Jahangirnagar University
Department of Computer Science and Engineering
3rd Year 1st Semester B.Sc. (Hons.) Final Examination - 2022

Course Title: Operating System
Time: 3 Hour

Course No: **CSE-309**
Full Marks: **60**

[Answer each of the following questions. Each question carries equal marks. Figures in the right margin indicate marks.]

1. Question No. 1 will be based on ***CO1***. This question will be consisting of ***Six*** Sections. Each section may contain several subsections like (*a*(*i*), *a*(ii), *a*(*iii*) *etc.*)
Students have to answer ***All of them***.

a) Define a system call and its effects on Operating System (OS). 2
b) List out the various services of an OS for the end users. 2
c) State the technique for avoiding the data inconsistency problem. 2
d) Identify the reasons of using banker's algorithm in deadlock avoidance. 2
e) Name the steps used in page fault service. 2
f) Enumerate the storage device hierarchy. 2

2. Question No. 2 will be based on ***CO2***. This question will be consisting of ***Four*** Sections. Each section may contain several subsections like (*a*(*i*), *a*(ii), *a*(*iii*) *etc.*)
Students have to answer ***Any Three*** out of ***Four***.

a) Compare the working principle of Mutex Locks with that of Semaphores. 4
b) Explain the superiority of synchronization hardware over other synchronization methods. 4
c) Show that the resource allocation graph is not capable of detecting a deadlock for multiple instance resources. 4
d) Illustrate the functions of a valid-invalid bit in a page table. 4

3. Question No. 3 will be based on ***CO3***. This question will be consisting of ***Four*** Sections. Each section may contain several subsections like (*a*(*i*), *a*(ii), *a*(*iii*) *etc.*)
Students have to answer ***Any Three*** out of ***Four***.

a) Consider 5 processes arriving at time 0 as 4

Process	Burst Time
P_1	9
P_2	25
P_3	4
P_4	8
P_5	12

Calculate minimum average waiting time for RR (q=10) CPU scheduling.

b) Choose an appropriate measure for the memory protection in memory management process by a modern operating system. 4

c) Construct a semaphore so that code snippet S_1 of P_1 to be happen in a computer program before the code snippet S_2 of P_2. 4

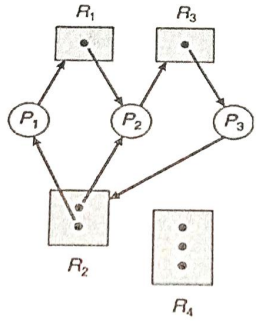
d) Develop a multithreaded program that outputs prime numbers. This program should work as follows: The user will run the program and will enter a number on the command line. The program will then create a separate thread that outputs all the prime numbers less than or equal to the number entered by the user. 4

Question No. 4 will be based on ***CO4***. This question will be consisting of ***Four*** Sections. Each section may contain several subsections like ($a(i)$, a(ii), $a(iii)$ *etc.*)
Students have to answer ***Any Three*** out of ***Four***.

4. a) Analyze the dining philosopher problem, and select the conditions for which it can avoid the deadlock problem altogether. 4

b) Illustrate the superiority of internal fragmentation technique over external fragmentation technique in memory management. 4

c) Analyze the below resource allocation graph whether it is in a deadlock state or not. 4



d) We add Translation Look-aside Buffers (TLBs) in a paging system with the page table stored in memory, and we see that 75 percent of all page table references are found in TLBs. Assuming that a memory reference takes 50 ns, and a page-table entry in the TLBs takes 2 ns (if the entry is present), evaluate the effective memory reference time. 4

Question No. 5 will be based on ***CO5***. This question will be consisting of ***Three*** Sections. Each section may contain several subsections like (*a*(*i*), *a*(ii), *a*(*iii*) *etc.*)
Students have to answer ***Any Two*** out of ***Three***.

5. a) There are 5 processes P_0 through P_4; and 3 resource types of A (10 instances), B (5 instances), and C (7 instances). The snapshot of the system at time T_0 is as follow: 6

	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

Test whether the request for (0, 2, 0) by P_0 can be granted or not?

b) Consider the following reference string, compare the average number of page faults for FIFO page replacement, Optimal page replacement and LRU page replacement algorithms in virtual memory management system. 6

7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1

c) Assume a machine has an 8-bit logical address space and is byte addressable. The physical address space is 10 bits and the page size is 32 bytes. Now, answer the following questions; 6

i) Calculate the number of virtual pages

ii) Calculate the number of physical pages

iii) Calculate the number of frames in physical address space

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Course Title: Computer Architecture and Organization **Course Code: CSE 307**
Duration: 3 hours **Full Marks: 60**

Q1. ***Section-I (CO1): Answer all the questions.***

a) Point out the distinction between computer architecture and computer organization. [2]
b) Define the system bus. [2]
c) Name the main structural components of a processor. [2]
d) Mention the differences between logical cache and physical cache. [2]
e) Define virtual memory. [2]
f) Outline the notion of binary representation of instructions. [2]

Q2. ***Section-II (CO2): Answer any three of the following.***

a) Using top-level view of computer components, explain the basic functions performed by a computer (with necessary diagram). [4]
b) Describe the possible states of an instruction execution with state diagram. [4]
c) Illustrate the bus interconnection scheme and explain the control lines of the control bus. [4]
d) Explain the non-restoring division algorithm showing the flow chart of hardware implementation. [4]

Q3. ***Section-III (CO3): Answer any three of the following.***

a) Illustrate direct mapping cache organization. [4]
b) Demonstrate the internal organization of an ***8 Megabit*** DRAM (***2Mx4***) with proper explanation. [4]
c) Construct a memory chip of ***1M*** words by ***8 bit*** per word using memory chips of ***256K*** words. [4]
d) Suppose, the size of the multiple block cache is ***64kb*** and total block size is ***32*** bit, Now, considering two-way set associative cache and ***32***-bit physical address, provide the details of division among index, tag and block of set. [4]

Q4. ***Section-IV (CO4): Answer any three of the following.***

a) Analyze the elements of a machine instruction. Categorize different addressing modes with the necessary diagram and description in brief. [4]
b) Compare one-, two-, and three-address instructions that could be used to compute $Y = (A-)/[C + (D \times E)]$. [4]
c) Figure out the steps of multiplication process using Booth algorithm of the following binary numbers: $Y = 8 \times 10$. [4]
d) Differentiate between address space and memory space. An address space is specified by 2 bits and the corresponding memory space by ***16*** bits. If a page consists of ***2K*** words, calculate the number of pages and blocks in the system. [4]

Q5. ***Section-V (CO5): Answer any two of the following.***

a) i. Explain the internal structure of the CPU with block diagram. [2]

ii. Describe the register organization of the CPU and explain the functions of each register. [4]

b) i. Explain the concept of instruction pipeline strategy. Give the simple approach of two-stage instruction pipeline with necessary diagram. [3]

ii. Write the sequence of events for the fetch cycle from the point of view of its effect on the processor registers. Give an example in context of micro-operations. [3]

c) i. Design a circuit to implement an ***AND*** and ***XOR*** logic microoprations. [3]

ii. Explain different types of interrupt in a microprocessor system. [3]

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Course Title: Computational Geometry
Time: 3 hours

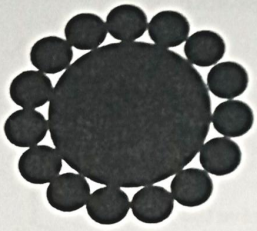
Course No: CSE-305
Full Marks: 60

Q1. ***Section-I (CO1). Answer all the questions.***

a) List out the applications of computational geometry. [2]
b) State pick's theorem and art gallery theorem. [2]
c) Define counterclockwise function $ccw(p, q, r)$ where $p, q, r \in Z^2$ [2]
d) Mention the properties of Voronoi diagram in $2D$ plane. [2]
e) Identify the characteristics of simple and complex polygon. [2]
f) Define K-D tree. [2]

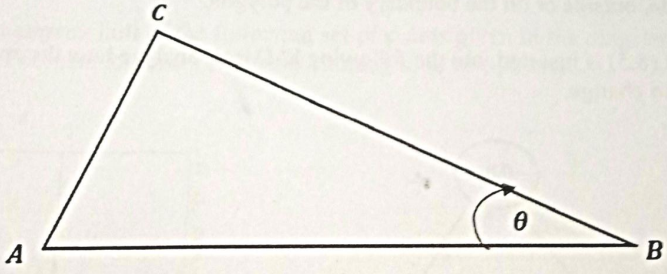
Q2. ***Section-II (CO2). Answer any three of the following.***

a) Upon the circumference of the inner circle with radius r are placed n outer circles each with radius R in such a way that two consecutive outer circles touch each other and the inner circle touches all the outer circles just as shown in the diagram below: [4]



i. Formulate an equation to compute R given the value of r and n. [absolute error or relative error should not exceed 10^{-6}]
ii. If $n = 100, r = 100$ then $R = ?$

b) A triangle has to be drawn in such a way that the length of the largest side is given as $AB = x$ and the sum of the other two sides is given as $AC + BC = S$ with a constraint that BC maintains an angle θ with AB as shown in the picture. [4]



i. Identify the case when the values of AC and BC cannot be determined if any.
ii. Write an algorithm of $log_2 n$ time complexity to find the value of AC and BC. [absolute error or relative error should not exceed 10^{-6}]
iii. Find the value of AC and BC given that $x = 12, S = 18, \theta = 90^0$. ***[only up to 3rd iteration]***

c) Given N points as $P_i (x_i, y_i)$; $0 \le i < N$ on a $2D$ space and a specific point $Q (x, y)$. Write an algorithm of at most **log linear** ($N log_2 N$) time complexity to find the minimum number of lines going through Q in order to cover all the points. [4]

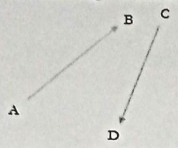
d) A line can be specified by any two points on it. Given the following points on 2D plane, express the equations of lines in parametric form. [4]
i. (2,3) and (8,9) ii. (-5,6) and (7,8) iii. (1,1) and (10,1) iv. (1,2) and (10,2)

For line (*i*), identify the point if a normal is dropped from point (7,2) on the line (*i*). For line (*ii*), represent a line in parametric form which is perpendicular to it and goes through the point (-5,6). Considering (*iii*) and (*iv*) as line segments, demonstrate an algorithm to check whether they intersect or not in $O(1)$ time.

Section-III (CO3). Answer any three of the following.

Q3.

a) Two ants are moving concurrently with their initial positions at A and C respectively maintaining a constant velocity. [4]



Assumptions:

i. Ant-1 is moving from A to B and Ant-2 is moving from C to D.

ii. If Ant-1 reaches B at T_1 and Ant-2 reaches D at T_2, then $T_1 = T_2$. Now,

i. Apply ternary search to calculate the minimum Euclidean distance between the two ants.

ii. If $A = (0,0)$, $B = (5,0)$, $C = (5,5)$ and $D = (5,0)$, simulate your algorithm up to 2nd iteration.

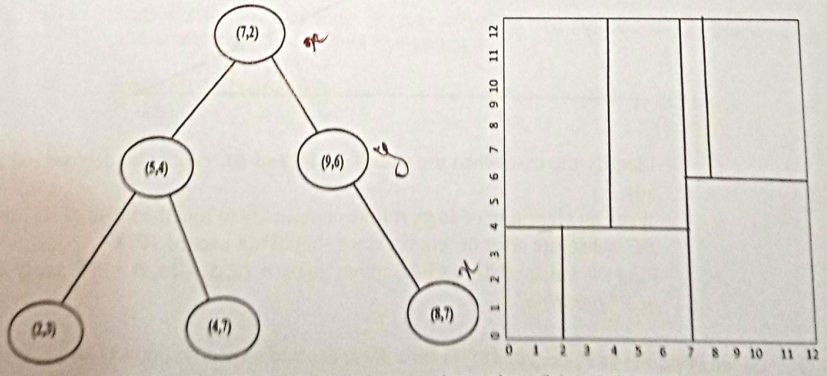
b) Let $P = (P_0, P_1, P_2 \ldots P_{n-1})$ be a sequence of n points where $(P.x, P.y) \in Z$ on a *2D* plane. Someone claims that the following algorithm can identify whether or not P describes the boundary of a convex polygons in clockwise order. [4]

```
bool is_convex(p_0, ..., p_{n-1}) {
    for i = 0, ..., n - 1:
        if (p_i, p_{(i+1) mod n}, p_{(i+2) mod n}) form a rightturn:
            return false;
    return true;
}
```

Disprove the claim and prepare a correct algorithm to solve the problem.

c) Let $P \subset Z^2$ be a convex polygon, given as an array *P[0], P[1],….P[n-1]* of its N $(\leq 10^6)$ vertices and M $(\leq 10^5)$ queries are provided. Each query contains a point $Q \in Z^2$. Construct an algorithm of not more than **log linear time complexity** to find if Q lies inside, outside or on the boundary of the polygon. [4]

d) If a point (8,5) is inserted into the following K-D tree, analyze how the splitting plane is going to change. [4]



Suppose, the following 3D points are given as the nodes of the *K-D (k=3)* tree. (3,1,4), (2,3,7), (4,3,4), (2,1,3), (2,4,5), (6,1,4), (1,4,4), (0,5,7), (5,2,5), (4,0,6) and (7,1,6)

i. Sketch the *3D* tree.

ii. Compute the minimum value in y dimension of the K-D tree.

Q4. ***Section-IV (CO4): Answer any three of the following.***

a) Two circles are defined as follows: circle-1 has its center at (-10, 8) and it has a radius of 30 cm. Circle-2 has its center at (14, -24) and it has a radius of 10 cm. Now, answer the following: [4]

i. Write the conditions for which two circle touch, intersect or does not intersect each other.

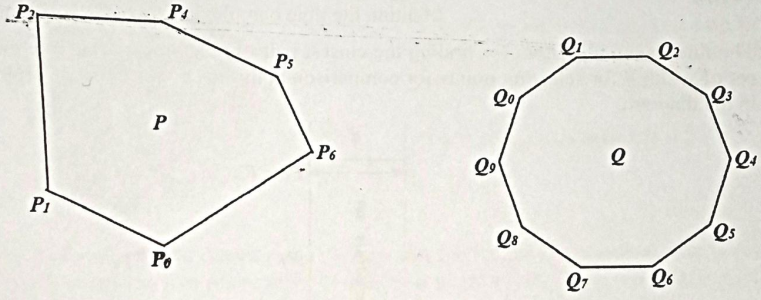
ii. Discover the intersection points if there are any.

b) Let $V \subset \mathbf{Z^2}$ be a **convex** polygon, defined with the following vertices. [4]

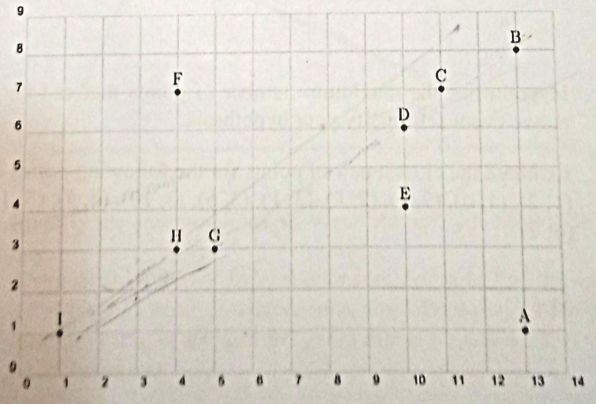
V_0	V_1	V_2	V_3	V_4	V_5	V_6	V_7
(7, 1)	(13, 2)	(14,7)	(10, 9)	(6, 10)	(5, 9)	(4, 6)	(4, 3)

Calculate the number of lattice points inside the convex polygon.

c) Let P and Q be two convex hulls such that $P_i.x < Q_j.x$; $\substack{0 \le i < n \\ 0 \le j < m}$. Illustrate the execution trace of the algorithm ***merge_CH(P,n,Q,m)*** of ***O(n)*** running time complexity in order to merge P and Q so that the resultant polygon still becomes a convex hull of the point sets P and Q. (use below diagram to compute ***ccw(p,q,r)***) [4]



d) Construct a convex hull of the following set of points given in the diagram using an algorithm of at most log linear ***(Nlog$_2$N)*** running time complexity. [4]



If there are 10^6 points in the plane, could Jarvis March algorithm be used to solve this problem. Mention the case for which Jarvis March runs in ***O(n)*** time complexity.

Section-V (CO5): Answer any two out of the following.

Q5.

a) i. Given n ($\leq 10^5$) lines as (m_i, c_i) and $Q(\leq 10^5)$ queries. For each query of x_j, develop an algorithm to find the minimum value of $y_i = m_i x_j + c_i$ considering all the lines. [6]

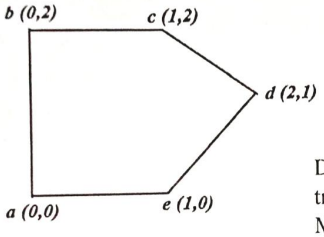
ii. Using the algorithm developed in (*i*), optimize the time complexity of the following dynamic programming problem of calculating minimum value of $DP[n]$ provided that $DP[i]$ is calculated as follows:

$$DP[i] = \min_{1 \leq j < i} \left(DP[i],\ DP[j] + (H_i - H_j)^2 + C \right) ; DP[1] = 0, DP[i] = \infty$$

Constraints: $2 \leq n \leq 10^5, H_1 < H_2 < \cdots < H_i < \cdots < H_n$

b) A convex polygon Y of n vertices can be triangulated into $n-2$ triangles with respect to any vertex. The cost of a polygon triangulation is defined as: [6]

$$Cost\ (Y, n) = \Delta_1 + \Delta_2 + \ldots + \Delta_i + \cdots . + \Delta_{n-2}$$

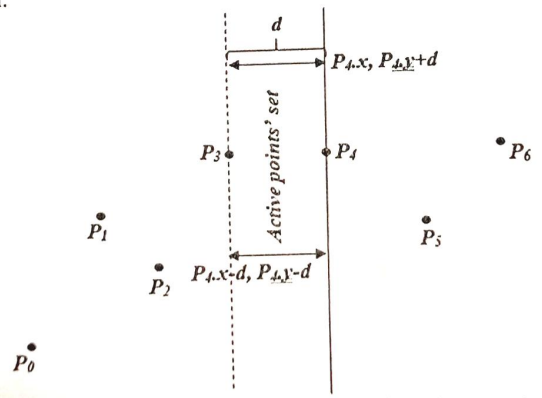


$$\Delta_i(a, b, c) = dist(a, b) + dist(b, c) + dist(a, c)$$

$$dist(p, q) = \sqrt{(p.x - q.x)^2 + (p.y - q.y)^2}$$

Determine the minimum cost of polygon triangulation considering the polygon to the left. Mention the time complexity of your algorithm.

c) The line sweep algorithm for finding the closest pair of points uses an **active event set** of width d for selecting points for comparison with the current point as depicted in the diagram.



i. Hypothesize the maximum number of points that can be present within active event set. Justify your hypothesis. [2]

ii. Estimate the closest pair of points for the following points in 2D space. [4]
(1, 2), (1, 6), (2, 4), (2, 8), (3, 1), (3, 6), (3, 10), (4, 3), (5, 1), (5, 5), (5, 9), (6, 7)

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Course Title: Computer Graphics **Course Code: CSE 303**
Duration: 3 hours **Full Marks: 60**

Q1. ***Section-I (CO1): Answer all the questions.***

a) Point out the differences between raster and vector graphics. [2]

b) List the adverse effects of scan conversion. Mention the ways to eliminate these adverse effects. [2]

c) Define the following: [2]

i. Window port and viewport

ii. Cel animation and path animation

d) State *Shear* and *Affine* transformations. [2]

e) Differentiate between *local* and *global* illumination models. [2]

f) Outline the notion of *rendering* and *morphing*. [2]

Q2. ***Section-II (CO2): Answer any three of the following.***

a) Discuss perspective projection along with its anomalies. Also explain parallel projection. [4]

b) Describe the Cohen-Sutherland algorithm for line clipping. [4]

c) Given a circle with its center at (0, 3) and a radius of 10. Identify all the pixel positions to draw the circle using Bresenham's circle drawing algorithm. [4]

d) Generalize the scaling matrix with respect to a fixed point $P(h, k)$ assuming the scaling factors m and n along the x-axis and y-axis, respectively. [4]

Q3. ***Section-III (CO3): Answer any three of the following.***

a) Write the steps required to scan-convert an ellipse using the trigonometric and polynomial method. [4]

b) Explain the hidden surface problem. Interpret the steps involved in the *Z*-buffer algorithm. [4]

c) Explain the curve and surface design requirements and discuss the basis function for *B*-Spline. [4]

d) Demonstrate the steps of constructing a *3D* view without hidden surface removal. [4]

Q4. ***Section-IV (CO4): Answer any three of the following.***

a) Find the normalization transformation that maps a window whose lower left corner is at L(1,1) and upper right-hand corner is at R(3,5) onto a viewport that has lower left corner at (0,0) and upper right corner at (1/2,1/2). [4]

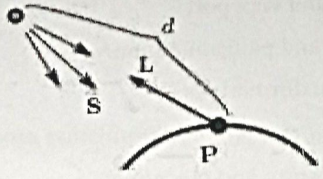
b) Illustrate the steps of developing animation and figure out a basic rule of animation to avoid distortions. [4]

c) Inspect the integration of hidden surface removal and projection into the ray-tracing process. [4]

d) Design the Pseudocode for boundary-filling and flood-filling algorithms. [4]

Q5. ***Section-V (CO5): Answer any two of the following.***

a) Assume that at a point **P**, the computed color according to a certain illumination model with a single point light source is $\mathbf{I_{point}} = \mathbf{I_a} + \mathbf{I_d}$, where $\mathbf{I_a}$ is ambient component and $\mathbf{I_d}$ is the diffuse component (the specular component is ignored). The light source is now replaced with a spot light source with attenuation with the same intensity and position, and its unit vector direction is S and its distance to P is d. The unit vector from P to the light is L. Starting from $\mathbf{I_{point}}$, give a formula for computing $\mathbf{I_{spot}}$ at P, i.e., the new color at P when lit up by the spot light, as a function of I_a, I_d, S, L and d. Evaluate your formula. [6]



b) Given a Bezier curve with 4 control points- [6]

$B_0[1\ 0]$, $B_1[3\ 3]$, $B_2[6\ 3]$, $B_3[8\ 1]$

Determine any 5 points lying on the curve. Also, draw a rough sketch of the curve.

c) Consider a triangle with vertices (10,20), (10,10), (20,10). Determine the resultant vertices after rotating it about the origin by 30 degree and then do translation by $t_x=5$, $t_y=10$. [6]

JAHANGIRNAGAR UNIVERSITY
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3rd Year 1st Semester BSc (Honors) Final Examination 2022
Course ID: CSE - 301 (Economics)
Time: 3 Hours Full Marks: 60

Answer any ***FIVE*** questions.

1. 5 + 3 + 4

a) Define Economics. Distinguish between Microeconomics and Macroeconomics.

b) Explain the concept of "Scarcity" and "Opportunity cost".

c) Distinguish between positive economics and normative economics. What are the various types of economic systems? Discuss.

2. 5 + 4 + 3

a) What is Production Possibility Frontier (PPF)? Suppose the economy of Bangladesh can produce two types of goods: Consumer good and Capital goods. Draw a PPF for these two goods and show the efficient, inefficient and unattainable point of PPF.

b) How we can relate the concept of opportunity cost with PPF? Explain.

c) When a country's PPF curve will shift rightward? Explain.

3. Consider the following production scenario of a firm 3 × 4 = 12

Amount of Labor	0	1	2	3	4	5	6	7	8	9	10
Amount of Capital	10	10	10	10	10	10	10	10	10	10	10
Total Product	0	10	30	60	80	95	108	112	112	108	100

a) Distinguish between the short run and the long run in the context of production.

b) Find the average physical product and marginal product of labor.

c) Explain the law of diminishing marginal product by drawing diagrams from the table.

d) Explain the relationship between the Average and Marginal physical product of labor.

4. 8 + 4

a) On Tuesday, price and quantity demanded are Tk. 7 and 120 units, respectively. Ten days later, price and quantity demanded are Tk. 5 and 150 units, respectively. Calculate the price elasticity of demand and interpret the result.

b) Elaborate the concept of "Income elasticity of demand" and "Cross-price elasticity of demand".

6 + 6

5. a) Explain the relationships between average cost and marginal cost, and average product and marginal product. Use appropriate diagrams.

b) Consider the following table:

Point	Labor	Output	Total Fixed Cost	Total Variable Cost
A	1	0	25	0
B	2	4	25	25
C	3	10	25	50
D	4	13	25	75
E	5	15	25	100
F	6	16	25	125

Calculate Total cost, average fixed cost, average variable cost, average cost and marginal cost.

4 + 5 + 3

6. a) What is meant by Gross Domestic Product (GDP)? How GNP and NNP are different from GDP? Explain.

b) Briefly explain the various methods of computing GDP.

c) Show the producer's equilibrium with isoquant map and the isocost lines.

5 + 4 + 3

7. a) What are the various types of unemployment? Briefly discuss.

b) Consider the following table:

Indicators	Amount
Number of Employed	450 Million
Number of Unemployed	55 Million
Not in the Labor force	350 Million

Calculate the Unemployment rate, and the Labor force participation rate.

c) Explain the concept of natural rate of unemployment.

4 + 2 + 6

8. a) What is Bitcoin? How does the Bitcoin system work? Discuss.

b) What does the *Gross Domestic Product* (*GDP*) deflator and *Consumer Price Index* (*CPI*) measure? In what respects the *GDP* deflator is different from the *CPI*.

c) Evaluate the impact of cryptocurrency as an alternative monetary system.