Jadavpur University
ME(Power Engg./Software Engg./Nucl.Engg.)2nd Semester Examination 2019
Real-time Embedded Systems

Answer Any Five

Time: 3 hrs. **Full Marks : 100**

1. Define WCET, Laxity, Deadline and Relative Deadline of a Task. 8

   Consider a 3 task system with a set of 3 tasks T_1, T_2, T_3 with WCETS 1,2 and 2 ms. respectively and the corresponding relative deadline of 4,5 and 8 ms. Draw the execution profile of the task-set for the first 3 cycles with (i) EDF scheduling and (ii) RM scheduling, assuming that the relative deadline of a task equals its period. Hence calculate the maximum achievable processor utilization in each case. 12

2. Enumerate the different assumptions for RM scheduling 4.

   Consider a 2 task system $[T_1, T_2]$ with WCETS C_1, C_2 and periods P_1, P_2 such that $P_2 > P_1$. With suitable assumptions of RM scheduling, deduce the condition for the minimum of maximum processor utilization and its value. 16

3. Differentiate between ***Burst Mode*** and ***FIFO Mode*** semaphores. 4

   Three tasks T_1, T_2, T_3 with priorities in the same sequence are synchronized using a flag semaphore. Initially, T_1 and T_2 are in the blocked state when T_3 runs for 10 ms after having set the semaphore, when it is pre-empted by T_2. T_2 runs for 20 ms. more before it is blocked again , while trying to set the same semaphore, and T_3 runs for a further period of 10 ms. when it is pre-empted by T_1 which runs for 20 ms. and gets blocked again when it tries to set the semaphore set by T_1. T_3 then runs for 15ms. and resets the semaphore. If T_2 and T_1 take further 20 ms. each to complete the activities for the particular cycle, draw the execution profile and calculate the time spent by T_1 in blocked mode assuming a) a burst mode semaphore and b) a FIFO mode semaphore. What is the processor utilization in this case? Does this depend on the execution profile or the semaphore type? 16

4. Explain ***priority inversion*** with a set of tasks A,B and C having different priorities. Enumerate two measures by which this can be avoided. 6+4
   Enumerate the different timer functions in an RTOS. Which timer function would you be using for implementing a Watch Dog Timer? 3+1
   Now, if the Basic Time Unit for this RTOS is 20 micro-sec and the context switch latency is 5 micro-sec, calculate the maximum error possible in pulse width if this system is used to generate a pulse of 500 micro-sec duration by a task which switches the pulse on and off in two successive instances. 6

5. Represent a Full Adder (Sum plus Carry) using a (i) Moore Machine and (ii) a Mealy Machine. 10
   A micro-controller based system generates a single pulse of duration t secs . once a button A is pressed. While the pulse is ON , it can be reset by pressing button B. With the use of appropriate automata represent the system 10

6. An embedded system is build around a hardware using a serial port with a 8 Byte FIFO both at output (CPU writes on this) and input (CPU reads from this).The CPU is interrupted to read from the FIFO(input) only when it is full. If the baudrate is 19.2 kbps and the protocol uses a frame with 8 bit no parity data and 2 stop bits, what is the maximum allowable time for the Interrupt Service Routine (ISR) to read the FIFO?
If the FIFO(output) is also programmed to interrupt the CPU when it is fully empty, and writing 8 Bytes on the output FIFO by the CPU takes 2 micro-sec. what is the time taken to transmit 1KB of data from the sender application to the receiver for this system?
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7. Calculate the bitwise efficiency of a message frame with a 8 Byte data, 2 Byte Header, 1 Byte Error Code and SOF and EOF of 2 bits each. 4

Represent a *Bus*, a *Ring* and a *Star* Topology of physical interconnect schematically. 6
A logical *Ring* Topology is implemented over *Bus* interconnect with 6 constituent stations. The ring is maintained by a *Master* which is the node 1 and it passes a token sequentially to each of the other nodes 2,3…,5 with a pre-determined interval. Each time a node receives a token C, it sends its data D to the next node in sequence , which receives the data, processes it and then waits for a new token to send it to the node next to it in sequence. Calculate the message efficiency of the protocol 6
What will be the bit stuffed bit string corresponding to 1111110000111110? 4

8. Define temporal, sequential and functional cohesion. 6
An application reads data periodically from an electronic data channel, processes the data and writes the same in a synchronized buffer. Data from this buffer is read periodically and displayed on a Display Station on request. Represent the application in terms of its constituent modules with both data and control flow elements and collapse these modules to derive the tasks applying appropriate cohesion criteria.
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