UNIVERSITI SAINS MALAYSIA

First Semester Examination
2011/2012 Academic Session

January 2012

CCS524 – Parallel Computing Architectures and Algorithms

[Seni Bina dan Algoritma Perkomputeran Selari]

Duration : 2 hours
[Masa : 2 jam]

INSTRUCTIONS TO CANDIDATE:
[ARAHAN KEPADA CALON:]

- Please ensure that this examination paper contains **THREE** questions in **SEVEN** printed pages before you begin the examination.

  *[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TIGA** soalan di dalam **TUJUH** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

- Answer **ALL** questions.

  *[Jawab **SEMUA** soalan.]*

- You may answer the questions either in English or in Bahasa Malaysia.

  [Anda dibenarkan menjawab soalan sama ada dalam bahasa Inggeris atau bahasa Malaysia.]

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

  [Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi bahasa Inggeris hendaklah diguna pakai.]

1. (a) (i) How are parallel computing and distributed computing different in terms of their computational goals?

(6/100)

(ii) What are the **four** (4) characteristics of parallel programs?

(8/100)

(b) Briefly compare the main strength of each shared-address space programming model: POSIX Thread, Java Thread and OpenMP.

(6/100)

(c) Briefly elaborate the past, present and future of high performance computing by Rudd van der Pas.

(6/100)

(d) Briefly explain the design patterns for thread programming.

(4/100)

2. (a) The following is part of a message-passing program segment involving 3 tasks participating in a group of tasks called "workers":

T1	T2	T3
.	.	.
.	.	.
.	.	.
`func1(...)`	`func1(...)`	`func1(...)`
`barrier(workers, 3)`	`barrier(workers, 3)`	`barrier(workers, 3)`
`func2(...)`	`func2(...)`	`func2(...)`
.	.	.
.	.	.
.	.	.

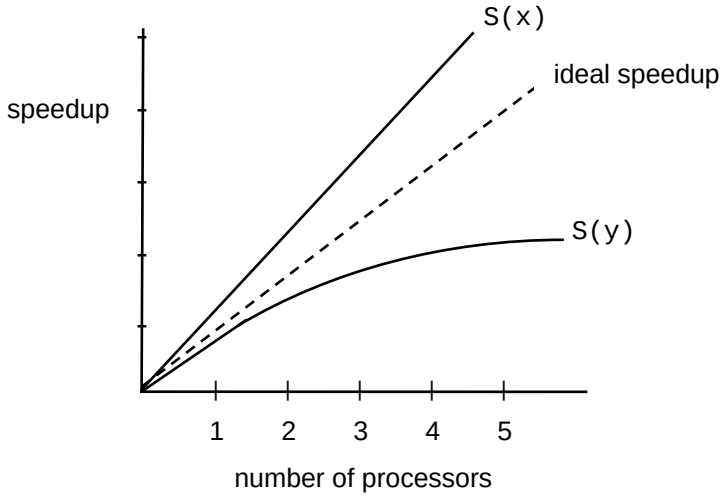
(i) Explain the purpose of the barrier function in the program segment above. Your explanation must be with respect to `func1` and `func2`.

(3/100)

(ii) If the barrier function was not provided, how could the same effect be achieved by using the send and receive functions. Explain your answer by modifying the above program segment.

(4/100)

(b) The following graph shows speedup curves obtained by a parallel program:



(i) Explain the phenomena in the speedup curve S(x).

(4/100)

(ii) The speedup curve S(y) flattens after 4 processors. Explain why it happens.

(4/100)

(c) (i) How can a message-passing program be emulated on a shared-address space programming model?

(6/100)

(ii) On the other hand, how can a shared-address space program be emulated on a message-passing programming model?

(6/100)

(iii) Which of the above emulations in 2(c)(i) and 2(c)(ii) is a more "expensive" venture in terms of latency? Provide explanation to support your answer.

(3/100)

3. Given a list of n integers where $n \geq 10$.

Your task is to design a parallel algorithm to find the smallest number from the list of integers.

Answer the following questions based on the problem above:

(a) Which decomposition strategy would you use: function or data? Illustrate your choice of decomposition strategy.

(5/100)

(b) Design a multithreaded algorithm for a shared-memory parallel architecture using the master-slave approach. Show your solution as pseudocode.

(15/100)

(c) Design a message-passing algorithm for a distributed memory parallel architecture using master-slave approach. Show your solution as pseudocode.

(15/100)

(d) How was synchronization (if any) achieved in your solutions for 3(b) and 3(c).

(5/100)

1. (a) (i) Bagaimanakah pengkomputeran selari berbeza dari pengkomputeran teragih dari aspek tujuan pengkomputeran masing-masing?

(6/100)

(ii) Apakah **empat (4)** ciri atur cara selari?

(8/100)

(b) Bandingkan secara ringkas kekuatan utama setiap model atur cara berasaskan perkongsian ruang alamat: Bebenang POSIX, Bebenang Java dan OpenMP.

(6/100)

(c) Terangkan dengan ringkas tentang masa lampau, masa sekarang dan masa akan datang berkenaan pengkomputeran berprestasi tinggi oleh Rudd van der Pas.

(6/100)

(d) Jelaskan dengan ringkas corak reka bentuk bagi pengaturcaraan bebenang.

(4/100)

2. (a) Diberi keratan program penghantaran mesej yang melibatkan 3 tugas yang mengambil bahagian di dalam kumpulan tugas bernama "workers":

T1	T2	T3

.
.
.
 	
`func1(...)`
`barrier(workers, 3)`
`func2(...)`
.
.
.
	.
	.
	.
	
	`func1(...)`
	`barrier(workers, 3)`
	`func2(...)`
	.
	.
	.
		.
		.
		.
		
		`func1(...)`
		`barrier(workers, 3)`
		`func2(...)`
		.
		.
		.

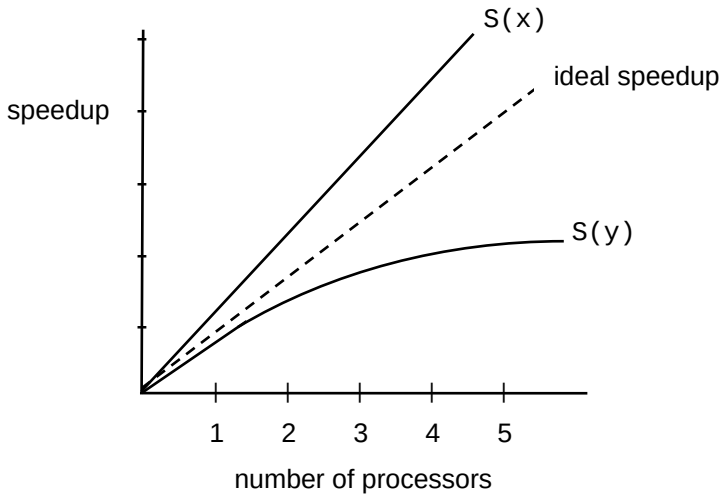
(i) Terangkan tujuan fungsi "barrier" di dalam keratan di atas. Penjelasan anda mestilah berdasarkan `func1` dan `func2`.

(3/100)

(ii) Sekiranya fungsi "barrier" tidak disediakan, bagaimana kesan di atas dapat dicapai hanya dengan menggunakan fungsi "send" dan "receive". Terangkan jawapan anda dengan mengubahsuai keratan program di atas.

(4/100)

(b) Geraf berikut menunjukkan lengkuk pencepatan (speedup) yang dihasilkan oleh suatu program selari:



(i) Terangkan fenomena dalam lengkuk pencepatan (speedup) S(x).

(4/100)

(ii) Lengkuk pencepatan (speedup) S(y) mendatar selepas 4 pemproses. Terangkan kenapa ini berlaku.

(4/100)

(c) (i) Bagaimanakah program penghantaran mesej boleh diemulasikan pada model pemprograman ingatan terkongsi?

(6/100)

(ii) Bagaimana pula program ingatan terkongsi boleh diemulasikan pada model pemprograman ingatan teragih?

(6/100)

(iii) Emulasi manakah 2(c)(i) dan 2(c)(ii) di atas yang lebih mahal dari aspek "latency"? Berikan penjelasan untuk menyokong jawapan anda.

(3/100)

3. Diberi satu senarai yang terdiri daripada n nombor integer, di mana $n \geq 10$.

Tugas anda ialah untuk mereka bentuk satu algoritma selari untuk mencari nombor integer paling kecil daripada senarai yang diberi.

Jawab soalan berikut berdasarkan masalah di atas:

(a) Strategi pemecahan manakah yang akan anda gunakan: data atau fungsi? Lakarkan pilihan anda.

(5/100)

(b) Hasilkan satu algoritma multibebenang untuk seni bina selari ingatan terkongsi menggunakan kaedah tuan-hamba. Gunakan pseudokod di dalam penyelesaian anda.

(15/100)

(c) Hasilkan satu algoritma penghantaran mesej untuk seni bina ingatan teragih menggunakan kaedah tuan-hamba. Gunakan pseudokod di dalam penyelesaian anda.

(15/100)

(d) Bagaimanakah sinkronisasi (jika ada) dicapai di dalam penyelesaian anda di 3(b) dan 3(c).

(5/100)