

BITS Pilani, Dubai Campus

DIAC, Dubai

I Semester 2011-12

Course	:	EEE C444 / CS C444 / INTRS C444	Real-Time Systems
Component	:	Comprehensive Examination	
Year	:	IV Year (Elective)	
Date & Duration	:	11-1-2012 & 180mins (A. N)	
Weightage	:	40 % (40 Marks)	
No. of Pages	:	03 Pages	

Note: Answer All Questions. Do not overwrite the Design / the specification.

I: All Questions carries 2 Marks each.

1. How real time systems differ from other computer based systems?
2. "Round Robin Scheduling does not work for the real-time applications". Comment on this statement.
3. What is the difference between static priority and dynamic priority in a real-time system?
4. How real-time database different from the general purpose database?
5. What do you mean by Critical Zone theorem?

II: All questions carry 3 Marks each.

1. A system contains nine non-pre-emptable jobs named  $J_i$  for  $i=1,2,3,\dots,9$ . Their execution times are 3,2,2,2,4,4,4,4, and 9, respectively, their release times are equal to 0, and their deadlines are 12.  $J_1$  is the immediate predecessor of  $J_9$ , and  $J_4$  is the immediate predecessor of  $J_5, J_6, J_7$  and  $J_8$ . There are no other precedence constraints. For all the jobs,  $J_i$  has a higher priority than  $J_k$  if  $i < k$ .
  - (i) Draw the precedence graph of the jobs.
  - (ii) Can the jobs meet their deadlines if we make them pre-emptable and schedule them preemptively. Explain your answer.
  - (iii) Can the jobs meet their deadlines if they are scheduled non-preemptively on four processors? Explain your answer.
2. Check whether the given sets of tasks are Harmonic or not. Give the time diagram that shows their cyclic schedule and meet their deadlines with the hyper periods? Also calculate the total utilization using RMA1 method?

Tasks	Period	runtime	Utilization	Priority
T1	3	9	?	?
T2	6	18	?	?
T3	8	36	?	?

3. Design a Finite State Machine specifying a simple controller for Train crossing gate. The supporting statement for the problem is as follows: there is a road crossing a railway track; and a gate that opens and closes over the road. When a train approaches the crossing, the gate should close. More than one train can be in the crossing area at once, for example, a convoy of trains, each with a single engine and no cars. When the last train has left and the area is empty of trains, the gate should open. The condition Train\_entering becomes true when the first part of a train enters the area; Train\_Leaving becomes true when the last car of a train leaves the area. Count keeps track of the number of trains in the crossing area. The required finite state Machine design of a simple controller for train crossing gate should show "Input events are Train\_Entering and Train\_Leaving signals; the output events are Open\_Gate and Close\_Gate commands, the latter being equivalent to the og and cg commands. The state variable count keeps track of the number of trains in the crossing area. The guards (count = 1 and count > 1) determine which transition is taken on a Train\_Leaving event; a guard is omitted when its value is always true".
4. Design a Warnier-Orr Semantics for the Automatic Teller Machine; Consider all possible cases starting from inserting the ATM card into ATM machine, enter PIN number, if Correct, select any one of the following function and they can be executed parallel, functions are "Withdraw", "Query" and "Deposit". Withdrawn: Enter the amount to be withdrawn, check whether the amount entered is valid or invalid; Query: display the balance / mini statement / last transaction; Deposit: select cash / cheque, check for the amount and the accept the envelope. If the PIN entered is wrong it has display the pre-defined statement "Sorry".
5. Using the Real-Time Design methods, model the operations of an automobile. The automobile design model should include the following subsystems:
  - a) steering, b) Braking, c) Acceleration, d) Dashboard display, e) Anti-Braking system

**III: All Question carry 5 Marks:-**

1. Check whether the given set of tasks can be schedulable using RMA 1 method with overload. The table given below shows the tasks and its parameters. The loss is 19% per KHz, find the rate, and overhead

Task	Computation Time	Period	Frequency	Utilization	Priority
T1	6	15	66	?	?
T2	4	20	50	?	?
T3	5	30	34	?	?

2. Check whether the task T3 is schedulable or not, using the RMA with Blocking? Calculate the total utilization, also assign priorities to the tasks and mention on what basis the priorities are assigned.

Task	pi (ms)	ei(ms)	priority	Blocking	Deadline
T1	100	40	?	0	100
T2	150	50	?	0	150
T3	400	70	?	0	270

3. 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.

\*\*\*All the Best\*\*\*

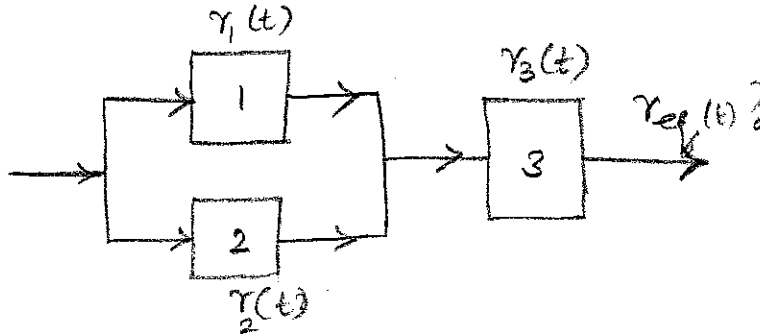
**BITS PILANI, DUBAI CAMPUS**

**I SEMESTER 2011-12**

<b>COURSE</b>	:	<b>CS C444 / ECE C444 / INSTR C444 REAL-TIME SYSTEMS</b>
<b>COMPONENT</b>	:	<b>TEST 2 (OPEN BOOK)</b>
<b>DATE &amp; DURATION</b>	:	<b>18/12/2011 &amp; 50 MINS</b>
<b>WEIGHTAGE</b>	:	<b>20 % (20 MARKS)</b>

- Note:**
1. Answer all the Questions and use required assumptions and mention them clearly in answer sheet.
  2. Number of pages: 2.
  3. Draw the design clearly and do not overwrite the design. *Make your own assumption wherever and whenever needed.*

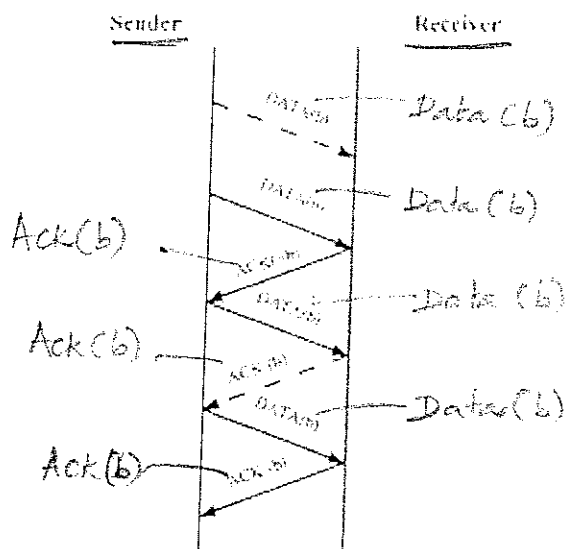
1. Calculate the overall system reliability function for the system given below? (2Marks)



2. Give the Data Flow Diagram for the following problem of statement describing for a manufacturing cell. As components to be assembled by a robot are placed on fixtures, a status bit is set within a **parts status buffer** (a control store) that indicates the presence or absence of each component. Event information contained within the **parts status buffer** is passed as a bit string to a process, *monitor fixture and operator interface*. The process will read **operator commands** only when the control information, bit string, indicates that all fixtures contain components. An event flag **start / stop flag**, is sent to *robot initiation control*, a control process that enables further command processing. Other data flows occur as a consequence of the **process activate** event that is sent to *process robot commands*. (3 Marks)
3. Design a State Chart for the Ringing and lighting the watch alarm application described below: consider a simple digital watch with time, date, hourly chime, and alarm clock functions, and 4 buttons, **a, b, c, & d**, for user control. The watch alarm has two super states, one is clock and another is Light, the **clock** super state consists of two sub-super states as **Main** and **Ring\_alarm**. The **Main** sub-superstate consist of three sub-states as **Normal\_display**, **Chime\_alarm\_Set** and **Update** states, The transition between Main and the ring\_alarm states takes place when the triggering event (Alarm\_On) of alarm ring **Alarm\_On**  $\rightarrow ct = t_{alarm}$  occurs when the condition  $ct = t_{alarm}$  becomes true. The notation **ct** denotes current time and  $t_{alarm}$  is the time to which the alarm clock is set. Pressing any button (the **any\_button**) will cause the alarm to stop ringing; otherwise, the ringing will continue and stop after 30 seconds, denoted by **timeout** transition and go back to **Main** state. In either case, the **Main** sub-superstate is reentered at the same point where it was interrupted by the alarm (**H** entry); that is, at the default entry of one of the three states of **Main**. In the **Main** sub-superstate the transition are given as below: the start state is of **Normal\_Display** state, transition takes from **Normal\_Display** state to **Chime\_Alarm\_Set** when the **b** button is pressed, and to **Update** state when the **c** button is pressed. The Digital watch can come back to **Normal\_Display**

state from *Chime\_Alarm\_Set* when the *d* button is pressed and also from *Update* state when the *d* button is pressed, and also when a button is pressed the transition takes place from *Update* state to *Normal\_Display* state. Show the concurrency and event broadcasting between the two super states of the statechart. The Light super state, which specifies that the light can be turned on or off with the *d* button and *d'* is the event associated with letting go of the button. The depress button event *d* is broadcast to both the Light and the clock super states. This is the principal way that the machines interact and communicate directly. (5 Marks)

4. Construct a efficient DFD for a Billing Application, similar to one at a supermarket check-out stand, for each customer transaction, a running itemized bill is computed and the parameters for the billing applications are as follows: the input *Transaction\_Control* provides the control data for the start and end of each transaction, denoted by *start\_trans* and *end\_trans*, respectively. At the end, the itemized bill, named bill, is read from Bill and then output 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)
5. Give the Petri Net Model for the following: The temporal sequence of possible internal events in the data transfer phase of the Alternating Bit Protocol (A B Protocol). The operation of the AB protocol is described as follows. The sender sends a 'DATA' message to the receiver and simultaneously enables its internal retransmission timer. Each DATA message sent by the sender to the receiver is accompanied by an additional bit 'b'. The value of this control bit alters with each new DATA message. The receiver, on receiving the DATA, acknowledges it by sending an ACK message accompanied by the same control bit b that accompanied the DATA. If no acknowledgment reaches the sender before the timer expires, a copy of the message is sent after each timeout repeatedly, until its reception is acknowledged. The DATA LOST during the transfer operation is to be considered in the design of the petri net modeling.



(4 Marks)

6. If the Cyclomatic Complexity,  $C=7$  and that the system is said to be well-structured module; if the number of tasks are 2, find out the values of others parameters so that the complexity value will be equal to 7 and also give the flow graph for the above defined problem. (2Marks)

# BITS PILANI, DUBAI CAMPUS

## I SEMESTER 2011-12

COURSE	:	CS C444 / EEE C444 REAL-TIME SYSTEMS
YEAR	:	IV YEAR (ELECTIVE)
COMPONENT	:	TEST 1 (CLOSED BOOK)
DURATION	:	50 MINS
DATE	:	23-10-2011, SUNDAY
WEIGHTAGE	:	25% (25 MARKS)

Note: Answer all questions.

1. Assume that there are 3 jobs  $J_1 = (3, 2, 9)$ ,  $J_2 = (5, 4, 12)$  and  $J_3 = (2, 1, 10)$ ; the parameters inside the parenthesis represent execution time, release time and deadline. Give a schedule that follows the EDF policy using One Processor. (2 Marks)
2. A system contains nine non-pre-emptable jobs named  $J_i$  for  $i=1,2,3,\dots,9$ ; their execution times are 3,2,2,2,4,4,4,4, and 9 respectively, their release time are equal to 0, and their deadlines are 12.  $J_1$  is the immediate predecessor of  $J_9$  and  $J_4$  is the immediate predecessor of  $J_5, J_6, J_7,$  and  $J_8$ . There are no other precedence constraints. For all the jobs,  $J_i$  has a higher priority than  $k$ , if  $i < k$ .
  - a) Draw the precedence graph of the jobs. (2 Marks)
  - b) Can the jobs meet the deadlines if they are scheduled on 3 processors? Explain your answer. (3 Marks)
  - c) Can the jobs meet their deadlines if they are scheduled non-preemptively on 4 processor? Explain your answer. (3 Marks)
3. If  $P_1$  and  $P_2$  are process and their execution time, release time, and deadline are (3,4,4,) and (2,8,8). Schedule both the processes on one processor using Round Robin scheduling method and Highest Priority scheduling method. In Round Robin method, each process will be given 1 unit of time (that is the time slice of the processor); in priority driven method priorities are assigned based on the execution time. Check whether Round Robin scheduling or Highest Priority scheduling is feasible for this problem, if so, justify your answer. (3 Marks)
4. What do you mean by Minimum-Laxity-First algorithm and what is the other name for it? (2 Marks)
5. Give the 0-Address machine code for the equation given below:
$$Y = \frac{X+Y+Z}{X*Y*Z}$$
(3 Marks)
6. If you want to copy the content from your CD ROM drive and to store it in D: drive. What are the signals generated by the system and what is the status of the CPU and system while doing this process. (3 Marks)
7. Design finite state machines that represent the vending machine, which prepare the drink as per the request made by the end user. The drinks are coffee, and tea with sugar or without sugar or with extra sugar. The amount for coffee is AED 1.50 and for Tea is AED 1.00. The machine will not give any change if the user insert TWO 1 Dhiram coins into the machine, but it will show the balance on the display stating that there is AED 0.50 is left, if you want you can use it for another drink. (4 Marks)

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4. Give the Petri Net notation for a *while loop* instruction. Consider your own *while loop* instruction and give its Petri Net notation. (1 Mark)

5. Draw the subsystem configuration for a system with four subsystems and an overall reliability function given by  $r_1(t)r_2(t) + r_3(t)r_4(t) - r_1(t)r_2(t)r_3(t)r_4(t)$  (1 ½ Marks)



**BITS PILANI, DUBAI CAMPUS**  
**DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI**  
**I SEMESTER 2011-12**

COURSE: EEE C444/ CS C444 / INSTR C444 REAL-TIME SYSTEMS

MAX. MARKS : 8 MARKS

COMPONENT: QUIZ I

DATE: 26-09-2011

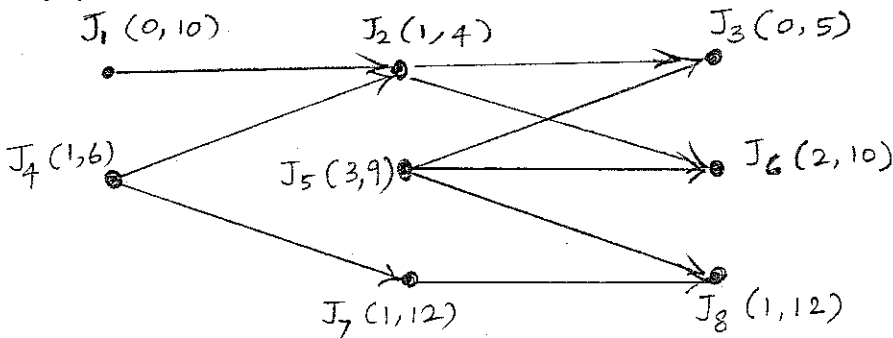
NAME: \_\_\_\_\_

ID NO.: \_\_\_\_\_

1. If a job  $J_i$  has a range of execution time  $[e_i^- \text{ and } e_i^+]$ , what do you mean by it. (1)

2. What do you mean by Aperiodic and Sporadic Task? What is the type of real-time systems, if they are executing only Aperiodic / sporadic tasks? (1)

3. Find the effective release time and effective deadline for the precedence graph given below; and redraw the graph with its effective release time and effective deadline. (2)



4. For the Precedence graph given below; apply the priority driven scheduling approach using EDF, LRT and LST algorithms. (3)

.....Please turn over ..... (3)

$J_1, 3(0, 5]$

$J_4, 2(4, 9]$

$J_2, 2(1, 6]$

$J_5, 1(2, 11]$

$J_3, 2(1, 9]$

5. Whether multiprocessor system are dynamic system or not? If so, why?

(1)