

University of Dhaka

Department of Computer Science and Engineering

3rd year 2nd Semester B.Sc. Final Examination-2019

CSE-3201: Operating Systems

Total Marks: 60, Credits: 3, Time: 3 hours

Answer any Four (4) of the following questions ($4 \times 15 = 60$)

- The OS161 currently running five processes that have CPU burst 10, 20, 25, 15 and 23-time units accordingly. The relative arrival time of the processes is 5, 0, 2, 4 and 7-time units. After execution of 4 (four) CPU burst processes are loading a file which takes 8-time units. Assume the long term scheduling is FIFO.
 - If the time quanta of the round robin scheduling are 5-time units, then determine the average turn around, waiting time of the processes. [5]
 - If processes have priorities (higher number lower priority) 1, 2, 3, 4, and 5 respectively and a constraint with the scheduling is that the processes priority changes to the maximum priority of the processes plus 1 when a process execute continuously 8 unit of time. Then determine the average waiting and turnaround time of the processes. In this case ignore the file loading. [5]
 - If the processes are sharing the same file, then determine the turnaround time of each of the processes described in question (a). If the programmer forgot to implement synchronization, then which scheduling algorithm results in inconsistency? Assume each of the processes read and update the file more than once. [5]
 - Let a system currently hosted hundreds of producer processes that send loan requests to four Bangladesh government listed banks which are Rupali, Sonali, Janata and Agrani. The bank accept a loan request if it has sufficient funds. Otherwise a loan request is rejected. The request function is described as follows:

```
1 bool loan_request (double amount){  
2     /*  
3     * A bank is selected randomly  
4     **/  
5     string bank=random('Janata','Sonali','Rupali','Agrani');  
6     /*  
7     * read the remaining available fund for loan  
8     **/  
9     double remainig_fund=fund[bank];  
10    /*  
11    * continue while not loan request is rejected  
12    **/  
13    while(true){  
14        /** Compare if the requested amount is less or equal  
15        to the available fund **/  
16        if(amount<=remainig_fund){  
17            /** loan is successful **/  
18            remainig_fund=remainig_fund-amount;  
19            /* Update remaining fund of a bank */  
20            fund[bank]=remainig_fund;  
21            /** We are done **/  
22            return true;  
23        }  
24    }  
25}
```

- a) Determine the critical region from the above function “loan_request(double)”. [2]
b) Propose a suitable solution for the above code to solve the synchronization problem. Your solution should eliminate race condition. [5]

- c) Now, let the banks are deposited \$10,000, and each of the producers makes the loan requests in order (FIFO) for five producers as [8]

1	p1: loan_request(5000); from Janata Bank
2	p2: loan_request(4000); from Sonali Bank
3	p3: loan_request(5000); from Agrani Bank
4	p4: loan_request(5000); from RupaliBank
5	p2: loan_return(2000); Reimburse loan money
6	p5: loan_request(6000); from Sonali Bank

Does the system go to deadlock? Explain why. Now each of the five process request \$5000 from another bank (p1: Sonali, p2: Rupali, p3: Janata, p4: Agrani and p5:Rupali) then state the status of the system. Devise an algorithm to keep system deadlock-free.

3. a) Consider a logical address space of 64 pages of 1,024 words each, mapped onto a physical memory of 32 frames. [4]
- How many bits are there in the logical address?
 - How many bits are there in the physical address?
- b) Consider the following page reference string: [6]
 7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.
 Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms?
 - LRU replacement
 - FIFO replacement
 - Optimal replacement
- c) Sharing segments among processes without requiring that they have the same segment number is possible in a dynamically linked segmentation system. [5]
 - Define a system that allows static linking and sharing of segments without requiring that the segment numbers be the same.
 - Describe a paging scheme that allows pages to be shared without requiring that the page numbers be the same.
4. a) How stack frame of a process and kernel stack is affected by a system call to dealing with page fault? [5]
- b) If a process request to store a 100MB file, which of I/O transfer an operating system should consider? Why? [5]
- c) R3000 processor has four registers $a_0 - a_3$ are used to passing arguments, however if a procedure call needs to pass five or more arguments then how it is done? [2]
- d) Let a system disk access time is 100ns, TLB access time is 1ns, and memory access time is 10ns, then what would be the effective memory access time when 90% of the process's page table in TLB cache and 60% pages are in main memory? [3]
5. a) If a super block of an Unix/Linux file system is damaged then how it is recovered? [5]
- b) Suppose an Operating System currently has five (not same) file systems which are mounted to its root file system, then how the files are accessed? Describe it with the help of VNODE. [5]
- c) All the i-nodes are created when we format a disk and divided into groups with other entities and file system blocks are kept at the end of the block group, why? Is it important? Propose a file system structure (i-node and other block group components) which stores your favorite movies [5]
6. a) If a disk management system has prior knowledge of the block request held by the processes then how the disk block requests would be served to increase the system performance? [5]
- b) Let a file's data are stored in cylinder 35 at number 5 sectors, and the head is currently parked at track 20. If the head takes 0.5ms move to the next track, latency delay for the next sector to read is 10ns. Note that a head can read a sector without moving. Transfer time for 512 bytes (or a sector) needs 1ns. [5]

Determine the access time to read the whole file. Your answer should be reasonable.

- c) Why the RAID5 need one extra disk? If we lost two disks, then how we cannot [5] recover the lost data explain? Propose an operating stable storage RAID that would be free from 20% data losses.

Time: 3.00 Hrs.

Answer Any Four

Full Marks: 60

- 1.(a) "It is true that a number of different types of errors arise during the process of numerical computing. All these errors contribute in the total error in final result." - Now draw an appropriate figure showing all the errors encountered in a numerical process. 5
- (b) Define symmetric roundoff and also derive absolute symmetric roundoff error. 5
- (c) Find the absolute and relative error in evaluating the following expressions: 5
- $\sqrt{x^2 + y^2}$ where $x = 1.25$ and $y = 2.16$. (*Significant digits = 3*)
- 2.(a) Explain the stopping/termination criterion of an iterative process. 3
- (b) Derive Newton's method to approximate the root of the equation $f(x)=0$. Also describe the geometrical significance of the Newton's method. 7
- (c) Use Secant method of finding the root of nonlinear function $f(x) = 4x^3 - 2x - 6 = 0$. (use suitable range) 5
- 3.(a) Write the basic principle of Gauss-Jordan method. 3
- (b) Explain the process of finding the solution of the system of linear equations step by step using LU decomposition (Doolittle) method. 7
- (c) Solve the following system of equations using LU decomposition (Doolittle) method. 5
- $3x_0 + 2x_1 + x_2 = 10$
 $2x_0 + 3x_1 + 2x_2 = 14$
 $x_0 + 3x_1 + 2x_2 = 14$
- 4.(a) Derive Newton's divided difference interpolation polynomial. 5
- (b) Illustrate the condition that must be satisfied for the case of piecewise cubic polynomial (cubic spline). 5
- (c) The table below are the data-points; 5
- | i | 0 | 1 | 2 | 3 |
|--------|-----|--------|------|-----|
| x | 1 | 2 | 3 | 4 |
| $f(x)$ | 0.5 | 0.3333 | 0.25 | 0.2 |
- Determine the value of $f(x)$ at $x = 2.5$ using Cubic Spline function.
- 5.(a) State Taylor's series for the function $f(x+h)$ and $f(x-h)$ and thus derive central difference quotient for differentiating a continuous function. 5
- (b) Analyze and derive the error in numerical derivation. 5

(c) The table below gives the value of distances traveled by a car at various time intervals; 5

<i>Time in second</i>	5	6	7	8	9
<i>Distance in km</i>	10.0	14.5	19.5	25.5	32.0

Estimate velocity of the car at $t = 5, 7$ and 9 using *3-points forward difference* and *3-point backward difference* formula.

6.(a) Explain Composite Trapezoidal rule of integrating a continuous function. 5

(b) Using Simpson's 1/3 rule show that the area is given by the product of the total width of the segment and the weighted average of heights $f(x_0)$, $f(x_1)$ and $f(x_2)$. 5

(c) Compute the integral; 5

$\int_0^{x/2} \sqrt{\sin(x)} dx$ using Simpson's 1/3 rule for $x=4$ and $x=6$ rad with an accuracy of 5 decimal places.

Answer any Four (4) of the following questions (4×15=60)

1. a) i) Write a pseudocode to generate distinct permutation of a given string with [6] duplicate characters with time complexity $O(n^2 * n!)$.
ii) Modify the above algorithm to generate all permutation of a given string [4] without duplicate characters. Also show that the time complexity of the algorithm is $O(n * n!)$.
 - b) Simulate the backtracking algorithm for N queen problem where N=3. [5]
2. a) A disk consists of a circle plus its interior and is represented by its center point and radius. Two disks intersect if they have any point in common. Give an [5] $O(nlg n)$ time algorithm to determine whether any two disks in a set of n intersect.
 - b) Consider the following function "orientation" which takes three ordered 2-D [8] points as argument and returns 0 /1/2 if triplets are co-linear or makes a clockwise or counter clock wise turn.

```
int orientation(Point p, Point q, Point r)
{
    int val = (q.y - p.y) * (r.x - q.x) -
              (q.x - p.x) * (r.y - q.y);
    if (val == 0) return 0; // colinear
    return (val > 0)? 1: 2; // clock or counterclock
}
```

You are given a set of 2-D points: S, your task is to simulate (all steps) Graham-Scan algorithm to find convex-hull from set S as given below. You can utilize "orientation" function in this purpose.

$$S = \{(0, 3), (1, 1), (2, 2), (4, 4), (0, 0), (1, 2), (3, 1), (3, 3)\}$$

- c) Professor Jami proposes that only the x-dimension needs to be tested to [2] determine ON-SEGMENT. Show why the professor is wrong.
3. a) What is Euler Totient function? Mention it's applications. [2]
 - b) Most computers can perform the operations of subtraction, testing the parity [8] (odd or even) of a binary integer, and halving more quickly than computing remainders. Design an efficient binary gcd algorithm for input integers a and b, where $a \geq b$, that runs in $O(\log a)$ time. Assume that each subtraction, parity test, and halving takes unit time.
 - c) RSA would be trivial to crack knowing the factorization into two primes of n in [5] the public key, explain why RSA would be trivial to crack knowing $\phi(n)$.
4. a) Write down a pseudocode to determine a longest prefix of a string which is also [4] suffix of the string. Using your algorithm, determine the longest prefix of the string "cgtacggtcgta" that is also a suffix of this string.
 - b) We call a pattern P nonoverlappable if $P_k \sqsubset P_q$ implies $k = 0$ or $k = q$. Describe [3] the state-transition diagram of the string-matching automaton for a nonoverlappable pattern.
 - c) Given a text $txt[0..n-1]$ and a pattern $pat[0..m-1]$, write a linear time function [8] $search(char pat[], char txt[])$ that prints all occurrences of $pat[]$ and its

permutations (or anagrams) in $\text{txt}[]$. You may assume that $n > m$ and all the characters in the pattern are distinct. Prove that the time complexity is $O(n)$.

5. a) For a given problem, is it possible to find optimal solution from a solution of decision problem? [2]
- b) Suppose $Y \leq_p X$. Justify the following statements. [4]

i) If X can be solved in polynomial time, then Y can be solved in polynomial time.

ii) If Y cannot be solved in polynomial time, then X cannot be solved in polynomial time.

- c) Prove that Traveling salesman problem is an NP-complete problem. [4]

- d) Write down 2-approximation algorithm for finding vertex cover. Prove that the approximation ratio of the algorithm is 2. [5]

6. a) Mention the features of online algorithm. Define the competitive ratio. [2]

- b) You are going skiing for an unknown number of days. Assume that renting skis costs 1 Taka per day and buying costs T taka. Everyday day you have to decide whether to continue renting skis for one more day or buy a pair of skis. If you know in advance how many days you will go skiing, you can decide your minimum cost. The question is what to do when you do not know in advance how many days you will ski.

i) What would be the optimal solution of an offline algorithm? [2]

ii) Provide at least three different strategies for online algorithm and calculate the competitive ratio of each strategy. Justify the best competitive ratio. [6]

- c) Define the concurrent instructions- parallel, spawn, sync. Write down the parallel algorithm to compute Fibonacci number. Please specify the different threads and the interaction among the threads. [5]

University of Dhaka
 Department of Computer Science and Engineering
 3rd Year 2nd Semester Examination, 2019
 CSE 3204: Formal Language, Automata, and Computability

Full Marks: 60

Time: 3 Hours

(Answer any Four (4) of the following Questions)

1. a) Define Finite Automata. What is the difference DFA and NFA in terms of final state? 1+1+2
 Build an NFA for the following language:

$$L = \{ w \mid w \text{ ends in } 01 \}$$

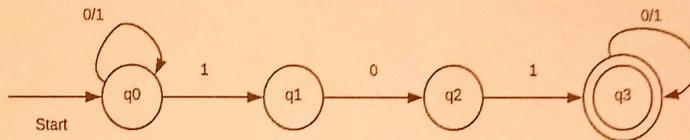
- b) Build DFAs for the following languages: 2+2

- i. $L = \{ w \mid w \text{ is a binary string that has even number of 1s and even number of 0s} \}$
 ii. $L = \{ w \mid w \text{ is a binary string that has odd number of 1's} \}$

- c) Give English description of the languages of the following regular expressions: 3

- i. $(1 + \epsilon) (00^*1)^* 0^*$
 ii. $(0^*1^*)^* 000 (0+1)^*$

- d) Obtain a DFA equivalent to the NFA given below: 4



2. a) If $D = (Q_D, \Sigma, \delta_D, \{q_0\}, F_D)$ is the DFA constructed from NFA $N = (Q_N, \Sigma, \delta_N, q_0, F_N)$ by the subset construction method, then prove that, $L(D) = L(N)$. 5

Note: $L(D) = \text{Set of strings accepted by } D$
 $L(N) = \text{Set of strings accepted by } N$

- b) Given the DFA below: 5+5

δ	0	1
$\rightarrow Q_1$	Q_2	Q_6
$/ Q_2$	Q_1	Q_3
$*Q_3$	Q_2	Q_4
Q_4	Q_4	Q_2
Q_5	Q_4	Q_5
$*Q_6$	Q_5	Q_4

- i. Draw the table of distinguishabilities for this automaton.
 ii. Construct the minimum state equivalent DFA.

3. a) What do you mean by the Yield of a parse tree, explain within an example. Design a Context-Free Grammar (CFG) for the following language: 2+4

$$\{a^i b^j c^k \mid i=j+k\}$$

- b) When do we call a grammar is inherently ambiguous? The following grammar is ambiguous. How we can prove that? 1+2

$$S \rightarrow SbS/a$$

- c) Find an unambiguous grammar for the language of the grammar given in 3(b). 3
 d) What is Right Linear CFG? Does it generates regular language? Explain with an example. 3

4. a) What kind of language is recognized by a Push Down Automata (PDA)? What is the role 1+2

of associated stack in a PDA?

- b) Convert the following PDA (P_N) to Context Free Grammar (CFG).

$$P_N: (\{q_0\}, \{b, e\}, \{Z_0, Z_1\}, \delta, q_0, Z_0)$$

$$1. \delta(q_0, b, Z_0) = \{(q_0, Z_1 Z_0)\}$$

$$2. \delta(q_0, b, Z_1) = \{(q_0, Z_1 Z_1)\}$$

$$3. \delta(q_0, e, Z_1) = \{(q_0, \epsilon)\}$$

$$4. \delta(q_0, \epsilon, Z_0) = \{(q_0, \epsilon)\}$$

- c) Convert the following grammar to a PDA that accepts the same language by empty stack.

$$S \rightarrow aAA$$

$$A \rightarrow aS \mid bS \mid a$$

- d) Design a PDA to accept the following language either accepting by final state or by empty stack.

$$i. \{0^n 1^n \mid n \geq 1\}$$

5. a) Using the pumping lemma for context free languages, find out whether the following language is a context free?

$$L = \{ww \mid w \text{ is in } \{0,1\}^*\}$$

- b) For the following grammar:

$$S \rightarrow aAa \mid bBb \mid \epsilon$$

$$A \rightarrow C \mid a$$

$$B \rightarrow C \mid b$$

$$C \rightarrow CDA \mid \epsilon$$

$$D \rightarrow A \mid B \mid ab$$

- i. Eliminate ϵ -productions.

3

- ii. Eliminate any unit productions in the resulting grammar

3

- iii. Eliminate any useless symbol in the resulting grammar

3

- iv. Put the resulting grammar to Chomsky Normal Form (CNF)

3

6. a) Both regular and context free languages (CFL) are closed under *union*, *complementation*, *substitution*, *homomorphism*, *Kleen closure* and *concatenation*. However, there are certain operations under which regular languages are closed but CFLs are not. Describe any such operation.

3

- b) What is the role of Turing machines? Turing machines can recognize recursively enumerable language. How it is related to regular and context free languages?

2+2

- c) What are the contents of ID (Instantaneous Description) for a Turing Machine?

2

- d) Design Turing machine for the language L, where:

5

$$L = \{a^n b^n c^n \mid n \geq 1\}$$

- e) If a problem cannot be solved by Turing machines can we solve it otherwise?

1

University of Dhaka
 Department of Computer Science and Engineering
 3rd Year 2nd Semester B.Sc. Examination, 2019
 CSE – 3205, Introduction to Probability and Statistics

Total Marks: 60

Time: 3 Hours

(Answer any 4 (Four) of the following Questions)

1. a) Define ‘experimental unit’, ‘variable’ and ‘measurement’ with appropriate example. 2
 b) The test scores on a 100-point test were recorded for 20 students: 13
- | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|
| 61 | 93 | 91 | 86 | 55 | 63 | 86 | 82 | 76 | 57 |
| 94 | 89 | 67 | 62 | 72 | 87 | 68 | 65 | 75 | 84 |
- i) Draw a stem and leaf plot to describe the data.
 ii) Use relative frequency histogram to describe the data.
 iii) Draw the box plot for the measurements.
 iv) Describe the shape and location of the scores.
 v) Is the shape of the distribution unusual? Can you think of any reason the distribution of the scores would have such a shape?
2. a) What do you mean by central tendency of data? Describe a situation in which it is more appropriate to use each of the following as a measure of central tendency: (i) mean (ii) median (iii) mode. 6
 b) What purpose does a measure of dispersion serve? 2
 c) For the following data compute (i) median absolute deviation (ii) standard deviation 4
 71, 69, 66, 64, 69, 61, 65, 56, 56, 66, 67, 60, 67, 63, 59
 d) What do you mean by robust measures of location? Discuss the trimmed mean and winsorized mean. 3
3. a) ‘Mutually exclusive events must be dependent’. Explain the statement. 2
 b) On the first day of kindergarten, the teacher randomly selects 1 of his 25 students and records the student’s gender, as well as whether or not that student had gone to preschool.
 i) Construct a tree diagram for this experiment. How many simple events are there?
 ii) The table below shows the distribution of the 25 students according to gender and preschool experience. Use the table to assign probabilities to the simple events in part i). 5
- | | Male | Female |
|--------------|------|--------|
| Preschool | 8 | 9 |
| No Preschool | 6 | 2 |
- iii) What is the probability that the randomly selected student is male? What is the probability that the student is a female and did not go to preschool?
 c) Given $P(A) = 0.43$, $P(B) = 0.29$, $P(C) = 0.30$, $P(A \cap B) = 0.13$, $P(A \cap C) = 0.15$, $P(B \cap C) = 0.07$, $P(A \cap B \cap C) = 0.03$. What is the value of $P(\bar{B} | A \cup C)$? 3
- d) A card is drawn from a well-shuffled ordinary 52 card deck. Prove that the events, E: The card is an 8 and H: The card is a spade, are independent. 2
 e) City crime records show that 20% of all crimes are violent and 80% are nonviolent, involving theft, forgery, and so on. Ninety percent of violent crimes are reported versus 70% of nonviolent crimes.
 i) What is the overall reporting rate for crimes in the city?
 ii) If a crime in progress is reported to the police, what is the probability that the crime is violent? What is the probability that it is nonviolent? 3
4. a) One of the properties of binomial probability distribution is ‘Probability of success on a single trial is p and remains constant from trial to trial’. How population and sample need to be related to maintain this property? 1
 b) Use the formula for the binomial probability distribution to calculate the values of $p(x)$ and construct the probability histogram for x when $n = 6$ and $p = 0.2$. 4
 c) Records show that 30% of all patients admitted to a medical clinic fail to pay their bills and that eventually the bills are forgiven. Suppose $n = 4$ new patients represent a random selection from the large set of prospective patients served by the clinic. Find these probabilities. 3

- i) All the patients' bills will eventually have to be forgiven.
ii) None will have to be forgiven.
- d) A manufacturer of power lawn mowers buys 1-horsepower, two-cycle engines in lots of 1000 from a supplier. She then equips each of the mowers produced by her plant with one of the engines. History shows that the probability of any one engine from that supplier proving unsatisfactory is 0.001. In a shipment of 1000 engines, what is the probability that none is defective? Two are?
- e) A candy dish contains five blue and three red candies. A child reaches up and selects three candies without looking.
- i) What is the probability that there are two blue and one red candies in the selection?
ii) What is the probability that the candies are all red?
iii) What is the probability that the candies are all blue?
5. a) How location of center and shape of a normal probability distribution are defined? Why a normal random variable is standardized? 2+2
- b) A normal random variable x has an unknown mean μ and standard deviation $\sigma = 2$. If the probability that x exceeds 7.5 is .8023, find μ . 2
- c) Cerebral blood flow (CBF) in the brains of healthy people is normally distributed with a mean of 74 and a standard deviation of 16. 6
- i) What proportion of healthy people will have CBF readings between 60 and 80?
ii) What proportion of healthy people will have CBF readings above 100?
iii) If a person has a CBF reading below 40, he is classified as at risk for a stroke. What proportion of healthy people will mistakenly be diagnosed as "at risk"?
- ~~Explain the importance of 'continuity correction'.~~
- d) A production line produces AA batteries with a reliability rate of 90%. A sample of $n = 250$ batteries is selected. Find the probability that at least 230 of the batteries work. 3
6. a) Differentiate stratified random sample and cluster sample with example. 2
- b) A random sample of public opinion in a small town was obtained by selecting every 10th person who passed by the busiest corner in the downtown area. Will this sample have the characteristics of a random sample selected from the town's citizens? Explain. 2
- c) How sampling distributions for the sample mean \bar{x} look like when sampled population is normal, approximately symmetric or skewed? 2
- d) Suppose a random sample of $n = 40$ observations is selected from a population with mean $\mu = 100$ and standard deviation $\sigma = 12$. 1+1
+3
- i) What will be the approximate shape of the sampling distribution of \bar{x}
ii) Give the mean and the standard deviation of the sampling distribution of the sample mean \bar{x} .
iii) Find the probability that \bar{x} between 105 and 110.
- e) Suppose that a response can fall into one of $k = 3$ categories with probabilities $p_1 = 0.4$, $p_2 = 0.3$, and $p_3 = 0.3$, and $n = 300$ responses produce these category counts: 4

Category	1	2	3
Observed Count	130	98	72

Do the data provide sufficient evidence to indicate that the cell probabilities are different from those specified for the three categories? Find the approximate p -value and use it to make your decision.