

**NATIONAL UNIVERSITY OF SINGAPORE**  
**DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING**  
**ONLINE EXAMINATION**

|   |           |
|---|-----------|
| Matriculation No.:  | A0224725H |
| Module Code:  | EE5902    |
| Number of pages in this PDF file<br>(including this cover page and Declaration Form):<br>i.e. 2+no. of answer pages | 7         |

**INSTRUCTIONS TO CANDIDATES**

1. Follow the instructions for online examination and invigilation.
2. Write your answers on **A4 size paper** with black or dark blue ink. Put page number on every page.
3. Write the question number at the top left corner of each page. **Start the answer to each question on a new page.** Indicate the part, e.g. "(a)", on the left margin.
4. At the end of the exam:
  - a) scan or take photographs of your answers (make sure your writing and/or drawings can be seen clearly);
  - b) enter your matriculation number, module code and the total number of pages (including the cover and declaration pages, i.e. 2+ scanned pages) on the cover page;
  - c) **merge the following documents in that order:** (1) Completed cover page, (2) signed declaration form, (3) scanned answer pages into a single PDF file named **<matric\_no>-<module code>.pdf** (e.g. **A1234567R- EE5902. pdf**)
  - d) **Important - open the PDF file to ensure that it has been generated without error and the contents are correct;**
  - e) **upload your PDF file into the stated LumiNUS exam submission folder within the stipulated deadline.** Late submissions will not be accepted.

**FOR OFFICE USE ONLY**

| Question     | Mark | Remarks |
|--------------|------|---------|
| Section A Q1 |      |         |
|              |      |         |
|              |      |         |
|              |      |         |
|              |      |         |
| <b>TOTAL</b> |      |         |



扫描全能王 创建

## Exam Declaration Form

Please read sections A, B and C below. Sign and submit this declaration form together with your answers.

### A. Academic, Professional and Personal Integrity

1. *The University is committed to nurturing an environment conducive for the exchange of ideas, advancement of knowledge and intellectual development. Academic honesty and integrity are essential conditions for the pursuit and acquisition of knowledge, and the University expects each student to maintain and uphold the highest standards of integrity and academic honesty at all times.*
2. *The University takes a strict view of cheating in any form, deceptive fabrication, plagiarism and violation of intellectual property and copyright laws. Any student who is found to have engaged in such misconduct will be subject to disciplinary action by the University.*
3. *It is important to note that all students share the responsibility of protecting the academic standards and reputation of the University. This responsibility can extend beyond each student's own conduct, and can include reporting incidents of suspected academic dishonesty through the appropriate channels. Students who have reasonable grounds to suspect academic dishonesty should raise their concerns directly to the relevant Head of Department, Dean of Faculty, Registrar, Vice Provost or Provost.*

### B. I have read and understood the rules of the assessments stated below:

- a. *Students should attempt the assessments on their own. There should be no discussion or communication, via face to face or communication devices, with any other person during the assessment.*
- b. *Students should not reproduce any assessment materials, e.g. by photographing, videography, screenshots, copying down of questions, etc. Posting on public forums, e.g. social media and websites, is prohibited.*

### C. I understand that by breaching any of the rules above, I would have committed offences under clause 3(1) of the NUS Statute 6, Discipline with Respect to Students, which is punishable with disciplinary action under clause 10 or clause 11 of the said statute.

- 3) *Any student who is alleged to have committed or attempted to commit, or caused or attempted to cause any other person to commit any of the following offences, may be subject to disciplinary proceedings:*  
*(1) plagiarism, giving or receiving unauthorized assistance in academic work, or other forms of academic dishonesty.*

I have read and will abide by the NUS Code of Student Conduct (in particular, (A) Academic, Professional and Personal Integrity), B and C when attempting this assessment.

Signature: LUO ZIJIAN

Date: NOV 24<sup>th</sup> 2021

Matric. No.: A0224725H



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Q<sub>1</sub>

- (i) the bits of address on bus  
the bits of data on bus
- (ii) the status of the working set of a process can be invalid ~~or~~ or valid (only copy in cache). If write-back protocol is used, it may cause fault
- (iii) FIFO: 5  
Optimal algorithm: 5

~~(iv)~~ Greedy cycles ~~must~~ does not have to be first simple cycles.

This means average latency of a greedy cycle must be always lower than those of simple cycles.

(v) FALSE

- (vi) a. allocate memory space in my host  
b. allocate memory space in GPU  
c. transfer data from CPU to GPU  
d. declaring kernel routine to run on GPU (vector addition)  
e. transfer data from GPU to CPU  
f. free the memory.

(vii) 12

(viii) FALSE

(ix) the ~~required~~ required block is not in cache, but can be found on Main Memory  
This means it does not achieve consistency.

(x)  $O(n)$

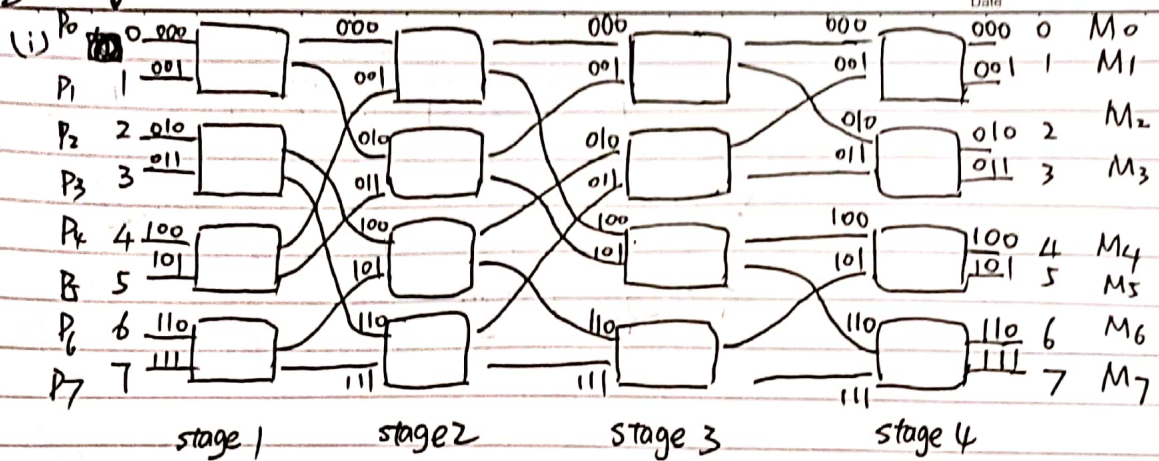
(xi) FALSE

(xii) ~~A, B~~ A, B



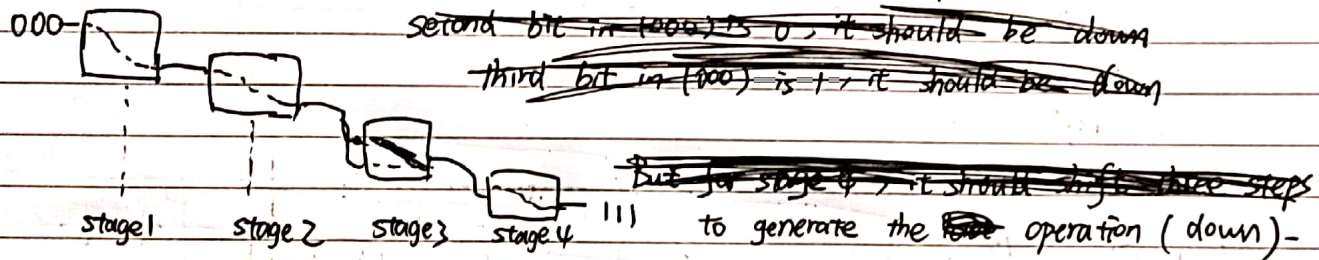


Q2



(ii) As we all know there is self-routing policy in baseline network  
That is ["0" means down, "1" means up]

I believe it can be used in this complex network in (i), ~~but not to shift~~  
For example: first bit in (000) is 0, the routing path should be down



In word, every switch should add a ~~right shift unit~~ recycle right shift unit

- 000 → 000 → 000 → 000 → 000
- ~~111 → 111 → 111 → 111 → 111~~
- 001 → 010 → 100 → 100 → 100
- 010 → 011 → 011 → 011 → 011
- 011 → 110 → 011 → 011 → 011
- 100 → 001 → 100 → 100 → 100
- 101 → 001 → 101 → 101 → 101
- 110 → 010 → 010 → 010 → 010
- 111 → 111 → 111 → 111 → 111



(iii)

Four pairs can exist

My choice to choose the first structure in (i)

Reasons: ① Shuffle network can shuffle the input ~~and~~, which can ~~also~~ maximize the possible routing path

② And then use the self-routing characteristics of base-line network to achieve the output.





Q3

4

$$(i) \text{ For MP-A } MIP_A = \frac{f}{CPI \times 10^6} = \frac{5 \times 10^6}{(6 \times 0.6 + 8 \times 0.1 + 10 \times 0.08 + 15 \times 0.05 + 3 \times 0.61) \times 10^6} = \frac{5}{5.14}$$

$$\text{For MP-B } MIP_B = \frac{f}{CPI \times 10^6} = \frac{5 \times 10^6}{(12 \times 0.6 + 12 \times 0.1 + 18 \times 0.08 + 5 \times 0.05 + 3 \times 0.61) \times 10^6} = \frac{5}{5.64}$$

$$MIP_A > MIP_B$$

$$T_A = I_C \cdot CPI_A \cdot \tau = 10^6 \times 5.14 \times \frac{1}{5 \times 10^6} = \frac{5.14}{5}$$

$$T_B = I_C \cdot CPI_B \cdot \tau = 10^6 \times 5.64 \times \frac{1}{5 \times 10^6} = \frac{5.64}{5}$$

$$T_A < T_B$$

MPA can perform better than B

(ii) If the percentage is changed,

$$\text{MP-A} = \text{MIP}_A = \frac{5}{4.54} \quad MIP_A > MIP_B$$

$$\text{MP-B} = \text{MIP}_B = \frac{5}{6.54}$$

$$T_A = I_C \cdot CPI_A \cdot \tau = 10^6 \times 4.54 \times \frac{1}{5 \times 10^6} = \frac{4.54}{5}$$

$$T_B = I_C \cdot CPI_B \cdot \tau = 10^6 \times 6.54 \times \frac{1}{5 \times 10^6} = \frac{6.54}{5} \quad T_A < T_B$$

MP-A can execute million instructions more ~~fast~~ fast than before  
but MP-B execute million instructions more slow than before.

At the same time, MP-A still perform better than MP-B

$$(iii) \text{ For MP-A: } 0.12 + (15 \times 0.05) + (3 \times 0.61 + 10 \times 0.08 + 8 \times 0.1 + 6 \times 0.16) \times 0.05 \approx 0.31$$

per clock cycle

$$\text{For MP-B: } 0.12 + (5 \times 0.05) + (3 \times 0.61 + 12 \times 0.16 + 12 \times 0.1 + 18 \times 0.08) \times 0.05 \approx 0.29$$

per clock cycle

So, MP-A may cost more energy than MP-B



Q4

Date

No.

(i)

|  |  |  |  |  |  |  |  |  |  |
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(ii)

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 | 2 |
|   | 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 |
|   |   | 4 | 7 | 6 | 1 | 7 | 6 | 1 | 1 |

# of hit = 4

hit ratio = 0.4

hit miss = 0.6

(iii)

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 | 2 |
|   | 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 |
|   |   | 4 | 7 | 6 | 1 | 7 | 6 | 1 | 1 |

# of hit = 4

hit ratio = 0.4

hit miss = 0.6

(iv)

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 | 2 |
|   | 4 | 7 | 6 | 1 | 7 | 6 | 6 | 1 | 7 |
|   |   | 4 | 7 | 6 | 1 | 7 | 2 | 6 | 1 |

# of hit : 4

hit ratio = 0.4

hit miss : 0.6

(v)

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 | 2 |
|   | 4 | 7 | 6 | 1 | 7 | 6 | 1 | 2 | 7 |
|   |   | 4 | 7 | 6 | 1 | 7 | 6 | 1 | 1 |
|   |   |   | 4 | 4 | 4 | 4 | 7 | 6 | 6 |

# of fault page :  $4 + 3 = 7$ But in Q4 (ii), # of fault page =  $3 + 3 = 6$ 

Therefore, it verify Belady's anomaly

