University of Dhaka
Department of Computer Science and Engineering
3rd Year 2nd Semester Final Examination, 2020
CSE-3201: Operating Systems (3 Credits)

Time: 2 hours **Total Marks: 70**

Answer any three (3) out of the following five (5) questions. Marks are given in the right margin.

1 (a) What are the responsibilities of static and dynamic memory allocation? For a uniprogramming system, draw the memory structure to explain the view of process memory. [5]

(b) Write short notes on best fit and first fit algorithm for managing the free list. [5]

(c) Direct memory access is used for high speed I/O devices in order to avoid increasing the CPU's execution load. How does the CPU interface with the device to coordinate the transfer? How does the CPU know when the memory operations are complete? [6]

(d) Explain the following four conditions which are necessary for arising a deadlock situation: [7.33]
- Mutual Exclusion
- Hold and Wait
- No preemption
- Circular wait

2 (a) Write down two differences between user-level threads and kernel-level threads. Under what circumstances is one type better than the other? [6]

(b) Consider a multicore system and a multithreaded program written using the many-to-many threading model. Let the number of user-level threads in the program be greater than the number of processing cores in the system. Discuss the performance implications of the following scenarios: [6]

I. The number of kernel threads allocated to the program is less than the number of processing cores.
II. The number of kernel threads allocated to the program is equal to the number of processing cores.
III. The number of kernel threads allocated to the program is greater than the number of processing cores but less than the number of user-level threads.

(c) Race conditions are possible in many computer systems. Consider a banking system that maintains an account balance with two functions: deposit(amount) and withdraw(amount). These two functions are passed the amount that is to be deposited or withdrawn from the bank account balance. Assume that a husband and wife share a bank account. Concurrently, the husband calls the withdraw() function and the wife calls deposit(). Describe how a race condition is possible and what might be done to prevent the race condition from occurring.might be done to prevent the race condition from occurring. [5]

(d) Discuss how the following pairs of scheduling criteria conflict in certain settings: [6.33]

I. CPU utilization and response time.
II. Average turnaround time and maximum waiting time.
III. I/O device utilization and CPU utilization.

3 (a) Many CPU-scheduling algorithms are parameterized. For example, the RR algorithm requires a parameter to indicate the time slice. Multilevel feedback queues require parameters to define the number of queues, the scheduling algorithm for each queue, the criteria used to move processes between queues, and so on. [8]

These algorithms are thus really sets of algorithms (for example, the set of RR algorithms for all time slices, and so on). One set of algorithms may include another (for example, the FCFS algorithm is the RR algorithm with an infinite time quantum). What (if any) relation holds between the following pairs of algorithm sets?

I. Priority and SJF
II. Multilevel feedback queues and FCFS
III. Priority and FCFS
IV. RR and SJF

(b) Consider the following set of processes, with the length of the CPU burst given in milliseconds: [12]

Process	Burst Time	Priority
P1	2	2
P2	1	1
P3	8	4
P4	4	2
P5	5	3

The processes are assumed to have arrived in the order P1, P2, P3, P4, P5, all at time 0.

I. Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: FCFS, SJF, non-preemptive priority (a larger priority number implies a higher priority), and RR (quantum = 2).
II. What is the turnaround time of each process for each of the scheduling algorithms in Part (a)?
III. What is the waiting time of each process for each of these scheduling algorithms?
IV. Which of the algorithms results in the minimum average waiting time (over all processes)?

(c) Which of the following scheduling algorithms could result in starvation? [3.33]

I. First-come, first-served
II. Shortest job first
III. Round robin
IV. Priority

4 (a) Consider a logical address space of 64 pages of 1,024 words each, mapped onto a physical memory of 32 frames. [4.33]

I. How many bits are there in the logical address?
II. How many bits are there in the physical address?

(b) Consider the following snapshot of a system: [9]

	Allocation	Max	Available
	ABCD	ABCD	ABCD
P0	2 0 0 1	4 2 1 2	3 3 2 1
P1	3 1 2 1	5 2 5 2	
P2	2 1 0 3	2 3 1 6	
P3	1 3 1 2	1 4 2 4	
P4	1 4 3 2	3 6 6 5	

Answer the following questions using the banker's algorithm:

I. Illustrate that the system is in a safe state by demonstrating an order in which the processes may complete.

II. If a request from process P1 arrives for (1, 1, 0, 0), can the request be granted immediately?

III. If a request from process P4 arrives for (0, 0, 2, 0), can the request be granted immediately?

(c) Consider a computer system that runs 5,000 jobs per month and has no deadlock-prevention or deadlock-avoidance scheme. Deadlocks occur about twice per month, and the operator must terminate and rerun about ten jobs per deadlock. Each job is worth about two dollars (in CPU time), and the jobs terminated tend to be about half done when they are aborted. **[10]**

A systems programmer has estimated that a deadlock-avoidance algorithm (like the banker's algorithm) could be installed in the system with an increase of about 10 percent in the average execution time per job. Since the machine currently has 30 percent idle time, all 5,000 jobs per month could still be run, although turnaround time would increase by about 20 percent on average.

I. What are the arguments for installing the deadlock-avoidance algorithm?

II. What are the arguments against installing the deadlock-avoidance algorithm?

5 (a) Write short notes on I-Nodes and V-Nodes. **[6]**

(b) A certain computer provides its users with a virtual memory space of 2^{32} bytes. The computer has 2^{20} bytes of physical memory. The virtual memory is implemented by demand paging, and page size is 2048 bytes. Determine the physical address from the following logical addresses (consider pages are loaded sequentially): **[10]**

a. 123456
b. 23465976
c. 456
d. 4789
e. 124967

(c) Assume you have an inode-based filesystem. The filesystem has 512 byte blocks. Each I-node has 10 direct, 1 single indirect, 1 double indirect and 1 triple indirect block pointers. Block pointers are 4 bytes each. Assume the inode and any block free list is always in memory. Blocks are not cached. **[7.33]**

I. What is the maximum file size that can be stored before
1. the single indirect pointer is needed?
2. the double indirect pointer is needed?
3. the triple indirect pointer is needed?

II. What is the maximum file size supported?

III. What is the number of disk block reads required to read 1 byte from a file
1. in the best case?
2. in the worst case?

University of Dhaka

Department of Computer Science and Engineering

3rd Year 2nd Semester Final Examination, 2020

CSE-3202: Numerical Methods (3 Credits)

Time: 2 hours **Total Marks: 70**

Answer any three (3) out of the following five (5) questions. Marks are given in the right margin.

1 (a) Make a short comparative discussion on "Accuracy versus Precision". **[7]**

(b) Describe different types of errors in a numerical process with suitable examples. Give an idea how the total error is calculated from these errors in a numerical process. **[8]**

(c) "The absolute relative error in representing a number is less than the machine epsilon" -- explain. **[8.33]**

2 (a) List the disadvantages of Newton-Raphson method. Compare the False Position method with Newton-Raphson method and explain how the False Position method is better than Newton-Raphson method. **[6]**

(b) (I) Use Bisection method to find a root of the equation $f(x) = cos\ (x)$ with absolute error ≤ 0.02 (assume the initial interval $[0.5, 0.9]$). **[10]**
(II) Show that the number of iterations required to solve the above problem is analogous to the theoretical one.

(c) (I) Determine the root of the equation $f(x) = 3x + sin\ x - e^x = 0$, using the false position method starting with an initial estimate of $x_l = 0$ and $x_u = 1$. **[7.33]**
(II) Compare the absolute error at 5th iteration with that of bisection method.

3 (a) Write the formula for "back substitution" from an upper-matrix. **[6]**

(b) Solve the following system of linear equations using the LU decomposition method: **[10]**

$$x_0 + 2x_1 - 3x_2 = 7$$
$$2x_0 - 5x_1 + 2x_2 = 5$$
$$3x_0 + x_1 + 7x_2 = 11$$
$$4x_0 + 3x_1 - 5x_2 = 13$$

(c) The table below gives the value of upward velocity of a rocket at various time intervals. **[7.33]**

Time in second	0	5	8	12
Velocity km/sec	0	106.8	177.2	279.2

The velocity of the rocket is approximated by a polynomial as;

$v(t) = a_1t^2 + a_2t + a_3,\ 5 \leq t \leq 12$

Find the velocity of the rocket at $t = 7$, 9 and 11 sec. using forward elimination and backward substitution method.

4 (a) Why do we use interpolation? Compare interpolation with approximation. **[7.33]**

(b) Given $(x_0, f(x_0))$, $(x_1, f(x_1))$ and $(x_2, f(x_2))$, to fit a quadratic interpolant through the data, $f_2(x) = b_0 + b_1(x-x_0) + b_2(x-x_0)(x-x_1)$, explain about the coefficients b_0, b_1 and b_2. **[8]**

(c) The table below contains some data-points. [8]

i	0	1	2	3
x	1	2	3	4
$f(x)$	0.5	0.3333	0.25	0.2

Using the above table, determine the value of $f(x)$ at $x = 3.5$ using divided difference formula.

5 (a) (I) Write the definition of spline. [6.33]
(II) "Higher order polynomial interpolation is not a good idea"-- explain.

(b) How to find '$3n$' equations for solving '$3n$' unknowns in quadratic splines? [7]

(c) The table below gives the value of upward velocity of a rocket at various time intervals; [10]

Time in second	0	10	15	20
Velocity km/sec	0	227.04	462.78	517.35

Estimate velocity and acceleration (1 sec step) at $t = 16$ sec. using quadratic spline formula.

University of Dhaka

Department of Computer Science and Engineering

3rd Year 2nd Semester B. Sc. Final Examination, 2020

CSE 3203: Design and Analysis of Algorithms-II

Total Marks: 70 Time: 2 Hours

Answer any three (3) of the following five (5) questions

1 a) Let $\mathcal{H}_{pm} = \{h_{ab} : a \in \mathbb{Z}_p^*$ and $b \in \mathbb{Z}_p\}$ where [10]

- $m < p$, p is a prime number and $U \subset \mathbb{Z}_p = \{0, 1, 2, ..., p-1\}$
- $\mathbb{Z}_p^* = \{1, 2, ..., p-1\}$
- $h_{ab}(k) = ((ak+b) \bmod p) \bmod m$

Prove that $\mathcal{H}_{pm}$ is a universal class of hash functions.

b) Insert the keys 13, 9, 4, 51, 8, 43, 47 and 24 into a hash table of length m = 11 following open addressing with quadratic probing. [8]
Use $h'(k) = \lfloor (3k+1)/2 \rfloor$, $c_1 = 3$ and $c_2 = 7$.

c) How did the insertion task of question 1b) perform compared to the expected number of probes required for insertion of the same keys with uniform hashing? [5.3]

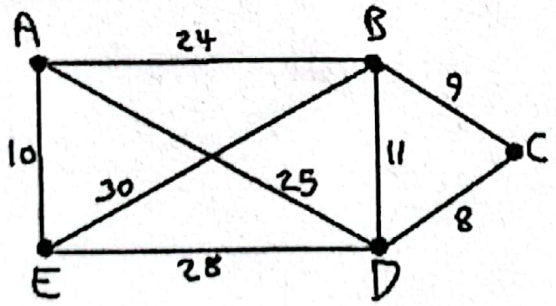
2 a) Prove that if $p_1 \times p_2$ is positive, then vector p_1 is clockwise from vector p_2 with respect to the origin $(0, 0)$ and that if this cross product is negative, then p_1 is counter clockwise from p_2. [5]

b) Professor Jami proposes that only the x-dimension needs to be tested to determine ON-SEGMENT. Show why the professor is wrong. [3.3]

c) Given a point $p_0 = (x_0, y_0)$, the right horizontal ray from p_0 is the set of points $\{p_i = (x_i, y_i) : x_i \geq x_0$ and $y_i = y_0\}$, that is, it is the set of points due right of p_0 along with p_0 itself. Show how to determine whether a given right horizontal ray from p_0 intersects a line segment p_1p_2 in $O(1)$ time by reducing the problem to that of determining whether two line segments intersect. [7]

d) Write down the pseudocode of Graham Scan algorithm to generate a convex hull from a given set of points. Show the following two cases (with diagram) [8]
i) include a point as a vertex of the convex hull and
ii) exclude a point from the vertex set of a convex hull.

3 a) Find the least cost hamiltonian cycle from the following edge weighted graph using branch and bound approach. [10]



b) Demonstrate the benefits of using *Most Constrained Variable*, *Least Constraining Value* and *Forward Checking* heuristics in backtracking with a suitable example. [6]

c) Analyse time complexity (expected matching time) of Rabin-Karp algorithm. [7.3]

4 a) Mention the features of online algorithms. Define the competitive ratio. [4]

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. Every 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? [3.3]

ii) Provide at least three different strategies for online algorithms and calculate the competitive ratio of each strategy. Justify the best competitive ratio. [8]

c) Define the concurrent instructions- parallel, spawn, sync. Write down the parallel algorithm to compute Fibonacci numbers. Specify the different threads and the interaction among the threads. [3 + 5]

5 a) Prove that the *Circuit-Satisfiability* problem is NP-complete. [10]

b) Show that *Vertex Cover* problem is polynomial time reducible to *Travelling Salesman* problem. [6]

c) Prepare a compressed trie structure from the following text (case-insensitive) to perform word matching. Also represent the compressed trie in a compact fashion using an array of words to reduce space complexity further. [7.3]
"*The bold bear became bored bearing the burden of its bland beauty*"

University of Dhaka
Department of Computer Science and Engineering
3rd Year 2nd Semester Final Examination, 2020
CSE 3204: Formal Language, Automata, and Computability

Full Marks: 70 **Time: 2 Hours**

Answer any three (3) of the following five (5) questions

1 a) Define Finite Automata. What is the difference between DFA and NFA in terms of final state? 2+2

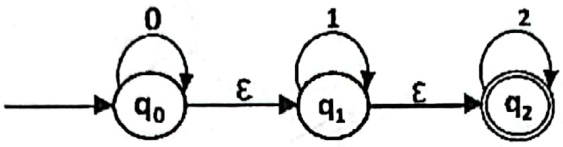
b) Build DFA for the following language: 4

$L = \{w \mid w$ *is a string with three consecutive 0's (not necessarily at the end)*$\}$

c) Construct the ε-NFA equivalent to the following regular expression: 4.33

$$(0 + \varepsilon)^* (00^*1)^* 1^*$$

d) Obtain a DFA equivalent to the ε-NFA given below: 6



e) Convert the following DFA into Regular Expression (Use State Elimination method). 5

	0	1
→ *p	s	p
q	p	s
r	r	q
s	q	r

2. a) Based on Pumping Lemma, mention the conditions for a language to be regular. 3.33

b) Prove that the following language is not regular: 5

$$L = \{0^i 1^j \mid i > j\}$$

c) What do you mean by the Yield of a parse tree? Explain with an example. 3

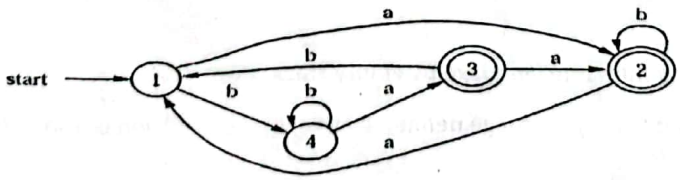
d) Design a Context-Free Grammar (CFG) for the following language: 6

$L = \{a^n b^{2n}$ where $n>=1\}$

e) Given the fact that the regular languages (RL) are closed under complementation, prove the following: 3+3

i. RLs are closed under intersection
ii. RLs are closed under set difference

3. a) Let M be the following DFA. 6



i. Write down four string accepted by M and the sequence of configurations that show this.
ii. Write down four strings not accepted by M.

b) Convert the following NFA in to a DFA: 4.33

	0	1
→p	{q, s}	{q}
*q	{r}	{q, r}
r	{s}	{p}
*s	∅	{p}

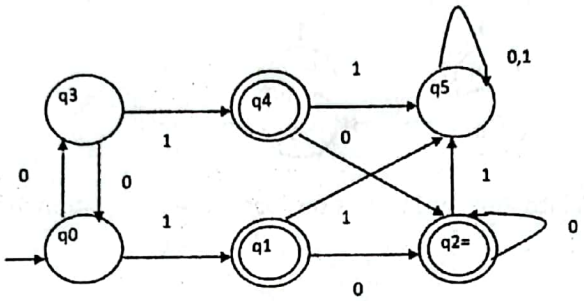
c) Write regular expressions for the following languages 5

i. The set of strings over {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -} which indicates a valid integer number. Example: 0, 1, 12340, -5 etc.

ii. The set of strings over {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -, .} which indicates a valid floating point number. Example: 0.2, .5, -2.3, 1 etc.

d) Design a Turing Machine (TM) to accept the language $L = \{a^n | n > 0$ and divisible by 2$\}$ 8

4. a) Given the DFA below: 7+ 4.33



i. Draw the table of distinguishabilities for this automaton.

ii. Construct the minimum state equivalent DFA.

b) For the following grammar:

$S \rightarrow$ 0A0 | 1B1 | BB

$A \rightarrow C$

$B \rightarrow S | A$

$C \rightarrow S | \varepsilon$

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

5. a) Design a PDA to accept each of the following languages. You may accept either by final state or empty stack, whichever is more convenient. 5

i. $\{0^n1^n \mid n \geq 1\}$

ii. The set of all strings of 0's and 1's such that no prefix has more 1's than 0's

iii. The set of all strings of 0's and 1's with an equal number of 0's and 1's

b) Convert the grammar 6

$S \rightarrow aAA$

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

to a PDA that accepts the same language by empty stack.

c) Inductively proof that "Every language defined by a regular expression is also defined by a finite automaton". 6.33

d) Given that $L_{0n1n} = \{0^n1^n \mid n \geq 0\}$ is not regular, use closure properties to prove that the language $\{0^n1^m2^{n-m} \mid n \geq m \geq 0\}$ is also not regular. 6

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Department of Computer Science and Engineering

3rd Year 2nd Semester B.Sc. Final Examination, 2020

~~CSE~~ STAT – 3205: Introduction to Probability and Statistics

Total Marks: 70 Time: 2 Hours

Answer any 3 (three) of the following 5 (five) questions

1 a) What do you mean by normal distribution? What are the parameters of a normal distribution? 4.33

b) A sample consists of the following data which specifies the "height" of 30 mango trees of a garden owned by Mr. Kalam. 10

61	69	73	76.2	78.5	82
63	71	73.5	76.5	79	83
64	71.5	74	77	79.2	84
64.5	72	74.5	77.5	80	85
65	72.5	76	78	81	87

I. Construct a frequency distribution by taking a suitable class interval.
II. Draw a histogram and describe the shape of the histogram.
III. Is there any outlier in the given distribution?
IV. What proportion of the trees are taller than 75?

c) State Tchebysheff's Theorem. What are the advantages of Tchebysheff's Theorem as compared to Empirical rule? 4

d) Scores on IQ tests have a bell-shaped distribution with mean μ=100 and standard deviation σ=10. Discuss what the Empirical Rule implies concerning individuals with IQ scores of 110, 120, and 130. 5

2 a) What do you understand by central tendency of data? Describe the relationship between mean and median depending on the shape of the distribution. 5.33

b) The following data are the heights of 20 students in a statistics class. 8

51	60	63	64	65	65	66	66	66	66
67	68	69	70	70	71	71	72	75	80

Draw the box plot for the measurements and find out the outliers, if any.

c) In the following table, a research physician recorded the temperatures of water (x) and the reduction in pulse rates (y) of the submerging faces of ten small children in cold water to control the abnormally rapid heartbeats. 10

x	68	65	70	62	60	55	68	65	69	63
y	2	5	1	10	9	13	10	3	4	6

I. Compute the correlation coefficient (r) between temperature of water (x) and reduction in pulse rate (y).
II. Write down the equation of the regression line for the given data.
III. Interpret the value of r in defining the direction and strength of the linear relationship between x and y.

3 a) 2 green, 4 red and 3 blue balls are in a box. Three of them are selected at random. 6

I. Consider the three events: A: 1st is red, B: 2nd is green and C: 3rd is blue. Now find $P(A \cap B \cap C)$.
II. Find the probability that at least two of those are red or at most one of those is green.

b) If events A and B are independent, show that $P(A \cap \overline{B}) = P(A).P(\overline{B})$ 4.33

c) Two fair dice are tossed. What is the probability that the sum of the number of dots shown on the upper faces is less than 11? What is the probability that the number of one upper face is double than the other upper face? 4

d) Use the definition of independent events to determine whether the following events from rolling a dice are independent or dependent. 4

I. The event of appearing odd numbers and the event of appearing 3 or 6.
II. The event of even numbers and the event of prime numbers.

e) A smoke-detector system uses two devices, A and B. If smoke is present, the probability that it will be detected by device A is .95; by device B is .98; and by both devices is .94. 5

I. If smoke is present, find the probability that the smoke will be detected by device A or device B or both devices.

II. Find the probability that the smoke will not be detected.

4 a) State the Law of Total Probability. 4.33

b) Three machines make parts of a factory. Machine 1 makes 50% of the parts, Machine 2 makes 30% of the parts and Machine 3 makes 20% of the parts. Of the parts Machine 1 makes 7% are defective, of the parts Machine 2 makes 15% are defective and of the parts Machine 3 makes 30% are defective. 8

I. A part is randomly selected; what is the probability that it is defective?

II. A part is randomly selected; what is the probability that it is defective given that Machine 1 made this part?

c) For a game, it has probability 0.25 of winning 10 points and probability 0.75 of winning no points. x is total points won in the game. Calculate the variance of x. 4

d) State Bayes' Rule. 2+5 = 7

Suppose that in an imaginary country, 25% of the people support party A, 38% of the people support party B, 17% support party C, and 20% support party D.
Let Q be a certain policy. We're given that 50% of the supporters of party A are in favor of Q, 40% of the supporters of party B are in favor of Q, 30% of the supporters of party C are in favor of Q, and 100% of the supporters of party D are in favor of Q.
If we draw a citizen from this imaginary country at random, what is the probability that the citizen supports Q?

5 a) What are the common characteristics that are exhibited by a binomial experiment? 3.33

b) A home security system is designed to have a 99% reliability rate. Suppose that nine homes equipped with this system experience an attempted burglary. Find the probabilities of these events: 5

I. At least one of the alarms is triggered (z table provided separately)

II. More than seven of the alarms are triggered

III. Eight or fewer alarms are triggered

c) Suppose a life insurance company insures the lives of 5000 men aged 42. If actuarial studies show the probability that any 42-year-old man will die in a given year to be .001, find the exact probability that the company will have to pay x = 4 claims during a given year. 5

d) A particular industrial product is shipped in lots of 20. Testing to determine whether an item is defective is costly; hence, the manufacturer samples production rather than using a 100% inspection plan. A sampling plan constructed to minimize the number of defectives shipped to customers calls for sampling five items from each lot and rejecting the lot if more than one defective is observed. (If the lot is rejected, each item in the lot is then tested.) If a lot contains four defectives, what is the probability that it will be accepted? 5

e) For a car traveling 30 miles per hour (mph), the distance required to brake to a stop is normally distributed with a mean of 50 feet and a standard deviation of 8 feet. Suppose you are traveling 30 mph in a residential area and a car moves abruptly into your path at a distance of 60 feet. 5

I. If you apply your brakes, what is the probability that you will brake to a stop within 40 feet or less?

II. If the only way to avoid a collision is to brake to a stop, what is the probability that you will avoid the collision?