## POKHARA UNIVERSITY

Level: Bachelor Semester: Fall Year : 2018
Programme: BE Full Marks: 100
Course: Real -time Systems Pass Marks: 45
Time : 3hrs.

*Candidates are required to give their answers in their own words as far as practicable.*

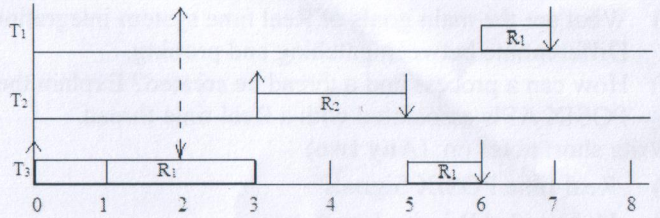
*The figures in the margin indicate full marks.*

***Attempt all the questions.***

1. a) What features should a programming language possess for it to be used for developing Real-time Systems? 7
   b) Differentiate between: 8
      i. Real time System and Real Time Operating System
      ii. Sporadic Task and Aperiodic Task
      iii. Relative and Absolute Deadline
2. a) How are formal requirements specification techniques for specifying Real Time Systems differ from semiformal and informal techniques? Explain with examples. How can the UML be used for specifying temporal constraints of an Air conditioning system that is required to meet soft deadlines? 8
   b) "All real-time solutions are just special cases of the foreground/background systems". Do you agree with this statement? Justify your claim with suitable examples. 7
3. **a) Automated Electric Furnace:** 8
   It is a system that monitors/controls several furnaces, the system is initialized and starts execution at time 20. It computes control law of each furnace by sampling and reading each temperature sensor every 100 msec and placing sampled readings in memory to determine flow rates of fuel, air and coolant.
      i. What will be the release times of subsequent jobs of this system?
      ii. If all control computation jobs must be finished by subsequent job's release time then what will be the absolute job deadlines
      iii. If the maximum allowed response time is the relative deadline then, what will be the relative deadline of subsequent jobs? 7



   b) **On Board Flight Control System**:
   An On Board Flight Control System is running three tasks. $T_1$ for processing the accelerometer data $T_2$ for monitoring the air pressure inside the plane and $T_3$ for updating the pilot's display with $T_1$ having the highest, $T_2$ having the medium and $T_3$ having the lowest priority. Task $T_3$, is released and starts executing at time 0 and at time 1 it locks resource $R_1$ (Buffer). Task $T_1$ gets released at time 2 and attempts to lock resource $R_1$(Buffer) currently held by task $T_3$ and becomes blocked so Task $T_3$ resumes. At time 3, Task $T_2$ is released and preempts task $T_3$, locks resource $R_2$ (Pressure Sensor) not required by either $T_1$ or $T_2$ and starts executing till time 5. Then Task $T_3$ resumes for one more unit and completes its execution. Then $T_1$ locks resource $R_1$(Buffer) and executes to completion.




   In this case there is a high probability of the highest priority job missing its deadline as it gets blocked by the low priority jobs. As a solution draw time lines to show how Priority Inheritance Protocol and Priority Ceiling Protocol can be used to reduce the blocking time of the highest priority task $T_1$.
4. a) Explain the techniques used for optimizing the performance of Real Time Systems. 7
   b) Why is it difficult to analyze Real-time systems? Perform response time analysis of Real time tasks be done in a system that is based on RMA principle 8

| $T_i$ | $E_i$ | $P_i$ |
|---|---|---|
| $T_1$ | 4 | 8 |
| $T_2$ | 4 | 12 |
| $T_3$ | 2 | 20 |

   Here, $P_i$ stands for periodicity and $E_i$ stands for execution time of the task $T_i$
5. a) What is N-Version Programming? How can it be used to provide 8

Fault tolerance in a Real-time System?

b) Draw a time line to schedule the following tasks using Fixed Priority Scheduling Scheme (RMA) and Dynamic Priority Scheduling Scheme (EDF). 7

| $T_i$ | $P_i$ | $E_i$ |
|---|---|---|
| $T_1$ | 2 | 0.8 |
| $T_2$ | 6 | 2.5 |
| $T_3$ | 10 | 0.5 |

Here , $P_i$ stands for periodicity and $E_i$ stands for execution time of the tasks

6. a) What are the main goals of Real time system integration? Differentiate between patching and probing. 7

b) How can a process and a thread be created? Explain the different POSIX APIs associated with a Real-time thread. 8

7. Write short notes on: (**Any two**) 2×5

a) Real-time POSIX Signals

b) Unbounded Priority Inversion

c) Frame size constraint