Instructions. No reading material, computer or calculator is allowed into the examination; you may only use a paper-based dictionary. The exam comprises 5 questions in 2 pages and will take 3 hours. Before starting to answer the questions, please make sure that your copy is properly printed. Good luck!

Question 1 (20/100 points). Explain how reading from memory differs from reading from memory mapped IO (one difference suffices, (**5 points**), what kind of challenge arises from the differences (mention two challenges, (**10 points**) and how these challenges can be overcome (mention at least one programming technique, (**5 points**).

Question 2 (20/100 points). Consider the following implementation of a program reading a temperature and a pressure sensor, calculating new goal temperature and pressure values based on the values read from the sensors and controlling a thermostat to reach the goal values.

```
int main() {
  int temp, goal_temp;
  int pres, goal_pres;
  while (1) {
    if (New_Temp) {
      temp = Temp_Data;
      calculate_goal_temp(temp, &goal_temp);
    }
    if (New_Pres) {
      pres = Temp_Pres;
      calculate_goal_pres(pres, &goal_pres);
    }
    control_thermostat(goal_temp, goal_pres);
  }
  return ERR_CODE;
}
```

Criticize and explain can go wrong with the above-given program (**10 points**).
Re-write this into a program that does not suffer from the problems you noticed (**10 points**).

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Question 3 (40/100 points). Consider the following specification of 3 periodic tasks.

Task	Execution Time	Period = Deadline
A	22	50
B	5	20
C	3	10

3.a. Is this set of tasks schedulable using Rate Monotonic scheduling? Motivate your answer (for your information: $2^{(1/2)} = 1.4$ and $2^{(1/3)} = 1.3$. (**10 points**)

3.b. Show the scheduling of the first instance of A with the first three instances of B and the first 5 instances of C, using both the Rate Monotonic and the Earliest Deadline First algorithm. Assume that the first instance of all three tasks arrive simultaneously. (**15 points**)

3.c. Assume that task A is replaced by a sporadic task with minimum inter-arrival time of 40. Assume that we schedule the new task set using Rate Monotonic scheduling with a Polling Server of capacity 8 for the sporadic task. Is the new task set schedulable? Explain your answer. (**15 points**)

Question 4 (10/100 points). Assume that you have two tasks Ta_1 and Ta_2 with the periods T_1 and T_2, respectively such that $T_1 < T_2$. Moreover assume that C_1 and C_2 are their worst-case execution times and $D_1 = T_1$ and $D_2 = T_2$ are their deadlines. Show that the worst response time for Ta_2 happens when Ta_1 and Ta_2 arrive at the same time. How many times an instance of Ta_2 should be preempted in such a case? (**10 points**)

Question 5 (10/100 points). Explain how an Android application can spawn a new thread and how the worker thread can interact with the activity.