L-3/T-2/CSE **Date: 22/03/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 301** (Mathematical Analysis for Computer Science)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Morpheus has one pill in his palm: it is either blue or red with equal probability. He puts another red pill in his palm (Now there are two pills in his palm) and randomly takes one out. If its color is red, what is the probability that the color of the other pill is also red? **(10)**

(b) Let X be a random (uniform) number x; $0 < x < 1$ and let $Y = X^2$. Find the covariance of X and Y. Also, specify if X and Y are positively or negatively correlated, or uncorrelated? **(10)**

(c) At a party n men take off their hats. The hats are then mixed up and each man randomly selects one. We say that a match occurs if a man selects his own hat. What is the probability of at most k matches? Assume that n is sufficiently large for the ease of calculation. **(15)**

2. (a) The number of traffic accidents on any given day is a Poisson random variable with mean 2, and these random variables for different days are independent. **(8)**

(i) What is the probability that there is a total of six accidents over two days?

(ii) Take some 5 days, for instance, SAT-WED this week. What is the probability that at least three of these five days each have exactly two accidents?

(b) A miner is trapped in a mine (M1) containing three doors. The first door (D1) leads to a tunnel that takes him to safety after 4 hours of travel. The second door (D2) leads to a tunnel that returns him to the mine after 2 hours of travel. However, the third door (D3) leads to another mine (M2) after 3 hours. Now, the second mine (M2) has two other doors. First one (D4) leads to safety after 1 hour of travel. But the second door (D5) leads to a tunnel that returns him to the same mine (M2) after 2 hours of travel. Assume that the miner is at all times equally likely to choose any one of the doors (in M1, the miner can choose between D1, D2, D3, and in M2, the miner can choose between D3, D4, D5). What is the expected duration of time until the miner reaches safety? **(15)**

Contd P/2

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Contd... Q. No. 2

(c) Let N be a Poisson random variable with mean λ. Given N, let X be another binomial random variable with parameters N and p (p being the probability).

Let $Y = N - X$ be a random variable and given that Y is non-negative. Prove that Y is a Poisson random variable with mean $\lambda(1 - p)$. **(12)**

3. (a) Three players play a game in which they take turns and draw cards from an ordinary deck of 52 cards, successively, at random, and with replacement. Player-I draws cards until an ace is drawn. Then Player-II draws cards until a diamond is drawn. Next, Player-III draws cards until a face card is drawn. At that point, the deck is returned to Player-I and the game continues. **(15)**

i. Draw a state diagram with transition probability identifying the relevant states.

ii. Determine the long-term proportion of cards drawn by each player out of the total number of cards drawn by the three players.

(There are 4 aces, 13 diamond cards, and 12 face cards in a standard deck).

(b) Consider a population of individuals each of whom possesses two genes that can be either type A or type a. Suppose that in outward appearance type A is dominant and type a is recessive. (That is, an individual will have only the characteristics of the recessive gene if its pair is aa.) Suppose that the population has stabilized, and the percentages of individuals having respective gene pairs AA, aa, and Aa are p, q, and r. Call an individual dominant or recessive depending on the outward characteristics it exhibits. Let S_{11} denote the probability that an offspring of two dominant parents will be recessive; and let S_{10} denote the probability that the offspring of one dominant and one recessive parent will be recessive. Compute S_{11} and S_{10} in terms of p, q, r to show that $S_{11} = S_{10}^2$. **(10)**

(c) Define counting process and illustrate its properties. When do we consider a counting process as a Poisson process? **(6)**

(d) Prove that Exponential distribution is memoryless. **(4)**

4. (a) Customers arrive at a bank at a Poisson rate λ. Suppose three customers arrived during the first hour. What is the probability that exactly two customers arrived during the first 20 minutes? **(8)**

(b) Consider a shoe shop consisting of two chairs. Suppose that an entering customer first will go to chair 1. When his work is completed in chair 1, he will go either to chair 2 if that chair is empty or else wait in chair 1 until chair 2 becomes empty. Suppose that a potential customer will enter this shop as long as chair 1 is empty. (Thus, for instance, a potential customer might enter even if there is a customer in chair 2.)

Contd P/3

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Contd... Q. No. 4(b)

Suppose that potential customers arrive in accordance with a Poisson process at rate λ, and that the service times for the two chairs are independent and have respective exponential rates of μ_1 and μ_2. **(15)**

i. Draw a state diagram of the system and write down balance equations for each state.

ii. What proportion of potential customers enters the system?

iii. What is the mean number of customers in the system?

iv. What is the average amount of time that an entering customer spends in the system?

v. What proportion of entering customers are blockers?

(c) Consider a network of three stations with a single server at each station. Customers arrive at stations 1, 2, 3 in accordance with Poisson processes having respective rates 6, 8 and 8. The service times at the three stations are exponential with respective rates 12, 60 and 120. A customer completing service at station 1 is equally likely to (i) go to station 2, (ii) go to station 3, or (iii) leave the system. A customer departing service at station 2 always goes to station 3. A departure from service at station 3 is equally likely to either go to station 2 or leave the system. **(12)**

i. What is the probability that at a certain time, station 1 is empty, there are 2 customers in station 2, and 1 customer in station 3.

ii. What is the average number of customers in the system (consisting of all three stations)?

iii. What is the average time a customer spends in the system?

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) E(n) denotes the maximum number of regions that can be formed on a plane by drawing n intersecting ellipses. **(10+3=13)**

i. Find the recurrence formula for E(n).

ii. Derive a closed form of E(n).

(b) Given that, **(12)**

$$x^4 = x^{\underline{4}} + 6\,x^{\underline{3}} + 7\,x^{\underline{2}} + + x^{\underline{1}}$$

and,

$$\left\{ {n \atop k} \right\} = \left\{ {n-1 \atop k-1} \right\} + k \left\{ {n-1 \atop k} \right\}$$

Contd P/4

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Contd... Q. No. 5(b)

Evaluate the following sum,

$$S = \sum_{0 \le k \le n} k^5$$

(c) Let $f(x)$ be any continuous, monotonically strictly increasing function with the property that, **(10)**

If $f(x)$ is an integer, then x is an integer.

Prove that,

$$\lceil f(\lceil x \rceil) \rceil = \lceil f(x) \rceil$$

6. (a) We have an ant and a worm on the tip of two different horizontal rubber strings. Both strings are of length 100 cm. The ant moves 1 cm per second and the worm moves 2 cm per second. The rubber string of the ant is stretched 100cm each second. On the other hand, the rubber string of the worm is stretched 100 cm each 0.5 second. During the stretching operation the ant and the worm maintain their relative positions on their respective strings. **(15)**

Prove or disprove that, after n seconds (where $n \geq 1$ and $n \in \mathbb{N}$),

(The fraction travelled by worm – the fraction travelled by ant) < 2%

(b) Prove that, there are at least n – 1 composite integers between n! and n! + n, where n is a positive integer. **(10)**

(c) Prove the recurrence of the Eulerian Numbers stated below **(10)**

$$\left\langle {n \atop k} \right\rangle = (k+1)\left\langle {n-1 \atop k} \right\rangle + (n-k)\left\langle {n-1 \atop k-1} \right\rangle$$

7. (a) A Double Tower of Hanoi contains 2n disks of n different sizes, two of each size. We are required to move only one disk at a time, without putting a larger one over a smaller one. **(5+10=15)**

i. How many moves does it take to transfer a double tower from one peg to another, if disks of equal size are indistinguishable from each other?

ii. What if we are required to reproduce the original top-to-bottom order of all the equal-size disks in the final arrangement? How many moves does it take?

(b) Prove that, for any m, $k \in \mathbb{N}$ **(10)**

$$\phi(m^k) = \phi(m) \cdot m^{k-1}$$

Where ϕ is the Euler's totient function.

Contd P/5

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Contd... Q. No. 7

(c) Evaluate B_1 and B_2 **(5+5=10)**

$$B_1 = \sum_{k=0}^{n} 2^k \binom{n}{k}$$

$$B_2 = \sum_{k=0}^{n} 3^{k-n} \binom{n}{k}$$

8. (a) Evaluate the following sum, **(13)**

$$S = \sum_{1 \le j \le k < n} \frac{1}{j(k+1)(k+2)}$$

(b) How many integers n are there such that, **(12)**

$\left\lfloor \sqrt[3]{n} \right\rfloor$ divides n and $1 \le n \le 2000$?

(c) Compute the value of 7^{10010} mod 11. **(10)**

L-3/T-2/CSE **Date: 18/04/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 313** (Operating Systems)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Write down the steps of booting a computer. **(8)**

(b) Consider the code written in C shown in the following figure. Here `fork()` is an UNIX system call that creates a child process identical to the parent. Executing this code will generate a process tree. Each of the created processes will have its own copy of variable *i*. Your task is to draw this process tree. At each node of the tree, you have to mention the starting value of *i* for the corresponding process. Consider that the root process is called P0. **(10)**

```
int i=0;
int main(){
        for(;i<3;i++){
                fork();
        }
        return 0;
}
```

(c) Write down the steps in making a system call. **(10)**

(d) What are the advantages of hybrid implementation of threads? **(7)**

2. (a) State the four conditions of resource deadlock. **(6)**

(b) State the problem definition of the classical Dining Philosophers problem. Show that the problem meets all the four conditions for resource deadlock stated in 2 (a). **(12)**

(c) A solution to the Dining Philosophers problem is given in Figure for Q2(c). **(12)**

(i) Suppose that in the `put-forks(i)` function, variable `state[i]` was set to `THINKING` **after** the two calls to test, rather than before. How would this change affect the solution? Explain with an example.

(ii) Suppose that in the `test(i)` function, **`up`**`(&s[i])` is placed outside the "if" condition. How would this change affect the solution?

Contd P/2

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Contd... Q. No.2

(d) Explain the race-condition that exists in the following solution to the producer-consumer problem. **(5)**

```
#define N = 100
int count = 0;
void producer (void) {
   int item;
   while (TRUE){
      item = produce();
      if (count == N) sleep();
      inset(item);
      count = count + 1;
      if (count == 1)
          wakeup(consumer);
}}
```

```
void consumer (void) {
int item;
while (TRUE){
    if (count == 0) sleep();
    item = remove-item();
    count = count - 1;
    if (count == N-1)
       wakeup(producer);
    consume(item);
}}
```

3. (a) A system has four processes and five allocatable resources. The current allocation and maximum needs are as follows: **(10)**

	Allocated	Maximum	Available
Process A	1 0 2 1 1	1 1 2 1 3	0 0 x 1 1
Process B	2 0 1 1 0	2 2 2 1 0	
Process C	1 1 0 1 0	2 1 3 1 0	
Process D	1 1 1 1 0	1 1 2 2 1	

What is the smallest value of x for which this is a safe state? Show the intermediate steps.

(b) What is the difference between livelock and starvation? **(5)**

(c) Draw the resource graph for the following scenario where A, B, C, D, and E denote processes and 1, 2, 3, 4, and 5 denote resource types. There exists only one resource of each type. Show the steps of the execution of the deadlock detection algorithm on the constructed graph starting from node B. **(20)**

(i) Process A holds 1 and 3, wants 2
(ii) Process B holds 4, wants 3 and 5
(iii) Process C holds nothing, wants 2
(iv) Process D holds nothing, wants 2
(v) Process E holds 5 and wants 1

4. (a) Discuss the difference between compute-bound and I/O bound process with figures. **(6)**

(b) Consider the following workload: **(24)**

Process	Priority	Duration (sec)	Arrival Time (sec)
P1	3	70	40
P2	1	40	0
P3	1	100	10
P4	2	50	70

Contd P/3

CSE 313

Contd... Q. No.4(b)

Draw the Gantt chart and calculate the average turnaround time for each of the following scheduling algorithms:

(i) Non-preemptive Shortest Job First

(ii) Round Robin with quantum 30 sec. Consider the processes enter FIFO queue according to their approval times.

(iii) Priority Scheduling. Within the same priority class, schedule according to the scheduling algorithm mentioned in (ii).

(c) Write down the goals of scheduling algorithms for Batch Systems. **(5)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Unless otherwise specified, 1 k = 2^{10}, 1 M =2^{10}, 1 G =2^{30}.

5. (a) In 64-bit systems, 48 bit addressing is usually used. Calculate the amount of space needed (in GB) for a single-level page table for 48 bit addressing if the page size is 4 kB and each page table entry takes 4 bytes. Discuss the feasibility of such a page table and mention two (2) better alternatives. **(6+4=10)**

(b) Describe the advantages and disadvantages of memory-mapped I/O. **(10)**

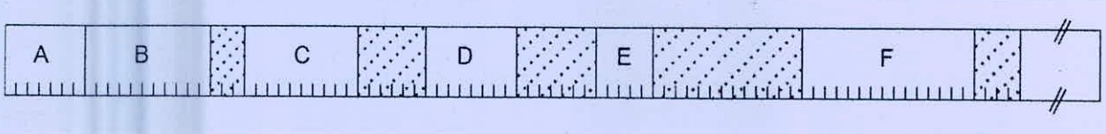
(c) Draw an omega switching network for 8 CPUs and 8 memory modules. Determine whether the following requests can be processed in parallel in this omega switching network and explain the reason. **(7+8=15)**

Request from CPU 000 to Memory 111 and

Request from CPU 110 to Memory 100

6. (a) The i-node of a Unix-like file system has 12 direct, one single-indirect and one double-indirect pointers. The disk block size is 4 kB and the disk block address is 32-bits long. Calculate the maximum possible file size for this file system. (Note that a single-indirect pointer points to a block of pointers that then point to blocks of the file's data. A double-indirect pointer points to a block of pointers that point to other blocks of the pointers that then point to blocks of the file's data.) **(10)**

(b) In the snapshot of memory given below, the dotted areas indicate holes and A, B, C, D, E, F are processes currently in memory. Create a linked list of processes and holes for swapping, assuming that there is no virtual memory. **(5+5=10)**



Contd P/4

CSE 313

Contd... Q. No.6(b)

A new process named G has to be allocated in memory now. The size of G is 4 allocation units. Mention the hole where G will be allocated if we follow:

(i) First-fit

(ii) Best-fit

(c) Define stable storage and mention the assumptions associated with it. Describe the three (3) basic operations a stable storage ensure. **(6+9=15)**

7. (a) Define precise interrupt and mention its four (4) properties. Describe the disadvantages of precise interrupts. **(5+5=10)**

(b) Mention the three (3) most essential properties of files. Explain how contiguous allocation of files may create both internal and external fragmentation in disk. **(3+7=10)**

(c) Mention the three key characteristics of a NUMA machine. In a directory-based NUMA multiprocessor having 1024 nodes, each memory address contains 48 bits. Each node consists of one CPU and 4 GB of RAM connected to the CPU via a local bus. Each cache line is 128 bytes long. The memory is statically allocated among the nodes. Calculate the directory overhead in percentage with respect to memory and discuss the feasibility of this system. **(3+12=15)**

8. (a) In a hypothetical machine, there are a total of 8 physical page frames. **(10)**

Page Table Index	Time of Last Use (t)	Referenced Bit	Modified Bit
0	214	1	1
1	381	0	1
2	402	1	0
3	289	1	1
4	409	0	0
5	160	1	1
6	315	1	0
7	387	0	1

At t = 430 and t = 440, two page faults occur. Using working set page replacement algorithm (with execution time approximation), identify the page frames that will be evicted. Assume the age threshold (τ) to be 50. Also assume that the clock interrupt to clear referenced bit last occurred at t = 425, and this interrupt occurs at 20 units time interval.

(b) Describe one (1) major advantage and one (1) major disadvantage of DMA. Briefly explain the major functions of device independent I/O software. **(6+14=20)**

(c) Write the full forms of the following abbreviations: **(5)**

NFTS, SMP, ECC, MBR, UDF

```
#define N           5                   /* number of philosophers */
#define LEFT        (i+N-1)%N           /* number of i's left neighbor */
#define RIGHT       (i+1)%N             /* number of i's right neighbor */
#define THINKING    0                   /* philosopher is thinking */
#define HUNGRY      1                   /* philosopher is trying to get forks */
#define EATING      2                   /* philosopher is eating */

typedef int semaphore;                  /* semaphores are a special kind of int */
int state[N];                           /* array to keep track of everyone's state */
semaphore mutex = 1;                    /* mutual exclusion for critical regions */
semaphore s[N];                         /* one semaphore per philosopher */

void philosopher(int i)                 /* i: philosopher number, from 0 to N-1 */
{
    while (TRUE) {                      /* repeat forever */
        think();                        /* philosopher is thinking */
        take_forks(i);                  /* acquire two forks or block */
        eat();                          /* yum-yum, spaghetti */
        put_forks(i);                   /* put both forks back on table */
    }
}

void take_forks(int i)                  /* i: philosopher number, from 0 to N-1 */
{
    down(&mutex);                       /* enter critical region */
    state[i] = HUNGRY;                  /* record fact that philosopher i is hungry */
    test(i);                            /* try to acquire 2 forks */
    up(&mutex);                         /* exit critical region */
    down(&s[i]);                        /* block if forks were not acquired */
}

void put_forks(i)                       /* i: philosopher number, from 0 to N-1 */
{
    down(&mutex);                       /* enter critical region */
    state[i] = THINKING;                /* philosopher has finished eating */
    test(LEFT);                         /* see if left neighbor can now eat */
    test(RIGHT);                        /* see if right neighbor can now eat */
    up(&mutex);                         /* exit critical region */
}

void test(i) /* i: philosopher number, from 0 to N-1 */
{
    if (state[i] == HUNGRY && state[LEFT] != EATING && state[RIGHT] != EATING) {
        state[i] = EATING;
        up(&s[i]);
    }
}
```

Figure for Q 2(c)

L-3/T-2/CSE **Date : 28/03/2020**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub : **CSE 317** (Artificial Intelligence)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Why would evolution tend to result in systems that act rationally? What goals are designed to achieve for such systems? **(15)**

   (b) What is Turing Test in the context of artificial intelligence? Explain what kind of capacities computer would need to possess for passing Turing test. **(20)**

2. (a) Define in your own words the following terms: agent, agent program, rationality and autonomy. **(10)**

   (b) Write agent programs (in pseudocode form) for the goal-based and utility-based agents. **(15)**

   (c) Discuss various parameters used for measuring problem-solving performance of search algorithms. **(10)**

3. (a) What are the main bottlenecks of depth first search and depth limited search algorithm? Using an appropriate example, explain how IDS (Iterative Deepening Search) algorithm solves those problems. **(13)**

   (b) What is the main pitfall of greedy algorithms? Discuss this pitfall in detail. Explain how an evolutionary algorithm can solve it. What evolutionary operator is more suitable for avoiding such a pitfall? Justify your answer using an appropriate example? **(22)**

4. (a) Explain why it is a good heuristic to choose the variable that is most constrained but the value that is least constraining in a CSP search. Discuss AC-3 algorithm with the help of its pseudo code. What is the worst-case complexity of running AC-3? **(17)**

   (b) Describe how the minimax and alpha-beta algorithms are to be changed for two-player, non-zero-sum games in which each player has a distinct utility function and both utility functions are known to both players. If there are no constraints on the two terminal utilities, is it possible for any node to be pruned by alpha-beta? **(18)**

Contd P/2

CSE 317

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Suppose two pathological tests, A and B, can identify the presence of a virus in a person's body. If the virus is present, Test A is 95% effective in recognizing it. But the false positive (i.e. recognizing the virus if it is absent) rate of Test A is 10%. On the other hand, Test B is 90% effective in recognizing the virus if it is present, but it has a false positive rate of 5%. You can assume that the tests are independent of each other. Say that a person is tested for a virus using only one of the tests, and that test comes back positive for carrying the virus. If the virus is carried by 0.1% of all people, calculate the appropriate probabilities to determine which test returning positive is more indicative of someone really carrying the virus. **(15)**

(b) Calculate P(W | dry) given the probability distributions in the **Tables for Q. 5(b).**

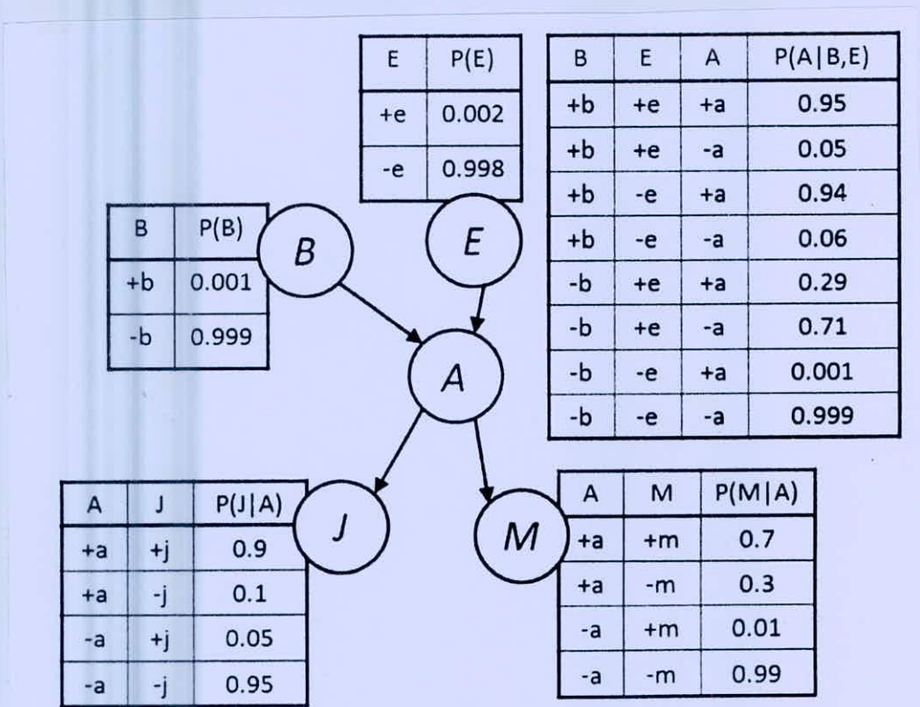
W	P(W)
sun	0.85
rain	0.15

D	W	P(D | W)
wet	sun	0.1
dry	sun	0.9
wet	rain	0.75
wet	rain	0.25

Tables for Q. 5(b)

(c) What are the problems of Rejection Sampling in Bayesian networks? How does Likelihood Weighting solve them? Explain with an example. **(10)**

6. (a) Calculate P(B | –e, +j) from the Bayesian network shown in the **Figure for Q.6**. **(15)**



E	P(E)
+e	0.002
-e	0.998

B	P(B)
+b	0.001
-b	0.999

B	E	A	P(A|B,E)
+b	+e	+a	0.95
+b	+e	-a	0.05
+b	-e	+a	0.94
+b	-e	-a	0.06
-b	+e	+a	0.29
-b	+e	-a	0.71
-b	-e	+a	0.001
-b	-e	-a	0.999

A	J	P(J|A)
+a	+j	0.9
+a	-j	0.1
-a	+j	0.05
-a	-j	0.95

A	M	P(M|A)
+a	+m	0.7
+a	-m	0.3
-a	+m	0.01
-a	-m	0.99

Figure for Q.6

Contd P/3

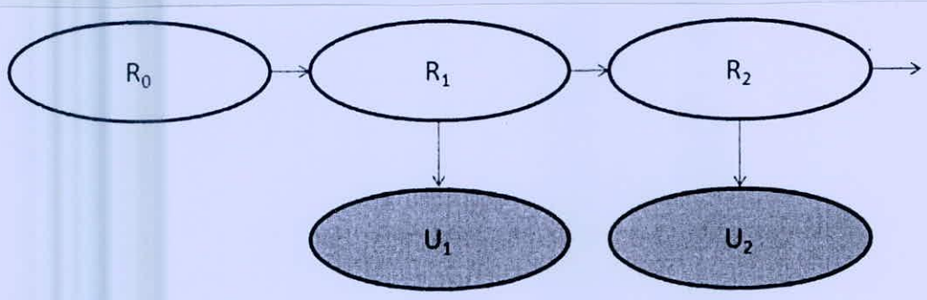
Contd...Q. No. 6

(b) Calculate P(+e | +m, +j) from the Bayesian network shown in the **Figure for Q. 6**, using the method of inference by Variable Elimination. **(20)**

7. (a) Mathematically express the conditions of stationary distribution for a first order Markov chain. If any state at time t, X_t can attain one of only two values, x_1 and x_2, show that $P(X_\infty)$ depends on transition probability but is independent of initial probability distribution. **(15)**

(b) Consider the Hidden Markov Model shown in the **Figure for Q. 7(b).** Calculate the belief state at time step = 2, given the following information. Also, justify the statement, "Uncertainty accumulates as time passes and decreases as we get observations", from your calculation. **(20)**

- Initial belief state: $B(R_0) = 0.6$ when $R_0 = +r$ and 0.4 when $R_0 = -r$.
- Observation at time step = 1: $U_1 = +u$
- Observation at time step = 2: $U_2 = -u$



R_t	R_{t+1}	$P(R_{t+1} \mid R_t)$
+r	+r	0.7
+r	-r	0.3
-r	+r	0.3
-r	-r	0.7

R_t	U_t	$P(U_t \mid R_t)$
+r	+u	0.9
+r	-u	0.1
-r	+u	0.2
-r	-u	0.8

Figure for Q.7(b)

8. (a) Consider the following dataset, shown in the **Table for Q. 8(a)**, comprised of three binary input attributes (A_1, A_2, A_3) and one binary output (y). **(12+3=15)**

A_1	A_2	A_3	y
1	0	0	0
1	0	1	0
0	1	0	0
1	1	1	1
1	1	0	1

Table for Q.8(a)

(i) Construct a decision tree based on the information gain heuristic for these data. Show the calculations in detail.

(ii) How will your decision tree classify the instance (0, 1, 1)?

(b) Draw the Bayesian network topology of a Naive Bayes classifier assuming there are three features. What are the parameters that need to be learnt in this model? **(10)**

(c) Write short notes on the following. **(5+5=10)**

(i) Supervised Learning

(ii) Overfitting

L-3/T-2/CSE **Date: 10/04/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 321** (Computer Networks)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) How many different Class B networks are possible? Show necessary calculations. How many hosts are possible per network? **(8)**

   (b) Distinguish between NAT and PAT. Which one is preferred? Why? **(10)**

   (c) Compare circuit switching and datagram with respect to speed, overhead and utilization factors. **(7)**

   (d) What is the main difference between distance vector and link state routing protocols? Which one is preferred for large networks? Why? **(10)**

2. (a) How can you prevent count-to-infinity problem in distance vector routing algorithm? **(5)**

   (b) Explain the purposes of Area Border Router (ABR) and Autonomous System Boundary Router (ASBR) in multi-area OSPF with necessary topology diagram. **(10)**

   (c) What is the main objective of Mobile IP? How is packet forwarded when the mobile device is in a foreign network? Explain with necessary topology diagram. **(10)**

   (d) Compare MANET, VANET and FANET. Write down few applications of each one. **(10)**

3. (a) What is the main objective of TCP 3-way connection establishment phase? Is it possible to exploit this to launch attacks? How? **(10)**

   (b) What is the purpose of using DHCP relay agent? Where should you place this agent in a network? Show necessary diagram. **(12)**

   (c) Consider a scenario where the TCP receiver's buffer size is 4KB. The receiver now sends a packet with ACK = 1, sequence number = 4096 and window size = 2048. What does it mean to the sender? What will happen next? **(13)**

4. (a) Compare POP3 and IMAP protocols. **(10)**

   (b) Consider that a user from cse.buet.ac.bd domain wants to resolve cs.mit.edu. Show necessary diagram if such DNS resolution is done through iterative approach. Assume that there is no DNS caching anywhere in the path. **(12)**

   (c) Show (with necessary diagram) where the HTTP Proxy server is placed in a network. What can the network admin monitor through this server? Explain. **(13)**

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) "Basic Bit-map Collision-free MAC protocol is always better than ALOHA, CSMA, or even Adaptive Tree Walk Protocol." – do you agree with it?
If you agree, you need to justify why this should happen. If you disagree, you need to explain reason(s) behind the disagreement. Show necessary derivations, as required. **(20)**

(b) A company has several departments and it needs to establish different LANs for different departments. The company expects to make sure that a machine (even while being in Promiscuous mode) in one department cannot capture packets generated from a machine in another department.
To do so, the company connects machines in the same department together in a single LAN and has machines in different departments under different LANs. Then, the company connects the different LANs using hubs. Alongside, the company makes sure that there exists single spanning tree architecture of the whole network so that there arises no loop in operation even after having parallel hubs.
Now, you need to determine whether the above design and deployment will work as expected. If so, then you need to elaborate how the above design and deployment will work as expected. If you think otherwise, then you need to explain why the above design and deployment will not work as expected. **(15)**

6. (a) A network engineer is given a task of designing a DLL protocol for data communication of a reliable application. In this regard, he is explicitly asked to perform the task of error detection and robust framing in his developed custom DLL protocol.
To do so, he has come up with the following DLL protocol –
   1) Putting character count at the beginning of a frame for the purpose of framing,
   2) Introducing r parity bits for m data bits maintaining the condition that $(m + r + 1) <= 2^r$ along with arranging x consecutive codewords in a matrix (one codeword in a row) and transmitting one column at a time to handle a maximum burst error of $3x$ bits, and
   3) Sliding window protocol using selective repeat.

Now, you need to pinpoint whether the above protocol will operate correctly only from the perspective of performing the task of error detection and robust framing. Justify your answer. **(20)**

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Contd... Q. No. 6

(b) In a fiber optic network, a network engineer enables the notion of different inter-frame spacing such as SIFS, EIFS, PIFS, and DIFS to lessen the extent of interference. Do you think that such a mechanism can result in lessening the extent of interference? If so, then elaborate how this can result in lessening the extent of interference with all necessary details and designs.

If you do not think so, then you need to elaborate why this cannot result in lessening the extent of interference. Besides, in such a case, you need to present an alternate design that can result in lessening the extent of interference. **(15)**

7. (a) "GSM adopts Time Division Multiplexing in addition to having the notion of multiframes." – validate or refute this statement with necessary explanations and figures. **(20)**

(b) OSI and TCP/IP reference models are two widely known reference models in the domain of computer networking. These models have different numbers of layers each with different operations.

In our real-life computer networks, which reference model we generally use? Elaborate the generally-used reference model and its layers. **(15)**

8. (a) Distinguish the following with necessary elaborations and figures. **(20)**

i) QPSK versus QAM, and

ii) GEO satellite versus LEO satellite

(b) How can an Ethernet network experience the following? Explain their underlying mechanisms with necessary diagram(s). **(15)**

i) Binary exponential backoff, and

ii) Exposed station problem.

L-3/T-2/CSE **Date: 02/04/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub: **CSE 325** (Information System Design)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Describe briefly how Unified Modeling Language is used for visualizing, specifying, constructing and documenting. **(10)**

(b) Consider a microwave oven that uses microwave technology for the purpose of heating foods. If you want to heat food items you must enter the food item in the heating chamber and then set the timer using the key pad in the front panel located on the door of micro wave oven. You have to press the start button to start heating. The oven will give a beep signal when the heating is complete. You can stop heating by pressing the Stop button any time. Do the following for the micro wave oven system: **(6+12+7=25)**

(i) Draw the use case diagram by identifying the actors and use cases for this micro wave oven system.

(ii) Write down the detailed use case scenarios related to setting the timer and heating.

(iii) Write down the acceptance test cases for these use cases as well.

2. (a) Explain the concept for Class and Instance with necessary examples. **(7)**

(b) An account holder of Sonali Bank can withdraw an amount from his or her account through debit card with the help of ATM (Automatic Teller Machine) booth. The account holder must insert the card into the machine and then after authorization through PIN (Personal Identification Number) the amount of money to be withdrawn will be entered through keypad of the ATM machine. The requested amount will be checked against the balance of the bank account and the amount will be dispensed from the machine if there is available balance to satisfy the request. There must be a notification to the registered phone number to the account holder from central server of the bank. Finally, the ATM machine ejects the card after the transactions. Show the steps of identifying the classes from this use case scenario. **(20)**

(c) What do you mean by Software Process and Software Process Model? How do you describe a process? Why is Software Process so important for software development? **(8)**

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3. (a) Define Waterfall Model for Software Engineering Process. Explain the problems of Waterfall Model with necessary examples. **(6)**

(b) Compare the concept of incremental delivery in the process model with the Bohem's spiral model. **(7)**

(c) "Rational Unified Process can be configured to Waterfall Model" – Justify. **(7)**

(d) Prescribe appropriate process model for the following cases with proper reasoning: **(15)**

(i) Development of an POS (Point of Sale) ERP for computer accessories shops of Bangladesh.

(ii) A war Simulator for Bangladesh Army.

(iii) Development of Insulin Injection System for Intensive Care Unit as an outsourcing project of an US based biomedical engineering company.

4. (a) Write short notes on the following in the context of Extreme Programming: Pair Programming, Testing, Change Adoption. **(12)**

(b) What are the advantages of Distributed Version Control model of source control over Copy Modify Merge Model? Consider a scenario where Andy, Bobby, Cally clone the remote repository locally. The work locally on a certain File F and commit locally to their repositories. What will happen if Cally wants to Push their change first, then Andy tries to push his change and finally Bobby tries to Push her change. Show the steps for conflict resolution in this scenario. **(15)**

(c) Define 5 levels of CMMI with process characteristics, behaviors and process areas. **(8)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) If you want to make a tour with a tourism operator, you have to select a package from their website. Each package presents a combination of site visit, hotels, food, activities. Depending on these components and number of days to spend, the price of the packages varies. A package can be customized for a group of tourists with size larger than 10 and price adjustment is made accordingly. The customer has to book a package with partial advance payment. The remaining payment is made prior to the tour to confirm all the components of the tour. If any activity is not available, the refund is made later.

Draw a BPMN diagram to design the portal of the tourism operator. **(15)**

(b) Draw state diagram for a customer booking considering the scenario described for Q. 5a. **(12)**

(c) How will you define Message Queue used while deploying software application? What are the benefits of using it? **(8)**

Contd P/3

CSE 325

6. In a Payroll Management System, the salary of every company is managed. The salary comprises several components such as basic, house rent (a certain percentage of basic), medical allowance, etc. and deductible components like PF contribution, insurance subscription, etc. If an employee takes loan, the repayment is adjusted. At the beginning of a financial year, basic of all employees are incremented following a rule which defines the percentage of increment. However, each salary grade has a maximum bound. The increment will be applicable within this bound.

   Based on the scenario discussed above, answer to the following questions a) and b):

   (a) Draw the ER diagram of this system. **(15)**

   (b) Draw Sequence diagram for the bulk salary increment usecase. **(12)**

   (c) Why Indexes are used in Database? When should we avoid them? **(8)**

7. (a) Create a Collaboration diagram for the following scenario descriptions for a Gym Center's customer management system.

   When members join the Gym Center, they pay a fee for a certain length of time (in months). The club wants to send SMS to members, asking them to renew their memberships one week before their memberships expire. About one-third of the members do not renew their memberships. These members are sent follow-up surveys to complete about why they decided not to renew so that the Center can learn how to increase retention. If the member did not renew because of cost, a special discount is offered to that customer. Typically, 12% of accounts are reactivated because of this offer. **(15)**

   (b) What are the questions to be considered about a caching technology to be used in your software deployment? Discuss Write-back caching mechanism. **(12)**

   (c) How should the requirements be validated? **(8)**

8. (a) What are the limitations of monolithic architecture? Discuss the features of microservice and explain how they overcome the limitations. Draw an ideal deployment architecture for BIIS system if it is developed using microservice architecture. **(16)**

   (b) Write down one nonfunctional requirement of each type for the website of a stock exchange in Bangladesh. There are 6 types of requirements. **(9)**

   (c) Briefly discuss 5 types of load balancing algorithms. **(10)**
