University of Applied Sciences Esslingen **Faculty Graduate School**

Summer Term 2017		Page No.:	1 of 11
Programme:	Automotive Systems	Semester:	ASM-SB
Module:	Reliable Embedded Systems		
Lecture:	**Distributed Real-Time Systems**	Lecturer:	Agrawal
Mode:	closed book apart from 2 sheets of DIN-A4 paper	Duration:	60 minutes
Name:		Student ID:	

Question 1: (10 Min.)

According to the NASA Managers, the Space shuttle Challenger had a failure rate of 1 in 100000 hours. However, Richard Feynman who was investigating the explosion of the space shuttle that led to the killing of all crew members, reported a failure rate of 1 in 200 hours.

1. Calculate the MTTF as per the NASA managers?
2. Calculate the MTTF as per Richard Feynman?
3. Calculate the reliability of the space shuttle 1 hour after the shuttle is switched on as per the NASA managers?
4. Calculate the reliability of the space shuttle 1 hour after the shuttle is switched on as per Richard Feynman?
5. Why is it important to carefully calculate the MTTF for highly critical systems?

Question 2: (20 Min.)

The US division of Mercedes & Bosch teamed up to create Robo-Taxis (driverless taxis) in April this year. There are innumerous challenges in driverless cars. One such challenge is driving in the city with lots of pedesterians around. Your job is to focus on the system design, where you can detect the movement of the pedesterians, and correspondingly steer / brake or accelerate the car.

1. Depict the design of your system with the help of 3 components of the real-time systems.
2. Define hard and soft deadlines through examples. Discuss if your designed system should have hard deadlines? If so, why?
3. List some of your system's functional and non-functional requirement. Please elaborate the temporal requirement falling under the category of non-functional requirements.
4. What kind of sensors would you employ to detect the pedesterians?
5. How can you monitor the failure of components such as sensors after the car has rolled out of production?

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Nodes with identical sensors are replicated to improve the reliability of the whole system, so that even if one of the sensor fails, the system will still continue working based on the other sensors.

1. Draw a block diagram to show how these different nodes are communicating via a communication bus.
2. Explain the difference between state messages and event messages. Mention some state messages with respect to your system.

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Following are 4 dependant tasks and 1 independent task to realise your software. The semantic for the task set is (Release time, Computation Time, Time Period)

- **Task A** : Sensor acquisition task (0, 50, 100)
- **Task B** : Sensor processing task (0, 20, 100)
- **Task C** : Communication Task (0, 20, 100)
- **Task D** : Decision Task (0, 10, 100)

A -> B -> C -> D (Dependancy graph)

- **Task E** : Independent Task: Diagnostic Task (0, 50, 3000)

1. Compute the Hyperperiod of all the task set.
2. Calculate the processor utilisation factor (Ratio of computation and time period of all tasks) for the combined task sets.
3. Discuss if its possible to run the above task set in a single core system? If not, then how many cores do you need?

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Question 3: (10 Min.)

In 2017, ten atomic clocks (all manufactured from SpetraTime) failed to oscillate in the European Union's Galileo navigation satellites. The possible cause is thought to be waking up the satellites after deep sleep which leads to a short circuit in the clock circuitry.

1. What is meant by oscillations in a clock?
2. What role does a clock play in the powermanagement of a CPU?
3. Assuming a clock drift at the rate of 10^{-5} sec/sec, what would be the offset of the clock after 1 hour?
4. In an ensemble of 4 clocks with a latency jitter of $5 * 10^{-5}$ seconds, the system designer wants to maintain a precision of 36 ms. In what intervals should the clock be synchronised?
5. Assuming 4 identical clocks are employed from the same manufacturer in your design, and one of the clock is Byzantine. Calculate the synchronisation interval to maintain the required precision.

Your solution

Please sketch a model here

Question 4: (10 Min.)

1. Draw the different layers of OSI Reference Model.
2. In a bus communication, discuss 2 methods, how the bus access is resolved at the time when two nodes want to send their data at the same time?
3. For a message length of 100 bytes, bandwidth of 1 Mbit/second and the distance between two nodes as 10 meters, calculate the bus efficiency. Assume speed of light in the medium as 2/3rd of speed of light.
4. How does the bus efficiency change, if the bandwidth is 1 Gbit/second?
5. How can you improve the bandwidth of the transmission from 1 Mbit/second to for example 10 Mbit/second through software methods?

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Question 5: (10 Min.)

1. What is a context switch?
2. What is the process of context switch between a running task and an interrupt?
3. Is the process of context switch between a running task and an interrupt the same as a context switch between two tasks?
4. What triggers a task switch in a round robin scheduling algorithm?
5. What is one major advantage of a multi core system over a single core system with respect to context switches?

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Your solution

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