COE718: Embedded Systems Design
Sample Final Exam

Name and Student ID: ____

Total Time Allowed: **120 Minutes** Maximum Marks: 70

i. The examination has 5 pages and 5 questions. Answer all the questions. State any **assumptions**.
ii. To earn maximum credit, your answer must be concise, to the point and in the given space
iii. All questions are not of the same difficulty and value. Consider this when allocating time for their solutions.

1. Draw a diagram of the Triple Modular Redundancy (TMR) architecture. Describe how it functions. Also list any possible issues that may arise using the TMR approach.

MARKS: 10

2. If an application is 20% serial, and 80% parallelizable, assuming four processors are used, what is the speedup of the application according to Amdahl's Law?

MARKS: 5

3. Table I presents an RMS schedule for a real-time military tracking system. The system consists of 3 tasks to be scheduled, each with their corresponding computation time and period.

Table I: Task Scheduling Requirements

Task	Description	Computation Time (C)	Period (T)	Priority
UTL	Update Track Log	10	20	
UTr	Object Tracking	3	10	
GPST	GPS Triangulation	1	5	

(a) Determine if the military tracking device is schedulable according to the RMS schedulability test.

MARKS: 5

(b) Verify if the schedulability test in (a) was correct by calculating the response times of all three tasks in Table I. Fill the "Priority" column as necessary. State your findings and compare to the schedulability test.

MARKS: 10

(c) Consider that the RMS schedule in Table I needs to be converted into an EDF schedule, with arrival times 1, 3, and 0 for tasks UTL, UTr, and GPST, respectively. Determine if this revised task set is schedulable using (1) the EDF schedulability test and (2) the timing diagram method.

MARKS: 8

(d) Briefly explain the differences between:

- Rate Monotonic Scheduling (RMS) and Deadline Monotonic Scheduling (DMS)
- Rate Monotonic Scheduling (RMS) and Earliest Deadline First (EDF)

MARKS: 6

(e) List and briefly explain two factors that are not considered during the response time calculations and real-time system scheduling you have calculated in (b).

MARKS: 4

4. A fault-tolerant system architecture consisting of seven components is shown in Fig 1. Determine the overall reliability of the system, assuming that the component reliabilities are defined as follows:
R1 = 0.95, R2 = 0.9, R3 = 0.9, R4 = 0.99, R5 = 0.87, R6 = 0.88 and R7 = R8 = 0.85.

MARKS: 10

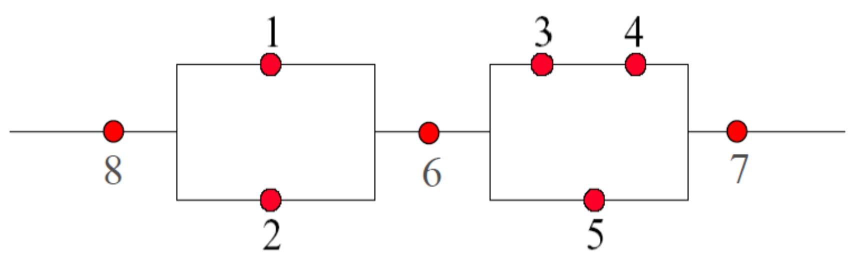

Fig. 1: Fault-Tolerant System Architecture

5. A client has approached you specifying that you are to design a hardware/software embedded system for a parabolic motion estimator. After assessing the requirements, you develop the DFG provided in Fig. 2. Your embedded system may consist of a CPU, and optional multiplier, add, and/or squaring hardware unit. The requirements specified by the client are as follows:

Execution Time ≤ 16 msec
Gates ≤ 2000

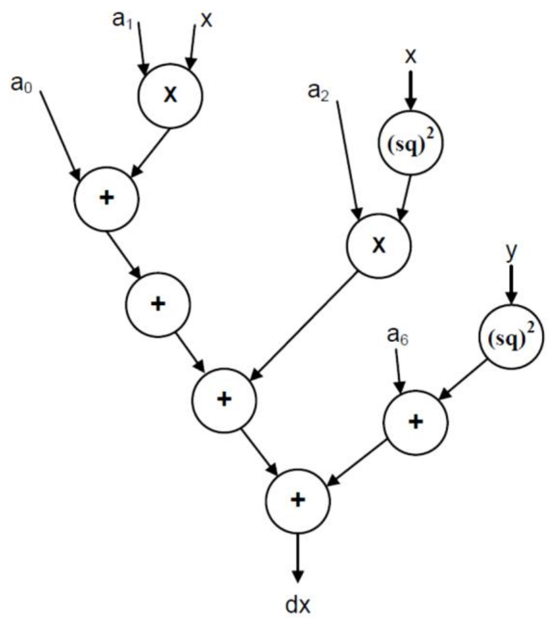

Fig. 2: DFG for Parabolic Motion Estimator Design

Find an ES design which meets the requirements specified above, assuming you have discovered the following specifications listed in Table II. Clearly specify your final results which meet the requirements Show all your work.

MARKS: 12

Table II: HW/SW System Specifications

Operation	SW Exe (ms)	HW Exe (ms)	Gates
Multiply	10.2	2.4	1200
Add	2.54	0.3	300
Square	8.35	1.2	600