Jadavpur University
MASTER OF Engineering 2nd Semester Examination 2018
Real-Time Embedded Systems

Answer Any Five   Time : Three (3) Hours   Full Marks : 100

1a. A real-time system comprises 2 tasks T_1 and T_2 with periods P_1 and P_2 and execution times C_1 and C_2. If $P_2 > P_1$, prove that the critical instant fro task T_2 occurs when the request for T_2 coincides with that of T_1.

1b. Prove that for the above system , if the task set is schedulable by a priority assignment with priority of T_2 greater than that of T_1, it is schedulable with Rate Monotonic scheduling .

$$10+10$$

2a. What is meant by U or the 'Least Upper bound of Maximum Processor Utilization'? Assuming RM scheduling , calculate value of U for a set of 2 tasks T_1 and T_2 with periods P_1 and P_2 and execution times C_1 and C_2 such that $P_2 > P_1$,

$$2+8$$

2b. A real-time system consists of 4 producers and one consumer task . The producers operate with a periodicity of 10msec. and have a WCET of 1 msec. each. If the consumer has a WCET of 2msec. and the same request period, can you calculate the maximum context switch latency if the timer's periodicity is 20 micro sec. ? Assume that all tasks have the same priority. If the relative deadline of each of these tasks is equal to its periodicity, calculate the laxity of each task.

$$8+2$$

3a. Assume that the tasks in problem 2b above are synchronized such that the producers write the data in a buffer with 4 elements and the consumer reads the data once all the 4 elements are written. What kind of synchronization would you use? Write the pseudo code of the nth producer and the consumer.   2+4+4

3b. A system consists of 3 tasks A,B and C with periods of 40,80 and 100 msec. and WCETS of 10, 10 and 30 msec. The tasks are scheduled by RM scheduling. C is requested first and it sets a semaphore. Request for task A arrives 2msec. after the request for task C and request for task B arrives 5 msec. after the request for C. If the task A now tries to set the same semaphore which C has set, 4 msec. after it starts running

(i) draw the execution profile of the tasks with the assumption that task C releases the semaphore 6msec. after it resumes.

(ii) What is this phenomenon called?

(iii) Is task A able to meet its deadline   10

4. Write short notes on any two of the following:　　　　　　　　　10+10
   (i) properties of an RTOS
   (ii) Classification of Embedded Systems
   (iii) Timer functions in an RTOS

5.
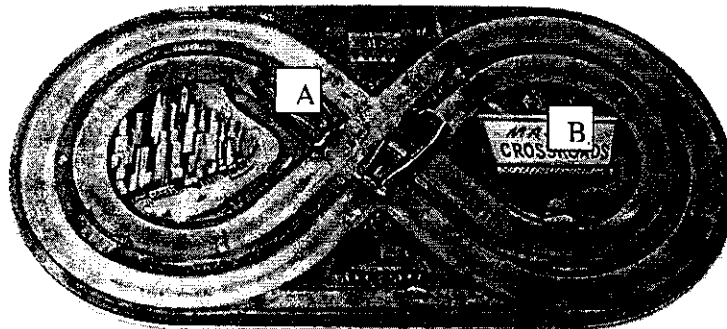
The fig. above shows a toy cross-road with two figure of 8 tracks which intersect at a crossroad. The tracks are designated as A(red car) and B(blue car). The cars run of tracks and are powered by electricity on the tracks. With a suitable assumption of initial state of the system and with a further assumption that the blue car has priority over the red car while transiting the cross-road and that the cars stop immediately when the track is powered off:

   a. Show the distribution of the sensors and their outputs for tracks A and B
   b. Using a Moore machine represent the control software as a FSM.
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6. Consider a pedestrian crossing with automated traffic lights consisting of the following states:

   s_0:(cars:green, ped:red), s_1 : (car:yellow, ped:red), s_3:(car:red, ped:red),

   s_4:(car:red;ped:green), s_5:(car:red,ped:red), s_6 :(car:red+yellow, ped:red)

   With the assumption that the initial state of the system is (g,r) i.e.green for cars and red for pedestrians, and that a pedestrian uses a push button to ask for access and further that transitions occur after definite delays, use a timed automata to represent the controlling software.　　　　　　20

7. 4 scanner tasks write data on a single synchronized buffer with some initial processing. The data is read by a data handler, which further processes the data and outputs the same in two output channels. The system is co-ordinated by a task monitor.

   a. Represent a *synchronized buffer, control transformation* and *stimulation.*
   b. Represent the system by a DFD with enhancements for representing synchronization
   c. Applying suitable cohesion criteria identify the tasks and assign a priority sequence　　　　　　　　　　　　　　　　　　6+6+8