Second Semester Examination
2017/2018 Academic Session

May / June 2018

# EEE 379 – COMPUTER SYSTEM AND MULTIMEDIA

## *[SISTEM KOMPUTER DAN MULTIMEDIA]*

Duration : 3 hours
*[Masa : 3 jam]*

Please ensure that this examination paper consists of **THIRTEEN (13)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TIGA BELAS (13)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instructions:** This question paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry the same marks.

[***Arahan:*** *Kertas soalan ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan. Semua soalan membawa jumlah markah yang sama.]*

In the event of any discrepancies, the English version shall be used.

*[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]*

**You are not allowed to take this question paper out of the examination hall.**
***Anda tidak dibenarkan membawa kertas soalan ini keluar daripada dewan peperiksaan.***

1. Given a typical contemporary cache memory as depicted in Figure 1, answer questions 1(a) and 1(b).

*Diberikan ingatan sorok kontemporari yang biasa seperti yang digambarkan dalam Rajah 1, jawab soalan-soalan 1(a) dan 1(b):*

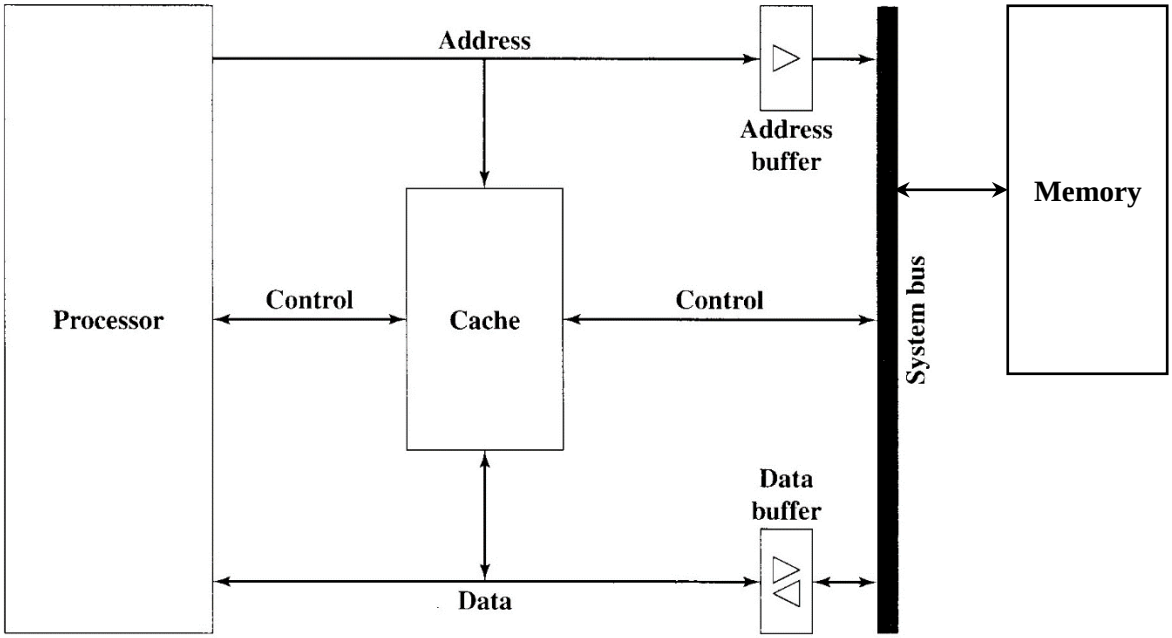



Figure 1 – Typical cache memory
*Rajah 1 - Ingatan sorok biasa*

(a) Provide a complete description of the cache memory design and organization in Figure 1.
*Berikan penerangan lengkap tentang rekabentuk dan organisasi ingatan sorok dalam Rajah 1.*

(10 marks/markah)

(b) Explain the operational procedure of this cache when:
*Terangkan tatacara operasi ingatan sorok ini apabila:*

(i) a cache miss occurs.
*berlakunya ingatan sorok tak mengena* (3 marks/markah)

(ii) write back occurs.
*berlakunya tulis semula* (4 marks/markah)

(c) There are various options to design a backup strategy for a computer system. One option is to use plug-in external disks, which cost $150 for each 500 GB drive. Another option is to buy a tape drive for $2500, and 400 GB tapes for $50 per piece. A typical backup strategy is to have two sets of backup media onsite, with backups alternately written on them so in case the system fails while making a backup, the previous version is still intact. There is a third set of backup kept offsite, with the offsite set periodically swapped with an on-site set.

*Terdapat pelbagai pilihan untuk merekabentuk strategi sandaran untuk sistem komputer. Satu pilihan ialah menggunakan cakera luaran masukan-plug, yang berharga $150 untuk setiap pemacu 500 GB. Pilihan lain ialah membeli pemacu pita untuk $2500, dan 400 GB pita untuk $50 setiap satu. Strategi sandaran tipikal adalah untuk mempunyai dua set media sandaran atas-lokasi, dengan sandaran ditulis secara bergantian pada kedua-dua set media supaya jika sistem gagal semasa membuat sandaran, versi sebelumnya masih utuh. Terdapat satu set sandaran ketiga yang disimpan di luar-lokasi, dengan set luar-lokasi secara berkala bertukar dengan set di lokasi tapak.*

(i) Given that you have 1 TB of data to backup, how much in total does a disk backup system cost?

*Diberikan bahawa anda mempunyai 1 TB data untuk sandaran, berapa jumlah kos sistem sandaran cakera?*

(2 marks/markah)

(ii) How much would a tape backup system cost for 1 TB of data?
*Berapa kos sistem sandaran tape untuk 1 TB data?*

(2 marks/markah)

(iii) How large does each backup have to be in order for a tape strategy to be less expensive?

*Berapa besar setiap sandaran harus dibuat agar strategi pita menjadi lebih murah?*

(4 marks/markah)

2. (a) A logic circuit is to be designed to handle three interrupt request lines in a computer system to implement an I/O priority network (see Figure 2). When a request is received on line INTRi, the network generates an acknowledgment on line INTAi. If more than one request is received, only the highest-priority request is acknowledged, where the ordering of priorities is as below:

*Satu litar logik perlu direkabentuk untuk mengendalikan tiga talian permintaan sampukan dalam suatu sistem komputer bagi melaksanakan satu rangkaian keutamaan I/O (lihat Rajah 2). Apabila permintaan diterima pada talian INTRi, rangkaian menghasilkan satu akuan pada talian INTAi. Jika lebih dari satu permintaan diterima, hanya permintaan keutamaan tertinggi akan diakui, di mana turutan keutamaan adalah seperti di bawah:*

priority of INTR1 > priority of INTR2 > priority of INTR3

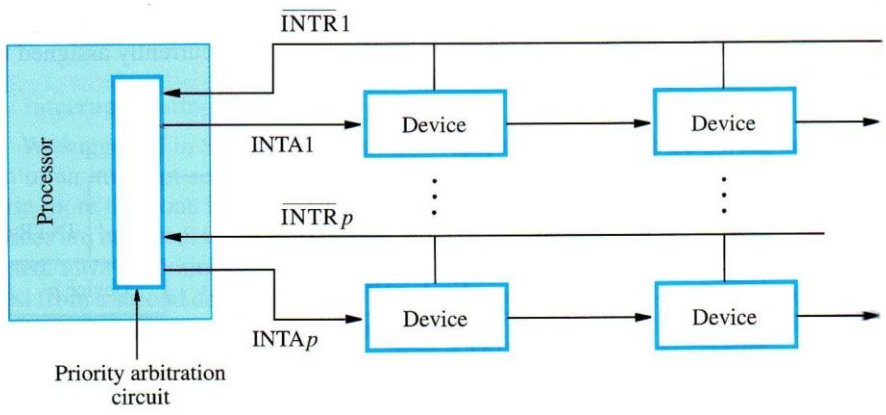



Figure 2
*Rajah 2*

(i) Prepare a truth table for the I/O device interrupt.
*Sediakan jadual kebenaran untuk sampukan peranti I/O.*

(6 marks/markah)

(ii) Write Boolean expressions for each of the outputs INTA1, INTA2, and INTA3.

*Tulis persamaan Boolean untuk setiap keluaran INTA1, INTA2 dan INTA3.*

(6 marks/markah)

(iii) Draw a logic circuit for implementing this priority network based on the expression obtained in (ii).

*Lukiskan litar logik bagi mengimplementasikan rangkaian keutamaan berdasarkan persamaan yang diperolehi dari (ii).*

(5 marks/markah)

(b) What is an operating system and its objective?
*Apakah sistem pengoperasi dan objektifnya?* (4 marks/markah)

(c) Which type of operating system (uni-programming or multi-programming) is better in a general-purpose computer? Why?

*Sistem pengoperasi jenis apakah (pengaturcaraan-uni atau pengaturcaraan-berbilang) adalah lebih baik untuk komputer tujuan am? Kenapa?*

(4 marks/markah)

3. (a) In a computer system, the external devices are not connected directly to the system bus. These devices are connected to the system bus via a module, known as I/O module.

*Dalam sistem komputer, peranti-peranti luaran adalah tidak disambungkan secara terus kepada bas sistem. Peranti-peranti ini disambungkan kepada bas sistem melalui satu modul, yang dikenali sebagai modul I/O.*

(i) Explain five I/O module functions.
*Terangkan lima fungsi modul I/O.* (5 marks/markah)

(ii) Draw a block diagram that shows the internal structure of an I/O module.
*Lukis gambarajah blok yang menunjukkan struktur dalaman sebuah modul I/O.*

(3 marks/markah)

(b) You want to make a modification to a non-pipelined processor that has a clock rate of 3.0GHz and an average CPI (cycles per instruction) of 5, by introducing a six-stage pipeline. However, due to internal pipeline delays, such as latch delay, the clock rate of the new processor must be reduced to 1.5GHz.

*Anda mahu membuat pengubahsuaian terhadap satu pemproses tanpa-talian paip yang mempunyai kadar jam 3.0GHz dan purata CPI (kitaran per arahan) sebanyak 5, dengan memperkenalkan satu talian paip enam-peringkat. Bagaimanapun, disebabkan kelewatan-kelewatan talian paip dalaman, seperti kelewatan selak, kadar jam bagi pemproses baru ini perlu diturunkan kepada 1.5GHz.*

(i) What is MIPS rate for the original non-pipelined processor?
*Apakah kadar MIPS bagi pemproses asal tanpa-talian paip?*

(3 marks/markah)

(ii) What is MIPS rate for the new pipelined processor?
*Apakah kadar MIPS bagi pemproses baru dengan talian paip?*

(3 marks/markah)

(iii) What is the speedup achieved for a typical program?
*Apakah kadar kecepatan yang dicapai oleh program biasa?*

(2 marks/markah)

(c) An effective utilization of registers is one of the criteria of a reduced instruction set computer (RISC). Assuming that one computer program is using 12 symbolic registers, which are marked with the letter from A to L. The processes involved with these symbolic registers are shown in Figure 4.1. You want to execute this program by using a processor with only 5 actual registers (R1, R2, R3, R4, and R5). Map these symbolic registers to the actual registers by using an appropriate technique.

*Penggunaan daftar-daftar yang berkesan adalah salah satu kriteria bagi komputer set arahan dikurangkan (RISC). Mengandaikan bahawa satu program komputer menggunakan 12 daftar-daftar simbolik, yang ditanda dengan huruf A hingga L. Process-process yang melibatkan daftar-daftar ini ditunjukkan oleh Rajah 4.1. Anda mahu menjalankan program ini dengan menggunakan pemproses dengan hanya 5 daftar sebenar (R1, R2, R3, R4, dan R5). Petakan daftar-daftar simbolik ini kepada daftar-daftar sebenar dengan menggunakan kaedah yang sesuai.*

(9 marks/markah)

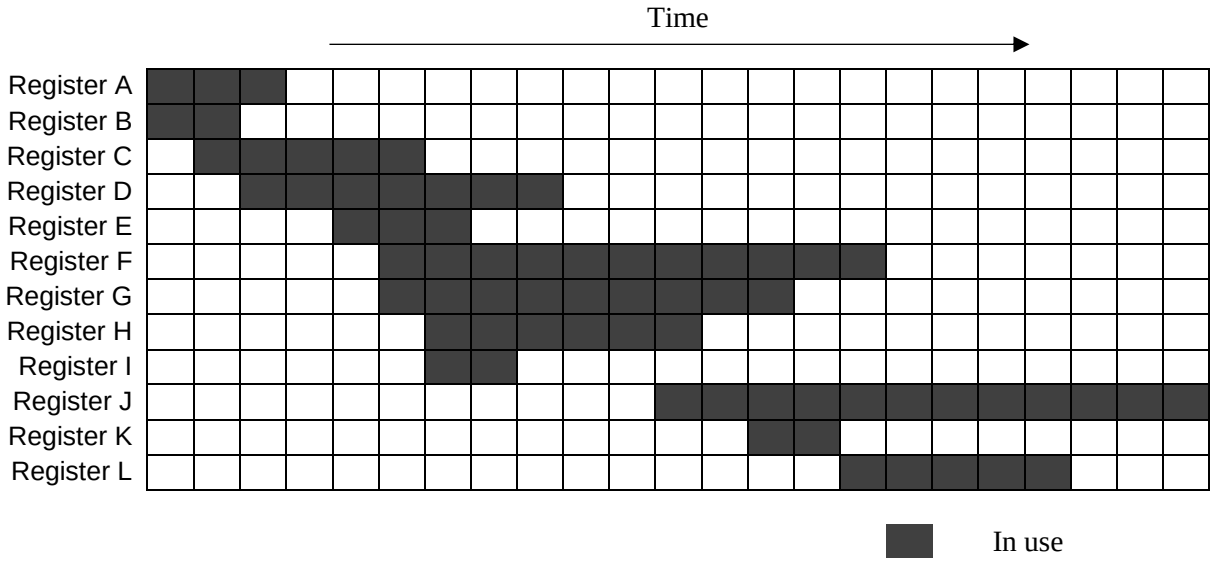



Figure 4.1
*Rajah 4.1*

4. (a) The term “multimedia” is commonly used nowadays. Write one short paragraph, around 20 words, to elaborate what do you understand with “multimedia”.

*Peristilahan “multimedia” digunakan secara meluas buat masa sekarang. Tulis satu perenggan pendek, kira-kira 20 patah perkataan, untuk memperincikan apa yang anda faham dengan “multimedia”.*

(3 marks/markah)

(b) You are developing a software to count the number of stars by using digital images captured at night time as the input. The images that you use are grayscale image, with 8-bit depth per pixel. You are supplied with two same images but stored in two different image formats. One is stored in bitmap format, whereas the other is stored in JPEG2000 format. When viewed through image viewer, both images look the same. Size of both images are the same, which is $1440 \times 1080$ pixel$^2$. However, the storage size for the image in bitmap format is much bigger as compared to JPEG2000 image. The average grayscale intensity for the bitmap image is 175, whereas the average for JPEG2000 image is 170. When inputted into the system that you developed, from the bitmap image, a total of 102 stars have been detected, whereas for JPEG2000 image, a total of 100 stars detected.

*Anda sedang membangunkan sebuah perisian untuk membilang bintang yang menggunakan imej digital yang diambil pada waktu malam sebagai masukan. Imej yang anda gunakan adalah imej paras kelabu, dengan kedalaman 8-bit per piksel. Anda dibekalkan dua imej yang sama, tetapi disimpan dalam dua format imej yang berbeza. Satu disimpan dalam format bitmap, manakala satu lagi di dalam format JPEG2000. Apabila ditayangkan melalui pemapar imej, kedua-dua imej kelihatan sama. Saiz kedua-dua imej juga sama, iaitu $1440 \times 1080$ piksel$^2$. Walaubagaimanapun, saiz penyimpanan bagi imej dalam format bitmap jauh lebih besar berbanding imej JPEG2000. Purata aras keamatan kelabu bagi imej bitmap tersebut adalah 175, manakala purata imej JPEG2000 adalah 170. Apabila dimasukkan ke dalam sistem yang anda bangunkan, daripada imej bitmap, sebanyak 102 bintang dikesan, manakala bagi imej JPEG2000, sebanyak 100 bintang dikesan.*

(i) Eplain why although both images appear the same, there are differences in terms of the storage size, average intensity level, and the results from stars detection?

*Terangkan mengapa walaupun kedua-dua imej tersebut kelihatan sama, terdapat perbezaan dari segi saiz penyimpanan, purata aras keamatan, dan keputusan pengesanan bintang tersebut?*

(5marks /markah)

(ii) In your opinion, which image format gives the accurate result? Justify your opinion.

*Pada pandangan anda, imej dalam format manakah yang memberikan keputusan lebih tepat? Berikan justifikasi untuk pandangan anda itu.*

(5 marks/markah)

(c) One four-bit per pixel color image is displayed on an LCD monitor. It appears as $6\times4$ inches$^2$ image, when the monitor's resolution is set to 120ppi. We intend to print this image as a black-and-white image, to size $9\times6$ inches, by setting the printer to 320 dpi. Assume the image uses square pixels.

*Satu imej warna empat-bit per piksel dipaparkan pada monitor LCD. Ia muncul sebagai imej $6\times4$ inci$^2$, apabila resolusi monitor ditetapkan kepada 120dpi. Kita bercadang untuk mencetak imej ini sebagai imej hitam-putih, kepada saiz $9\times6$ inchi$^2$, dengan menetapkan pencetak kepada 320 dpi. Andaikan imej tersebut menggunakan piksel segiempat sama.*

(i) Explain how this four-bit per pixel image can be displayed as color image by the monitor.

*Terangkan bagaimana imej empat-bit per pixel ini boleh dipaparkan sebagai imej berwarna oleh monitor.*

(3 marks/markah)

(ii) Determine the actual size of the image in pixels (i.e., width × height).
*Tentukan saiz sebenar imej dalam pixels (i.e., lebar × tinggi).*

(2 marks/markah)

(iii) Propose one matrix that can be used to add texture to the black-and-white printing.

*Cadangkan satu matrix yang boleh digunakan untuk menambah tekstur kepada cetakan hitam-putih tersebut.*

(2 marks/markah)

(iv) Figure 4.1 shows a part of the color image. By using the matrix in part (iii), what will be printed for these pixels? (Use '0' to indicate black, and '1' to indicate white).

*Rajah 4.1 menunjukkan sebahagian daripada gambar warna tersebut. Dengan menggunakan matrix dalam bahagian (iii), apakah yang akan dicetak oleh piksel-piksel tersebut? (Gunakan '0' untuk menyatakan hitam, dan '1' untuk menyatakan putih).*

(5 marks/markah)

| | | | | |
|---|---|---|---|---|
| 0 | 1 | 2 | 3 | |
| 4 | 5 | 6 | 7 | |
| 8 | 9 | 10 | 11 | |
| 12 | 13 | 14 | 15 | |

Figure 4.1
*Rajah 4.1*

ooo0ooo

## Solution 1

(a) In this organization, the cache is connected to the processor via data, control, and address lines. The data line is attached to the data buffer.
The address line are attached to the address buffer.
The data, address and control line extend to connect to the system bus.
The system bus has a connection to the main memory.

(b) (i) When a cache miss occurs, the desired address is loaded onto the address buffer and extended onto the system bus. Then, the data are read from main memory and stored in the data buffer. Later the data are returned through the data line to both the cache and the processor.

(ii) When a write back occurs, the block address is loaded into the address buffer via the address line. Then the updated data is loaded into the data buffer via the data line. Once memory is ready, the data is sent to main memory via the system bus for memory write operation.

(c)

(i) $2 \times 3 \times \$150 = \$900$

(ii) $\$2500 + (3 \times 3 \times \$50) = \$2950$

(iii) Let Z = the number of GB at which the two approaches yield approximately the same cost.
For the disk, the cost is

$$C_d = (Z/500) \times 3 \times \$150.$$

For tape, the cost is

$$C_t = 2500 + ((Z/400) \times 3 \times \$50).$$

If we set Cd = Ct and solve for Z, we get Z = 4762.

So the size of the backup would have to be about 5 TB for tape to be less expensive.

## Solution 2

2(a)(i)

| INT1 | INT2 | INT3 | z |
|---|---|---|---|
| 0 | 0 | 1 | 3 |
| 0 | 1 | X | 2 |
| 1 | X | X | 1 |

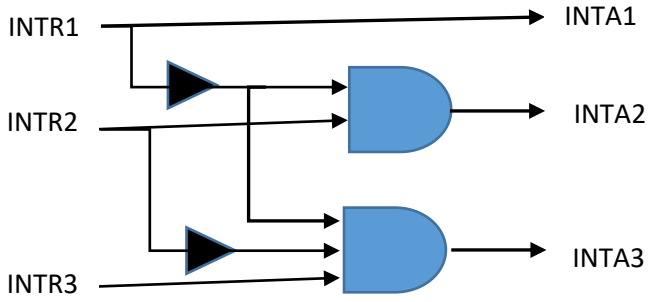
2(a)(ii)

INTA1 = INTR1

INTA2 = INTR1 · INTR2

INTA3 = INTR1 · INTR2 · INTR3

2(a)(iii)




2(b) An operating system is a program which is implemented to interface the users with the computer hardware.

2(c) A multi-programming OS is better than a uni-programming OS for a general-purpose computer.

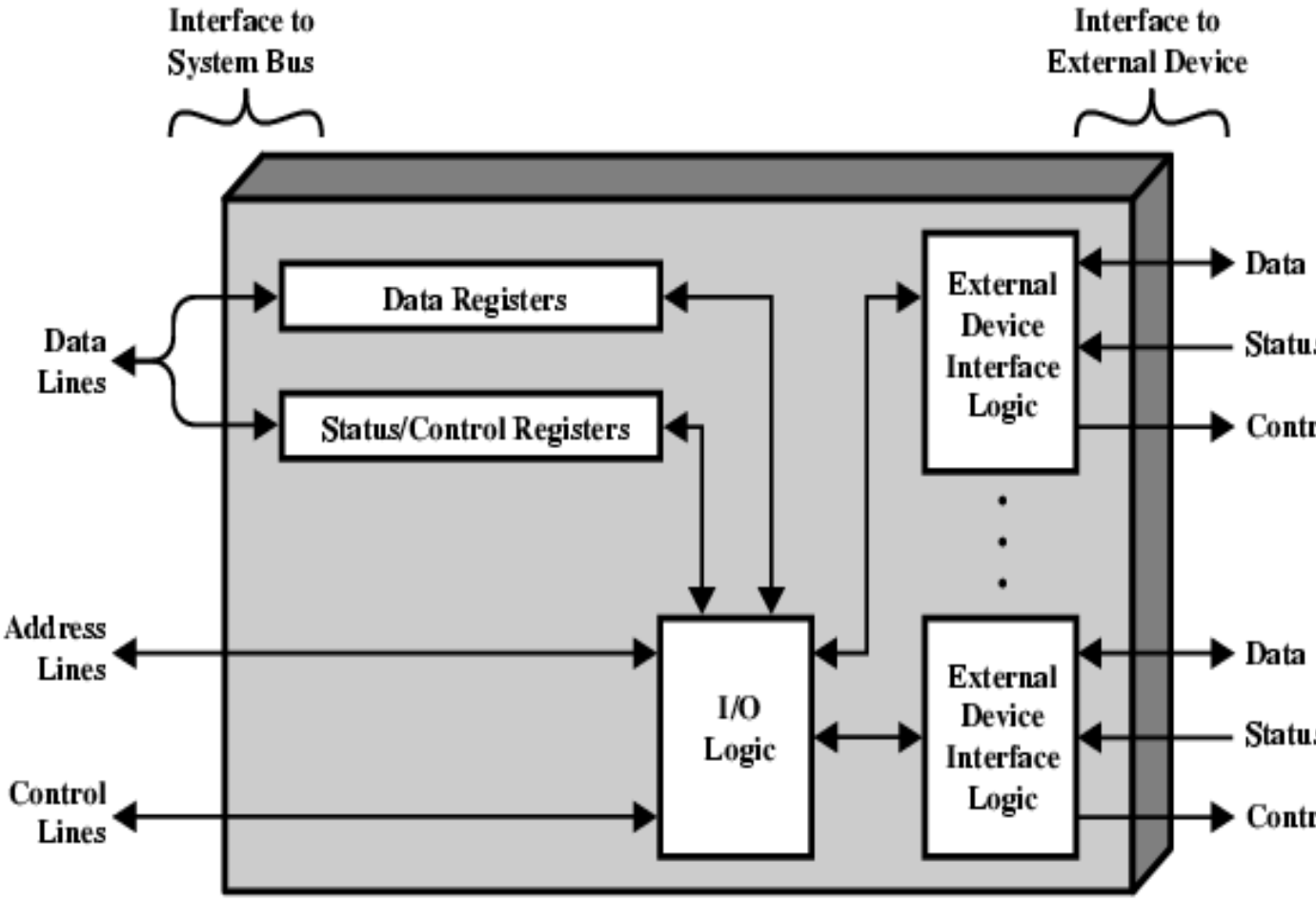
This is because multi-programming OS is able to load as many programs into the computer memory to be served in a proper selection manner to avoid the processor from being idle most of the time. This way, the speed of the computer system will be higher and more jobs can be processed within a specific time.

**Solution 3:**

(a) (i)

1. **Control and timing**
2. Processor communication
3. Device communication
4. Data buffering
5. Error detection

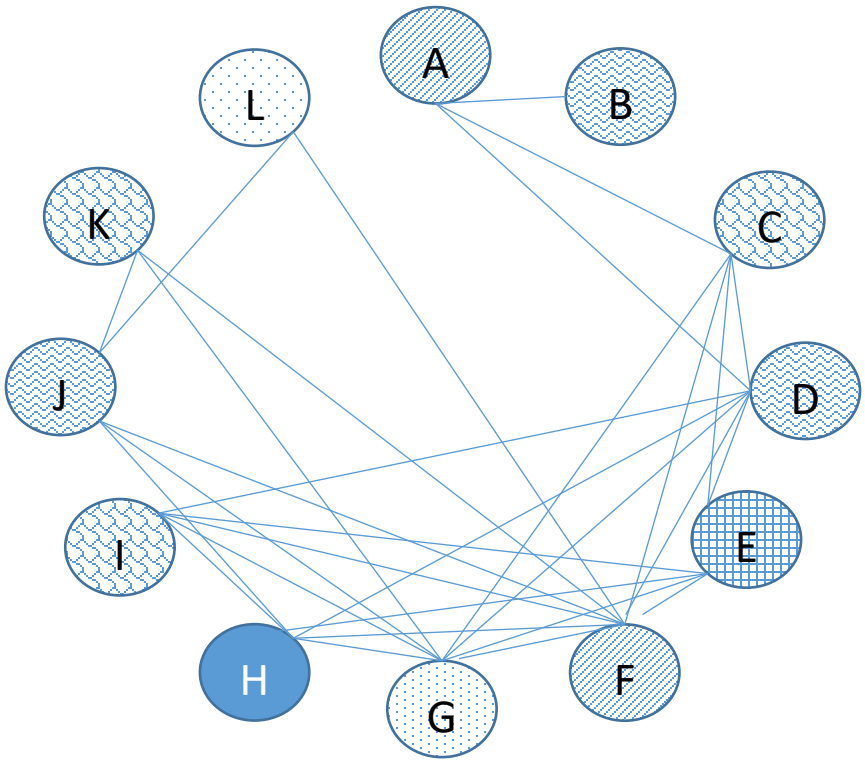
(a) (ii)




(b)

(i) Throughput = no. of million instructions per second = 3000/5 = 600 MIPS
(ii) Throughput = 1500 MIPS
(iii) Speedup = (6)(3.0/1/5) = 3

(c)
By using graph coloring method:




Outcomes:
Register A and Register F → Register R1
Register B, Register D, and Register J → Register R2
Register C, Register I, and Register K → Register R3
Register E → RegisterR4
Register G and Register L → Register R5
Register H → Memory

(* there are many other possible solutions)

**Solution 4:**

(a) The candidate needs to emphasize two main things: "the combination of more than two modalities" and "digital contents"

(b)

(i) The candidate should explain, in general, how lossy compression works. Student is also expected to compare lossy compression scheme with lossless compression scheme. In this question, BMP image is without compression, or with lossless compression, and JPEG2000 applies lossy compression.

(ii) There are two possible solutions (chose either one):

[1]. BMP image gives the more accurate result. Justification: The data used is the actual data, which expected to be near to the original scene. (or any other acceptable reason).

[2]. JPEG2000 image gives the more accurate result. Justification: The data acquired during night time, and more sensitive towards noise. JPEG2000 uses wavelet in its transformation, and wavelet may reduce some noise level. More stars detected in BMP may be due to noise.

(c)

(i) The candidate should explain the concept of color pallet.

(ii) The actual size = (6×120pixels) ×(4×120pixels) = 720pixels × 480 pixels.

(iii) Based on the printing specification, the dithering matrix that will be used is in size 2×2 pixels. Example of dithering matrix that can be used (there are many other possible solutions):

| | |
|---|---|
| 1 | 2 |
| 3 | 0 |

(iv) First, convert the input into 5 levels:

| Input | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Output | 0 | | | | 1 | | | 2 | | | 3 | | | 4 | | |

| | | | |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 2 |
| 2 | 2 | 3 | 3 |
| 3 | 4 | 4 | 4 |

Then, based on part (iii):

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |