

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 4<sup>th</sup> Year 1<sup>st</sup> Term Examination, 2024  
Department of Computer Science and Engineering  
CSE 4105  
Computer Networks

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
ii) Figures in the immediate right column of the questions indicate full marks.  
iii) The rightmost column indicates course outcomes.

**SECTION A**

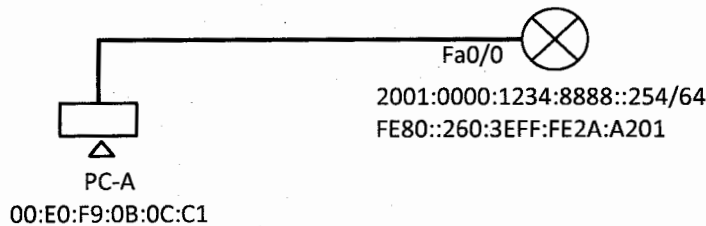
(Answer **ANY THREE** questions from this section in Script A)

1. a) As an application developer, why do you choose to run an application over UDP rather than TCP. (06) [CO1]  
b) Explain the concept of piggybacking in data communication. Discuss how it affects network congestion. (05) [CO2]  
c) Discuss how TCP detects congestion in a network. Describe the congestion control techniques used in TCP to manage and avoid congestion. (12) [CO3]  
d) An organization's network is connected to the internet through a 25 Mbps access link. Users request objects of average size 800 Kbits at 30 requests/second, with average internet delay 1.5 seconds. The organization's internal LAN has a speed of 1 Gbps. To reduce response time, the organization considers:  
Option 1: Upgrade the access link to 100 Mbps.  
Option 2: Install a local web cache that serves 40% of requests.  
Compare the average end-to-end delay for both options and recommend which provides better performance and is more cost effective. (12) [CO4]
2. a) Explain how a TCP connection is established, detailing the role of SYN and ACK flags. Justify why a two-way handshake is not sufficient for reliable communication. (08) [CO2]  
b) Describe why flow control is required in TCP implements flow control between sender and receiver, specifying the conditions that must be met, and illustrate your answer with a suitable example. Additionally, explain the concept of silly window syndrome. (13) [CO3]  
c) In TCP, *EstimatedRTT*, *DevRTT* and *TimeoutInterval* adapt to changing network conditions. Suppose, three successive *SampleRTT* measurements are recorded as 110 ms, 95 ms, and 120 ms. Given: initial *EstimatedRTT* = 100 ms, initial *DevRTT* = 5 ms,  $\alpha = 0.125$ , and  $\beta = 0.25$  (14) [CO3]  
i) Compute *EstimatedRTT*, *DevRTT* and *TimeoutInterval* after each *SampleRTT*  
ii) Explain why it is not advisable to use the RTT of retransmitted packets when updating *TimeoutInterval*
3. a) Discuss why DNS is used in networking. Illustrate the hierarchy of DNS servers and describe how a DNS query is resolved. (09) [CO2]  
b) Explain the working of the Selective Repeat (SR) protocol. Given a sequence number space of 4 and a sender window size of 3, determine whether the window size is appropriate for SR protocol. Discuss the problems that can occur if the window size exceeds the allowed limit with a timeline diagram. (13) [CO3]  
c) Are IP address alone sufficient for communication between applications? Suppose, you have a web server that hosts three web applications on ports 3000, 5000, and 8000, but for some reasons users can't access them via standard HTTP/HTTPS requests using the domain name. Identify the underlying issue and recommend an appropriate solution to enable access via standards ports. Illustrate your approach with a request-routing diagram. (13) [CO4]
4. a) While searching for new pair of shoes, you visited multiple e-commerce sites and may or may not have completed a purchase. Later, when browsing a social media platform, you noticed advertisements for the same types of shoes you had viewed earlier. Explain the underlying mechanism that enables such personalized advertisements across different websites. (10) [CO3]  
b) Explain the rules for generating acknowledgements in TCP and discuss the fast retransmit mechanism. Illustrate your answer with suitable examples. (14) [CO3]  
c) Describe how man-in-the-middle attack hinders the authentication process (ap5.0) that uses a nonce and public key cryptography. (11) [CO3]

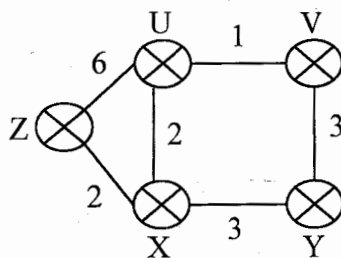
**SECTION B**

(Answer ANY THREE questions from this section in Script B)

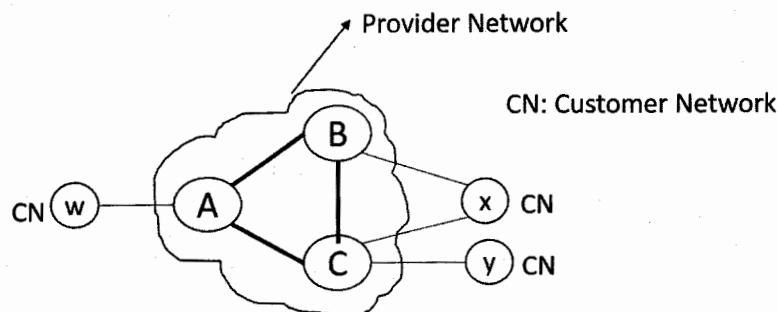
5. a) Explain the necessity of a trunk port in VLAN. Compare “Router-on-a-Stick” and “Layer 3 Switch (SVI)” based on following criteria: (10) [CO1]
  - i) Scalability
  - ii) Performance/Latency
  - iii) Implementation Complexity
  - iv) Cost
- b) Explain HOL Blocking. Analyze the major switching techniques with their benefits and drawbacks. (10) [CO1]
- c) Suppose a TCP message that contains 2048 bytes of data and 20 bytes of TCP header is passed to IP for delivery across two networks of the Internet (i.e., from the source host to a router to the destination host). The first network uses 14 bytes header and has an MTU of 1024 bytes; the second network uses 8 bytes header with an MTU of 512 bytes. Give the sizes and offsets of the sequence of fragments delivered to the network layer at the destination host. Assume all IP headers are 20 bytes. (15) [CO3]
6. a) “IPv6 is faster and more secure than IPv4” – justify the statement based on IP datagram header. (05) [CO2]
- b) What are the differences between IP based forwarding and generalized forwarding? Explain simple packet handling rules for generalized forwarding based on OpenFlow protocol. (10) [CO3]
- c) What is link-local address in IPv6? Describe the process of Router Solicitation Message showing IPv6 header and ICMPv6 header values to get an IP using Stateless Auto Configuration mode. Calculate the IP of PC-A during this process shown in following figure. (20) [CO4]



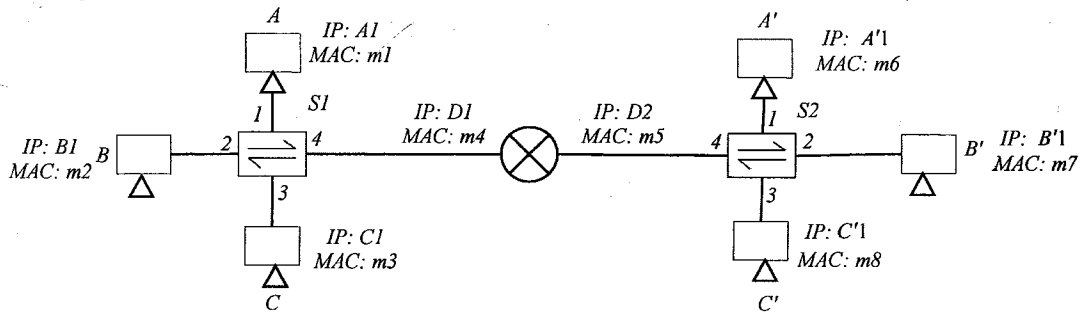
7. a) Consider the network shown in following figure and assume that each node initially knows the costs to each of its neighbors. Consider the distance vector algorithm and show the distance table entries at node Z. (12) [CO3]



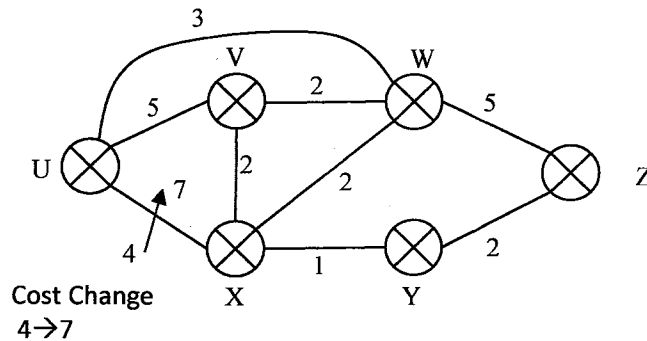
- b) What is Hot Potato routing? Describe the policy-based path selection for the following scenario. (10) [CO2]



- c) You have to look carefully the following figure. Computer A wants to send a frame to Computer C'. Describe the two switches' behavior when A connects to C' and after completing the communication, how the switch table of both switches look like? Initially switch table was empty. Finally, write down the self-learning algorithm of switch.



8. a) Explain Layer 2.5 protocol-based packet forwarding operation using an example. (10) [CO3]  
 b) Emulate the Software Define Network (SDN) controller's interaction with local switches to modify the link-state changes occurred in the following network. Apply Dijkstra's link-state algorithm in the SDN controller to calculate the updated routing table for 'U'. (17) [CO4]



- c) State how packet filtering firewall works. (08) [CO1]

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 4<sup>th</sup> Year 1<sup>st</sup> Term Examination, 2024  
Department of Computer Science and Engineering  
CSE 4109  
Artificial Intelligence

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
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iii) The rightmost column indicates course outcomes.

**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) Artificial Intelligence aims to build systems that can perceive, reason, and act (20) [CO3] intelligently in dynamic environments.
  - i) Define Artificial Intelligence and discuss four major areas or subfields of AI with suitable real-world examples.
  - ii) Explain the differences between Strong AI and Weak AI, and provide examples of each category.
  - iii) Analyze how AI techniques (Search, Knowledge representation, or Learning) contribute to solve real world problems in one selected domain such as healthcare, transportation, or agriculture.
- b) How can you be certain that a machine or a program is intelligent? (10) [CO2]
- c) What are the properties of a Learning Agents? (05) [CO1]
  
2. a) What is a Fuzzy Logic System? Explain. (10) [CO1]
- b) You are asked to design a Fuzzy Logic System (FLS) to evaluate student performance (25) [CO4] in an Artificial Intelligence course. The proposed system considers the following input variables:
  - Exam score ( $E$ ) (0-100) marks
  - Class participation ( $C$ ) (0-10) marks
  - Assignment quality ( $A$ ) (0-100) marksThe output is performance ( $P$ ) (0-100) expressed linguistically as Poor, Average, or Excellent.
  - i) Define the appropriate linguistic variables and membership functions for the input ( $E, C, A$ ) and output ( $P$ ). Represent them using suitable diagram.
  - ii) Construct a fuzzy rule base that can infer performance from  $E, C$ , and  $A$  scores.
  - iii) For a student with exam score 78, class participation 6, and assignment score 85, demonstrate the fuzzy inference process and compute the approximate performance score using centroid method.
  
3. a) What is PEAS? Give description of the task environment for each of the following (10) [CO1] activities: (i) Automated Taxi Driving, (ii) Playing Soccer.
- b) What is uncertainty? Explain different types of uncertainty using example(s). (10) [CO1]
- c) How does a simple reflex agent differ from a goal-based agent? "Learning agent is suitable for dynamic environment" – justify the statement using an appropriate example. (15) [CO2]
  
4. a) What is NLP? Explain syntax, semantics, pragmatics using example(s). (10) [CO1]
- b) Consider an artificial invigilator, monitoring students in an exam hall. What are its sensors, actuators, and environment? Discuss how its sensors and actuators are well suited for its task. (15) [CO1]
- c) Construct a grammar for the following sentence: (10) [CO3]  
"The hunter shot the deer with his gun"  
Also draw the syntactic tree.

**SECTION B**

(Answer **ANY THREE** questions from this section in Script B)

5. a) In propositionalization, we can solve any first order logic (FOL) problem using (07) [CO2] propositional rules. Is this an effective method for inference in FOL? Discuss your view.

- b) Consider the following tic-toc-toe board. Design a simple heuristic function to evaluate non terminal board states, and using this heuristic, generate the search tree up to depth 2. Apply the minimax algorithm to determine the best move for X and explain whether this move guarantee a win, a draw, or a lose. (16) [CO4]

O	X	
O	O	X

- c) Consider the graph with nodes  $A, B, C, D$  and goal  $G$ , and edges with  $A \rightarrow B = 2$ ,  $A \rightarrow C = 5$ ,  $B \rightarrow D = 4$ ,  $C \rightarrow D = 1$ ,  $D \rightarrow G = 3$ . A heuristic  $h(n)$  is defined as  $h(A) = 6$ ,  $h(B) = 4$ ,  $h(C) = 2$ ,  $h(D) = 3$ ,  $h(G) = 0$ . Determine whether  $h(n)$  is admissible and consistent. (12) [CO3]

6. a) Consider a state where the start state is number 1 and each state  $k$  has two successors: number  $2k$  and  $2k+1$ . Suppose the goal state is 11. List the order in which nodes will be visited for breadth-first-search, depth limited search with limit 3 and iterative deepening search. How well would bidirectional search work on the problem? What is the branching factor in each direction of the bidirectional search? (12) [CO3]
- b) Consider the following partially filled  $4 \times 4$  Sudoku grid. Formulate this as a Constraint Satisfaction Problem (CSP) by defining the variables, domain and constraints, then use MRV, Degree and LCV heuristic to select a variable, assign a value and show how this assignment reduces the domains of other variables. (16) [CO4]

1		4	
	2		1
	3		4
2		1	

4 x 4 Sudoku

- c) Assuming predicates Parent ( $p, q$ ) and Female ( $p$ ) and constants Alice and Jack, express each of the following sentences in first-order logic. (You may use the abbreviation  $\exists^1$  to mean "there exists exactly one"). (07) [CO2]
- Alice has exactly one child, a daughter.
  - Alice and Jack have exactly one child together.
  - Alice has exactly one child with Jack, and no children with anyone else.

7. a) If  $KB \models \alpha$  and  $KB \models \beta$ , does it always follow that  $KB \models \alpha \wedge \beta$ ? Explain. (07) [CO1]
- b) Consider a game tree with branching factor ( $b = 2$ ) and depth ( $d=3$ ), where the root is MAX node. Assign values to the leaf nodes such that (a)  $\alpha - \beta$  pruning performs best and (b)  $\alpha - \beta$  pruning performs worst. Draw the complete tree for both cases showing all nodes and indicate the pruned nodes. (10) [CO3]

- c) Consider the following First-Order Logic sentences: (18) [CO4]
- $\forall x [\forall y \text{ Animal } (y) \Rightarrow \text{Loves } (x, y)] \Rightarrow [\exists y \text{ Loves } (y, x)]$
  - $\forall x [\exists z \text{ Animal } (z) \wedge \text{Kills } (x, z)] \Rightarrow [\forall y \neg \text{Loves } (y, x)]$
  - $\forall x \text{ Animal } (x) \Rightarrow \text{Loves } (\text{Jack}, x)$
  - $\text{Kills } (\text{Jack}, \text{Tuna}) \vee \text{Kills } (\text{Curiosity}, \text{Tuna})$
  - $\text{Cat } (\text{Tuna})$
  - $\forall x \text{ Cat } (x) \Rightarrow \text{Animal } (x)$

Convert all the above sentences into Conjunctive Normal Form (CNF). Then, using resolution, prove that the statement  $\text{Kills } (\text{Jack}, \text{Tuna})$  is false.

8. a) An autonomous delivery robot operates inside KUET campus. The robot needs to plan a sequence of actions to deliver a parcel from the Main Gate to the CSE building, while avoiding blocked pathways and optimizing delivery time. (25) [CO2]
- Explain the concept of planning in AI and discuss how it differs from traditional search-based problem solving.
  - Represent the delivery task using State-Action-Goal (SAG) formulation. Clearly specify the initial state, goal state, and at least four relevant action with their preconditions and effects.
  - Discuss how a heuristic or Knowledge-based planning approach could improve the robot's planning efficiency compared to blind search.
- b) Identify the valid and satisfiable sentences from the following sentences and justify your logic behind your identification: (i)  $(p \rightarrow q) \wedge (\neg p \rightarrow \neg q)$ , (ii)  $(p \wedge q \rightarrow p)$  (10) [CO1]

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 B.Sc. Engineering 4<sup>th</sup> Year 1<sup>st</sup> Term Examination, 2024  
 Department of Computer Science and Engineering  
 CSE 4111  
 Machine Learning

TIME: 3 hours

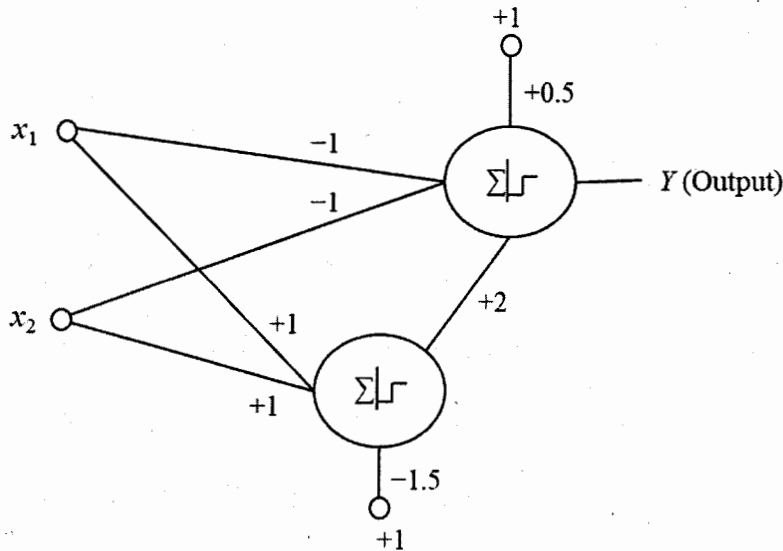
FULL MARKS: 210

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**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) “In Machine Learning (ML), explicit programming is not performed to solve a particular problem” – justify this statement. (08) [CO1]
- b) Briefly describe the basic learning types. Arrange the learning types in order of the increasing feedback from the environment; provide justification of the ordering. (09) [CO2]
- c) Differentiate learning and generalization in the context of ML. Which one mostly indicates the performance of any ML model and what techniques are employed to achieve the indicative? (09) [CO3]
- d) Does the following neural architecture solve 2 input non-linear problem? Justify your answer considering the inputs (0,0), (0,1), (1,0), and (1,1) at  $x_1$  and  $x_2$ . (09) [CO3]



2. a) Describe importance of bias weight value in artificial neuron construction. “Changing only the bias weight value can change the operation of a neuron” – justify the statement for appropriate logic gates. (08) [CO1]
- b) What is the condition to use a function as activation function in artificial neural network? Graphically represents two different forms sigmoidal functions and their derivatives. Explain similarity and dissimilarity between the functions. (09) [CO2]
- c) What is the local gradient in Back Propagation (BP) learning algorithm? “Local gradient may be zero even error at neural network remain” – justify the statement with an appropriate activation function. (09) [CO2]
- d) Draw diagram of RBF networks with approximate parameter values to solve AND, OR, and XOR logic operations for two inputs. (09) [CO4]
3. a) What are the various ways to produce diverse networks for ensemble construction? Which one is more effective? Why? (07) [CO1]
- b) Briefly describe independent, sequential, and simultaneous training of component networks in ensemble construction. Mention prominent ensemble methods for different ensemble training methods. (10) [CO2]
- c) Consider two computation systems: (i) multiple processing units and (ii) single high power unit. What are the preferable ensemble methods for the systems individually and why? (10) [CO4]
- d) Identify the learnable parameters for the below Convolutional Neural Network (CNN) to classify numeral images having size  $28 \times 28$  pixels. Also, count the learnable parameters. (08) [CO3]

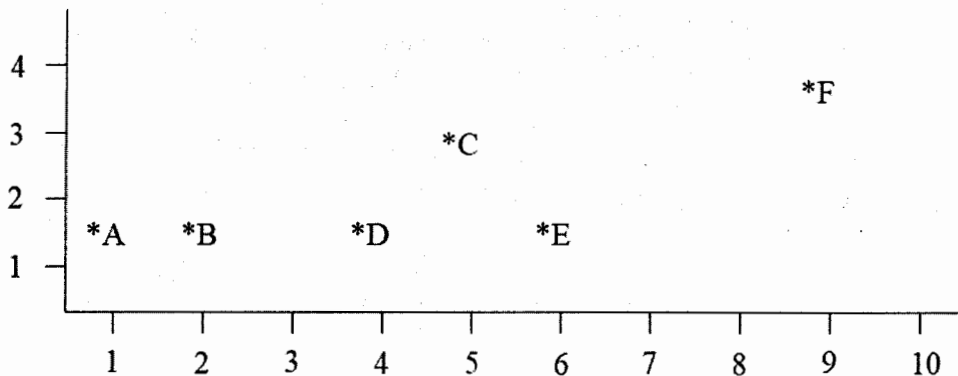
$$I_{28 \times 28} \rightarrow \{6K1_{5 \times 5} C1_{24 \times 24} - S_{2 \times 2} 6S1_{12 \times 12}\} \rightarrow \{6K2_{5 \times 5} C2_{8 \times 8} - S_{2 \times 2} 6S2_{4 \times 4}\} \rightarrow W_{096 \times 10} \rightarrow O_{10}$$

where symbols hold usual meanings.

4. a) Discuss advantages and disadvantages of Decision Trees relative to Neural Networks (10) [CO2] for classification on the basis of important issues (e.g., data type, compatibilities, sample complexities, model interpretabilities).
- b) Consider the following table where attribute “Play Tennis” represents class label. (10) [CO3] Construct a Decision Tree using the table measuring information gain and then generate rules from the Decision Tree.

Sl. No.	Outlook	Temp	Humidities	Wind	Play Tennis
1	Sunny	Hot	High	Weak	No
2	Sunny	Hot	High	Strong	No
3	Rain	Mild	High	Weak	Yes
4	Rain	Cold	Normal	Weak	Yes
5	Rain	Cold	Normal	Strong	No
6	Sunny	Mild	Normal	Strong	Yes

- c) Briefly discuss strength and weakness of K-means clustering. (07) [CO2]
- d) Draw a dendrogram considering six data points shown below; no need exact distance calculation. (08) [CO3]



### SECTION B

(Answer ANY THREE questions from this section in Script B)

5. a) Explain the relationship among Artificial Intelligence, Machine Learning, and Deep Learning. (06) [CO1]
- b) What is meant by pre-training, fine-tuning, and transfer learning? Give example of each case. (09) [CO1]
- c) What are support vectors in Support Vector Machine (SVM)? How does Linear SVM work? (12) [CO2]
- d) What is curse of dimensionality problem? Why is it an issue in ML? Briefly explain a dimensionality reduction technique. (08) [CO2]
6. a) Differentiate between heuristic and meta-heuristic with examples. (06) [CO1]
- b) “Meta-heuristics are designed to solve a problem more quickly and efficiently than classic methods” – justify it. (10) [CO2]
- c) Explain exploration and exploitation with suitable example. (10) [CO1]
- d) “Crossover and mutation are not always beneficial” – is it true? If so, justify with a numeric example. (09) [CO2]
7. a) Write simple Genetic Algorithm (GA). Why is choosing proper fitness function important in GA? Explain with example. (10) [CO2]
- b) Suppose, you want to minimize  $f(x) = x^2$  where  $-5 \leq x \leq 5$  using GA. Assume the required initial values, and consider MSB as sign bit and rest of the bits are magnitude during encoding. Now, perform calculation for one generation by hand. (12) [CO4]
- c) Write an algorithm for Enhanced Edge Recombination Operator with proper example. (13) [CO3]
8. a) What is Swarm? Write properties of a Swarm Intelligence (SI) system. (05) [CO1]
- b) Explain Particle Swarm Optimization (PSO) technique. What are the drawbacks of this technique? (12) [CO2]
- c) Explain Ant Colony Optimization (ACO) to solve Traveling Salesman Problem (TSP). (10) [CO4]
- d) Which bees perform exploration and exploitation in Artificial Bee Colony (ABC) optimization? What is significance of parameter “limit” in ABC optimization? (08) [CO2]

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 4<sup>th</sup> Year 1<sup>st</sup> Term Examination, 2024  
Department of Computer Science and Engineering  
CSE 4115

Computer and Network Security

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
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**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) "Asymmetric cryptosystems are based on clever application of number theory concepts" – individually establish it for RSA, ElGamal and Paillier cryptosystems about different keys. (12) [CO2]  
b) Establish usages of both block and stream ciphers in cases of two asymmetric and one symmetric cryptosystems. If not possible to deploy, also establish it. (12) [CO3]  
c) Discuss properties of digital signatures. Analyze them about ElGamal digital signature. (11) [CO2]
2. a) Discuss characteristics of cryptographic hash functions. Digital signature, asymmetric cryptosystem and hash function need to combine concurrently – why and how? (13) [CO1]  
b) Define and discuss characteristics of 'Zero Knowledge Proof'. Using a block diagram depict the symmetric cryptosystem along with the ways of the key distribution. (14) [CO2]  
c) Derive a bonding among order, prime, and primitive element considering the prime 13 and order 2. (08) [CO4]
3. a) Explain how triple DES performs data encryption. Using a block diagram illustrate the major steps of each cycle of AES algorithm. (11) [CO1]  
b) Discuss the following attacks: (i) Ciphertext-only, (ii) Chosen-plaintext, (iii) DoS, and (iv) DDoS. How Known-plaintext-attack can be mounted on RSA cipher? Using the required parameters, derive the mechanism. (15) [CO4]  
c) Define Firewalls. Discuss major types of Firewalls. Discuss various network threats elaborately. (09) [CO2]
4. a) Describing required conditions and parameters, discuss how RSA and ElGamal cipher can be used to develop product cipher. Derive re-randomization property of ElGamal cipher. (15) [CO3]  
b) 'Confusion' and 'Diffusion' are the ultimate goal of every cryptosystem – why? Discuss Shannon characteristics of good cipher. (09) [CO1]  
c) Establish a comparison between AES and DES. Show that the encryption and decryption operations of Caesar cipher work according to substitution cipher. (11) [CO2]

**SECTION B**

(Answer **ANY THREE** questions from this section in Script B)

5. a) Define the Discrete Logarithm Problem (DLP) and explain why it is considered computationally difficult to break in cryptography. (09) [CO1]  
b) In the Diffie-Hellman Key Exchange (DHKE) protocol, each participant selects a private key 'a' from the range {2, ..., P-2} where P is a prime number. Explain why the values a = 1 and a = P - 1 are excluded from this range. (11) [CO2]  
c) Explain scalar multiplication operation on Elliptic Curve (EC). Given an EC (15) [CO3]  
 $E: y^2 = x^3 + 3x + 5 \pmod{17}$  and point  $P = (1,3), Q = (4,8)$ ,  
compute  $2P = P + P = (x_3, y_3)$  and  $P + Q = (x_4, y_4)$ . Consider the equations:

$$\begin{aligned}x_3 &= S^2 - x_1 - x_2 \pmod{P} \\y_3 &= S(x_1 - x_3) - y_1 \pmod{P} \\S &= \begin{cases} \frac{3x_1^2 + a}{2y_1} \pmod{P} \\ \frac{y_2 - y_1}{x_2 - x_1} \pmod{P} \end{cases}\end{aligned}$$

6. a) Explain Post-Quantum Cryptography (PQC) and discuss its impact on symmetric and asymmetric cryptographic algorithms. (07) [CO1]
- b) Explain the DHKE protocol and its key setup. Describe the EC-DHKE protocol and compare it with standard DHKE in terms of security and key size. (13) [CO3]
- c) Define Transport Layer Security (TLS) and its purpose. Describe the TLS 1.2 handshake process. Compare TLS 1.2 and TLS 1.3 in terms of handshake efficiency and latency. Is O-RTT handshake supported in TLS 1.3, and under what conditions? (15) [CO4]
7. a) Explain the  $N^2$  key distribution problem in symmetric key systems. (05) [CO1]
- b) Define Elliptic Curve Discrete Logarithm Problem (ECDLP) and explain why computing it is considered difficult. (05) [CO2]
- c) Explain Elliptic Curve Cryptography (ECC) by describing its key generation, encryption and decryption processes. (10) [CO3]
- d) Illustrate the following web attacks with diagrams showing attacker-victim-server interactions, and explain effective mitigation techniques for each: (15) [CO4]
  - i) Cross-site Request Forgery (CSRF).
  - ii) Server-side Request Forgery (SSRF).
  - iii) Cross-site Scripting (XSS).
8. a) Various malicious codes have different characteristics – discuss them briefly. Explain characteristics of good viruses. (05) [CO2]
- b) Define the Point at Infinity in ECC and explain the conditions under which it is reached. (06) [CO2]
- c) Explain homomorphic encryption and its types. Derive the equations of homomorphic operations in the Paillier cryptosystem and illustrate each with an example. (12) [CO3]
- d) Illustrate a Man-in-the-Middle (MITM) attack on the DHKE protocol and discuss methods to prevent such attacks in public key cryptosystems. (12) [CO3]

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
 B.Sc. Engineering 4<sup>th</sup> Year 1<sup>st</sup> Term Examination, 2024  
 Department of Computer Science and Engineering  
 CSE 4127

Image Processing and Computer Vision

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
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**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) Briefly describe the role of different components of an image processing system. (06) [CO1]  
 b) A lunar rover captured a 4-bit image of moon-surface under poor lighting condition, (20) [CO3]  
 then it transmitted multiple 6×6 RLC patches. You are given an RLC image of a patch  
 and a PDF. Your task is to adjust the pixel intensity according to the given PDF, then  
 stretch the contrast of the output/obtained image to its maximum possible range.  
 RLC image: <3,3>, <4,2>, <3,3>, <6,4>, <5,4>,  
 <3,5>, <7,2>, <4,5>, <6,4>, <7,4>

PDF:

$x$	0	1	2	3	4	5	6	7	8	9
$f(x)$	0.06	0.07	0.1	0.15	0.2	0.15	0.1	0.07	0.05	0.05

- c) Prove that 'convolution in time domain corresponds to multiplication in frequency domain'. (09) [CO2]
2. a) Explain the impact of wrong choice of order for contra-harmonic mean filter. (05) [CO2]  
 b) All the MRI images captured by an MRI machine contains periodic noises of different (10) [CO4]  
 frequencies within the band (6 to 10). Design a butterworth filter to visualize the noise  
 pattern.  
 c) Given a grayscale 4×4 image of  $f(x, y)$  and a quantization matrix  $Q$ . Apply JPEG (20) [CO3]  
 algorithm and compute the RMS error of compression-decompression.

$$f(x, y) = \begin{bmatrix} 52 & 55 & 61 & 66 \\ 70 & 61 & 64 & 73 \\ 63 & 59 & 55 & 90 \\ 67 & 73 & 78 & 85 \end{bmatrix} \quad Q = \begin{bmatrix} 16 & 11 & 10 & 16 \\ 12 & 12 & 14 & 19 \\ 14 & 13 & 16 & 24 \\ 14 & 17 & 22 & 29 \end{bmatrix}$$

3. a) Compute the Golomb code for the following representation: (10) [CO3]  
 i)  $G_{12}(-15)$   
 ii)  $G_{exp}^2(13)$   
 b) Apply pruning on the given binary image (Fig: 3(b)) using the structuring elements (15) [CO2]  
 ( $B1 \sim B8$ ) where-

$$B1 = \begin{bmatrix} x & 0 & 0 \\ 1 & 1 & 0 \\ x & 0 & 0 \end{bmatrix}$$

$$B5 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$B2, B3$  &  $B4$  are 90° rotated version of  $B_{i-1}$  from  $B1$

$B6, B7$  &  $B8$  are 90° rotated version of  $B_{i-1}$  from  $B5$

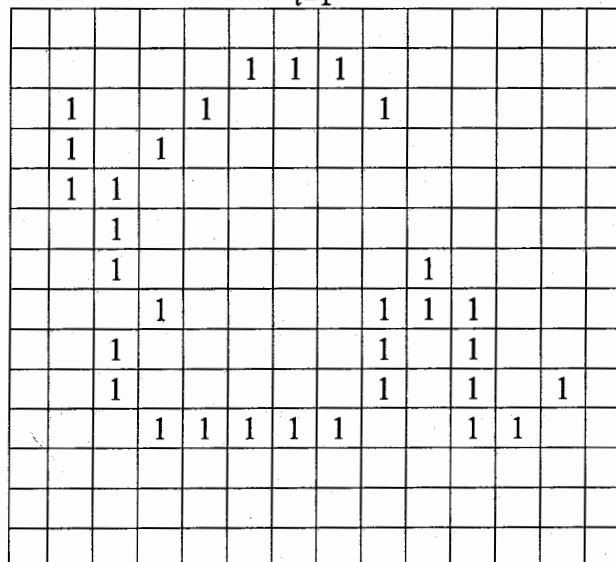


Fig: 3(b)

- c) Develop a mathematical model for degradation due to uniform linear motion. (10) [CO4]
4. a) Find the frequency domain filter  $H(u, v)$  that works as a Laplacian filter in spatial domain, hence design a Wiener filter using  $H(u, v)$  taking  $SNR = 10$ . (12) [CO3]
- b) Explain the procedure of morphological reconstruction with its application. (10) [CO1]
- c) A satellite captured an image of earth when one side of the earth is exposed to sunlight and other side remained dark, resulting a non-uniform illumination. Further, the memory of the satellite was lit by the cosmic rays causing an addition of very dense impulse noise to the stored image. What are the appropriate filters that can be used one after another to remove the impulse noises then to suppress the illumination? (13) [CO4]

**SECTION B**

(Answer ANY THREE questions from this section in Script B)

5. a) Perform a full convolution on the following image using the given kernel. Be aware of the input and output indices. Use border replication padding while convolving. (10) [CO1]

	0	1	2	3
0	5	6	8	2
1	3	1	0	2
2	7	8	3	9
3	3	4	5	1

image

	-1	0	1
0	1	2	-2
1	-1	0	1

kernel

- b) Prove that convolution with a 2D separable filter can be accomplished by performing two one-dimensional convolutions. (09) [CO2]
- c) Suppose you want to segment the following image using normalized graph cut method proposed by Shi-Malik. Represent the image as a weighted graph considering 4-connected pixels and  $\sigma_F = 4$ ;  $\sigma_S = 1.5$ , where symbols have their usual meaning. (16) [CO4]

8	4	9	25
5	11	22	28
9	2	27	30
29	27	28	31

6. a) Consider a grayscale image where foreground and background pixels are normally distributed with  $\mu_f = 150$ ,  $\mu_b = 50$ ,  $\sigma_f = \sigma_b = 15$  and foreground pixels are one-third of total pixels. Find a minimum error threshold to separate the foreground from background. (09) [CO2]
- b) For the following binary image, compute first two invariant  $Hu$  moments. Equations given below are for your convenience, where symbols bear usual meanings. (15) [CO3]

		→ x				
		0	1	2	3	4
	0	0	0	0	0	0
	1	0	0	1	1	0
	2	0	1	1	1	0
	3	1	1	1	1	0
	4	0	0	1	1	0

$$\phi_1 = \eta_{20} + \eta_{02}; \phi_2 = (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^2$$

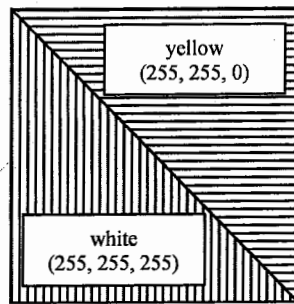
$$\eta_{pq} = \frac{\mu^{pq}}{\mu_0^p \mu_0^q}; \gamma = \frac{p+q}{2} + 1$$

$$\mu_{pq} = \sum \sum (x - \bar{x})^p (y - \bar{y})^q f(x, y); \bar{x} = \frac{m_{10}}{m_{00}}; \bar{y} = \frac{m_{01}}{m_{00}}$$

$$m_{pq} = \sum \sum x^p y^q f(x, y)$$

- c) Briefly explain Harris-Stephens corner detection method to find interest points from an image. Why is this method not covariant to image scaling? (11) [CO2]
7. a) What does it mean by homography transform of an image? Explain how can you estimate homography matrix using direct linear transform from two images. (12) [CO2]
- b) Following figure shows a RGB image with a white and a yellow region, where values in the parenthesis means RGB channel values. Compute edge magnitude and orientation at the diagonal line separating the regions using- (16) [CO3]
- (i) Di Zenzo-Cumani color edge operator.

(ii) First convert the image to grayscale then apply monochromatic edge operator. Use simplest possible derivative operator.



- c) State the pros and cons of histogram based texture descriptors with proper example. (07) [CO3]
8. a) How can you modify the Lucas-Kanade optical flow estimation method to handle reasonably large motion? Explain with necessary illustration. Do you need image warping? If so, why? (13) [CO3]
- b) The following table shows some features extracted from some binary images along with their known classes. If you would like to use them as training set of your Naïve Bayes classifier, then, estimate the classifier parameters. Also, determine the class of the test sample (0.5, 0.42, 260, 0.59). (16) [CO4]

Form factor	Roundness	Compactness	Eccentricity	Class
0.455	0.327	276	0.587	Star
0.469	0.416	268	0.26	
0.48	0.34	262	0.64	
0.453	0.29	277	0.75	
0.78	0.66	161	0.46	Hexagram
0.79	0.58	159	0.66	
0.82	0.54	153	0.67	
0.84	0.56	148	0.62	

[Hint: Estimate  $\mu_{ji}, \sigma_{ji}$  for features  $x_j$  and class  $c_i$ ]

- c) Explain how histogram intersection can be used as a distance measure for feature descriptor matching. (06) [CO1]

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 4<sup>th</sup> Year 1<sup>st</sup> Term Examination, 2024  
Department of Computer Science and Engineering  
IEM 4127

Industrial Management

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
ii) Figures in the immediate right column of the questions indicate full marks.  
iii) The rightmost column indicates the course outcomes.

**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) What is industrial management? Explain how management and administration are similar and different. (12) [CO1]  
b) Briefly explain 14 principles of management. (12) [CO1]  
c) What are the main differences between scientific management theory and management science theory? (11) [CO1]
2. a) Which leadership allows communication to flow freely in both direction? Explain it with proper example. (11) [CO2]  
b) What is motivation? Explain Herzberg's two factor theory and identify the hygiene and motivator factors that affect employee satisfaction. (12) [CO3]  
c) What are the differences between wages and salaries? Briefly explain different types of wages. (12) [CO2]
3. a) Mention the sources of employees within the organization. What are the attributes that are identified by taking "Aptitude Test" and "Personality Test"? (12) [CO4]  
b) Define the bureaucracy theory school. "A successful organization should react as an organic and open system". To what extent, do you agree with this opinion? Explain. (13) [CO1]  
c) Assume that you are a quality manager in an organization. Explain your managerial roles in the organization. (10) [CO3]
4. a) Describe upper and lower breakeven point with necessary figures. (10) [CO4]  
b) A compressed air compressor has a first cost of 50,000 TK and estimated salvage value of 8,000 TK after 12 years. (10) [CO4]
  - i) Calculate the depreciation for year three using straight line depreciation.
  - ii) Calculate the book value at the end of year six.
  - iii) Plot book value vs time for the 6-year period.
- c) A wastewater treatment facility at the Greenfield Plan costs 9,00,000 TK to construct. It is projected to have 30-year life with an estimated salvage value of 10% of the construct cost. However, the facility will book depreciated to 30,000 over recovery period of 25 years. Calculate the annual depreciation for years 5, 15, and 30 using:
  - i) Straight Line Depreciation (SL).
  - ii) Double Declining Balance Depreciation (DDB).
  - iii) DDB with Implied Salvage Value.

**SECTION B**

(Answer **ANY THREE** questions from this section in Script B)

5. a) Define forecast. What advantages as a forecasting tool does experimental smoothing have over moving average? (12) [CO4]
- b) A textbook publishing company has compiled data on total annual sales of its business texts for the preceding nine years: (16) [CO4]

Year	1	2	3	4	5	6	7	8	9
Sales (000)	40.2	44.5	48.0	52.3	55.8	57.1	62.4	69.0	73.7

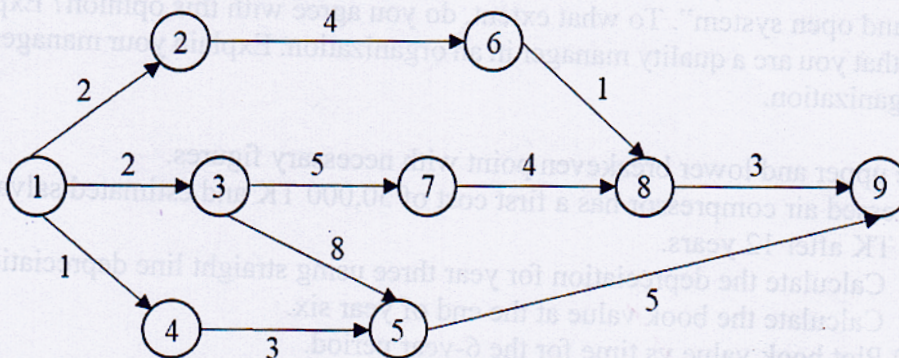
- i) Using an appropriate model, forecast textbook sales for each of the next five years.
  - ii) Prepare a control chart for the forecast errors using the original data. Use 2s limits.
- c) Differentiate between level capacity strategy and chase demand strategy of aggregate planning. (07) [CO2]

6. a) Briefly explain the reasons for including purchasing cost in the quantity discount model. (07) [CO1]  
 b) A manager just received a new price list from a supplier. It will now cost \$1.00 a box for order quantities of 802 or more boxes, \$1.05 a box for 200 to 801 boxes, and \$1.10 a box for small quantities. Ordering cost is \$80 per order, and carrying costs are \$0.7 per box a year. The firm uses 3,800 boxes a year. The manager has suggested a round number order size of 800 boxes. The manager rationale is that with U-shaped cost curve that is fairly flat at its minimum, the difference in total amount between 800 and 801 units would be small anyway. How would you reply to manager's suggestion? What order size would you recommend? (15) [CO4]  
 c) Define safety stock. What is lot sizing, what is its goal, and why is it an issue with lumpy demand? (07) [CO2]  
 d) Differentiate between PERT and CPM. (06) [CO2]

7. a) "Inventory is called necessary evil" – explain. Describe the A-B-C approach to inventory control. (12) [CO4]  
 b) Given the following information on job times and due dates, determine the optimal processing sequence using (i) FCFS, (ii) SPT, (iii) EDD, and (iv) CR. For each method, find the average job flow time and the average job tardiness. (15) [CO4]

Job	Job Time (hours)	Due Date (hours)
a	3.5	7
b	2.0	6
c	4.5	18
d	5.0	22
e	2.5	4
f	6.0	20

- c) What reasons usually prompt an existing organization to seek a new location? How management avoid the problem of considering a new location? (08) [CO2]
8. a) What is dummy activity? Why is it used? (05) [CO1]  
 b) Find the critical path and calculate the slack time of each activity for the following network using computing algorithm. (15) [CO2]



- c) Determine the best way to assign workers to jobs, given the following cost information. Compute the total cost for your assignment plan. (15) [CO4]

Worker	Job		
	A	B	C
1	5	8	7
2	6	7	9
3	4	5	3