L-4/T-2/CSE **Date : 01/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 471** (Machine Learning)

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) Mention two machine learning tasks which can be defined as function approximation. Define a performance measure that strikes a balance between precision and recall. **(6+4)**

   (b) Draw the computational graph of the function **(5+10+10)**

$$f = \frac{1}{1+e^{-\begin{bmatrix} w_2 & w_1 & w_0 \end{bmatrix}\begin{bmatrix} x_2 \\ x_1 \\ 1 \end{bmatrix}}}$$

   for input $\begin{bmatrix} w_2 & w_1 & w_0 \end{bmatrix} = \begin{bmatrix} -3 & 2 & -3 \end{bmatrix}$ and $\begin{bmatrix} x_2 \\ x_1 \\ 1 \end{bmatrix} = \begin{bmatrix} -2 \\ -1 \\ 1 \end{bmatrix}$.

   Compute the value of each intermediate node using forward propagation.

   Compute the output gradient with respect to each intermediate node using back propagation.

2. (a) Max-pooling layer implements a non-differentiable function. Can we compute gradient using backpropagation within a convolutional neural network containing multiple max-pooling layer? YES or NO? Explain your position. **(10)**

   (b) Can we use filters in convolutinal neural network without parameter sharing? If YES, mention an application why you would want to do that? If NO, explain the reason. **(10)**

   (c) Define vanishing gradient problem in the context of recurrent neural network (RNN). Between the following two sentences, which one will be more difficult to encode accurately using RNN. Explain your reason. **(5+10)**

   Sentence 1: *The boy who played football yesterday on the school yard injured himself.*

   Sentence 2: *The boy injured himself yesterday during playing football on the school yard.*

3. (a) Write the objective function for matrix factorization with L2 regularization. Define each quantity in your equation. **(10)**

   (b) What are the steps of a single update for an AdaGrad implementation incorporating Nesterov momentum? **(15)**

   (c) How can we convert and fine-tune a stacked autoencoder as a classifier after parameter initializing with layer-wise pretraining? **(10)**

Contd P/2

CSE 471

4. (a) A 3-node hidden layer word2vec model has been trained over a 6-word unique vocabulary corpus. The weight matrix is given below: **(10)**

$$\begin{bmatrix} 1 & 2 & 3 \\ 2 & 8 & 2 \\ 9 & 8 & 9 \\ 6 & 5 & 4 \\ 2 & 3 & 2 \\ 5 & 6 & 7 \end{bmatrix}$$

What are the one-hot encoding of two most similar words and two most dissimilar words in the corpus? Use Euclidian distance as your distance measure.

(b) The following objective function can be used to train a variational autoencoder by minimization

$-log(p(\mathbf{x}_i)) + D_{KL}(q(\mathbf{z}|\mathbf{x}_i)||\, p(\mathbf{z}\,|\,\mathbf{x}_i))$. Why do we use an alternative objective function for training instead? Define that alternative function. All symbols carry their usual meaning. **(10)**

(c) Give a geometric proof that maximizing variance of 2-D data points is equivalent to minimizing reconstruction loss in the context of computing first principal component. **(15)**

SECTION – B

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

5. (a) With an example explain the steps of Adaboost method. **(15)**

(b) Computer Stacking and Bagging. **(10)**

(c) Compare with example "overfitting" and "underfitting". **(10)**

6. (a) How does EM algorithm work? Explain the steps. **(20)**

(b) Let events be "grades in a class". The probability of getting Grade A is P(A) = ½, Grade, B is P(B) = μ, Grade C is P(C) = 2μ, and Grade D is P(d) = $½ - 3\mu$, (Note $0 \leq \mu \leq 1/6$). Assume we want to estimate μ from data. In a given class, the number of students having grade A is $n1$. Grade B is $n2$, Grade C is n3 and grade D is $n4$. What's the maximum likelihood estimate of μ given $n1$, $n2$, $n3$, $n4$? **(15)**

7. (a) Define *Least Square Regression and Ridge Regression* Model. When dimension is large what are the problems? **(15)**

(b) Prove that $\mathbf{w} = (\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$ in the context of adaptive basis function model. All the symbols carry their usual meaning. **(20)**

Contd P/3

CSE 471

8. (a) Calculate information Gain for A and B. Make Decision Tree based on the best split. **(20)**

A	B	C
T	F	+
T	T	+
T	T	+
T	F	–
T	T	+
F	F	–
F	F	–
F	F	–
T	T	–
T	F	–

(b) Define and explain Entropy, Recall, Precision, Sensitivity, F measure. **(15)**

L-4/T-2/CSE **Date : 01/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 481** (VLSI Design)

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) Formulate partitioning problem in graph theoretic terms mentioning the objection functions and constraints. **(7)**

   (b) Write down the pseudo code for VLSI partitioning algorithm using simulated annealing technique explaining perturbation, updating and stopping criteria in details. **(13)**

   (c) What are the layout design rules? Demonstrate the design rules in a VLSI design layout of a CMOS inverter circuit. **(8)**

   (d) Describe the process of manufacturing *n*-well for a CMOS inverter showing the cross section while manufacturing. **(7)**

2. (a) Present the basic structure of an nMOS transistor. **(5)**

   (b) Define different regions of operation explaining the mobility of the free electrons and holes in the nMOS transistor. Derive equations of drain to source current of an nMOS transistor for different regions of operation. **(15)**

   (c) Compare the relative advantages and disadvantages of Bipolar Junction Transistor and CMOS transistor in implementing the inverter circuit. **(7)**

   (d) Draw circuit of 2-input CMOS NOR gate. Explain the operation of the circuit using the V-I characteristic curve of nMOS and pMOS gates. **(8)**

3. (a) Sketch a transistor-level schematic for a compound CMOS logic gate for each of the following functions: **(9)**

   (i) $f_1 = \overline{ABC + D}$ (ii) $f_2 = \overline{(AB + C) \bullet D}$ (iii) $f_3 = \overline{AB + C(A + B)}$

   (b) What is a CMOS pass transistor? Why is it preferred to nMOS or pMOS pass transistor? **(6)**

   (c) Derive the differential equations for different phases of inverter ramp response. **(6)**

   (d) Sketch a 2-input NOR gate with transistor widths chosen to achieve effective rise and fall resistances equal to a unit inverter. Compute the rising and falling propagation delays of the NOR gate driving *h* identical NOR gates using the RC delay model. **(7)**

   (e) Sketch a multiplexor using CMOS pass transistor gates. Why do these gates produce nonrestoring multiplexor? Design a restoring multiplexor. **(7)**

Contd P/2

CSE 481

4. (a) What are the different sources of power dissipation in CMOS logic gates? **(4)**

(b) Show that in a CMOS inverter only half of the energy of the power supply is stored in the capacitor. **(6)**

(c) What do you mean by activity factor of a switching circuit? How does activity factor of a switch affect the dynamic power dissipation of a switch? **(5)**

(d) You are considering lowering *VDD* to try to save power in a static CMOS gate. You will also scale V_t proportionally to maintain performance. Will dynamic power consumption go up or down? Will static power consumption go up or down? **(8)**

(e) How are parallelism and pipelining used for reducing power consumptions? **(6)**

(f) Write short note on Dynamic Voltage scaling. **(6)**

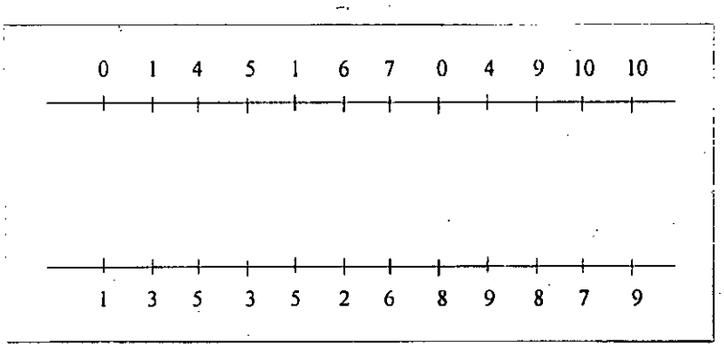
SECTION – B

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

5. a) What are the considerations in detailed routing of a region? **(3)**

(b) Explain the following with necessary figures in the context of detailed routing: (i) HVM routing Model (ii) unreserved routing model (iii) dogleg (iv) Horizontal Constraints. **(12)**

(c) Consider the following netlist for channel routing. Show different steps of net merge channel router using Yoshimura and Kuh's channel routing algorithm to assign nets to the tracks. **(20)**



6. (a) Draw the circuit diagram a 6-transistor SRAM cell. Explain read and write operation of a 6 transistor SRAM cell for read stability and writeability. **(10)**

(b) What are the benefits of a 12-transistor SARAM cell over a 6 transistor SRAM cell? Explain with necessary diagrams and operations. **(8)**

(c) What is the function of sense amplifier in reading a DRAM cell? Explain the operation of sense amplifier with necessary circuit diagram and timing diagrams. **(10)**

Contd P/3

CSE 481
Contd. Q. No. 6

(d) Present the folded bitline architecture in the DRAM array to incorporate two bitlines in the sense amplifier. **(7)**

7. (a) A Show a ROM layout with two words and four bits. Explain how a particular cell of the ROM is configured to store 0 or 1 in the layout design. **(10)**

(b) Design a dynamic PLA with necessary column and row circuitry to implement the following Sum of Product functions: **(15)**

$$f_1 = \sum(1,3,5,8,10,19,23)$$
$$f_2 = \sum(2,3,7,8,12,19,23)$$
$$f_3 = \sum(1,3,6,8,17,19,23,28)$$

(c) Transform floor planning of fixed blocks to an Integer Programming problem. **(10)**

8. (a) Show the process of routing using flowchart. **(5)**

(b) Define channel, 2D switch box and 3D switch box for routing nets in VLSI layout. **(9)**

(c) Why is channel intersection graph model called the most accurate model? Explain with necessary examples. **(6)**

(d) What are the basic principles of different maze routing algorithms? Compare them in terms of computational complexity and accuracy. **(15)**

L-4/T-2/CSE **Date : 01/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 461** (Algorithm Engineering)

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) Recursive optimization algorithm are often modified to use memoization or converted into dynamic programming algorithms. Explain with example. **(10)**

   (b) Suppose you were to drive from one city to another. Your gas tank, when full, holds enough gas to travel m miles, and you have a map that gives distances between gas stations along the route. Let $d_1 < d_2 \ldots < d_n$ be the locations of all the gas stations along the route where d_i is the distance from origin to the gas station. You can assume that the distance between neighboring gas stations is at most m miles. Your goal is to make as few gas stops as possible along the way. Give the most efficient algorithm you can find to determine at which gas stations you should stop and prove that your strategy yields an optimal solution. Be sure to give the time complexity of your algorithm as a function of n. **(12)**

   (c) You are given an exam with questions numbered 1, 2, 3, … n. Each question i is worth p_i points. You must answer the questions in order, but you may choose to skip some questions. The reason you might choose to do this is that even though you can solve any individual question i and obtain the p_i points, some questions are so frustrating that after solving them you will be unable to solve any of the following f_i questions. Suppose that you are given the p_i and f_i values for all the questions as input. Devise the most efficient algorithm you can for choosing set of questions to answer that maximizes your total points, and compute its asymptotic worst case running time as a function of n. **(13)**

2. (a) Dominating Set Problem is defined as: Given the network G, and a number k, is there a way to place k copies of the database at k different nodes so that every node either has a copy of the database or is connected by a direct link to a node that has a copy of the database. Show that Dominating Set Problem is NP-complete. **(14)**

   (b) A restaurant chain is considering opening a series of restaurants along a high-way. The n possible location are along a straight line, and the distance of these locations from the start of the highway are, in miles and in increasing order, $m_1 < m_2 \ldots < m_n$. The constraints are as follows: **(14)**

Contd P/2

CSE 461

Contd. Q. No. 2(b)

- At each location, you may open at most one restaurant. A restaurant at location i makes profit p_i, where $p_i > 0$ and i = 1, 2 …, n.
- Any two restaurants should be at least k miles apart, where k is a positive integer.

Give an efficient algorithm to find the placement of the restaurants such that the maximum profit is achieved subject to the given constraints.

(c) What are the advantages and disadvantages of Needleman Wunsch algorithm? **(7)**

3. (a) Explain Christofides Algorithm with the approximation ratio. **(15)**

   (b) What is the competitive ratio with respect to online algorithm? Explain with example. **(8)**

   (c) What is the probability that Karger's algorithm returns a min-cut. **(12)**

4. (a) What are the advantages of Miller-Rabin theorem over Fermat's little theorem? **(10)**

   (b) Explain closest pair of points algorithm using divide and conquer approach. **(15)**

   (c) What is a randomized algorithm? Explain the differences between Monte Carlo and Las Vegas algorithms. **(10)**

SECTION – B

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

5. (a) For the paging problem with cache size *k*, prove that any deterministic online algorithm cannot have a competitive ratio better than *k*. **(15)**

   (b) Give a 4-approximation algorithm for Sorting by Reversals problem. Analyze the approximation ratio. **(15)**

   (c) Show that in an *n*-Queen problem, a greedy Las Vegas algorithm takes expected *n* attempts to reach success. **(5)**

6. (a) Define 3-satisfiability problem. Prove that it is NP-Complete. **(15)**

   (b) Describe how a Skip-list is built for a given set of *n* sorted elements. How can a search operation of element *x* be performed in the Skip-list? Briefly describe with an example. **(20)**

7. (a) How does splaying improve the performance of a Splay tree? Describe the advantages of a Splay tree. Analyze the amortized cost of Zig step in a splay operation on an *n*-node splay tree. **(15)**

   (b) What do you mean by "Problem X is as hard as Problem Y"? Show that the vertex cover problem and the independent set problem are equally hard. **(12)**

Contd P/3

CSE 461

Contd. Q. No. 7

(c) What is affine gap penalty? Write the recurrences for sequence alignment problem that think of affine gap penalty but run in $O(n^2)$ complexity. **(8)**

8. (a) Define approximation ratios for both minimization and maximization problems. Give an approximation algorithm for the set cover problem and prove its approximation ratio. **(5+15=20)**

(b) What is sequence alignment problem? Describe global and local alignment of two sequences. Write the dynamic programming based approach to solve global alignment problem and then efficiently modify it to solve the local one. **(15)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 409** (Computer Graphics)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.0

SECTION – A

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

1. (a) Briefly describe the stages of the raster-based graphics pipeline. **(13)**

   (b) Define affine and convex combination of vectors. **(6)**

   (c) Hermite curve is C^1 continuous, i.e., the 1^{st} derivatives of two consecutive segments are equal at the join point. You want to design C^2 continuous Hermite curve, where both 1^{st} and 2^{nd} derivatives of two consecutive segments must be equal at the join point. For a C^2 continuous Hermite curve, what will be the lowest degree of the parametric polynomial? What will be the dimension of the basis matrix? Derive the basis matrix. It is not required to compute the inverse of a matrix if it shows up in your expression for the basis matrix. **(2+2+12=16)**

2. (a) Prove that the inverse of a 3D rotation matrix is its transpose. **(12)**

   (b) Consider the following 2D parametric curve, $x(t)=t^2-2t+3$ and $y(t)=3t^2+t-2$. Let P(t) denote the point (x(t),y(t)). Determine P(0), P(0.25), P(0.5), P(0.75), and P(1) using forward differencing method. **(13)**

   (c) Consider the vectors $\vec{p}$ = (1,0,1) and $\vec{q}$ = (0,1,1). You want to align $\vec{p}$ with $\vec{q}$ by rotating around the axis (–1,–1,1). What will be the angle of rotation? **(10)**

3. (a) Describe the classification of projection. **(14)**

   (b) For a perspective projection, the COP is (1,2,3) and the projection plane is z=10. Let L be a set of parallel 3D lines whose vanishing point under the perspective projection defined above is (8,9,10). Determine the unit vector along the direction of L. Justify your answer. **(12)**

   (c) How can it be possible that two curve segments are C^1 continuous, but not G^1 continuous at the join point? **(9)**

4. (a) A ray falls on a plane P and gets reflected. The directions of the incident and reflected rays are given by the vectors $\vec{a}$ and $\vec{r}$ respectively. The unit vector along the normal direction of P is $\vec{n}$. **(6+6+6=18)**

Contd P/2

CSE 409

Contd ... Q. No. 4(a)

(i) Prove that, $\vec{r} = \vec{a} - 2(\vec{a}.\vec{n})\vec{n}$

(ii) Convert the vector formula in Q. 4(a) (i) into a matrix equation that transforms $\vec{a}$ to $\vec{r}$, assuming $\vec{n}$ is given.

(iii) Using the matrix equation, determine the direction of the reflected ray when an incident ray along the vector (1,1,1) gets reflected on the plane 3x+2y+6z=30.

(b) For a parallel projection, the projection plane is x+y+z=10 and the direction of projection is (1,1,1). Determine where the point (1,2,3) will be transformed under the parallel projection defined above. **(9)**

(c) Explain with example why we use parametric polynomials instead of polynomial functions to represent curves. **(8)**

SECTION – B

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

5. (a) Apply *Cyrus-Beck Parametric Line Clipping Algorithm* on the following two lines: **(15)**

(i) (1,1) to (21,21)

(ii) (1,12) to (14,18)

The clip region is defined as the following four clipping edges: y=3, y=14, x=8, and x=18. Show detailed calculation to determine whether an intersecting point is potentially entering or potentially leaving the clip region. For your convenience, the chart for determining the parameter is given in Table 5(a).

Clip Edge	$t = \frac{N_i.(P_0 - P_{E_i})}{-N_i.D}$
Left: $x = x_{min}$	$\frac{-(x_0 - x_{min})}{(x_1 - x_0)}$
Right: $x = x_{max}$	$\frac{-(x_0 - x_{max})}{(x_1 - x_0)}$
Bottom: $x = y_{min}$	$\frac{-(y_0 - y_{min})}{(y_1 - y_0)}$
Top: $x = y_{max}$	$\frac{-(y_0 - y_{max})}{(y_1 - y_0)}$

Table 5(a): Determining the parameters for different clip edges in Cyrus-Beck Algorithm

(b) Derive a string production rule that will generate the fractal tree shown in Figure 5(b) **(10)**

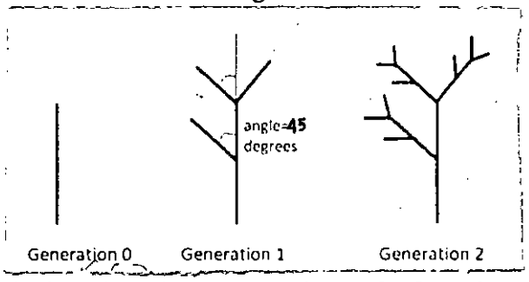


Figure 5(b): Three generations of a fractal tree

Contd P/3

CSE 409

Contd ... Q. No. 5

(c) Write the mathematical formula for *Phong Illumination Model* for all three color channels. Then, using the formula, show how a red object will appear in green light if we render an image using this illumination model. **(5)**

(d) The following polygon shown in Figure 5(d) is scan converted using *Polygon Scan Conversion Algorithm*. Determine which edges of the polygon will be drawn by the algorithm. You have to write your answer including the endpoints. You do not have to show any calculation or explanation. **(5)**

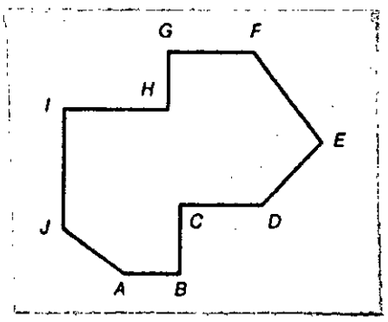


Figure 5(d): Polygon ABCDEFGHIJ for Question 5(d)

6. (a) You have to develop a *Midpoint Hyperbola Algorithm* for the hyperbola $\frac{y^2}{b^2} - \frac{x^2}{a^2} = 1$.

The algorithm will draw the lower left part of the hyperbola only, as shown in Figure 6(a). **(20)**

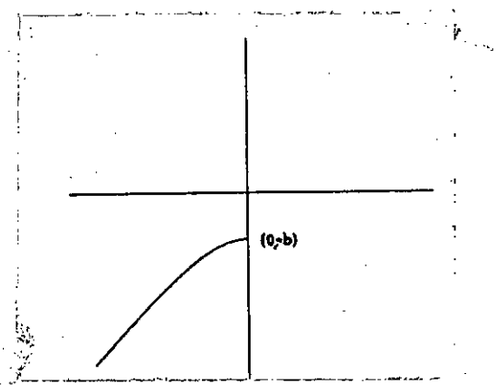


Figure 6(a): Figure for Question 6(a)

You have to identify two regions based on the slope of the curve. For each region, you have to do the following:

(i) Determine which two pixels are of interest in each iteration

(ii) Derive a decision variable

(iii) Identify the two cases using the decision variable. In each of the cases, you have to identify which pixel will be populated

(iv) Derive the value of the decision variable for the next iteration in terms of the value for current iteration and other constants

Contd P/4

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

The Algorithm must address both of the regions that you have identified.

Note: you do NOT have to reduce computational load by introducing forward differencing.

(b) Write a short note on *Blinn and Torrence variation.* **(5)**

(c) Write the texture formula for modulating reflection coefficient. You only have to write the formula with standard notations. No explalnation is necessary. **(5)**

(d) Make a comparison between *Phong Shading* and *Gouraud Shading.* In doing so, make reference to two different scenarios where one is preferable over the other. **(5)**

7. (a) To render antialiased line, two standard techniques are used: *unweighted* and *weighted area sampling.* In weighted area sampling using *Gupta-Sproul Filter,* we determine D, the distance of a pixel from the center of the line that is being rendered. This value of D is used to determine the weight for a certain pixel (which is to be populated at a certain intensity).

If the *Midpoint Line Algorithm* chooses the pixel NE, then we have to determine intensity for three pixels: NE, the pixel above NE, and the pixel below NE. Therefore, to use Gupta-Sproul Filter, we have to determine three D values, namely D, D_{up} and D_{down} respectively.

With detailed mathematical calculations, determine the values of D, D_{up} and D_{down} if the pixel chosen by the Midpoint Line Algorithm is NE. **(15)**

(b) A *pinhole camera* is shown in Figure 7(b). It generates an unorthodox projection of the objects on the screen, as you as you can understand from the figure.

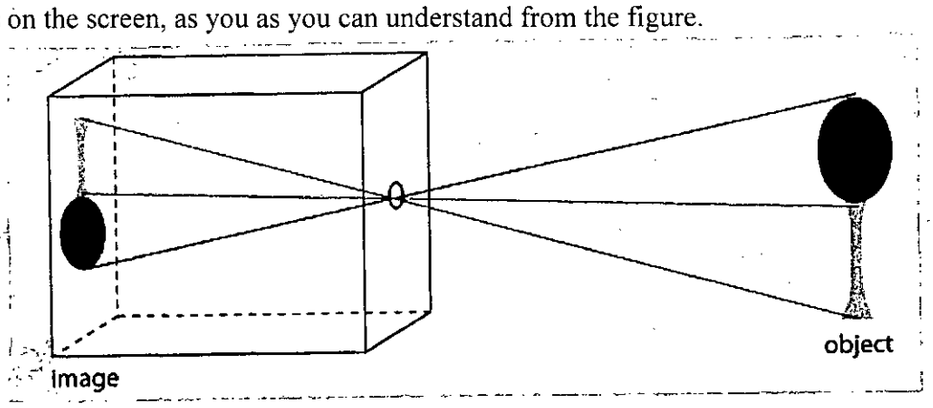


Figure 7(b): A pinhole camera

Make necessary modifications to the *ray tracing algorithm* for implementing a pinhole camera. **(10)**

(c) Show a case where unnecessary splitting of polygons occurs for *Depth Sort Algorithm* for resolving visibility. You do NOT have to write the five tests that are performed in the Depth Sort Algorithm. **(5)**

(d) Classify the following five algorithms for resolving visibility in the following four categories: image precision and conservative, image precision and non-conservative, object precision and conservative, object precision and non-conservative. **(5)**

(i) Back face Culling (ii) Z-buffer (iii) Depth Sort (iv) BSP tree (v) Scan Line Algorithm

Contd P/5

CSE 409

8. (a) Point out the limitation(s) of *Cyrus Beck Parametric Line Clipping Algorithm.* **(5)**

(b) Note the polygons in Figure 8(b). For each of the three scan lines, show the contents in AET (Active Edge Table) to be used in *Scan Line Algorithm* for resolving visibility. For the scan line γ, simulate the algorithm to show how visibility is resolved. **(10)**

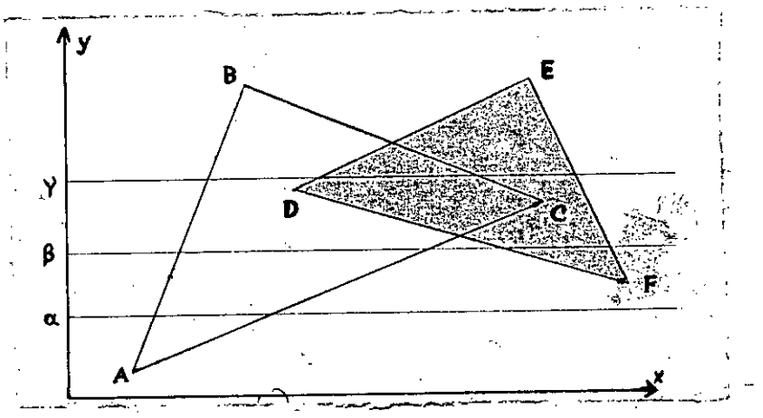


Figure 8(b): Figure for Question 8(b)

(c) Two generations of a fractal are shown in Figure 8(c). One third of the original curve is deleted from Generation 1, which is added four times in a zigzag pattern in the deleted portion to construct Generation 2. **(10)**

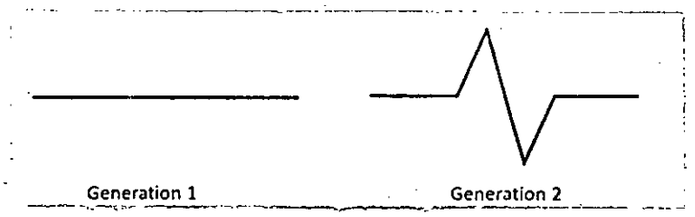


Figure 8(c): First two generations of a fractal curve

(i) Draw the third generation

(ii) Determine the length of the n^{th} generation of the fractal.

(iii) Determine the dimension of the fractal.

(d) Study the lines shown in Figure 8(d). For the described scene, **(10)**

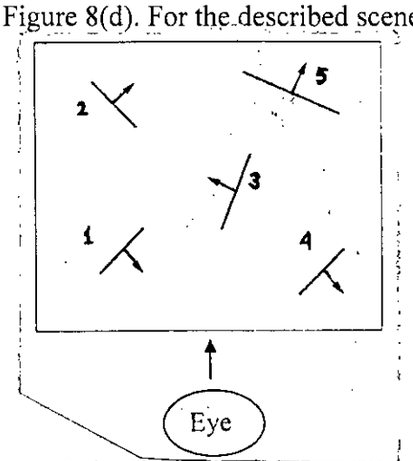


Figure 8(d): Figure for question 8(d)

construct a BSP tree (*Binary Space Partitioning* tree). Use any arbitrary order of the lines. If you need to split a line at a certain point while constructing the tree, show the appropriate split portions in a clearly drawn figure. Finally, show the visibility order when the camera is below the scene and looking up.

L-4/T-2/CSE **Date : 27/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **HUM 275** (Economics)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Explain the main challenges that every economy struggles to overcome. **(13⅓)**

   (b) What are the major macroeconomic objectives that governments typically pursue? Briefly give an overview of the major macroeconomic issues. **(10)**

2. (a) What do you understand by short run and long run with reference to theory of production and cost? Explain the law of diminishing marginal returns and show the short run cost curves in production with graphically presentations. **(13⅓)**

   (b) How would you construct the long run average cost curve? Why is the curve called an envelope curve? Explain the internal economics of scale of production. **(10)**

3. (a) What do you understand by revenue of a firm? Draw the average and marginal revenue curves of a firm facing a downward sloping demand curve. Describe the conditions for profit maximization involving marginal revenue (MR) and marginal cost (MC). **(13⅓)**

   (b) Clarify the concepts of 'profit' and 'opportunity cost'. The total revenue (TR) and total cost (TC) functions of a firm are given by **(10)**

   $TR = 4350M - 13M^2$

   $TC = M^3 - 5.5M^2 + 150M + 675$

   where M refers to quantity of output.

   Find the profit maximizing level of output and maximum profit.

4. Write short notes on any THREE of the following: **(23⅓)**

   (i) Circular flow of income in an open economy

   (ii) GDP, GNI, NNI and Household's disposable income

   (iii) Monopolistic competition

   (iv) Optimum combination of factors in a production process

Contd P/2

HUM 275(CSE)

SECTION – B

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

5. (a) What is the 'Law of Demand'? Mention some variables that can shift the demand curve and explain. What is the 'Law of Supply'? Mention some variables that can shift the supply curve and explain. **(11 ⅓)**

   (b) If the demand and supply curve for computers are: $Q_D = 100 - 6P$, $Q_S = 28 + 3P$ where P is the price of computers, what is the quantity of computers bought and sold at equilibrium? **(5)**

   (c) How an increase in demand affects the equilibrium? Show graphically. **(7)**

6. (a) Suppose $U = (8X^3Y^3 / 4X^2Y^2)$ where X and Y are two consumer goods. Suppose price of X is 10 and price of Y is 20. You have wealth, W = 300. Draw the budget Line. Find the optimal choice of X and Y. What is the total utility as in value of U? Show the whole scenario diagrammatically. **(13 ⅓)**

   (b) In case of Perfect Substitutes and Perfect Complements, how will you find the optimal choice? **(10)**

7. (a)

Price	Quantity Demanded (Business Travelers)	Quantity Demand (Vacationers)
150 Tk	2100 tickets	1000 tickets
200 Tk	2000	800
250 Tk	1900	600
300 Tk	1800	400

   (i) As the price of tickets rises from tk 200 to tk 250, what is the price elasticity of demand for business travelers and vacationers? **(13 ⅓)**

   (ii) Why might the vacationers have a different elasticity from the business travelers?

   (b) Describe any five principles of Economics. **(10)**

8. (a) Suppose the government has fixed a minimum wage of RMG labors which is above the equilibrium wage. What will be the impact of this policy on the labor market? What if the minimum wage is set below the equilibrium wage? Discuss its impact on labor market. **(13 ⅓)**

   (b) Consider a hypothetical equilibrium in the market for Igloo. Think for instance, a heat wave is going over the country. What will be the change in the equilibrium price and quantity? **(5)**

   (c) Describe four properties of Indifference Curves. **(5)**

L-4/T-2/CSE **Date : 16/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 473** (Pattern Recognition)

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) With appropriate examples show that the capacity of a linear classification model is inversely related to its margin. **(11)**

   (b) Why does *k*-means sometimes produce empty clusters? Explain how incremental updating of centroids solve this problem. Do you think this updating scheme creates further issue? Justify. **(24)**

2. (a) Show that a linear SVM targets to optimize the same Lagrangian dual objective function irrespective of linear separability of the training samples. **(20)**

   (b) Define inter symbol interference with respect to channel equalization problem. Explain why channel equalization problem is a context dependent classification problem. **(15)**

3. (a) Why is *basic sequential algorithmic scheme* (BSAS) order dependent? How does *maxmin* algorithm reduce order dependency problem? **(15)**

   (b) Explain why *coin toss problem is a hidden Markov model* (HMM) problem. Assuming

   $\alpha_k(i) = \boldsymbol{P}(o_1, o_2 \ldots o_k,\ q_k = s_i)$ and $\beta_k(j) = \boldsymbol{P}(O_{k+1}, O_{k+2} \ldots O_K \mid q_k = S_j)$,

   show all necessary steps to simplify the following expressions: **(20)**

   (i) $\boldsymbol{P}(q_k = s_i,\ q_{k+i} = s_j,\ o_1 o_2 \ldots o_K)$ (ii) $\boldsymbol{P}(q_k = s_j, o_1, o_2 \ldots o_K)$, where the symbols carry usual meanings. You must state all justifications of simplification, if you use any.

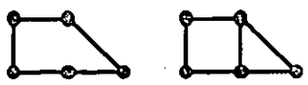
4. (a) A variation of *k*-means is very similar to divisive hierarchical clustering algorithm. Justify whether this variation of *k*-means finds local minima with respect to total *sum of square error* (SSE). Explain whether agglomerative clustering can avoid this problem. What other issues does agglomerative clustering face? **(17)**

Contd P/2

CSE 473

Contd ... Q. No. 4

(b) For the geometric patterns shown in Fig. for Q. No. 4(b), find matched graph and show that the maximal clique of the matched graph makes sense. **(18)**



Pattern# 1 Pattern# 2

Patterns

□ Horizontal line segment
◇ Vertical line segment
○ Diagonal line segment

Node Attributes

Relation: ——Connected

Fig. for Q. No. 4(b)

SECTION – B

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

5. (a) What are **supervised** and **unsupervised** learning? Give an example for each type. **(6)**

(b) Suppose you are required to classify a dataset with an attribute set $\{x_1, x_2, x_3, \ldots x_n\}$ and target class **y** where $y \in \{0, 1\}$. Discuss the condition under which a Bayesian Network classifier will be preferable to Naïve Bayesian classifier for performing this classification. **(8)**

(c) What is a **linearly separable** dataset? Give an example with appropriate figure. **(6)**

(d) Suppose you are trying to classify a non linearly separable dataset using the perceptron algorithm. Is the algorithm guaranteed to converge if you do not allow any misclassification? If so, give an appropriate proof for the convergence. Otherwise, if you think the algorithm may not converge, explain the reasons. **(15)**

6. (a) What is **loss function** for a classifier? Why loss functions are necessary to evaluate a classifier instead of evaluating the classifier with respect to its classification accuracy? **(8)**

(b) The following scatterplot represents a dataset consisting of two classes denoted by circles and triangles respectively. Determine whether it will be possible to classify the dataset into two classes using each of the following classifiers. Also, explain your answer with appropriate reasons. **(27)**

(i) Naive Bayes (ii) Single Layer Perceptron (iii) Neural Network

Contd P/3

CSE 473

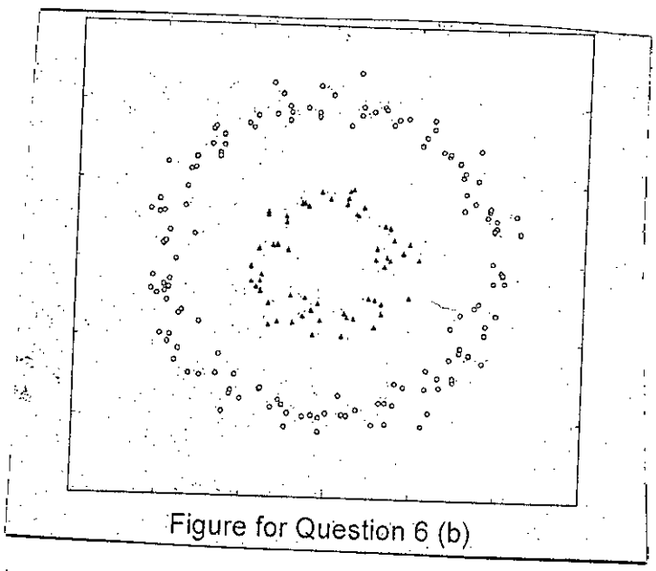


Figure for Question 6 (b)

7. (a) What is the purpose of activation function in a neural network? Discuss the problems of using step function as an activation function. Suggest a way by which they can be overcome. **(15)**

   (b) Does the backpropagation algorithm guarantee to achieve the global minimum? Justify your answer. **(10)**

   (c) Discuss how increasing and decreasing the **learning constant** affect training of a classifier using backpropagation algorithm. **(10)**

8. Suppose you are required to find a reference pattern **x** in an image **t**.

   (a) Discuss why searching for an image segment in **t** having a minimum Euclidean distance from **x** may not provide the best result. **(7)**

   (b) What approach would you take for finding the pattern and why? **(12)**

   (c) Discuss a case where two-dimensional logarithmic search may fail to find the pattern in the image. **(8)**

   (d) The hierarchical search technique for finding a pattern in an image requires less computation. Discuss a case where this technique would fail to identify the pattern. **(8)**

L-4/T-2/CSE **Date : 16/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 483** (Computer Interfacing)

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) Describe all the possible ways of powering your Arduino Uno up. **(7)**

   (b) Suppose you are using a temperature sensor, LM35, which produces an output voltage of 0V to 3.3 V for 0 degree to 330 degree Celsius linearly. The sensor is connected to the pin A0 of your Arduino Uno. Assume that a push button is also connected to Arduino Digital Pin 9. You have to use 4V as reference voltage of ADC. Note that you can not use any external power source but you can use any valued resistance in your circuit.

   Now with proper circuit diagram, write an Arduino code to use the built in ADC of Arduino Uno in interrupt mode so that when a button is pressed, your Uno will read the sensor value and determine the temperature. You have to dump the temperature value on the Arduino Serial Monitor. Keep in mind that the buttons bounce a lot. Do necessary steps in your code so that the debouncing is achieved. **(20)**

   (c) Draw the circuit for hardware button debouncing. **(8)**

2. (a) What is the main difference between synchronous and asynchronous communication? Is asynchronous communication really asynchronous as the name suggests? If not, then write some basic mechanisms that can be undertaken to coordinate such communication among devices. **(3+5=8)**

   (b) 9600 8N1 protocol is an example of asynchronous serial communication. Write the characteristics of this protocol. Suppose, in an asynchronous serial communication, you have to send the characters 'C' 'S' and 'E' one after another. The ASCII codes of these characters are 67, 83, and 69 respectively. Now, construct the frames needed to send these characters using 9600 8N1 protocol. **(3+3+3+3=12)**

   (c) "SPI communication can be conceptually modeled as the interaction between two shift registers" – do you agree with this statement. Justify your answer. **(10)**

   (d) What is the special feature of Schottky diode? Give an example scenario where we need a Schottky diode. **(5)**

Contd P/2

CSE 483

3. (a) Suppose, you have to design a fire alarm system for ECE building. The alarm should be triggered with the detection of smoke by the smoke sensor (s). However, once the alarm is started, it continues even after removing the smoke from the sensing range of the sensor (s). In your design, which switching element should be attached with the alarm. With proper schematic diagram, discuss the self repeating characteristic of your chosen switching element. **(2+10=12)**

   (b) Give an example of hardware project where you might need to incorporate machine learning technique(s) for data analysis. **(5)**

   (c) Discuss the pros and cons of so called "k-NN" classifying method. Discuss with proper diagram how the selection of proper 'k' value can put significant influence on the precision of this classification method. **(4+4+10=18)**

4. (a) Suppose, you have to interface a device that provides 8-bit parallel output to your Raspberry Pi. However, only a single digital i/o pin of your Pi is available. What is the simple mechanism that you can use to interface this device to your Pi. Discuss with the connection diagram. **(10)**

   (b) How can you ensure that your Raspberry Pi(RPi) script runs at the start-up? **(5)**

   (c) Write short notes on channels and pipes in terms of NRF24L01 module. Write how acknowledgement and re transmission issues are resolved in the RF module. **(3+3+2=8)**

   (d) Suppose, we want to interface a button and an LED with RPi in such a way that as long as the button is pressed, the LED will remain lit up. When we remove pressure from the button, the LED will turn off. Let us further assume the button is attached to BROADCOM pin number 7 with a pullup resistor and the LED is attached to BROADCOM pin number 8 with a current limiting resistor. The corresponding code is written below. **(3+5=8)**

```
1   import RPi.GPIO as GPIO #alias module for convenience
2
3   GPIO.setMode(GPIO.BCM) #specify BROADCOM pin numbering style
4
5   buttonPin = 7 #pin to attach button with a pullup
6   ledPin = 8 #pin to attach LED with a current limiting resistor
7
8   GPIO.setup(buttonPin, GPIO.IN) #configure buttonPin as input
9   GPIO.setup(ledPin, GPIO.OUT) #configure ledPin as output
10
11  while True: #infinite loop
12   if not GPIO.input(buttonPin): #button is pressed
13     GPIO.output(ledPin, GPIO.HIGH) #turn LED ON
14   else: #button is not pressed
15     GPIO.output(ledPin, GPIO.LOW) #turn LED OFF
```

Now let us assume a scenario where you run your script, exit out by keyboard interrupt, and then run it again. When you run it for the second time you see a *Runtime Warning*, saying something along the lines of *channels already in use*. Write down the reason behind such *Runtime Warning*. Mention two possible solutions and rewrite the code in case you need to.

(e) What is *clock stretching* of I2C communication protocol? **(4)**

Contd P/3

CSE 483

SECTION – B

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

5. (a) What do you mean by Bridges in term of computer bus. Define Southern Bridge and Northern Bridge. Draw a high level diagram to depict the connection of these two bridges with other computer bus(es) or component(s). **(2+4+4=10)**

(b) What are the reasons behind the elimination of ISA bus? **(10)**

(c) An error prone timing diagram of basic read operation using PCI bus is given below. Find out the errors in this diagram and redraw the corrected one in your answer script. In this diagram, every signal labels and notations hold their usual meanings. **(15)**

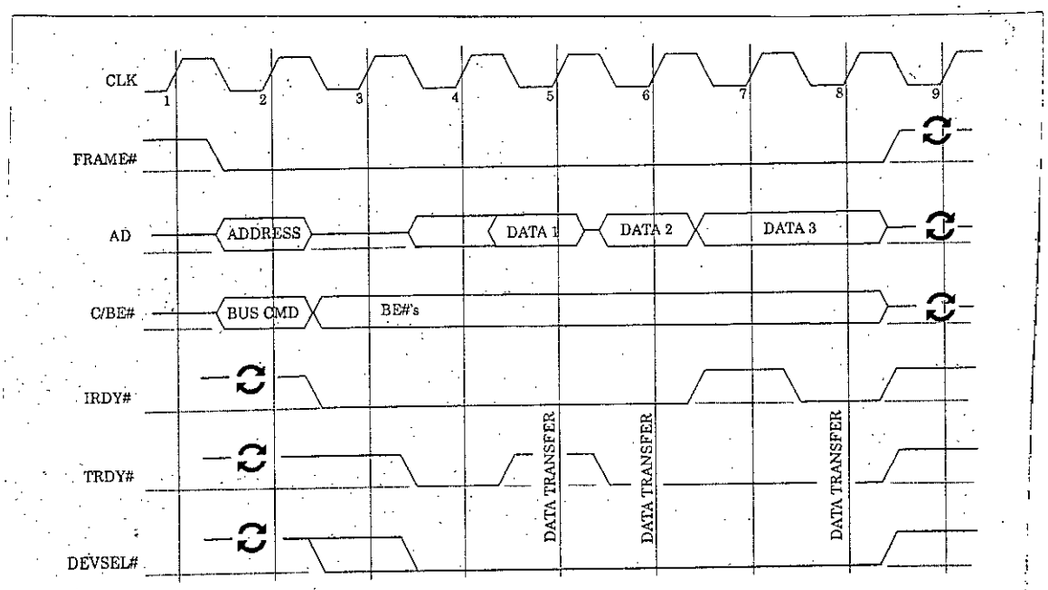


Figure 1: Timing Diagram for PCI Read Operation

6. (a) What is IOT? Discuss the security issues of IOT. **(10)**

(b) Using PS/2 protocol, a Device-to-Host communication has been initiated. Prepare the frame that will be transmitted in order to send the character 'Q' (ASCII code 81). **(5)**

(c) What is priority inversion and blocking chain? What is the mechanism that RTOS follows in order to mitigate these two phenomena? Describe with necessary timing diagram(s). **(3+3+6=12)**

(d) Suppose, by scanning the barcode printed on an iPhone box, you have found the following digits with 2 (two) digits are missing. The product code for Mobile Phones is 3. Find out the missing digits. **(8)**

?	4	7	0	1	?	2	4	7	0	1	6

7. (a) Suppose an Composite USB device can provide both printing and scanning facilities to the user. The printing functionality is done through dedicated IN1 endpoint. On the other hand, the scanning functionality is done through another IN1 and OUT1 endpoints. Moreover, since it is a highly smart device, the user can give input command to this device by using the built in keyboard, which is done thorough another dedicated IN1 endpoint.

Contd P/4

CSE 483

Contd ... Q. No. 7(a)

Now draw a descriptor tree for this device provided that it possesses only a single configuration. **(10)**

(b) In case of High Speed USB, how do SOF packets differ from other packets in terms of EOP (End of Packet)? Differentiate the packet synchronization patterns of HS and LS/FS USB? **(5+5=10)**

(c) Describe the mechanism of High Speed Negotiation between an HS hub and an HS USB Device. **(15)**

8. (a) What are the advantages/improvements that Super Speed USB (version 3.0) offers over the previous USB versions? Discuss in terms of speed, physical configuration, power management, and protocol. **(15)**

(b) In PS/2 protocol, who generates the clocks and who has the ultimate control over it? By observing the control over the clock, how does the device can recognize that an error has occurred? **(5)**

(c) Write short notes on any three of the followings: **(3×5=15)**

(i) SMF

(ii) USB Type C

(iii) USB 3.0 Hub

(iv) Configuration Address Space

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 463** (Computational Geometry)

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) Define a 2-dimensional rectangular range query. Now describe a data structure which can be used to efficiently handle such range queries. Illustrate the data structure with a proper example. **(15)**

   (b) Give an $O(n \log n)$ time randomized incremental algorithm for Delaunay triangulation. Prove the correctness of the algorithm. **(20)**

2. (a) (i) Prove that every polygon P of n vertices may be partitioned into triangles by adding zero or more diagonals. **(12+8=20)**

   (ii) Show that any triangulation of a simple polygon with n vertices consists of exactly $n - 2$ triangles.

   (b) Define Voronoi diagram. Prove that the size of a Voronoi diagram of a set of n sites is $O(n)$. **(10)**

   (c) How many overlapping ears can a polygon of n vertices have? Give an example. **(5)**

3. (a) What is an empty circle? Prove that an edge ab is in the Delaunay triangulation $D(P)$ of Voronoi sites P if and only if there exists an empty circle through two sites a and b. **(10)**

   (b) Define and illustrate the five types of vertices of a polygon which are classified to partition a polygon into monotone pieces. Prove that a polygon is y-monotone if it has no split or merge vertices. **(20)**

   (c) Prove that every polygon must have at least one strictly convex vertex. **(5)**

4. (a) How can we detect and deal with the improper intersection between two line segments? Illustrate with examples. **(10)**

   (b) Prove that $\lfloor n/3 \rfloor$ guards are sometimes necessary and always sufficient for guarding a simple polygon of n vertices. **(15)**

   (c) Analyze the performance of 1-dimensional balanced binary search tree. **(10)**

Contd P/2

CSE 463

SECTION – B

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

5. (a) Define Schnyder labeling of a triangulated plane graph. Prove that in a Schnyder labeling of a triangulated plane graph G, all angles at one of the three outer vertices has label 1, all angles at another have label 2, all angles at the other have label 3, and these three appear around the outer face in counterclockwise order. **(10)**

   (b) Briefly outline an algorithm to compute Schnyder labeling of a triangulated plane graph. **(15)**

   (c) Define (i) subdivision of a planar graph and (ii) separating triangle with illustrative examples. **(10)**

6. (a) What is a plane graph? When we call a plane graph triangulated? **(5)**

   (b) Find a straight line drawing for the graph shown in Figure for Q. No. 6(b) using the Shift algorithm for straight line drawing of a plane graph showing every step. **(30)**

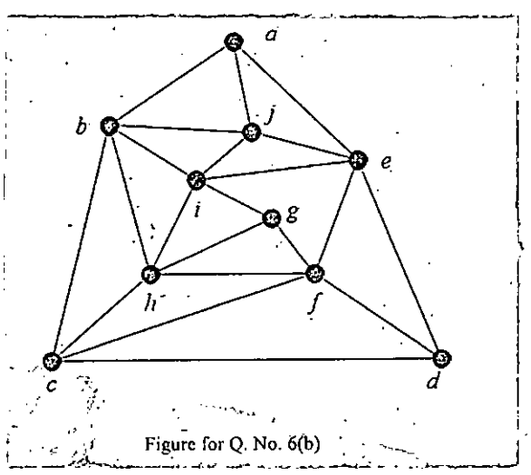


Figure for Q. No. 6(b)

7. (a) Let S be a set of n (possibly intersecting) circles. Each circle has a radius of 1 unit. Give an algorithm to compute the area of the convex hull of S. **(7)**

   (b) Briefly describe the Chan's algorithm to find the convex hull of a set of points in 2D. Analyze the time complexity of the algorithm. **(18)**

   (c) Prove that the lower bound of time complexity of convex hull problem in 2D is $\Omega(n \log n)$. **(10)**

8. (a) Draw two test cases, each with 8 points, where the Quickhull algorithm performs best and worst respectively. **(8)**

   (b) How can you find a tangent to a convex polygon from a point outside the polygon in $O(\log n)$ time? **(10)**

   (c) Write down the outline of a plane sweep algorithm to find all intersection points of a set of n lines in 2D. Mention the data structures you would use to achieve $O((n + k) \log n)$ time complexity where k is the number of intersection points. **(17)**
