EECS 507: Introduction to Embedded Systems Research
Midterm Exam
11 March 2021

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You have until 60 minutes for the exam, and a 20 minutes grace period to upload it to Gradescope (or, if special arrangements were made, to email it to me). If you email, you should not consider it submitted until you receive confirmation from me. It must be to me by 2:50pm.

Open book. Open notes. Open internet. No communicating with anybody except the teacher about the exam. This remains true even after you have submitted the exam. I'll tell you when it is O.K. to discuss.

If you can print and scan/photograph, do that and upload to Gradescope instead of using the forms. If you cannot print and scan/photograph, then use the forms to the degree possible and submit the exam to me via both Gradescope and email. Only those using forms need also email.

There are answer length limits to control exam duration. For the sake of fairness, if you exceed the length limits, I will evaluate only the portion of the answer within the length limit.

Skim all the questions before starting so you can budget your time. They have different difficulties, but each is worth similar credit; that's intentional.

Printed name

Sign below to acknowledge the Engineering Honor Code: "I have neither given nor received aid on this examination, nor have I concealed a violation of the Honor Code."

Signature

12 1. What is the primary disadvantage of static scheduling that on-line scheduling overcomes? Use two or fewer sentences.
Soln: Static scheduling cannot adapt to changes to task execution times.

12 2. Indicate two distinct reasons the particular assignment of tasks to PEs during embedded system design/synthesis may influence adherence to system-level deadlines. Use two sentences in total.
Soln: A specific task type may have different execution times on different PE types, so the particular assignment may influence task execution time. Tasks assigned to the same PE may require less (or no) communciation than tasks assigned to different PEs, so the particular assignment may influence communication time.

12 3. Has the general graph coloring problem been proven to require exponential worst-case time in terms of problem instance size? Yes No

Soln: No. It was proven to be NP-Complete. However, NP-Complete problems have not been proven to require exponential worst-case time in the problem instance size, even when executed on deterministic computers.

12 4. What is the main challenge customer discovery interviews are structured to overcome? Use two or fewer sentences.
Soln: They are structured to avoid biasing the interviewee into giving unrealistically encouraging feedback due, e.g., to politeness. This is accomplished, in part, by avoiding revealing what you prefer to hear.

12 5. Give the Pareto-rank of each of the following solutions, given that price, power consumption, and delay are all costs.

Solution	Price ($)	Power (mW)	Delay (ms)	Pareto-rank
1	20	50	500	**Soln: 2**
2	10	70	100	**Soln: 3**
3	14	20	50	**Soln: 3**
4	300	150	20	**Soln: 3**

Soln: Recall that the the Pareto-rank was defined as the number of other solutions that do not dominate the solution being considered, and that domination was defined as being superior in all costs.

14 6. Consider the following table, which indicates the power management state dependent power consumptions of components in an embedded system.

	Power consumption (mW)		
Component	Active	Standby	Sleep
CPU	500	200	10
Wireless	900	800	0
Gimbal	1200	n.a.	0
Ion accelerators	2000	1500	0

The components have the following activity distributions.

Component	Active	Standby	Sleep
CPU	5%	85%	10%
Wireless	3%	5%	92%
Gimbal	1%	0%	99%
Ion accelerators	1%	1%	98%

Check the design change that would extend battery lifespan more?

Enable the CPU to spend 5% more time in Sleep mode by reducing its time in Standby mode.

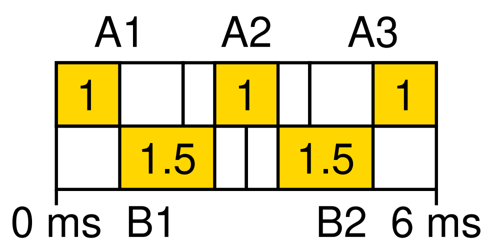
Reduce the CPU's active power consumption by 20%.

Show your work to make partial credit possible.
Soln: The first answer is correct. Analysis was simplified by the fact that only entries related to the CPU changed, so only CPU power need be considered.
Case 1: $500\,\text{mW} \cdot 5\% + 200\,\text{mW} \cdot 80\% + 10\,\text{mW} \cdot 15\% = 186.5\,\text{mW}$
Case 2: $400\,\text{mW} \cdot 5\% + 200\,\text{mW} \cdot 85\% + 10\,\text{mW} \cdot 10\% = 191\,\text{mW}$

12 7. If you were designing an energy scavenging necklace capable of recording video during interesting events, what are the two most important questions that need to be answered to determine whether energy scavenging is feasible?
Soln: What is the power consumption of the necklace? Given the operating environment and necklace size constraints, how much power can each scavenger deliver.

14 8. Given the assumptions in Liu's and Layland's paper, determine minimum processor speed, in MIPS, to allow all deadlines to be satisfied for a task set containing two tasks with periods 2 ms and 3 ms. At 1 MIPS, the execution time of each task is equal to its period. This is a particular question about this specific task set, not a question about a bound for arbitrary task sets.
MIPS:
Show your work.
Soln: 2.5 MIPS or 2 MIPS, depending on whether RMS or EDF is used. Liu and Layland considered a uniprocessor system: multiple tasks cannot simultaneously execute. This was for a specific task set, so direct calculation makes sense and using general bounds for a worst-case task set does not.

EDF at 2 MIPS



RMS at 2.333 MIPS