

# EEE4120F



# High Performance Embedded Systems

## Quiz 0

# Sample Solutions & Explanations

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# Quiz 0 Review...



Stats based on 29 students who wrote the quiz this year

Usually I have some repeat questions and some new questions  
These show the repeat questions first

# Quiz0 review: Q1

Q1 What do you think is the difference between a High Performance Embedded System (HPES) and a regular Embedded System (ES). Think for a moment and then give a brief written response. [5min]

***It's essentially a task-specific HPC which is built into a larger system for the purpose of controlling and monitoring that larger system.***

*A more rigorous definition ...*

# Snippets from answers

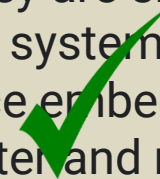
Embedded system is a special type of computer built to control a particular function in a larger system. HPES is like an advanced ES which controls everything in a system.



Think about those underlined things

Good answer, not  
Really entirely right

Both are classified as embedded systems meaning they are small computers (microcontrollers) that exist within a larger system that perform a specialised task. However, high performance embedded systems are able to perform their specialised task faster and more efficiently as they make use of parallel computing principles



Likely not microcontrollers, maybe multicore ucnt.

Be careful when and how you use efficiently.  
Faster is not necessarily more efficient.

Quiz0  
Q1

# High-Performance Embedded Computing

## What Is High-Performance Embedded Computing (HPEC)?

High-performance embedded computing delivers high levels of computing for mission-critical applications that need to perform in rugged and small resources. HPEC brings super-computing performance once only possible in the data center to dense, rugged systems deployable in today's most rigorous environments. For example, EW, radar, and Signals Intelligence (SIGINT) sensors and analysis demands multiple processing elements and I/O interconnected via high-throughput, low-latency switched

fabrics. Even small, unmanned vehicles utilize sensors generating large volumes of data that require high performance embedded computing capability at the edge of the network. This drives difficult size, weight, and power requirements to go along with the environmental requirements of a rugged vehicle.

One way to deal with the SWAP-C demands is by utilizing strategies and technology deployed by data centers in order to bring high-performance computing closer to the edge of the network. This includes shifting towards heterogeneous compute workloads.

Source: [High Performance Embedded Computing | New Wave DV](#)



### Heterogeneous Workloads Enable High-Performance Embedded Computing

SWAP-C is a part of the latest trends in heterogeneous computing. These trends are increasing efficiency and allowing more data to be processed with less power to allow high-level computing in smaller environments and devices. Rather than take a common, brute-force approach to all problems on a single type of processor, heterogeneous computing uses the best silicon for the job. By combining general-purpose processors with FPGAs, network processors, and GPUs, the most efficient solution can be used.

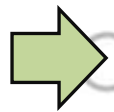
Advances in heterogeneous computing have driven multi-card solutions to single-card solutions and are now enabling single-chip solutions. A single package with a CPU, FPGA, and GPU not only provides a higher

# Quiz0 review: Q2

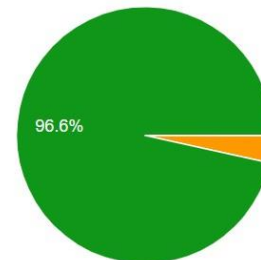
So you might or might not have heard of (or remember) what Verilog is. Which point below seems most correct?



- It is a means to check logical expressions
- It is a general-purpose programming language
- It is used in high performance computing to run threads on a processor
- It is a coding language for hardware description
- None of these, engineering has nothing to do with 'verilogs'



Good stats!



- It is a means to check logical expressions
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- None of these, engineering has nothing to do with 'verilogs'

# Quiz0 review: Q3

What is AMD Xilinx Vivado?

- No idea - I would probably delete it from my PC if I found it there
- It is a software tool for analyzing Inter-Species Expressions (like the face your dog makes when he sees your neighbor's cat and then barks like mad).
- It is an application for converting C code into something BASIC
- It is an application used to develop HDL code and programme FPGAs

In 2023: 66% of class got it right!

24% 'no idea' (that was a type of logic test by the way 😊)

... and thanks for being honest, saying 'no idea' == blank answer).



# Quiz0 review: Q4

## Q4 What is spatial computing?

Previous version was MCQ:

[1] A new programming language

Most of the class got it right though!

[2] A programming paradigm whereby computation is described as happening in different spaces instead of different times.

[3] This term (if rather informal) refers to an algorithm implementation that has certain awkward imperfections; kind of like when someone accidentally snorts uproariously at a good joke in polite company.

[4] It refers to fitting computing infrastructure into a limited space.

How did the class respond?...

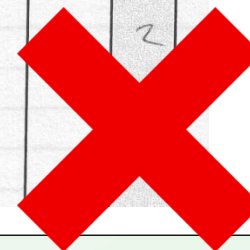
Generally all sorts, mostly incorrect 😞

Amusing but failed previous attempt at this one...

A technically wrong response:

Q5	What is 'spatial computing'?	60	2	10%	
	[1] A new programming language				
	[2] A programming paradigm whereby computation is described as happening in different spaces instead of different times.				
	[3] This term (if rather informal) refers to an algorithm implementation that has certain awkward imperfections; kind of like when someone accidentally snorts uproariously at a good joke in polite company.				
	[4] It refers to fitting computing infrastructure into a limited space.				

X for office use=



Nice try, wise-guy!



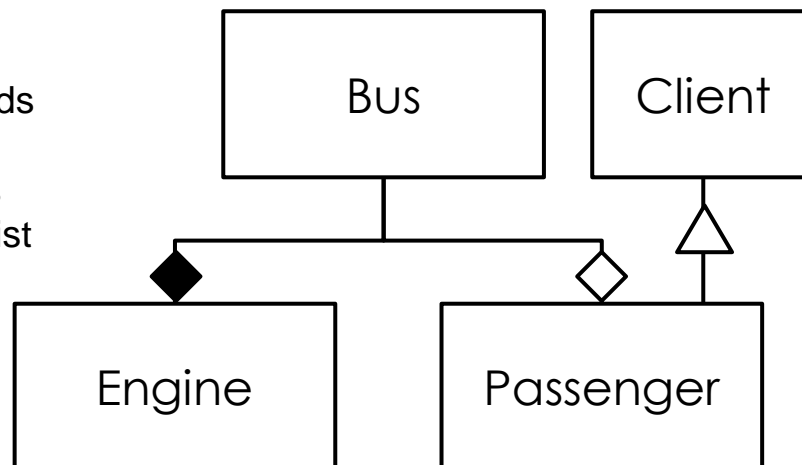
# Quiz0 review: Q5

Q5. Explain the difference between composition and aggregation in UML.

A:

- ◆ A UML composition relationship is where the element (or subpart) is situated within the container; the container is considered broken or incomplete if it does not contain the element.
- ◇ A UML aggregation relationship is where an element (or part) is one of potentially multiple items in a group. It can be considered a loose collection, possibly abstraction. It might refer to physical items or design parts, for example the part names of a system would be an aggregation because the container (i.e. the list) can exist without any part name in it.

Here is a UML diagram showing that a bus needs an engine, to be operational, and relates to passages but can exist in a functional state without them.



And I thought to throw in inheritance while I'm at it, which is the triangle which points to the item that is inherited (so passengers inherits the properties and functions of a client, e.g. like a client a passenger might ask about sales, buy stuff, etc.).

# Quiz0 review: Q6

Q6 Is there any difference between a thread and a process? Explain briefly. ...

Choose: [ ] Are Same [X] Are Different

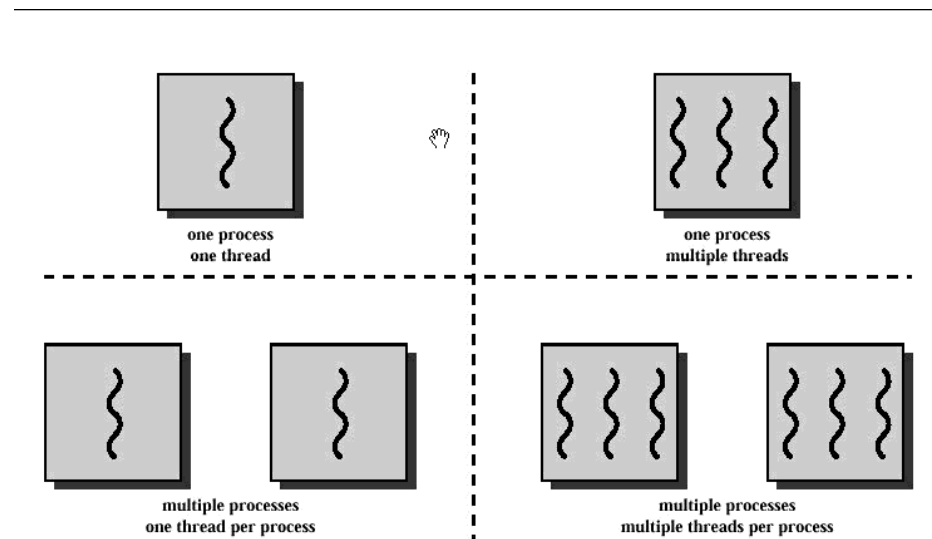
*Reasoning: lots of people seem to think these are the same...*

Answer: It is basically an issue of technical terminology, as defined by the multithreading literature...

These **are not** one and the same!

- Threads are a part of a process
- A process contains one or more threads... but a thread cannot contain a process.

(think of a program made up of pthreads, see figure)



# Quiz0 review: Q7

Which of these is Amdahl's law used to judge for computation?

[A] Cost between two implementations?

→ [B] Speed between two implementations

In computer architecture, **Amdahl's law is a formula** which gives the theoretical speedup in latency of the execution of a task at fixed workload that can be expected of a system whose resources are improved.

(source: [https://en.wikipedia.org/wiki/Amdahl%27s\\_law](https://en.wikipedia.org/wiki/Amdahl%27s_law))

Amdahl's law can be formulated in the following way:

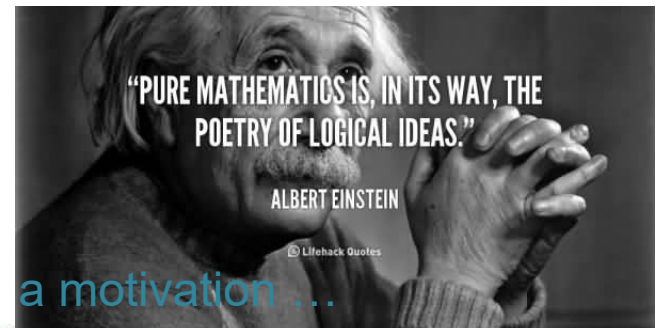
$$S_{\text{latency}}(s) = \frac{1}{(1-p) + \frac{p}{s}}$$



EEK, some mathsy stuff already!!

where

- $S_{\text{latency}}$  is the theoretical speedup of the execution of the whole task;
- $s$  is the speedup of the part of the task that benefits from improved system resources,
- $p$  is the proportion of execution time that the part benefiting from improved resources originally occupied.



End of this year  
quiz 0 review

...

Some Answers  
from  
Previous Quiz0's

*See extra slides at end of  
this presentation*

# Quiz0 review: Q3

Q2 The 'Internet of Things' has become a catchy term. Explain briefly what this refers to.

Q3	The 'Internet of Things' has become a catchy term. Explain briefly what this refers to.	60	3	.15%
	I have definitely heard this term. not sure exactly what it means things being accessed			

0/3: but thanks for the honesty!... so 100 brownie points for you 😊

Q3	The 'Internet of Things' has become a catchy term. Explain briefly what it refers to.			
	The internet of things			

1/3: Not really about what the internet has become & offloading computing

Q3	The 'Internet of Things' has become a catchy term. Explain briefly what this refers to.			
	It is about connecting every device to the internet to the auto			

My thoughts

2/3 maybe more: This is more correct, but *isn't everything* (and neither limited to household items as some people said.) (Getting the geyser to check the weather sounds like an interesting research project!!)

.... maybe +1 for novelty, at least 1,000 brownie points for you



# Quiz0 review: Q3

Q2 The 'Internet of Things' has become a catchy term. Explain briefly what this refers to.

## *Sample solution*

The 'internet of things' (IoT) refers to a larger scale internet in which everyday objects, like alarm clocks, light bulbs and such like, are connected to a network that allows data to be sent to or received from them.

Mark? ...

**3/3**



*Yebo! It is 100% right.*

+100 brownie points for good grammar 😊

+1 bonus mark for fun

(that's sometimes the problem with marking your own work)

# Quiz0 review: Q4

Q4 Motivate why computer engineers, planning to work on large and complex FPGA projects, should understand both Verilog and VHDL.

VHDL and Verilog are *programmable logic* to effectively *by* *sin* physical hardware. *itz*

Nice story but didn't quite interpret the question as planned (in reflection an imperfectly phrased question). 2/3 ?

If there are multiple eng  
As subjects come right a

Bit too much intro, didn't take it quite far enough 2/3

Q4	Briefly motivate why computer engineers, planning to work on large and complex FPGA projects, should understand both Verilog and VHDL.	60	3
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I understand why they should learn VHDL as it instruct the machine directly.



Ag shame! Missed the mark. 0/3

My thoughts...

# Quiz0 review: Q4

Q4 Motivate why computer engineers, planning to work on large and complex FPGA projects, should understand both Verilog and VHDL.

Answer:



Now you're talking  
big savings & benefits

The main reason is **reuse**. Reusing existing gateware devices. For example, there might be an excellent digital filter out there on the web (e.g. opencores) that does *almost* what you want; but it's in Verilog instead of your favorite VHDL. So you have to either start from scratch or learn Verilog.

# Quiz0 review: Q5

Q5 When would you recommend an FPGA over a microprocessors? Consider some design characteristics that would favour the one over the other?

*Reasoning: it is often unclear to developers not so familiar with FPGA-based design why one would choose to use an FPGA instead of a processor (the latter being much easier to deal with)*

Answer:

Historically FPGA were more expensive (still are) so one would choose to use it only if there wasn't a cheaper alternative but now things are more flexible.

Basically when to use FPGA vs. mciro is about these four main design aspects:

... (pto)

# Quiz0 review: Q5

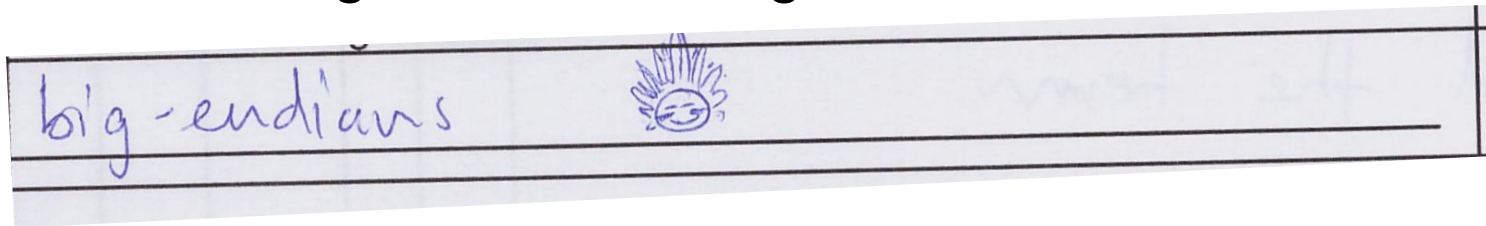
Q5 When would you recommend an FPGA over a microprocessors? Consider some design characteristics that would favour the one over the other?

Issue	Choose FPGA / Prog. Logic IF...	Choose Instruction-based processor IF...
How concurrent is your concurrency?	Many things must happen together	Less true concurrency (time slicing)
How closely coupled is your concurrency?	Close coupling (tightly connected)	Looser coupling (limited num registers and instructions)
How RT is your concurrency?	High RT, very predictable	Less RT
Type of IO and how much simultaneous IO?	A lot of IO (esp. GPIO) / a lot of simultaneous IO to concurrent processing components	Smaller amount of simultaneous IO (can use buffers / DMA)

# Quiz0 review: Q8

Let's play a game of little and big endians...

If you are told that  $00000001_2$  was greater than  $1_{10}$  would we be looking at a little or big endian?



**1/1 Spot on!**

Mainly in this course we'll be little-endians... it tends to be much more common and natural in terms of writing and theorizing.



# Quiz0 review: Q7

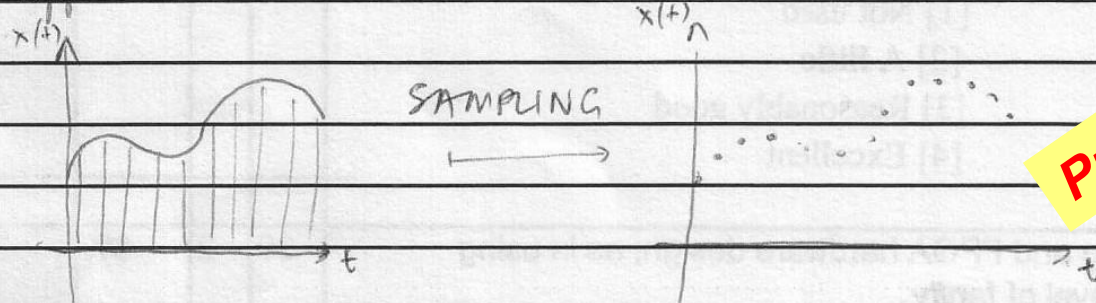
**Q:** In computer engineering terminology, what does 'co-design' mean?

**A:** co-design means:

Software/Hardware co-design is generally considered simultaneous design of both hardware and software to implement required functions. Often it refers to a hardware team and a software team needing to work closely together while developing the software and hardware parts of an embedded system, together with the activities involved in achieving this, such as defining clear hardware/software interfaces, functional decomposition, etc.

# Past Quiz0 review: Q6

In computer engineering terminology, what is meant by *sampling*? Include a short example and possibly a image to aid your explanation.

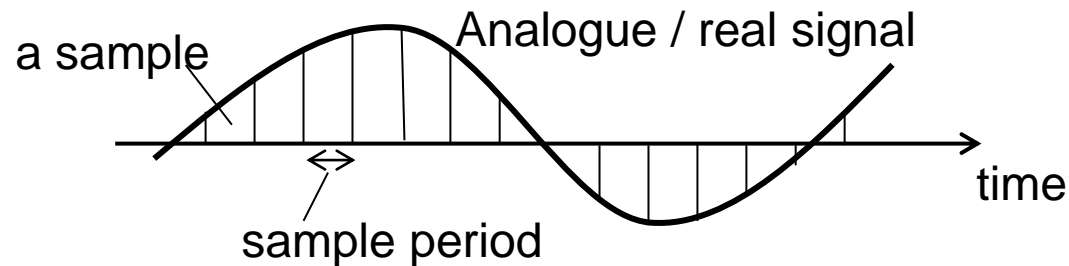
Q6	In computer engineering terminology, what is meant by <i>sampling</i> ? Include a short example and possibly a image to aid your explanation.	60	6	24%
	Sampling is a term commonly encountered in signal processing. It is the process of getting data points at particular intervals usually in ADC applications.			
				

**Pretty good!!**

# Past Quiz0 review: Q6 elaboration

In computer engineering terminology, what is meant by *sampling*? Include a short example and possibly a image to aid your explanation.

Sampling, used by computer engineers, typically refers to the process of digitizing an analogue signal, or looking at discrete instances of a continuous signal. A sample is basically a value or set of related values representing an instance in time of an analogue/real event. Usually a fixed sample period is used.



# Quiz0 review: Q4

Q4	What is your impression of a parallel computer? Give a description.
	PARALLEL COMPUTING ALLOWS FOR
	<b>MORE INTELLIGENT,</b> NON LINEAR
	<b>DEUCE THINKING</b> BY MAKING
	USE OF PARALLEL DESIGN
	PRINCIPLES <sup>CAN</sup> ALLOW FOR OPTIMAL
	UTILISATION OF AVAILABLE HARDWARE
	WHICH MAY HAVE SAT <del>IDEA</del> IDLE
	UNTIL NO UNRELATED TASKS
	HAD BEEN COMPLETED).

**More 'intelligence'?!  
My cellphone is  
probably as  
intelligent as my  
PC... as in not at all  
intelligent based on  
the turning test.  
Heading into  
troubled waters here**



**Close! But no cigar 😞**

# End of Quiz0 Reviews