L-3/T-2/CSE Date: 30/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **NINE** questions in this section. Answer any **SEVEN** questions.

1. A radar system is designed such that the probability of detecting the presence of an aircraft in its range is 0.98. However, if no aircraft is present in its range it still reports (falsely) that an aircraft is present with a probability of 0.05. At any time, the probability that an aircraft is present within the range of the radar is 0.07. **(10+5=15)**

   (a) What is the probability that no aircraft is present in the range of the radar given that an aircraft is detected?

   (b) If two such radar systems are set up that operate independently, and if an aircraft enters the area, what is the probability that neither of the radar systems detects it?

2. Prove that when the number of trials n in a binomial distribution is large and the probability of success p is very small, the binomial distribution can be approximated by a Poisson distribution with mean $\lambda = np$. **(15)**

3. (a) Derive the moment generating function of the normal distribution with parameter μ and σ^2, and calculate its first two moments. **(10+5=15)**

   (b) State and explain the central limit theorem.

4. (a) Prove the law of total expectation for discrete random variables. **(5+10=15)**

   (b) A bus arrives at the 1st station with zero passengers on board. At the 1st station, 0, 1, or 2 passengers could get on the bus with probabilities 0.3, 0.5, 0.2, respectively. At every station, each passenger could get off the bus with a probability of 0.1. Find the expected value of the number of passengers that get off the bus at the 2nd station.

5. A professor frequently gives exams to her students. She can give three possible types of exams, and her class is graded as either having done well or badly. Let p_i denote the probability that the class does well on a type i exam, and suppose that $p_1 = 0.3$, $p_2 = 0.6$, and $p_3 = 0.9$. If the class does well on an exam, then the next exam is equally likely to be any of the three types. If the class does badly, then the next exam is always type 1. **(8+7=15)**

   (a) What proportion of exams are of type i, $i = 1, 2, 3$ assuming the process has run for a long time?

   (b) If the first exam is of type 3, then calculate the probability that there is no type 1 exam in the first 10 exams.

Contd P/2

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6. Suppose, a data centre has 100 storage devices. The designer of the data center assumed that the time to failure of the storage devices is exponentially distributed with mean two years, that is, $\lambda = 1/2$. (15)

   (a) What is the probability that the first failure occurs after 1 year?

   (b) What is the probability that there are exactly 10 failures in the 13th month?

   (c) Do you think modeling failure of storage devices using an exponential distribution is reasonable?

7. (a) Provide the instantaneous transition rates of a linear growth process (birth-death process) with immigration. (5+10=15)

   (b) Derive Kolmogorov's forward and backward equations for a general continuous-time Markov chain using Chapman-Kolmogorov equations i.e. $P_{ij}(t+s) = \sum_{k=0}^{\infty} P_{ik}(t)P_{kj}(s)$. Now show that $\boldsymbol{P}(t) = \boldsymbol{P}(0)e^{\boldsymbol{R}t}$ where $\boldsymbol{P}(t)$ is the transition probability matrix and $\boldsymbol{R}$ is the instantaneous transition rate matrix.

8. Derive the balance equations for a single-server exponential queuing system having finite capacity. Solve the equations to obtain the expression for the limiting probability that there are n customers in the system P_n and the average number of customers in the system L. (5+10=15)

9. Consider a system of two servers where customers from outside the system arrive at server 1 at a Poisson rate 4 and at server 2 at a Poisson rate 5. The service rates of 1 and 2 are 8 and 10, respectively. A customer upon completion of service at server 1 is equally likely to go to server 2 or to leave the system; whereas a departure from server 2 will go 25 percent of the time to server 1 and will depart the system otherwise. Determine the limiting probabilities (n customers at server 1 and m customers at server 2), the average number of customers L, and the average amount of time spent by customers in the system W. It is known that the limiting probabilities of an M/M/1 queue is given by $\left(\frac{\lambda}{\mu}\right)^n\left(1-\frac{\lambda}{\mu}\right)$. (15)

Contd P/3

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SECTION – B

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

You may use any formula from the supplementary materials without proving them.

10. (a) Find all positive integers n such that $J(n)=\frac{1}{2}n$, where $J(n)$ denotes the survivor's number in the *Josephus problem* with n persons. **(10)**

(b) What is the maximum number of regions defined by n planes in a 3-dimensional space? You must systematically derive the closed form as a function of n and provide necessary justifications. **(10)**

(c) Solve the following recurrence relation defined on the set of non-negative integers: **(15)**

$$a_n=\begin{cases}1, \text{if } n=0\\ \frac{4}{11}, \text{if } n=1\\ \frac{a_{n-1}a_{n-2}}{2a_{n-2}-a_{n-1}}, \text{otherwise}\end{cases}$$

11. (a) Solve the following recurrence relation defined on the set of non-negative integers: **(10)**

$$T_0=5$$
$$2T_n=nT_{n-1}+3\cdot n! \quad \text{for } n>0$$

(b) Evaluate the following sum: **(10)**

$$\sum_{n=1}^{\infty}\frac{1}{n(n+k)}$$

where k is a positive integer. You are allowed to include *harmonic numbers* in the closed form.

(c) Evaluate the following sum: **(15)**

$$\sum_{k=1}^{n}(-1)^{k+1}(2k-1)$$

12. (a) If $\frac{m}{n}$ and $\frac{m'}{n'}$ are consecutive fractions at any stage of the construction of the *Stern-Brocot tree*, prove that $m'n-mn'=1$. **(10)**

(b) Find all primes p, q such that $p^3+1=q^2$. **(10)**

(c) Let m be an even positive integer. Assume that $\{a_1,a_2,\cdots,a_m\}$ and $\{b_1,b_2,\cdots,b_m\}$ are two complete sets of residue classes modulo m. Prove that the set $\{a_1+b_1,a_2+b_2,\cdots,a_m-b_m\}$ is not a complete residue class. **(15)**

Contd P/4

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13. (a) Show that $\sum_{d \setminus m} \varphi(d) = m$, where φ is the *Euler's totient function.* (1

(b) Let p, q be two distinct prime numbers. Show that every integer n satisfies the congruence $n^{pq-p-q+2} \equiv n \pmod{pq}$. (1

(c) A partition of a positive integer n is a way of writing n as a sum of positive integers (each integer in the sum is called a part). For example, 4 can be partitioned in five distinct ways. (1

$$4,\ 3+1,\ 2+2,\ 2+1+1,\ 1+1+1+1.$$

Show that for each positive integer n, the number of partitions of n into unequal parts is equal to the number of partitions of n into odd parts. For instance, if $n = 6$, there are four partitions into unequal parts: $6,\ 5+1,\ 4+2,\ 3+2+1$. And there are also four partitions into odd parts: $5+1,\ 3+3,\ 3+1+1+1,\ 1+1+1+1+1+1$.

L-3/T-2/CSE Date: 29/03/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

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

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.

X. (a) Draw the Processes State Transition Diagram. Include the following states: *Embryo, Running, Runnable, Zombie, Sleeping.* **(10)**

(b) Given a basic spinlock, Assume that locking the spinlock takes **A** time units (if no one is holding the lock); unlock also takes **A** time units. Assume further that a context switch takes **C** time units, and that a time slice is **T** time units long.

Assume this code sequence, executed by **two** threads on **one** processor at roughly the same time: **(5×3=15)**

```
mutex_lock() ;
do_something() ;   // takes no time to execute
mutex_unlock() ;
```

i. What is the best-case time for the two threads on one CPU to finish this code sequence?

ii. What is the worst-cast time for the two threads to finish this code sequence? Assume that only **three** context switches can occur at a maximum.

iii. If the spin lock is instead changed to a queue-based lock, how does that change the worst-case time?

(c) You are given a new atomic function, called `FetchAndSubtract()`. It executes as a single atomic instruction, and is defined as follows: **(10)**

```
int FetchAndSubtract  (int *location )  {
    int value = *location;        // read the value pointed to by location
    *location = value - 1;        // decrement it and store result back
    return value ;                // return old value
}
```

You are given the task: write the `lock_init()`, `lock()`, and `unlock()` functions (and also Define a `lock_t` structure) that use `FetchAndSubtract()` to implement a working lock.

Contd P/2

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2. (a) The variable **counter**, is shared within process A and process B. The initial value is `counter = 0` before execution of either process. Here, R0 is a register. **(7+8=15)**

Process A	Process B
LOAD (counter, R0)	LOAD (counter, R0)
ADD (R0, 1, R0)	ADD (R0, 2, R0)
STORE (R0, counter)	STORE (R0, counter)

i. Add semaphores (with initial values) so that the final value of counter **is 2.**

ii. Add semaphores (with initial values) so that the final value of counter is **not 3.**

(b) You wrote a piece of code with four threads (1-4) and four locks (A-D).

Thread 1 grabs Locks A and B (in some order); Thread 2 grabs Locks B and C (in some order);

Thread 3 grabs Locks C and D (in some order); Thread 4 grabs Locks D and A (in some order);

Is it possible that this code might result in deadlock? Briefly explain. **(5)**

(c) Consider the following program: **(5+10=15)**

```
1    int main{
2        int count =1;
3        int pid = 0, pid2 = 0;
4        if ((pid = fork())) {
5            count = count + 2;
6            printf("%d ", count);
7        }
8
9        if (count == 1) {
10           count++;
12             pid2=fork();
13           printf("%d ", count);
14       }
15
16       if (pid2) {
17           wait(pid2, NULL, 0);
18           count = count * 2;
19           printf("%d ", count);
20       }
21   }
```

i. How many processes are created during the execution of this program? Explain briefly.

ii. List all the possible outputs of the program.

3. (a) Let's examine a program having two threads: **(5)**

Thread 1	Thread 2

`pending = 1;`
`while (pending) {`
`  printf("hello\n");`
`}`
	`pending = 0;`

How could we re-write the code such that Thread 2 would only run after "hello" has been printed at least twice? You can use any synchronization primitive of your choice.

Contd P/3

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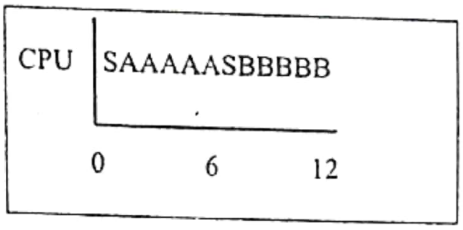
Contd... Q. No. 3

(b) Scheduling policies can be easily depicted with some graphs. For example, let's say we run scheduler **S** for 1 time unit, job **A** for 5 time units, run scheduler **S** again for 1 time unit, and then run job **B** for time units. Our graph of this policy will look like this: **(5×3=15)**



i. Draw a similar graph of **ROUND-ROBIN** scheduling for jobs **A** (arriving at **T=0**), **B** (arriving at **T = 5**), and **C** (arriving at **T = 10**), each running for **6 time-units**. Assume a **2 time unit** time slice; also assume that the scheduler (**S**) takes 1 time unit to make a scheduling decision. Make sure to label the x-axis appropriately.

ii. What is the *average* ***RESPONSE TIME*** for jobs A, B and C?

iii. What is the *average* ***TURNAROUND TIME*** for jobs A, B and C?

(c) Consider the producer/consumer problem and the (broken) solution mentioned below. Briefly describe why solution is broken, and demonstrate it with a specific example of thread interleaving (*Hint: you can assume two consumers and one producer*). **(15)**

Producer		Consumer	
`void *producer (void *arg) {`		`void *consumer (void *arg) {`	
`  int i;`		`  int i;`	
`  while (1) {`		`  while (1) {`	
`    mutex_lock (&mutex);`	`//p1`	`    mutex_lock (&mutex);`	`//c1`
`    if (count == MAX)`	`//p2`	`    if (count == 0)`	`//c2`
`      cond_wait(&empty, &mutex);`	`//p3`	`      cond_wait (&full, &mutex);`	`//c3`
`    put (i);`	`//p4`	`    int tmp = get ();`	`//c4`
`    cond_signal (&full);`	`//p5`	`    cond_signal (&empty);`	`//c5`
`    mutex_unlock (&mutex);`	`//p6`	`    mutex_unlock (&mutex);`	`//c6`
`  }`		`    printf ("%d\n", tmp);`	
`}`		`  }`	
		`}`	

4. (a) A typical OS provides some APIs to create processes. **fork(), exec()**, and **wait()** can be used combinedly for that purpose. Write some code that uses these system calls to launch a new child process, have the child executed a program named "hello" (with no arguments), and have the parent wait for the child to complete. **(10)**

(b) Assume an OS with MLFQ (multi-level feedback queue) scheduler.

Here is a timeline of what happens when two CPU-bound (no I/O) jobs, **A** and **B** run: **(4×5=20)**

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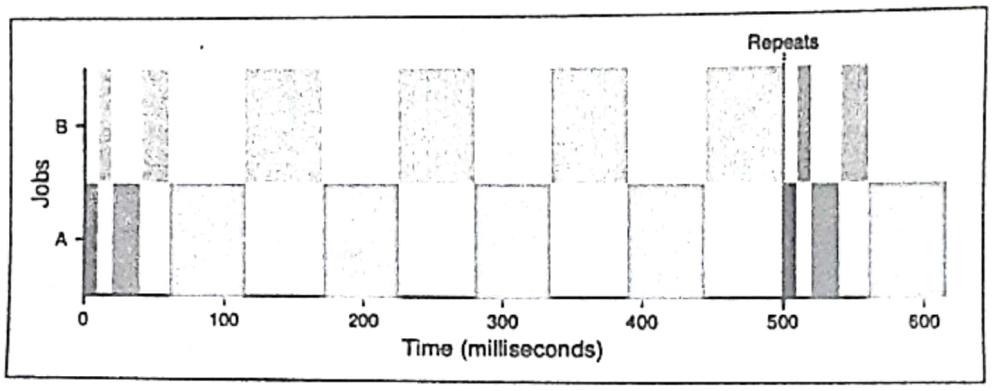
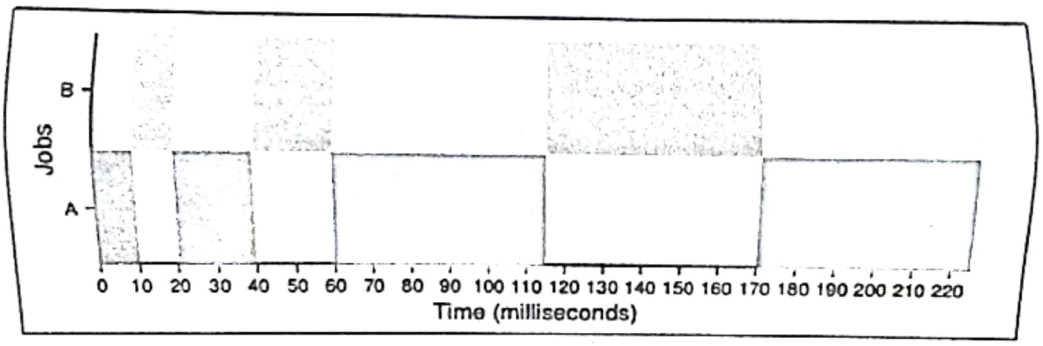
Contd... Q. No. 4(b)



This figure shows when A and B run over time. Note that after 500 milliseconds, the behavior repeats, indefinitely (until the jobs are done). To help you further, a closeup of the first part of the graph is shown below:



Now, answer the following questions:

i. How many queues do you think there are in this MLFQ scheduler?

ii. How long is the time slice at the top-most (high priority) queue?

iii. How long is the time slice at the bottom-most (low priority) queue?

iv. How often do processes get moved back to the topmost queue?

v. Why does the scheduling policy MLFQ move processes to higher priority levels (i.e., the topmost queue) sometimes? Briefly explain.

(c) With the round robin (RR) scheduling policy, a question arises when a new job arrives in the system: should we put the job at the front of the RR queue, or the back? Does this subtle difference make a difference, or does RR behave pretty much the same way either way? Briefly explain. **(5)**

Contd P/5

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SECTION – B

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

5. (a) Alice has implemented a fast file system (FFS) with inodes having 12 direct pointers, 1 indirect pointer and 1 double indirect pointer. **(15)**

i. In a 1TB disk with 2KB blocks, how big of a file can be handled using Alice's file system?

ii. FFS divides the disk into multiple block groups. Now, can a 100 MB file be saved in Alice's file system? If so, then how all the data will be distributed on disk?

iii. If the disk spends 5ms time for positioning on the average and has 100MB/s transfer rate, how long will it take to read the file in (ii)?

(b) What is TLB in the context of memory virtualization? Show its structure. Mention its control flow using pseudocode. How does it manage context switches? ***(10)***

(c) What is RPC? Suppose the user has written the following codes: ***(10)***

```
int main() {
    ...
    m = f1(x1, x2);
    ...
}
int f1(char* a, char* b){
    ...
    p = f2(*a);
}
float f2(int t){
    ...
}
```

If the user wishes to run the function `f2` in a distributed manner, how will a RPC run-time library handle it? Write down which steps it needs to take and corresponding details that are needed to be taken care of in each step.

6. (a) Suppose the OS made the following 3 batch of block requests to a disk (each number represents block id): **(15)**

- 1, 40, 2, 15
- 10, 1, 13, 32, 2, 7
- 70, 49, 0, 6, 28

Contd P/6

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Contd... Q. No. 6(a)

The requests were sent in such a way that one batch is requested after the previous one is handled. The disk has 1GB capacity, 4KB blocks, 8 blocks in each track and max seek time of 100ms. Now, calculate how much time the disk will spend on seeking, if the disk head is initially on the first track and the scheduling algorithm is

i. SSTF

ii. SCAN

iii. C-SCAN

(b) A program named `'test'` execute some code and writes some text to the console. **(10)**

The program is executed as:

```
./test > /etc/out.txt
```

Now, write down the timeline for read/write operation in the file system. Assume that it is vsfs (very simple file system) and there is no cached value to aid.

(c) Bob has created the following files in an FFS (file sizes are written inside brackets). **(10)**

- `/a/f1 (2KB)`
- `/b/f2 (1KB)`
- `/c/b/f3 (10 KB)`
- `/c/f4 (7KB)`
- `/b/f5 (60KB)`

Suppose, the disk has 4KB blocks and 5 block group. If `/c/b` is symbolic link to the directory `/b`, show how the files will be saved with illustrative diagrams.

7. (a) You created an elegant device that has to deal with both big bursts of small I/O requests and very large I/O requests. While writing a device driver for it, what design decisions would you take and why? Elaborate the pros and cons of your design. **(15)**

(b) We need to write data in block 8, 11, 12 inode is in block 3, bitmap is in block 2. Journal is in blocks 24 to 31. Write down the journaling timeline if the system uses – **(10)**

i. Data Journaling

ii. Metadata Journaling

iii. Metadata Journaling with Checksum Optimization

(c) What is track skew? Why was it required in older disks? Why is it not good for newer disk models? **(5)**

(d) You know that RAID-4 has terrible Random Write performance. If the parity disk is mirrored in RAID-4, what would happen to its Random Write performance? What about Random Read or Sequential Read-Write? Explain your derivation. **(5)**

Contd P/7

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8. (a) You ran the following rename operation: **(20)**

```
mv ~/a/foo.txt ~/b/bar.txt
```

Explain with illustrative figure what happens during this operation in-

i. Very Simple File System (VSFS)

ii. Log-structured File System (LFS)

(b) Using illustrative figures and pseudocodes, show how the OS talks to a canonical IO device while using DMA. **(10)**

(c) When using the swapping mechanism, the OS reserves some swap space on disk and works with directly. However, we know the OS already has File API to communicate with disk. Why do you think this discrepancy is there? **(5)**

L-3/T-2/CSE **Date: 05/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

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** questions.

1. (a) Define the terms intelligent and rationality. Why would evolution tend to result in systems that act rationally? Which goals are such systems designed to achieve? (Use the concepts of evolutionary algorithm in answering the second and third parts of this question). **(20)**

(b) Discuss Turing test in detail. In a Turing test which question would you ask an AI system to verify that it is really intelligent and is not just imitating what it thinks a human would do? **(15)**

2. (a) Draw the block diagram of a general learning agent and discuss each component of the diagram in detail. Explain how the learning agent differs from a model based agent. **(20)**

(b) Write pseudo code of a simple problem-solving agent that first formulates a goal and a problem, searches for a sequence of actions that would solve the problem, and then executes the actions one at a time. **(15)**

3. (a) The missionaries and cannibals problem is usually stated as follows. Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place. **(22)**

i. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution. Draw a diagram of the complete state space.

ii. Describe an appropriate search algorithm to solve the problem optimally. Is it good idea to check for repeated states?

(b) Describe a state space in which iterative deepening search performs much worse than depth-first search. **(13)**

4. (a) Describe how the minimax and alpha-beta algorithms change for two-player, nonzero-sum games in which each player has a distinct utility function and both utility functions are known to both the players. If there are no constraints on the two terminal utilities, is it possible for any node to be pruned by alpha-beta? What if the player's utility functions on any state differ by at most a constant k, making the game almost cooperative? **(23)**

Contd P/2

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Contd... Q. No. 4

(b) Compare simulated annealing and greedy search algorithms based on their advantages and pitfalls. **(12)**

SECTION – B

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

If you find any information missing in the question. Just assume a value of your choice and clearly mention your assumption.

5. (a) Consider the function named *check_all*, shown in Figure for Q.5(a), used for implementing the Model Checking inference algorithm for propositional logic. Its parameters are **(15)**

- knowledge: knowledge base used to draw inferences
- query: a query, or the proportion that we are interested in whether it is entailed by the knowledge base
- symbols: a list of all the symbols (or atomic propositions) used
- model: an assignment of truth and false values to symbols

Can this *check_all* function correctly implement the Model Checking algorithm? If not, explain why this function fails to correctly implement the Model Checking algorithm by referring to the relevant lines of code.

```
1   def check_all(knowledge, query, symbols, model):
2       """Checks if knowledge base entails query, given a particular model."""
3
4       # If model has an assignment for each symbol
5       if not symbols:
6
7       # If knowledge base is true in model, then query must also be true
8           if knowledge.evaluate(model):
9               return query.evaluate(model)
10          return True
11      else:
12
13          # Choose one of the remaining unused symbols
14          remaining = symbols.copy()
15          p = remaining.pop()
16
17          # Create a model where the symbol is true
18          model_true = model.copy()
19          model_true[p] = True
20
21          # Create a model where the symbol is false
22          model_false = model.copy()
23          model_false[p] = False
24
25          # Ensure entailment holds in both models
26          return (check_all(knowledge, query, remaining, model_true) or
27                  check_all(knowledge, query, remaining, model_false))
28
```

Figure for Q.5(a)

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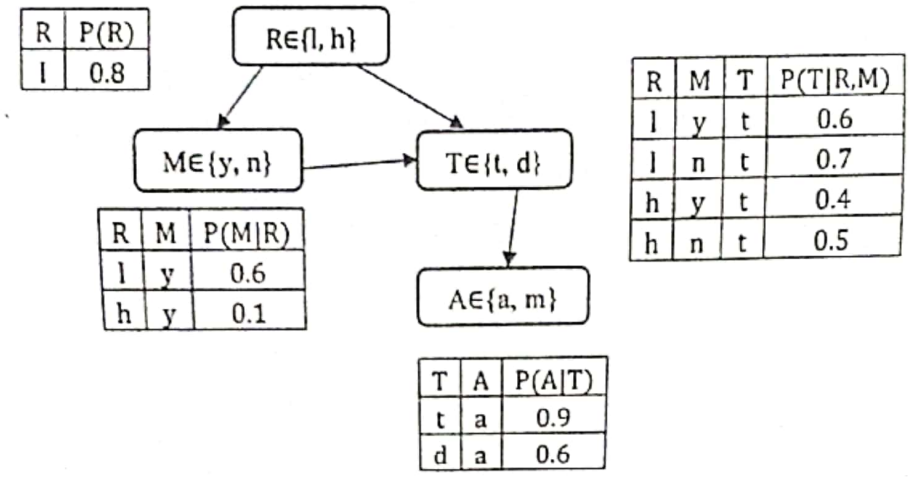
Contd... Q. No. 5

(b) Consider the Bayesian Network and corresponding probability tables shown in Figure for Q.5(b). Now based on the observation T = d, calculate the updated probability distribution of M and R using inference by enumeration. **(20)**



R	P(R)
l	0.8

R	M	P(M|R)
l	y	0.6
h	y	0.1

R	M	T	P(T|R,M)
l	y	t	0.6
l	n	t	0.7
h	y	t	0.4
h	n	t	0.5

T	A	P(A|T)
t	a	0.9
d	a	0.6

Figure for Q.5(b)

6. (a) Consider the knowledge base (KB) comprising eigth First-Order Logic sentences each converted into Conjunctive Normal Form shown in Figure for Q.6(a). Here **(20)**

- A, B, C, D, E, F, G, H are predicates
- x, y, z, are variables
- M_1, M_2, M_3, M_4, are constants

Using Resolution, prove that KB ⊨ E (M_2).

1. $\neg F(M_1, x) \vee \neg G(x) \vee D(M_2, x, M_1)$
2. $\neg H(x, M_3) \vee C(x)$
3. $\neg G(x) \vee B(x)$
4. $F(M_1, M_4)$
5. $\neg A(x) \vee \neg B(y) \vee \neg C(z) \vee \neg D(x, y, z) \vee E(x)$
6. $G(M_4)$
7. $A(M_2)$
8. $H(M_1, M_3)$

Figure for Q.6(a)

Contd P/4

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Contd... Q. No. 6

(b) Suppose you want to keep track of an animal in a triangular enclosure using sound. You hav 3 microphones that provide unreliable (noisy) binary information at each time step. The animal is either close to one of the 3 points of the triangle or in the middle of the triangle. If the animal is in a cornet, it will be detected by the microphone at that corner with probability 0.6, and will be independently detected by each of the other microphones with a probability of 0.1. If the animal is in the middle, it will be detected by each microphone with probability of 0.4. If the animal is in a corner it stays in the same corner with probability 0.8, goes to the middle with probability 0.1 or goes to one of the other corners with probability 0.05 each. If it is the middle, it stays in the middle with probability 0.7, otherwise it moves to one the corners, each with probability 0.1. Initially the animal is in one of the four states, with equal probability. **(15)**

Now you have to formulate the above scenario using a Hidden Markov Model. What are the hidden states? List the possible observations at any time step? Construct the appropriate observation model and transition model in tabular format.

7. (a) Suppose we want our AI agent to learn the meaning of 10 words based on valid sentences composed only of those words stored in a document. To accomplish this, we want to semantically represent each word as a 3-D vector of real values between -1.0 to 1.0. Also we want to use the Skip-Gram Architecture which is a neural network architecture for predicting context given a target word. Draw the required neural network architecture clearly showing the number of neurons in each layer. Discuss which layer of this architecture represents the target, meaning, and context respectively. **(20)**

(b) Q-Learning is a model of reinforcement learning, where a function Q(s, a) outputs an estimate of the utility value of taking action a in state s. Every time we take an action a in state s to reach a new state s' and observe a reward r, we update Q(s, a) based on the following mechanism. **(15)**

$$Q(s, a) \leftarrow Q(s, a) + \alpha((r + \gamma \max_{a'} Q(s', a')) - Q(s, a))$$

Explain the intuitions behind the components of this update mechanism. You must discuss the effect of increasing/decreasing the values of α and γ.

8. (a) Explain the Perceptron learning rule for binary classification task using necessary equation. **(15)**

Contd P/5

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Contd... Q. No. 8

(b) Consider the program (Figure for Q.8(b)) that parses a given English sentence using the syntax defined by a Contest-Free Grammar, Show the output of this program for the input 'she saw car on street with dog'. **(20)**

```
import nltk

grammar = nltk.CFG.fromstring("""
    S -> NP VP

    AP -> A | A AP
    NP -> N | D NP | AP NP | N PP
    PP -> P NP
    VP -> V | V NP | V NP PP

    A -> "big" | "blue" | "small" | "dry" | "wide"
    D -> "the" | "a" | "an"
    N -> "she" | "city" | "car" | "street" | "dog" | "binoculars"
    P -> "on" | "over" | "before" | "below" | "with"
    V -> "saw" | "walked"
""")

parser = nltk.ChartParser(grammar)

sentence = input("Sentence: ").split()
try:
    for tree in parser.parse(sentence):
        tree.pretty_print()
except ValueError:
    print("No parse tree possible.")
```

Figure for Q.8(b)

L-3/T-II/CSE Date : 06/05/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-II B. Sc. Engineering Examinations 2020-2021

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

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**.

1. (a) When to use static NAT? Explain with an example. Write down the benefits and limitations of PAT. (8)

   (b) Suppose a company uses a 172.16.20.0/23 network which the network admin wants to divide equally among the four divisions. What will be the network address, subnet mask, and the IP ranges of each division? Show necessary calculations. (9)

   (c) How to get IPv6 address dynamically? Explain all three options. (9)

   (d) "Mobile IP tries to optimize network bandwidth usage" Do you agree with this statement. Justify your answer with necessary diagram(s). (9)

2. (a) What can be inferred about an IPv4 packet whose M-bit is 0 and offset bits are non-zero? Again, what if M=0, Offset = 0? Explain briefly. (8)

   (b) Distinguish between Internal router, ABR and ASBR in multi-area OSPF. Use necessary diagram to explain: (9)

   (c) If the source and destination PCs are in two separate networks, how can the source PC acquires the destination MAC address? Explain with a simple topology diagram. (9)

   (d) Distinguish between milk and wine policy while discarding packets? Give example applications for which these policies are applicable. Justify your answer. (9)

3. (a) What is the purpose of RST and URG flag in TCP header? Is there any possible attack that can be launched using this flag? (8)

   (b) What are the challenges in TCP if it uses selective repeat policy instead of Go-back-N policy? Give an example to explain. (8)

   (c) Compare TCP Reno and TCP Tahoe congestion control algorithm with necessary figure. (12)

   (d) What is the purpose of floating static route in a routing protocol? How is it configured? (7)

4. (a) Consider that an organization has 10 internal LANs and wants to use DHCP server for their client machines. How many DHCP servers should they deploy? Do they need any other component? Use a necessary topology diagram to explain. (9)

Contd P/2

CSE 321

Contd...Q.No. 4

(b) Compare iterative and recursive DNS resolutions. Which one is better in your opinion? Why? **(9)**

(c) Using necessary diagram(s), explain the operations of SMTP and IMAP protocols in email communication. **(9)**

(d) What are the possible applications of web proxy server? Explain in brief. **(8)**

SECTION – B

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

5. (a) "Between Limited-Contention Protocols and CSMA with Collision Detection Protocol, CSMA with Collision Detection Protocol is better as CSMA with Collision Detection Protocol completely eliminates collision, whereas, Limited-Contention Protocols allow collisions to a great extent." – based on this statement, you need to answer the following. **(20)**

(i) Do you agree with the statement?

(ii) If you agree, you need to justify why and how the scenario mentioned in the statement can happen in reality. If you disagree, then you need to explain reason(s) behind your disagreement. Show all necessary derivations and figures, as required.

(b) A network engineer is experienced with Switched Ethernet, Fast Ethernet, and Gigabit Ethernet. He can enable data transmission over such Ethernets. **(15)**

When the engineer starts working with wireless medium, he understands the shared nature of the wireless medium. To overcome the interference problem over the shared medium, he adopts physical carrier sensing and enables transmission only when a channel is found to be clear.

Now, your task is to go one step ahead and enable virtual carrier sensing instead of physical carrier sensing. How can you do that mimicking 802.11? Explain with necessary figure(s) and elaboration.

6. (a) "In the Data Link Layer, if a timer is maintained in software for each outstanding packet within the window of a Sliding Window Protocol, then the Sliding Window Protocol can have the maximum value of its window size (2^n-1) while having n-bit sequence number in each packet." – based on this statement, you need to answer the following. **(20)**

(i) Do you agree with the statement?

(ii) If you agree, you need to justify reasons behind the statement. If you disagree, then you need to explain reason(s) behind your disagreement. Show all necessary derivations and figures, as required.

Contd P/3

CSE 321

Contd...Q.No. 6

(b) If we employ r-bit redundant information for error correction over m-bit data using Hamming distance, then the lower limit of r can be determined using the following formula. (1

$$(m+r+1) \leq (2^r)$$

Does this hold even if we utilize bit stuffing and de-stuffing for the purpose of frame generation?

If so, you need to justify why the above formula will hold even in the case of utilizing bit stuffing and de-stuffing. If not, then you need to elaborate the reasons for which the above formula will not hold.

7. (a) A network designer needs to design a network that enables communication with a classical GEO satellite. To do so, in his designed network, he plans to utilize the frequency assignment, time division multiplexing, and framing format used for GSM. You need to elaborate how the network designer can do it. Or, if you think that the intended communication with a classical GEO satellite cannot be enabled in such a way, then you need to elaborate this with all underlying reasons. Show necessary figures in your elaboration. (20)

(b) If an application demands that network congestion gets handled at the very beginning of its transmission and the congestion will not occur afterwards, then which of the following methods will be the best choice to be implemented - circuit switching, message switching, or packet switching?

Justify your answer with necessary elaborations. Besides, you need to present relevant figures to support your elaborations. (1

8. (a) You are given a task of enhancing fault tolerance of a network containing multiple LANs through having redundant active connectivity between the LANs. To do so, can you use the concept of spanning tree bridges, where each of the bridges is a transparent bridge? Justify your answer with necessary elaborations and figures. (2

(b) Distinguish among Wide Area Networks, Metropolitan Area Networks, and Local Area Networks with necessary figures. (1

L-3/T-2/CSE Date: 12/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

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) You are designing software for a Life Insurance company. The requirements are as follows. If the client has a stable job with salary more than 50,000/= and his/her age is below 40 years, s/he is considered a safe customer and offered a Gold rate for premium payment. If any of these conditions are not made, the premium is 20% higher than the Gold rate. Clients may opt to pay premium installment monthly or yearly and via cheque or mobile banking. If a client fails to make a payment, a penalty of 10% of original premium is applied on the next premium. Before due date of premium, the client receives SMS mentioning the amount to pay. If s/he fails to pay two successive premiums, his/her policy is cancelled. **(14)**

Draw a BPMN diagram to design the premium calculation scenario discussed above.

(b) What do you understand by Feature Envy, Refused Bequest and Cyclomatic Complexity type of Code Smell. Give an example of Inappropriate Intimacy in the context of Code Smell. **(16)**

(c) What do you need to check about requirements collected for a software application? **(5)**

2. (a) In an educational institution, the teachers offer different course in different semesters. Some courses are jointly offered by multiple teachers. Students enroll in multiple offerings and receive grades at the end of the course. The grades are computed following some grading rule from the marks of different test items. Draw a Class Diagram to reflect the scenario discussed above. Apart from model classes, show the classes that would implement business logic and store computed values. You are not required to show any Boundary or Controller class. **(13)**

(b) Draw Collaboration diagram for the scenario described in Q 2(a) to show the computation of grade. You are required to show relevant Boundary and Controller classes. **(14)**

(c) Give examples of 4 types of Non-Functional requirements for the example of the application to be developed for the scenario discussed in Q 2(a). **(8)**

Contd P/2

CSE 325

6. (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 Sequence diagram to model the scenario discussed above. **(15)**

(b) What do you understand by Second Order SQL injection? Give and example. What is the primary (most recommended) way of prevention SQL injection? **(12)**

(c) Show an example of "extends" in a Use Case diagram. **(8)**

4. (a) In an automatic Inventory Management System, an office stocks different products that are expected to be used by the users. When a user needs something, s/he makes a Requisition. If that is in the stock, the requisition is approved by the management and becomes ready to Issue. If the stock-level of a product reaches below a threshold, a re-order request is generated. If the product is not consumable, it has to be returned when the employee is retired or transferred. **(12**

Design a State diagram to show different status of a product in the context discussed above.

(b) What is the difference between Reflected and DOM-based XSS attack? Draw the flow of a DOM-based XSS attack? **(11)**

(c) What do you understand by relative importance of usability dimensions in the context of User Interface design? Discuss in the context of a Sales Management software. **(12)**

SECTION – B

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

5. (a) Class A has a public method which is needed by class B. If class B inherits class A, class B gets access to that method. On the other hand, passing an instance of class A to class B also enables class B to access that method. How do you decide which technique to use? Explain your reasoning. **(15)**

(b) Give an example of "Evil switch" anti-pattern. Incorporation of which design principle is most likely to avoid "Evil switch"? **(10)**

(c) Both KISS and YAGNI encourage simpler code. Explain their differences with a code example. **(10)**

Contd P/3

CSE 325

6. (a) State the basic idea of each of five SOLID principles. Explain them with appropriate code examples. **(25)**

(b) What is the difference between dependency inversion and dependency injection? Explain with an appropriate code example where we need to separate an object's creation from its use. **(10)**

7. (a) Assume you are a scrum master and you are in the beginning of a sprint after which you need to deliver an additional database search feature along with UI. Plan a sprint which will last for 4 weeks. Include all the scrum events. **(15)**

(b) What is the differences between message-driven architecture and event-driven architecture? Explain with an example. **(10)**

(c) What is containerization? Why do we need containerization even though we have virtual machines? **(10)**

8. (a) Among all the components of a simple three-tier web application expecting to process large number of request per seconds, which component is most likely to become initial bottleneck? What are the solutions? **(15)**

(b) What is the difference between vertical and horizontal scaling? **(10)**

(c) Discuss different production deployment strategies for web applications. **(10)**
