BITS, PILANI-DUBAI CAMPUS

KNOWLEDGE VILLAGE, DUBAI.

II – SEMESTER 2006-2007

Course Number	:	**CS UC444**
Course Title	:	**Real-Time Systems (Elective – CS)**
Nature of Component	:	**Comprehensive Exam (Closed Book)**
Date	:	**27-05-2007**
Weightage	:	**40%**
Max. Marks	:	**40 marks**
Duration	:	**3 hrs.**

No. of Pages : 3
No. of Questions: 17

Note:

1. Answer all questions. All parts of the question should be answered consecutively. Each answer should start from a fresh page.
2. Please follow all the instructions to candidates given on the cover page of the answer book.

1. Where do you need the following condition in a real-time system "A small sampling period means more frequent control-law computation and higher processor-time demand"? (1 Mark)
2. What are the two factors to be considered in selection of sampling period? Mention and write about it. (2 Marks)
3. Give one example for the real-time command control system and justify your answer. (1 Mark)
4. Consider a real-time weapon control system aboard an aircraft. Discuss which of the following events would be considered synchronous and which would be considered asynchronous to the software. (2 Marks)
   a) A 10 millisecond clock interrupt.
   b) A divide-by-zero error
   c) A built-in-test software failure
   d) A signal indicating "low on fuel"
5. What is the most important real-time characteristics of memory? (2 Marks)
6. Explain programmable interrupt controller and also the concept of handling multiple interrupts with block diagrams? (2 Marks)
7. Give the pseudocode describing an automatic teller machine application. (2 Marks)
8. Give the DeMarco's Rules for the construction of dataflow diagram for a real-time application. (2 Marks)

9. Construct a Warnier-Orr notation for performing the sequence operation for a dubbed foreign movie on digital video. The design should consider all features like video, sound, and subtitle missing in a proper manner so that it matches with the sequence of the movie. (3 Marks)

10. Give a partial design for the Air Traffic Control software, considering the following events are the major functions of the ATC processing. Identify the periodic and sporadic processes in the proposed design based on the major functions defined. The major function s of each process are:

Tracker	:	Maintains the Track file, controls radar output, and processes radar hits.
Background search	:	Searches airspace for unknown objects
Command Processor	:	Receives and interprets operator input, and directs it to the appropriate internal process.
Display Manager	:	Displays airspace contents, the response to operator commands, and any other output of interest to the operator.
Radar Input and Output	:	Controls and handles message IO for the communications subsystemtrue.

(2 Marks)

11. What do you mean by Minimum-Laxity-First algorithm? What is the other name for it?

(2 Marks)

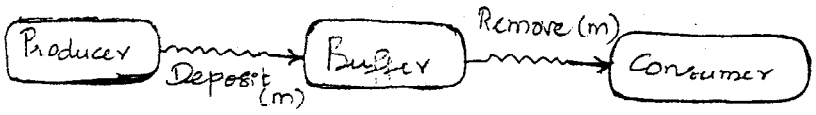
12. Consider two processes as P1 and P2 with execution time, period, and deadlines as (2, 4, 4) and (5,10,10). Schedule these processes using EDF scheduling, on a single processor so that processes meets it deadlines, the process of scheduling of processes has to considered up to the time period 20 and see that the process don't miss its deadline by preemption operation whenever or wherever it is required. (3 Marks)

13. What do you mean by Priority Inversion, priority Inheritance, and priority ceiling in case of Process Interaction? (3 Marks)

14. Consider a real-time version of a producer process and a customer process interacting through a bounded buffer. The producer will insert or deposit data elements into the buffer, while the customer removes them in first-in-first-out order. The data is stored in a buffer array, one data element per array element. Construct three communicating real-time finite state machines, one each for the producer, consumer, and buffer. There is deposit channel directed from the producer to the buffer and a remove channel from buffer to the customer. The message type m for both channels is identical. The channel is drawn as a wavy line in the figure to indicate communications.

Ignore the timing specifications on the transitions at present. For example, assume that producer is a physical device that generates signals through its Generate(data) transition, that are then sent to Buffer by a Deposit(data) output. If the deposit IO doesn't occur in time, the clock transition is taken and error message is sent on an error channel. Consumer is a software task that removes and processes the data; it invokes remove to obtain the next input signal.

(4 Marks)



15. Construct a state chart for a patient monitoring system(PMS) in an ICCU. The PMS has two superstates one for indicating Normal(N)condition and the other superstate for the emergency(E) indcating unit/system. A superstate has its own related states which are called its component states of the superstate. A superstate has a default strat or entry (sub)state. Transitions between supersatates denote their potential execution in sequence. Consider that the two superstates N and E are connected by the transition i as shown below. The meaning of this visual form is that all states in N are connected by transition i to the entry state of E. The figure below describe the N1 – normal operation of some subsystem of the N, E1 the emergency operation and i the fault event (interrupt) causing the transition between normal and emergency modes. Your design should consider all possible features of this real-time system.

(2 Marks)

16. Construct a DFD for a billing application and the parameters for the billing applications are as follow: the input transaction_control provides the control data for the start and end of each transaction, denoted by start_trans and end_trans, respectively. The itemized bill is maintained in the bill storage area. At the end, the itemized bill, named bill, is read from bill and then ouput by the print_bill function. The compute_cost function computes the total cost of an item and sends the result to update_bill which then updates the bill data. (4 Marks)
17. Giev the Petri Net's design for a Model communication protocol between Two Processes. The design should consider the parameters like send message, send acknowledge, wait acknowledge, receive acknowledge, buffer between the two process in order to avoid loss of information during communication, Process 1 and Process 2 and justify your design in order to implement it in the real application. (3 Marks)

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BITS Pilani - Dubai Campus

Knowledge Village, Dubai
Second Semester 2006-07

Course Number & Name	:	**CS UC444 – Real-Time Systems (IV Year CS Elective)**
Nature of Component	:	**Open Book**
Weightage	:	20%
Duration	:	50 mins
Date & Day	:	06-05-2007, Sunday
Max. Marks	:	20 Marks

Note:- 1. Answer all Questions.
2. Read the instructions from the cover page of the main answer book.

1. Illustrate the mapping of workflow management concepts onto Petri nets, for this; let us consider the processing of complaints as the problem. Modeling a work flow process definition in terms of a Petri net is rather straightforward: ***tasks*** are modeled by *transitions*, ***conditions*** are modeled by *places*, and *cases* are modeled by tokens. First the complaint is registered (task *register*), then in parallel a questionnaire is sent to the complainant (task *send questionnaire*) and the complaint is evaluated (task *evaluate*). If the complainant returns the questionnaire within two weeks, the task *process questionnaire* is executed. If the questionnaire is not returned within two weeks, the result of the questionnaire is discarded (task *time out*). Based on the result of the evaluation, the complaint is processed or not. The actual processing of the complaint (task *process complaint*) is delayed until the questionnaire is processed or a time-out has occurred. The processing of the complaint is checked via task *check processing*. Finally, task *archive* is executed. The work flow process definition for the processing of complaints specified in terms of a Petri net. The ***tasks*** *register, send questionnaire, evaluate, process questionnaire, time out, process complaint, check processing* and *archive* have been modeled by transitions. The transitions *processing OK* and *processing NOK* have been added to model the two possible outcomes of executing task *check processing*. The transitions *no processing* and *processing required* have been added for similar reasons. To model the states between tasks, conditions have been added. Each condition is modeled by a ***place***. (5 Marks)

2. Give a Warnier ORR design for generating the payroll of an employee in an organization, and your design should consider the following parameters: (3 Marks)
   - it should have an option for *get payroll record*
   - *calculate the net pay*
   - *print check*
   - *read payroll record*
   - *validate payroll record*
   - *Calculate grosspay*
   - *Update employee records*
   - *Calculate deduction*
   - *Calculate tax with held*
   - *Calculate saving scheme with held*
   - ***Reject*** *if the option selected /opted are not correct*

3. Research the difference between deterministic fsm and non-deterministic fsm. Under what circumstances would a deterministic fsm be used to specify system requirement (i.e., what kind of system would be amenable to this technique)? (2 Marks)
4. What does the sequence represent in real-time programming? And what type of real-time machine it represents? Give the commercially available machine that uses these sequences of operations and justify it. (2 Marks)

   a) top ← top+1
      stack(top) ← accumulator

   b) accumulator ← stack(top)
      top ← top-1
5. What is the similarity between the return and RI instructions? (2 Marks)
6. Give the *Petri net* design for the real-time systems (RTS) defined below: let us consider there is a RTS which can process ***n*** tasks at a time by synchronizing unless a time out or interrupted with interrupts. Depending on the type of RTS, it can be a multitasking system, assume that there are ***n*** number of interrupt handlers which is used to handle the interrupts occurring during the process of execution. For our design we consider a system with two processes as process A and process B you have to give the Petri net design for process A has to be synchronizes with process B unless time out or interrupted with interrupt and it has multiple interrupt handlers for handling different signals processing for a specific purpose. Your design should include all features and parameters defined in the problem.(3 Marks)
7. Design a State Chart which specifies the behavior of the coolant monitor in a nuclear reactor that monitors the coolant flow in an experimental nuclear reactor. In this application there are three levels of processing: as *foreground process, dispatcher, and background process.* In foreground process (FG) there are three processes: *a timer process (T) has responsibility for maintaining elapsed time for use by a background alarm clock task and for time stamping events. A second task in FG- F is the second process which detects, isolates, and handles faults by reconfiguring the hardware. The third process in FG is the S process performs the principal application functions of reading and processing coolant flow and related data from sensors. The Background tasks (B) contain less critical processes for testing and display.* The Dispatcher is triggered by a timer interrupt on a 100 ms cycle. One each cycle, it successively activates T, F, and S; each runs to completion and then returns to the Dispatcher. The processes of B are then dispatched in the remaining cycle time.(3 Marks)

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BITS, Pilani – Dubai Campus
Knowledge Village, Dubai.
II Semester 2006-07

Course Name	:	**Real-Time Systems (Elective)**
Course Number	:	CS UC444
Nature of Component	:	**Closed Book**
Date	:	01-04-2007 (Sunday)
Duration	:	50 mins.
Max. Marks	:	20 Marks
Weightage	:	20 %

Note: Please read the instructions in the front page of Main Answer sheet. Always start answering in a fresh page. Answer all Questions.

1. Explain the Nearest Neighbor Algorithm and for what purpose it has been used? (2 Marks)
2. What do you mean by a multirate system? (2 Marks)
3. Define the following terms with its notation: (2 Marks)
   a) Release Time, b) Relative Deadline, c) Absolute Deadline, d) Execution Time.
4. Classify and justify the events given below into Hard and Soft Deadline in a Real-Time System.
   a) A late command to stop a train may cause a collision. (2 Marks)
   b) A bomb dropped too late may hit a civilian population instead of the intended military target.
5. What do you mean by Jittered release time? Explain why it is there in any Real-Time system. (2 Marks)
6. Mention the following events comes under the what type of Real-Time Scheduling approaches:
   a) Traffic in a High speed Switched network. (1 Mark)
   b) An approach that never leave any resources Idle intentionally or a resource idles only when no jobs requiring the resource are ready for execution.
7. Draw the precedence graph and schedule the given set of jobs based on the Priority-Driven approaches (both preemptive and non-preemptive methods). The problem definition is as follow: There are 8 jobs for executions in a real-time environment and the execution is carried out using **two** processors only. At time 0, jobs J_1, ^{3} , J_2, ^{1}, and J_7, ^{4} are ready for execution; and J_3, ^{2} , J_4, ^{2} are the dependent on J_1, and J_2. The Job J_5, ^{2} is released at time 5 and its successor is J_6, ^{4} ; J_6 is also dependent on J_7. The job J_8, ^{1} is the successor of J_5, and J_7. (3 Marks)
8. Explain the LRT algorithm with an example. (2 Marks)
9. What type of logic circuit is required to help the microprocessor read or write cycle by a certain number of processor clock cycles to allow the device or memory to "catch up". Explain it? (2Marks)
10. Give the advantages of using RISC machine in a Real-Time Systems? (2 Marks)

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