SULIT

UNIVERSITI MALAYSIA PERLIS

Peperiksaan Akhir Semester Pertama
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EKT 224 – Data Structures and Algorithms
[Struktur-Struktur Data dan Algorithma]

Masa : 3 jam

Please make sure that this question paper has **TWELVE (12)** printed pages including this front page before you start the examination.
*[Sila pastikan kertas soalan ini mengandungi **DUA BELAS (12)** muka surat yang bercetak termasuk muka hadapan sebelum anda memulakan peperiksaan ini.]*

This question paper has **TWO (2)** sections.
*[Kertas soalan ini mengandungi **DUA (2)** Bahagian.]*

Section **A** has **FOUR (4)** questions with total marks of 80. Answer **ALL** questions from this section.
*[Bahagian A mengandungi **EMPAT (4)** soalan dengan jumlah markah 80. Jawab **SEMUA** soalan dari bahagian ini.]*

Section **B** has **TWO (2)** questions with total marks of 20. Answer **ONLY ONE (1)** questions from this section.
*[Bahagian B mengandungi **DUA (2)** soalan dengan jumlah markah 20. Jawab **HANYA SATU (1)** soalan daripada bahagian ini.]*

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SECTION A
BAHAGIAN A

Answer ALL questions in this section.
[Jawab SEMUA soalan dalam bahagian ini.]

Question 1
[Soalan 1]

(C4, CO1, PO1)

(a) Given the following functions in **Table 1**, analyze their complexity by using Big O notation and arrange them in their ascending orders of asymptotic growth rate.
[Berdasarkan fungsi di dalam Jadual 1, analisa kompleksiti fungsi-fungsi tersebut dengan menggunakan notasi Big O dan susun dalam turutan menaik mengikut kadar pertumbuhan asimtotik.]

Table 1
[Jadual 1]

Functions	Big O Notation	Rank (Order)
$5 + 0.001n^3 + 0.025n$		
$n^2 \log_2 n + n(\log_2 n)^2$		
$0.3n + 5n^{1.5} + 2.5 \cdot n^{1.75}$		
$100n + 0.01n^2$		
$0.003 \log_4 n + \log_2 \log_2 n$		
$0.01n + 100n^2$		
$n \log_3 n + n \log_2 n$		

(7 Marks/*Markah*)

(C2, CO1, PO1)

(b) Compare the efficiency of polynomial and exponential algorithms.
[Bandingkan keefisienan algorithma 'polynomial' dan 'exponential'.]

(3 Marks/*Markah*)

...3/-

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(C4, CO1, PO2)

(c) Given three algorithms A, B, and C to be executed on a machine M (as described in **Figure 1**) and T(n) is the processing time. Assume that the machine M consumes 10^{-5} seconds to execute an instruction (constant *c* equals 10^{-5} seconds), compute the time taken by each of the algorithms to complete their execution on machine M for an input of size 1000.

[Diberi algorithma A, B, dan C untuk dilaksanakan di atas mesin M (sebagaimana digambarkan di Rajah 1) dan T(n) adalah masa pemprosesan. Anggap bahawa mesin M mengambil 10^{-5} saat untuk melaksanakan sebuah arahan, kira masa yang diambil bagi setiap algoritma untuk menghabiskan perlaksanaan di mesin M untuk input bersaiz 1000.]

(6 Marks/*Markah*)

Processing Time

Algorithm A

$T(n) = cn$

Algorithm B

$T(n) = c(n \log n)$

Algorithm C

$T(n) = cn^2$

Note: c is a constant and $c=10^{-5}$ seconds

Figure 1
[Rajah 1]

(C4, CO1, PO2)

(d) Based on the following code segment in **Figure 2**, analyze the complexity for each **for** loop in Line 1, Line 2 and Line 3. Then, find out the total computational complexity.

*[Berdasarkan keratan kod pada Rajah 2, analisa 'complexity' untuk setiap gegelung **for** dalam baris 1, baris 2 dan baris 3. Kemudian, dapatkan keseluruhan komputasi 'complexity'.]*

```
for(inti=n; i>0; i/=2){                                    (Line 1)
        for(intj=1; j<n; j*=2){                            (Line 2)
                for(intk=0; k<n; k+=2){                    (Line 3)
                ... // constant number of operations
                }
        }
}
```

Figure 2
[Rajah 2]

(4 Marks/*Markah*)

....4/-

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Question 2
[Soalan 2]

(C1, CO2, PO1)

(a) List **THREE (3)** operations of Abstract Data Type (ADT) for Queues.
[Senaraikan tiga (3) operasi Abstract Data Type (ADT) untuk Queue.]

(3 Marks/*Markah*)

(C3, CO2, PO2)

(b) For the array given in **Table 2** with base address α=1020, determine the addresses of the array elements.
*[Untuk jujukan yang diberi di dalam **Jadual 2** dengan alamat asas α= 1020, tentukan alamat untuk setiap elemen di dalam jadual.]*

Table 2
[Jadual 2]

Array		Element	Address
(i)	M[1: 20]	M[13]	
(ii)	M[1: 7, 1:10]	M [6,7]	
(iii)	M [1: 7, 1:3, 1: 5]	M [5,1,4]	

(5 Marks/*Markah*)

(C3, CO2, PO2)

(c) A two-dimensional array MARK [1:15, 1: 6] stores the grade of 15 students for 6 subjects. The specification for the array is given in **Figure 3.** In the design, determine the number of elements in MARK; the address of MARK [3 : 4]; and the space occupied by MARK in the memory.
*[Sebuah jujukan dua dimensi MARK menyimpan gred untuk 6 subjek bagi 15 pelajar. Spesifikasi jujukan diberikan dalam **Rajah 3**. Di dalam rekabentuk tersebut, tentukan jumlah elemen di dalam MARK, alamat untuk elemen MARK[3:4], dan ruang yang digunakan oleh MARK di dalam memori.]*

Specification of Array MARK

Base address : α= 1013
Size of the memory location : 4 bytes

Figure 3
[Rajah 3]

(7 Marks/*Markah*)

....5/-

(C5, CO2, PO2)

(d) For the following sparse matrix A in **Figure 4**, design an array representation to avoid wasting space in memory.
*[Untuk 'sparse matrix' di dalam **Rajah 4**, reka sebuah jujukan yang dapat mengelakkan pembaziran ruang di dalam memori.]*

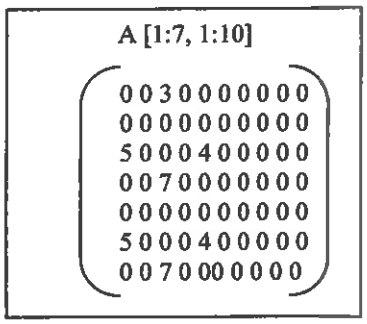

Figure 4
[Rajah 4]

(5 Marks/*Markah*)

Question3
[Soalan 3]

(C5, CO3, PO2)
(a) Consider an undirected graph G shown in **Figure 5**. Demonstrate the Breadth First Traversal (BFT) on the graph G where the start vertex is 1.
[Pertimbangkan suatu graf G tidak berarah yang ditunjukkan dalam Rajah 5. Tunjukkan susur kelebaran carian pertama (BFT) pada graf G di mana vertex permulaan adalah 1.]

(6 Mark/*Markah*)

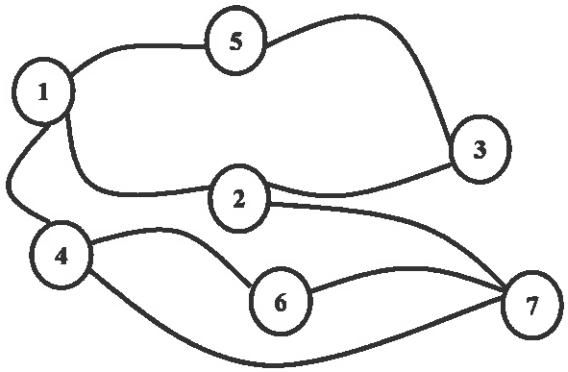

Figure 5
[Rajah 5]

(C3, CO3, PO1)
(b) Consider an undirected graph G shown in **Figure 6**. Create graphical representation for graph data structure using linked list.
[Pertimbangkan suatu graf G tidak berarah yang ditunjukkan dalam Rajah 6. Dengan menggunakan rajah, hasilkan grafik untuk mewakili graf struktur data menggunakan senarai berpaut.]

(4 Mark/*Markah*)

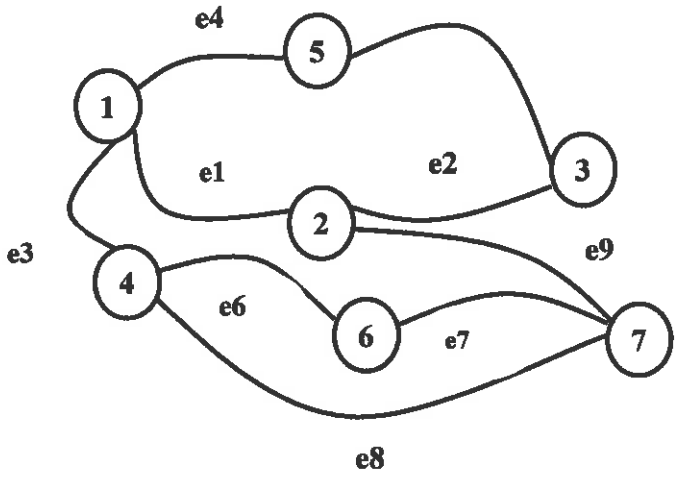

Figure 6
[Rajah 6]

....7/-

(C5, CO3, PO1)

(c) Rewrite the Breadth First Traversal algorithm into Breadth First Search algorithm.
[Tuliskan semula algorithma susur kelebaran carian pertama kepada algoritma Carian Kedalaman Pertama.]

(4 Mark/*Markah*)

(C4, CO3, PO1)

(d) Analyze and trace the search for a key 6 using Breadth First Search algorithm in **Figure 6.**
*[Analisa dan jejak proses carian bagi kekunci 6 dengan menggunakan algorithma Carian Kedalaman Pertama di dalam **Rajah 6**]*
Hints: You should use the following **Table 3** to represent your answer.
[Petua: Anda perlu menggunakan Jadual 3 berikut untuk jawapan anda.]

(6 Mark/*Markah*)

Table 3
[Rajah 3]

Current Vertex	Queue Q (content of queue Q)	List of Visited Vertices

Question 4
[Soalan 4]

(C5, CO2, PO2)

(a) Algorithm EvalPostfix in **Figure 7** illustrates the procedure to evaluate a postfix expression by using stack. Based on this algorithm, devise the evaluation the following postfix notation of expression. Explain the content of the stack and the actions (POP or PUSH) executed as given in the example in **Table 4.**
[Algorithma EvalPostFix di dalam Rajah 7 menggambarkan prosedur untuk menilai sebuah postfix ekspresi dengan menggunakan tindanan. Berdasarkan algorithma ini, rangka proses penilaian notasi ekspresi postfix berikut. Terangkan kandungan tindanan dan operasi (POP atau PUSH) yang dilaksanakan sebagaimana di dalam contoh pada Jadual 4.]

(i) Postfix notation of expression: a b c + / d + e *. The variable values are a=15, b=3, c=2, d=7 and e=2.
*[Notasi ekspresi postfix: a b c + / d + e *. Nilai pembolehubah adalah a=15, b =3, c=2, d =7 and e=2.]*

(7 Marks/*Markah*)

(ii) Postfix notation of expression: a+b*(c*d-e). The variable values are a=4, b =2, c=6, d =3 and e=12.
[Notasi ekspresi postfix: a+b(c*d-e). Nilai pembolehubah adalah a=4, b=2, c=6, d=3 dan e=12.]*

(7 Marks/*Markah*)

```
Algorithm EvalPostfix: Procedure to evaluate a postfix expression E.
Procedure EVAL_POSTFIX(E)

      X = get_next_character (E);
                /* get the next character of expression E */
       case x of
           :x is an operand:     Push x into stack S;
           :x is an operator:    Pop out required number of
                                 operands from the stack S,
              evaluate the operator and push
              the result into  the stack S;
           :x = "$":             Pop out the result from stack S;
       end case
end EVAL-POSTFIX.
```

Figure 7
[Rajah 7]

Table 4 : Example answer for the first two operations for question (a)(i)

[Jadual 4 : Contoh jawapan untuk dua operasi yang pertama untuk soalan (a)(i)]

X	Stack S	Action
a	a (15)	Push a into S
b	b (3)	Push b into S

(b) Devise the conversion process of the infix expression **a+b*(c*d-e)** into prefix and postfix expression.

[Rangka proses penukaran ekspresi "infix" a+b(c*d-e) kepada ekspresi "prefix" dan 'postfix".]*

(6 Marks/*Markah*)

....10/

SECTION B
[*BAHAGIAN B*]

Answer ONLY ONE (1) questions from this section.
*[Jawab hanya **satu** (1) soalan daripada bahagian ini.]*

Question 5
[Soalan 5]

(a) Consider an ordered list below.
[Pertimbangkan senarai nombor mengikut urutan di bawah.]

10, 12, 34, 45, 65, 70, 73, 76, 80, 84, 87, 94, 99

(C5, CO3, PO2)
(i) Construct the trace of Binary search algorithm to search a set of key {25, 87}.
[Bina jejak algoritma Binari untuk mencari set kunci {25, 87}.]

(6 Marks/*Markah*)

(C4, CO3, PO2)
(ii) Analyze the worst and the average time complexity of Binary Search algorithm.
[Analisa kerumitan masa terburuk dan purata bagi algoritma Carian Binari.]

(2 Marks/Markah)

(C2, CO3, PO1)
(iii) Compare the Binary Search technique with the Interpolation Search.
[Bandingkan teknik carian Binari ini dengan carian Interpolasi.]

(2 Marks/Markah)

(b) Consider the list of number below.
[Pertimbangkan senarai nombor di bawah.]

220, 218, 223, 112, 107, 126, 119, 316, 124, 140

(C5, CO3, PO2)
(i) Construct the trace of the quick sort algorithm to rearrange the following numbers into ascending order. Indicate clearly the pivots that you use.
[Bina jejak isihan cepat untuk menyusun enam nombor berkenaan ke dalam bentuk susunan menaik. Nyatakan dengan jelas pivots yang digunakan.]

(6 Marks/*Markah*)

(C2, CO3, PO1)
(ii) Explain why quick sort is not a stable sort.
[Terangkan kenapa isihan cepat merupakan isihan yang tidak stabil.]

(2 Marks/*Markah*)

(C3, CO3, PO2)
(iii) Analyse the worst time complexity for quick sort and explain its condition.
[Analisa kerumitan masa terburuk bagi isihan cepat dan terangkan situasinya.]

(2 Marks/*Markah*)

....11/

Question 6
[Soalan 6]

(a) Let L = {71,17 ,86 ,100 ,54 ,27} be an unordered list of elements.
[L={71, 17, 86, 100, 54, 27} adalah senarai elemen yang tidak tersusun.]

(C5, CO3, PO2)
(i) Construct the trace of selection sort to rearrange six numbers into ascending order.
[Bina jejak isihan pilihan untuk menyusun enam nombor berkenaan ke dalam bentuk susunan menaik.]

(6 Marks/*Markah*)

(C2, CO3, PO1)
(ii) Describe the condition when the sorting process is said to be stable and state whether selection sort is stable.
[Terangkan situasi apabila proses isihan adalah stabil dan nyatakan samada isihan pilihan adalah isihan yang stabil.]

(2 Marks/*Markah*)

(C3, CO3, PO2)
(iii) Analyse the best and average time complexity for selection sort.
[Analisa kompleksiti terbaik dan masa purata kompleksiti untuk isihan pilihan.]

(2 Marks/*Markah*)

(b) Consider an ordered list below.
[Pertimbangkan senarai nombor mengikut urutan di bawah.]

2, 4, 8, 9, 17, 36, 44, 55, 81, 84, 94, 116, 221, 434

(C5, CO3, PO2)
(i) Construct the trace of the Fibonacci search algorithm to search for the key{434}.
[Bina jejak algoritma Carian Fibonacci untuk mencari kunci {434}.]

(6 Marks/*Markah*)

(C4, CO3, PO2)
(ii) Analyze the worst and the average time complexity of the Fibonacci Search algorithm.
[Analisa kerumitan masa terburuk dan purata bagi algoritma Carian Fibonacci.]

(2 Marks/Markah)

(C2, CO3, PO1)
(iii) Compare the Fibonacci search technique with the Interpolation search.
[Bandingkan teknik carian Fibonacci ini dengan carian Interpolasi.]

(2 Marks/Markah)

....12/

APPENDIX
[Lampiran]

a) Course Outcome *[Hasil Pembelajaran]*

No.	Course Outcome, CO
CO1	Ability to analyze algorithm and to determine algorithm correctness and time efficiency.
CO2	Ability to design and implement linear and non-linear data structures.
CO3	Ability to design and implement sorting and searching algorithms.

b) Programme Outcome *[Hasil Program]*

No.	Programme Outcome, PO
PO1	Ability to apply knowledge of basic mathematics, science and in-depth technical competence in Materials Engineering discipline to solve complex engineering problem.
PO2	Ability to identify, formulate and solve complex engineering problems.
PO3	Ability to design a system, component or process to meet desired needs.
PO4	Ability to design and conduct experiments, as well as to analyze and interpret data.
PO5	Ability to use techniques, skill and modern engineering tools necessary for engineering practices.
PO6	Ability to demonstrate the social, cultural, global and environment responsibilities of a professional engineer.
PO7	Ability to understand entrepreneurship, the process of innovation and the need for sustainable development of the environment.
PO8	Ability to understand professional and ethical responsibilities and commitment to the society.
PO9	Ability to function on multi-disciplinary teams.
PO10	Ability to communicate effectively.
PO11	Recognition of the need for, and an ability to engage in life-long learning.
PO12	Demonstrate understanding of project management and finance principles.

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