	Chipset	(skip)
	Corsair CX Series CX450M 450 Watt ATX	Power supply	$80
	Kingston 16GB DDR4, 2133MHz DIMM - KVR21R15D4/16	RAM	$70 - $80
-1	AMD Phenom II X2 560	CPU	$65 (peak: $120) X $30
-1	NVIDIA Tesla K80 24GB GDDR5 CUDA Cores	Graphic card	$1700 X $215
-1	Creative Sound Blaster Z Series ZXR	Sound card	$350 X $200
-1	Seagate 1TB SATA 7.2K RPM 6GBPS 2.5IN	HDD	$150 X $52

Question 3 **20/20**

⊛ Summary of q4s

N	Instr
6	3
5	2
4	4
3	2
2	3
1	-

At level 1:

- Instr type A – 25% – 44 ns
- Instr type B – 45% – 40 ns
- Instr type C – 30% – 20ns

#Instr: 500,000

a) Number of level-1 instrs, for each level-6 instr : $3 \times 2 \times 4 \times 2 \times 3 = \boxed{144}$ instrs ✓

b) Average instr execution time at level 1: $t_1 = \dfrac{25 \times 44 + 45 \times 40 + 30 \times 20}{100} = \boxed{35}$ ns ✓

c) Number of level-1 instr, for each level-4 instr : $4 \times 2 \times 3 = 24$ instrs

→ Average instr execution time for each level-4 instr : $t_4 = 24 \times 35 = \boxed{840}$ (ns) ✓

$(= I_4 \times t_1)$

d) Average instr execution time for each level-6 instr : $t_6 = I_6 \times t_1 = 144 \times 35 = \boxed{5040}$ ns ✓

e) Program completion time : $T_{prog} = t_6 \times M = 500{,}000 \times 5040$

$= \boxed{252 \times 10^7}$ ns ✓

f) Recalculation for new program:

Number of level 1 instr, for each level 6 instr : $3 \times 2 \times 4 \times 2 \times 2 = 96$ instr

Average instr execution time for each level-6 instr : $96 \times 35 = 3360$ ns

Program completion time : $T_{prog.N} = 3360 \times 500{,}000$

$= 168 \times 10^7$ ns

Ratio of new program completion time, compare to old : $\dfrac{T_{progN}}{T_{prog}} = \dfrac{168 \times 10^7}{252 \times 10^7} = \boxed{\dfrac{2}{3}}$ ✓

speed up is 1.5

$\boxed{\text{Question 4}}$ **11/15**

+) Let t be the time it takes to execute a program in level 1.

+) An instruction at level n is translated into S instructions at level $n-1$

→ Each level is S times as powerful as the level below it

But as optimal translation from a level to one below is hard to achieved → each additional level of translation slow the machine down.

→ Each level runs S times faster than the level above it.

+) Given the above conclusion:

Runtime at level 2 : $\frac{t}{S}$

level 3 : $\frac{\frac{t}{S}}{S} = \frac{t}{S^2}$

level 4 : $\frac{t}{S^3}$

level 5 : $\frac{t}{S^4}$

level 6 : $\frac{t}{S^5}$

. . . .

level N : $\frac{t}{S^{N-1}}$

⇒ Ratio of runtime of level 6 vs level 1

-2

$\frac{t}{S^5} : t = \boxed{\frac{1}{S^5}}$ $\frac{S^5}{W^5}$

⇒ Ratio of runtime of level N vs level 1

-2

$\boxed{\frac{1}{S^{N-1}}}$ $\frac{S^{N-1}}{W^{N-1}}$

Need to take W into consideration since we are looking for the ratio of the time it takes to execute a program at level 6 to the time it takes an optimal sequence of instructions to do the same work at level 1

level	# instr	power
N	S	W
.	.	.
.	.	.
6	*S*	*W*
5	*S*	*W*
4	*S*	*W*
3	*S*	*W*
2	*S*	*W*
1	-	1

at level 6 ... $S/W \times S/W \times S/W \times S/W \times S/W = (S/W)^5 = S^5/W^5$

generally ... S^{N-1}/W^{N-1}

Question 6 **10/12**

a) Number of transistors on 12 A size chip, year 0: $8000 \times 12 = 96{,}000$

Doubling pe. \ Year	0	4	8	12	16	20
✓ 2 years	96000 (N_0)	$N_0 \times 2^{4/2}$ $= 384{,}000$	$N_0 \times 2^{8/2}$ $= 1{,}536{,}000$	$N_0 \times 2^{12/2}$ $= 6{,}144{,}000$	$N_0 \times 2^{16/2}$ $= 24{,}576{,}000$	$N_0 \times 2^{20/2}$ $= 98{,}304{,}000$
✓ 1.5 years (18 months)	96000 (N_0)	$N_0 \times 2^{4/1.5}$ $= 609{,}562$	$N_0 \times 2^{8/1.5}$ $= 3{,}870{,}477$	$N_0 \times 2^{12/1.5}$ $= 24{,}576{,}000$	$N_0 \times 2^{16/1.5}$ $= 156{,}047{,}873$	$N_0 \times 2^{20/1.5}$ $= 990{,}842{,}231$

(graph attached below)

b) (Since the question didn't mention the chip size, assuming chip with area A)

Length of one side of the chip: $\sqrt{A}$

Number of transistors on one side of the chip: $\sqrt{8000} = 40\sqrt{5}$

$\rightarrow$ Length of 1 side of transistor, year 0: $\dfrac{\sqrt{A}}{40\sqrt{5}}$ (l_{old})

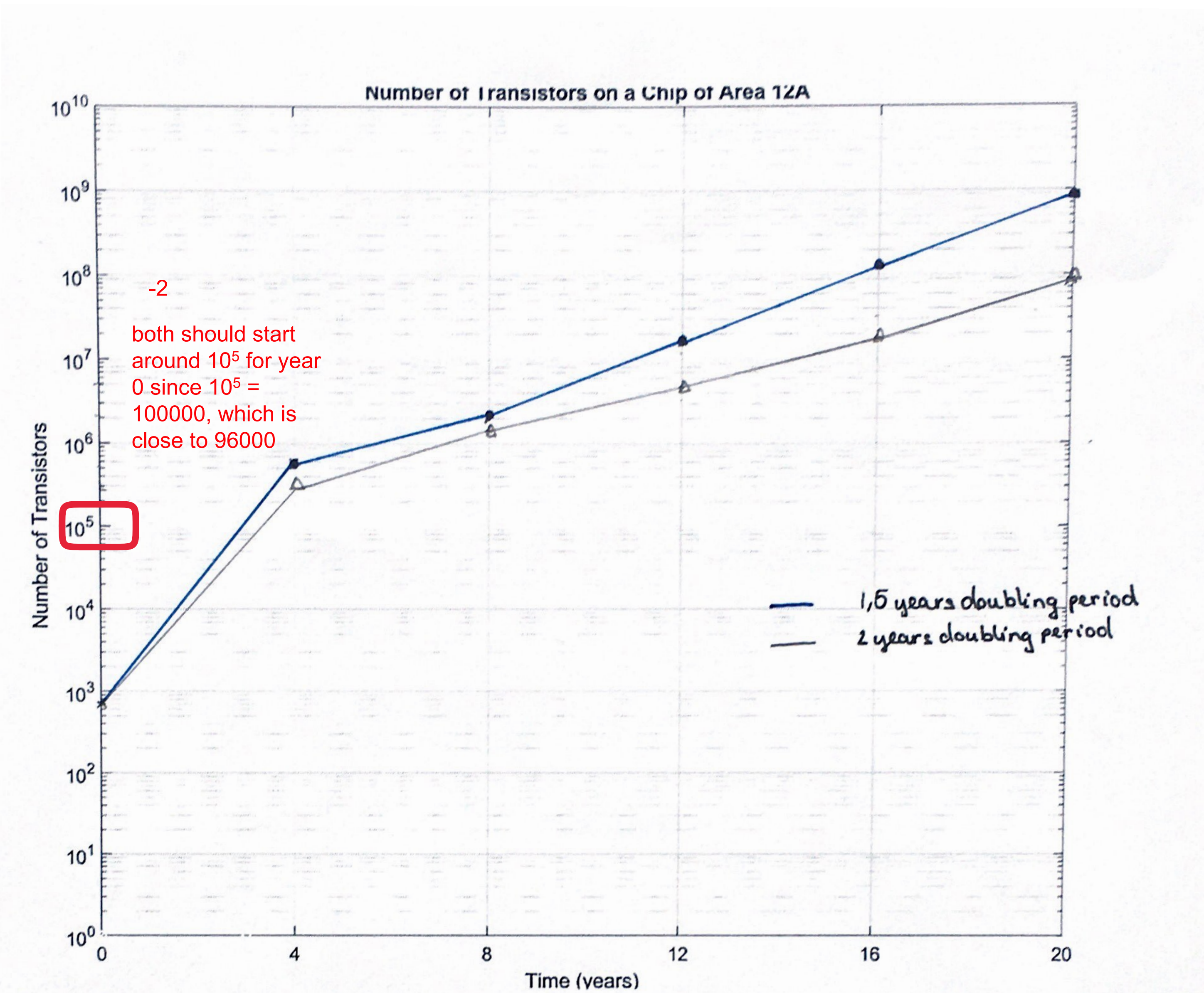
Since we have $l_{new} = \dfrac{l_{old}}{\sqrt{2^n}}$ $\rightarrow$ $\dfrac{l_{new}}{l_{old}} = \dfrac{1}{\sqrt{2^n}}$, with n is the number of doubling period

+) For <u>2 years</u> doubling period.

$$\frac{l_{new}}{l_{old}} = \frac{1}{\sqrt{2^{30/2}}} \checkmark = \boxed{5.524 \times 10^{-3}}$$

+) For <u>1.5 years</u> (18 months) doubling period

$$\frac{l_{new}}{l_{old}} = \frac{1}{\sqrt{2^{30/1.5}}} \checkmark = \boxed{\frac{1}{1024} = 9{,}766 \times 10^{-4}}$$



Number of Transistors on a Chip of Area 12A
Number of Transistors
Time (years)
1,5 years doubling period
2 years doubling period
-2
both should start around 10^5 for year 0 since 10^5 = 100000, which is close to 96000