

BITS, Pilani – Dubai Campus
Knowledge Village, Dubai
Second Semester 2003 – 2004
Comprehensive Examination

Real-Time Systems (CS UC 444)
(EEE / CS)

Weightage: 40%
Max. Marks: 80

Date: 01.06.2004

Time: 3 Hrs.
Closed Book

Note: All questions are compulsory. Write any assumption made with its requirement. Symbols have usual meaning.

Q1. Answer the following questions. (to the point only)

- 1.1) Classify the given system/task as Hard or Soft Real-Time Systems/ task and justify them.
 - a) In Communication System using time out protocols.
 - b) Database System for Air traffic Control.
 - c) Automotive Control System.
 - d) Power supply frequency controller i.e, to maintain it at $(50 + 1)$ Hz in Dubai, at power generating station. (3+3+3+3 = 12)
- 1.2) Explain why RISCs have a major Real-Time **advantage** than CISCs ? Name any **Two** CISC Processors for two different processor manufacturing Corporation. (3 + 2 = 5)
- 1.3) What is the physical significance of given equation (inequality) and the symbols have usual meaning. $2f - gcd(p_i, f) \leq D_i$. (5)
- 1.4) What are called as the special characteristics of a Real-Time Systems. (8 points = 8 marks)

Q2. Explain and show that the Priority-Driven System Scheduling behavior is Anomalous for the set of jobs **J1, J2, J3, J4, J5, J6** and all the jobs are independent. The **release time** of jobs are 0,0,2,0,3,0 and the **Deadlines** of the jobs are 10,10,18,12,20,25 and their **execution times** are 7, (4,7), 15,8,10, (10,15) and all the jobs are scheduled on **Two** Processor for execution. For the above given problem **draw the job table** and prove that the priority-Driven System of scheduling behavior is Anomalous using the **timing diagram** revealing the all possible scheduling sequences of the given independent jobs. (2+2+2+2+2 = 10)

Q3. Answer the following questions:

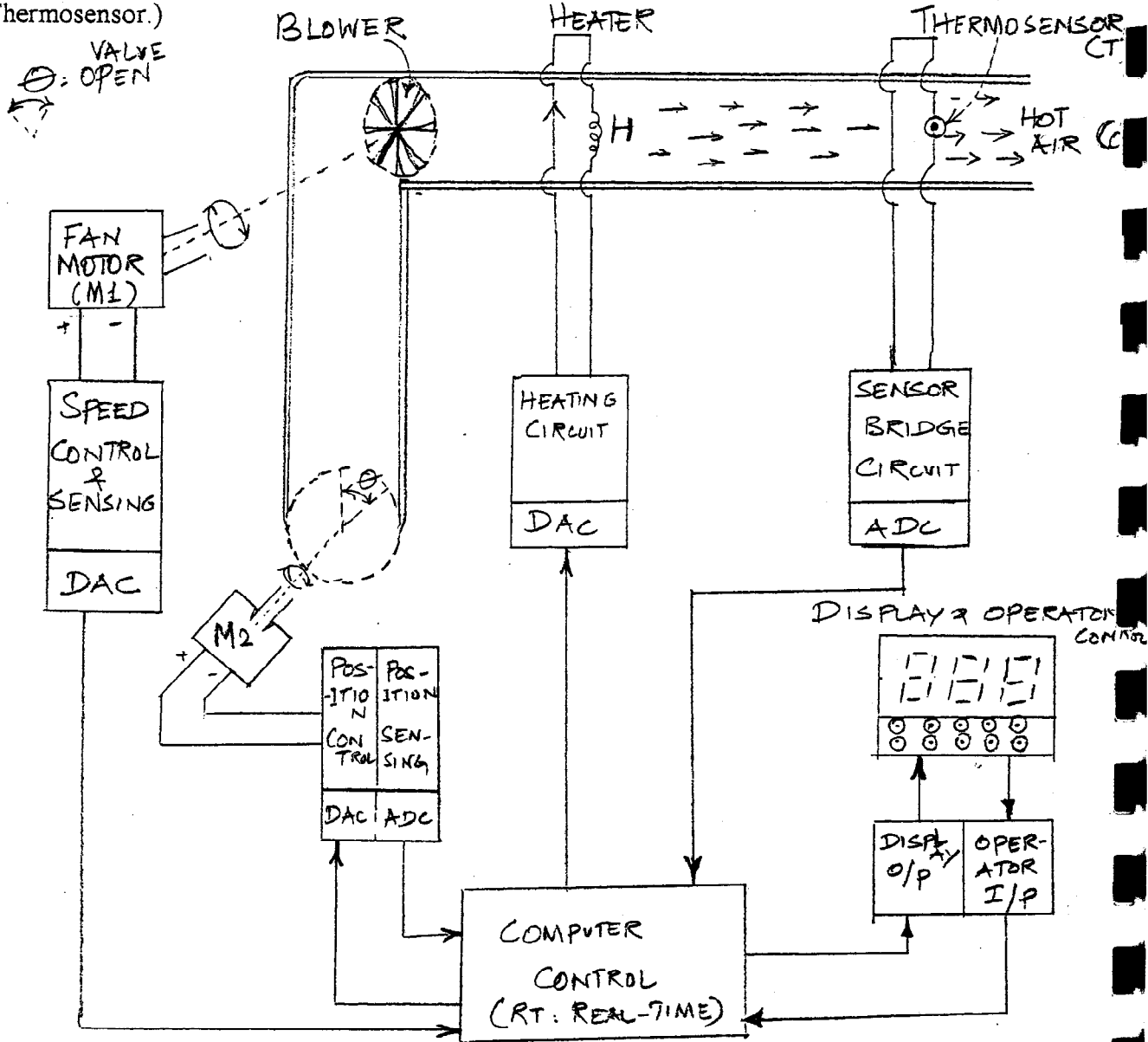
- 3.1) consider that you have been given with some set of tasks:
 $\{ (p_1 = 24, e_1 = 5), (p_2 = 48, e_2 = 5), (p_3 = 100, e_3 = 36) \}$
Calculate the Utilization of the system for the above mentioned tasks and check whether the periods of the tasks are Harmonic. (1+1+1+2 = 5)
- 3.2) Draw the Deterministic Finite State Automata to accept the following set string over the alphabets (0,1):
 - a) All strings that start with 0 and have odd length or start with 1 and have even length.
 - b) All strings that don't contains the substring 110. (3 + 2 = 5)

Q4. Write short notes on:

- a) Dynamic System and Static System.
- b) Effective Release time and Effective Deadline.
- c) Calling Tree in Real-Time System Design.
- d) Tightly coupled system and loosely coupled system.
- e) Mention the different types of Addressing Architecture available in Real-Time System. (2+2+2+2+2 = 10)

Q5. For a Real-Time computer controlled Hot Air Blower System (shown in fig. below) which is used to dry leaves in a plant, identify various major control, sensing and other types of tasks. Label these as periodic and Aperiodic as per your design judgment. Give the approximate numerical values and units of periods for the tasks which are periodic and deadlines for jobs(Periodic and Aperiodic). Classify each task as a hard or soft task and finally give a statement about the overall system, whether it is a hard or soft real-time system? Tabularize your Answer. (2+2+2+2+2=10)

(note to the figure: M1: Fan speed control Motor, M2 : Air inlet valve position control motor, ADC: Analog to Digital Converter, DAC: Digital to Analog Converter, H: Heating Elements, T: Thermosensor.)



Q6.

- What are the effects of **Resource Contention** on a Real-Time system's performance and design?
- Draw the Petri Net representation for the complex algebra which is used frequently in many engineering applications and give the firing table for the above complex arithmetic example.

$$(a+bi)(a+bi) = a^2 + b^2 + 2abi$$

- What is meant by **leveling** in Data Flow Diagram?

(3+5+2=10)

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QUIZ – I

COURSE: REAL-TIME SYSTEM CS UC 444
DATE: 13.04.2004

DURATION: 30 MINUTES
MAX. MARKS: 10

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1. The difference between *Specification* and *Design*:
Specification
is: _____

Design
is: _____
 2. *Structure Charts* are otherwise called as _____
 3. *Programming Design Language* differ slightly from *pseudocode*. (True / False)
 4. *Finite State Machines* are a type of Mathematical model, but they never helps the designer in designing of compilers, communication systems and hard-wired logic. (True / False)
 5. The Two different types of *Finite State Automata* are _____
and _____.
 6. _____ are used as a structured analysis tool for modeling software systems.
 7. Once an overall dataflow diagram has been drawn, further detail within the process blobs is provided. The diagram is then redrawn with the additional detail. This *process* is called
a) Structure approach b) Finite State Automata c) leveling d) Petri nets
 8. The *control flow diagram* is a type of data flow diagram that shows the flow of control signals through the system. (True / False)
 9. The major *weakness* that seems to be inherent in *dataflow diagram* is that they make it difficult to depict synchronization in flow. (True / False)
 10. Petri nets are another type of Mathematical Model used to specify the operations to be performed in a Multiprocessing or Multitasking environment. (True / False)

11. Warnier – Orr Notation is a representation methodology that is similar to structure charts, with several improvements. (True / False)
12. A Periodic Task T_i is a 4-tuple (ϕ_i, p_i, e_i, D_i) , represents
- (period, frames, execution time, deadline)
 - (period, phase, execution time, absolute deadline)
 - (phase, period, execution time, relative deadline)
 - none of the above.
13. When an aperiodic job is released, it is placed in the queue without the attention of the scheduler. (True / False)
14. Utilization of the tasks are calculated by the formula $U =$ _____
15. A Periodic static Schedule is otherwise called as
- cyclic schedule
 - non-cyclic schedule
 - both (a) and (b)
 - None of the above
16. The scheduling decision times partition the time line into intervals called _____
- partitioning
 - frames
 - cyclic schedule
 - all of the above
17. Forced to partition each job in a task that has a large execution time into slice with smaller execution times is called _____
18. A natural way to improve the response times of aperiodic jobs is by executing the aperiodic jobs ahead of the periodic jobs whenever possible, this approach is called _____
19. The one of the frame size constraints is that we have make the frame size f larger than the execution time e_i of every task T_i . (True / False)
20. If a Task T_1 has a period $p_1 = 4$ and execution time $e_1 = 1$, calculate the Utilization?

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QUIZ – I

COURSE: REAL-TIME SYSTEM CS UC 444
DATE: 13.04.2004

DURATION: 30 MINUTES
MAX. MARKS: 10

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1. The difference between *Specification* and *Design*:
Specification is: performed by the customer, and tell us what the software is to do.
Design is: performed by the system analyst, and tell us how the software will do it.
 2. *Structure Charts* are otherwise called as Calling Trees.
 3. *Programming Design Language* differ slightly from *pseudocode*. (True / False)
 4. *Finite State Machines* are a type of Mathematical model, but they never helps the designer in designing of compilers, communication systems and hard-wired logic. (True / False)
 5. The Two different types of *Finite State Automata* are Deterministic Finite Automata and Non-Deterministic Finite Automata.
 6. Data Flow Diagram are used as a structured analysis tool for modeling software systems.
 7. Once an overall dataflow diagram has been drawn, further detail within the process blobs is provided. The diagram is then redrawn with the additional detail. This *process* is called
a) Structure approach b) Finite State Automata c) leveling d) Petri nets
 8. The *control flow diagram* is a type of data flow diagram that shows the flow of control signals through the system. (True / False)
 9. The major *weakness* that seems to be inherent in *dataflow diagram* is that they make it difficult to depict synchronization in flow. (True / False)
 10. Petri nets are another type of Mathematical Model used to specify the operations to be performed in a Multiprocessing or Multitasking environment. (True / False)
 11. Warnier – Orr Notation is a representation methodology that is similar to structure charts, with several improvements. (True / False)

12. A Periodic Task T_i is a 4-tuple (ϕ_i, p_i, e_i, D_i) , represents
- (period, frames, execution time, deadline)
 - (period, phase, execution time, absolute deadline)
 - (phase, period, execution time, relative deadline)**
 - none of the above.
13. When an aperiodic job is released, it is placed in the queue without the attention of the scheduler. **(True / False)**
14. Utilization of the tasks are calculated by the formula $U = \underline{e_i / p_i}$.
15. A Periodic static Schedule is otherwise called as
- cyclic schedule**
 - non-cyclic schedule
 - both (a) and (b)
 - None of the above
16. The scheduling decision times partition the time line into intervals called _____
- partitioning
 - frames**
 - cyclic schedule
 - all of the above
17. Forced to partition each job in a task that has a large execution time into slice with smaller execution times is called **Job Slices**.
18. A natural way to improve the response times of aperiodic jobs is by executing the aperiodic jobs ahead of the periodic jobs whenever possible, this approach is called **Slack Stealing**.
19. The one of the frame size constraints is that we have make the frame size f larger than the execution time e_i of every task T_i . **(True / False)**
20. If a Task T_1 has a period $p_i = 4$ and execution time $e_i = 1$, calculate the Utilization?

$$U = e_i / p_i$$

$$U = 1 / 4$$

$$= 0.25.$$

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SECOND SEMESTER 2004

Course : CS UC 444 - REAL-TIME SYSTEMS
DURATION: 50 MINUTES

MAX.MARKS: 20
DATE: 11.4.2004

OPEN BOOK TEST - II

1. Using any one of the real-time system design technique, design a model for a network based course registration system for your university. (5)
2. Give a Warnier-ORR notation, representing a system design for patient monitoring system in an ICCU of a hospital. The patient monitoring system should contain the following devices like Blood pressure, pulse rate, ECG etc., for each patient in that unit. These machines issues Boolean signal indicating a fail or no failure condition and the result of these machine are ORd together to form a signal called alarm. The alarm signals for each of these rooms (one patient per room) are then ORd together and sent to the Master patient Monitoring System. If any machine indicates a failure, then the emergency alarm is sounded and the nurse is directed to the appropriate patient and take necessary steps for the treatment of that particular patient. (5)
3. Give the Dataflow diagram for an Automatic Teller Machine, that the ATM as to check the following events: PIN Number, validity of the pin number, requesting the mode operation like withdrawal, Deposit, query etc., and also checking their validity of operations. (4)
4. Design a finite state automaton for the alphabet, $L = \{0,1\}$ which accepts the set of all strings with 3 consecutive zeros. (3)
5. Illustrate the slack stealing in an clock-driven scheduling with an example. (3)

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SECOND SEMESTER -2004 - TEST -I**

COURSE: CS UC444

DATE: 14.2.2004

COURSE NAME: REAL-TIME SYSTEMS

MAX. MARKS: 40

DURATION: 50 MINUTES

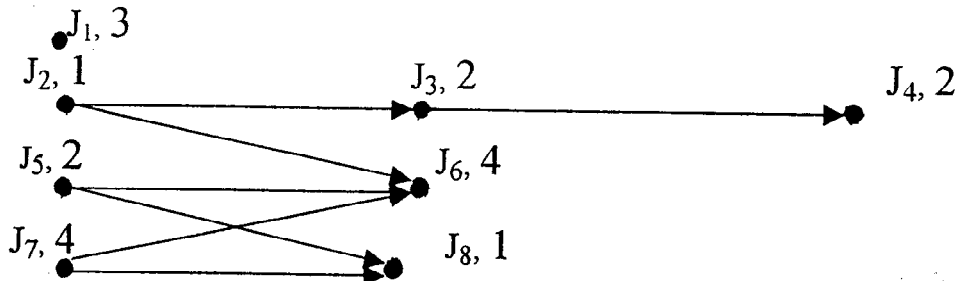
WEIGHTAGE: 20 %

ANSWER ALL THE QUESTIONS:

1. Classify and justify the following systems into Soft Real-time systems or Hard Real-Time systems:
 - a) On-Line Transaction Systems. (5)
 - b) Telephone Switches.
 - c) Electronic Games.
 - d) Stock Price Quotation System.
 - e) Multimedia Applications.
2. Define and explain Dynamic systems and Static Systems. (2)
3. Mention the 4 different types of Addressing Architecture and explain how they differ from each other. (3)
4. Explain the usage of MUX Transceivers with a block diagram and also show the Bus Structure Represented by Mil-Std-1553B as a transmission and receipt protocol. (5)
5. Draw the Architecture of an Air Traffic Control System and explain its functions (5)
6. Construct a RAM Device using Semiconductor material and give the logic diagram for a single bit of semiconductor memory and also show its Block Diagram representation.
7. Explain the anomalous behavior of Priority-Driven Systems and prove the anomalous behavior based the job table given below. The table shows FOUR different independent jobs and they are scheduled to TWO identical Processor in a priority manner. Draw the timing diagram shows the scheduling sequences of the given jobs. (10)

	r_i	d_i	$[e_i^-, e_i^+]$
J1	0	10	5
J2	0	10	[2, 6]
J3	4	15	8
J4	0	20	10

8. Illustrate the Priority-Driven Scheduling under Preemption and Non-preemption conditions for the precedence graph given below: (5)



The jobs in the precedence graph has a release time of 0, except jobs 5 and it released at time 4. Use Two Processors and show the scheduling sequences under preemption and non-preemption conditions of Priority-Driven Scheduling.