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Cluster Innovation Centre, University of Delhi, Delhi-110007

Examination	**: End Semester Examination – August 2022**
Name of the Course	**: B. Tech (Information Technology and Mathematical Innovations)**
Name of the Paper	**: Linearity in Nature: Engineering through *Linear Algebra*.**
Paper Code	**:32861201**
Semester	**: II**
Duration	**: 2 Hours**
Maximum Marks	**: 40**

Section-A

Attempt any three questions from this section, each carries 8 marks. (8x3=24 marks)

1. Budget Rent Car in certain city has a fleet of about 500 cars, at three locations. A car rented at one location may be returned to any of the three locations. The various fractions of cars returned to the three locations are shown in the matrix below. Suppose that on Monday there are 295 cars at the airport (or rented from there), 55 cars at the east side office, and 150 cars at the west side office. What will be the approximate distribution of cars on Wednesday?

Cars Rented From:			Returned to
Airport	**East**	**West**	
0.97	0.05	0.10	**Airport**
0.00	0.90	0.05	**East**
0.03	0.05	0.85	**West**

2. A herd of American buffalo (bison) can be modelled by a stage matrix similar to that for the spotted owls. The females can be divided into calves (up to 1 year old), yearlings (1 to 2 years), and adults. Suppose an average of 42 female calves are born each year per 100 adult females. (Only adults produce offspring.) Each year, about 60% of the calves survive, 75% of the yearlings survive, and 95% of the adults survive. For $k >= 0$, let $x_k = (c_k, y_k, a_k)$ where the entries in x_k are the numbers of females in each life stage at year k.

a. Construct the stage-matrix A for the buffalo herd, such that $x_{k+1} = A\,x_k$, for $k >= 0$. **(3)**

b. Show that the buffalo herd is growing, determine the expected growth rate after many years, and give the expected numbers of calves and yearlings present per 100 adults. **(5)**

3. Let P_3 be the vector space over R of all degree 3 or less polynomial with real number coefficient. Let W be the following subset of P_3.

$$W = p(x) \in P_3 \,|\, P'(-1) = 0 \quad and \quad P''(1) = 0$$

Here, $p'(x)$ is the first derivative of $p(x)$ and $p''(x)$ is the second derivative of $p(x)$. Show that W is a subspace of P_3 and find a basis for W.

4. Diagonalise the following matrix, if possible

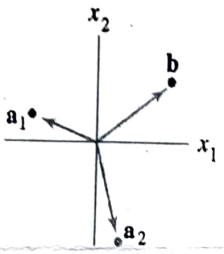
$$A = \begin{bmatrix} 5 & 0 & 0 & 0 \\ 0 & 5 & 0 & 0 \\ 1 & 4 & -3 & 0 \\ -1 & -2 & 0 & -3 \end{bmatrix}$$

5. Find a QR factorisation of the matrix $A = \begin{bmatrix} 3 & -5 & 1 \\ 1 & 1 & 1 \\ -1 & 5 & -2 \\ 3 & -7 & 8 \end{bmatrix}$

Section-B

Attempt any four questions from this section, each carries 4 marks. **(4X4=16)**

1. Let a_1; a_2, and b be the vectors in R^2 shown in the figure, and let $A = [a_1 \quad a_2]$. Does the equation $Ax = b$ have a solution? If so, is the solution unique? Explain.



2. Use matrix multiplication to find the image of the triangle with data matrix $D = \begin{bmatrix} 5 & 2 & 4 \\ 0 & 2 & 3 \end{bmatrix}$ under the transformation that rotate point 30^0 and then reflects points through the x-axis. Sketch both the original triangle and its image.

3. Let $y = \begin{bmatrix} 3 \\ 1 \\ 5 \\ 1 \end{bmatrix}$, find the closest point to y in the subspace W spanned by v_1 and v_2, where $v_1 = [3 \quad 1 \quad -1 \quad 1]^T$ and $v_2 = [1 \quad -1 \quad 1 \quad -1]^T$.

4. Define a linear transformation $T : P_2 \to R^2$ by $T(p) = \begin{bmatrix} p(0) \\ p(1) \end{bmatrix}$. For instance, if $p(t) = 3 + 5t + 7t^2$, then $T(p) = \begin{bmatrix} 3 \\ 15 \end{bmatrix}$. Find a polynomial **p** in P_2 that spans the kernel of **T** and describe the range of **T.**

5. Find the change-of-coordinates matrix from β to the standard basis in R^n where $\beta = \left\{ \begin{bmatrix} 3 \\ -1 \\ 4 \end{bmatrix}, \begin{bmatrix} 2 \\ 0 \\ -5 \end{bmatrix}, \begin{bmatrix} 8 \\ -2 \\ 7 \end{bmatrix} \right\}$.

Cluster Innovation Centre, University of Delhi, Delhi-110007

Examination : End Term Examination, August 2022
Name of the Course : B.Tech (Information Technology and Mathematical Innovations)
Name of the Paper : Understanding real life situations through Discrete Mathematics
Paper Code : 32861202
Semester : II
Duration : 2 Hours
Maximum Marks : 50

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1. Attempt any 3 questions. Each question carries 4 marks. [3x4=12]

(i) A computer system considers a string of decimal digits a valid codeword if it contains an even number of 0 digits. For instance, 1230407869 is valid, whereas 120987045608 is not valid. Let a_n be the number of valid n-digit codewords. Find a recurrence relation for a_n.

(ii) Assume that in a group of six people, each pair of individuals consists of two friends or two enemies. Show that there are either three mutual friends or three mutual enemies in the group.

(iii) Use Huffman coding to encode the following symbols with the frequencies listed: A: 0.08, B: 0.10, C: 0.12, D: 0.15, E: 0.20, F: 0.35. What is the average number of bits used to encode a character?

(iv) How many different license plates can be made if each plate contains a sequence of three uppercase English letters followed by three digits (and no sequences of letters are prohibited, even if they are obscene)?

(v) You and a friend meet three other couples at a party and several handshakes take place. Nobody shakes hands with himself or herself, there are no handshakes within couples, and no one shakes hands with the same person more than once. The numbers of hands shaken by the other seven people (excluding you) are all different. How many hands did you shake? How many hands did your partner shake? Use a graph to aid your solution.

2. Attempt any 2 questions. Each question carries 3 marks. [2x3=6]

(i) A connected graph 5 has 11 vertices and 53 edges. Show that it is Hamiltonian but not Eulerian.

(ii) Could 6, 6, 6, 6, 1, 1, 1, 1 be the score sequence of a tournament? If so, why?

(iii) What are the chromatic number of κ_{14} and $\kappa_{5,14}$? Why?

(14) (2)

(iv) What is the value of k after the following code, where $n_1, n_2, \ldots, n_m$ are positive integers, has been executed?

```
k := 0
for i_1 := 1 to n_1
    k := k + 1
for i_2 := 1 to n_2
    k := k + 1
.
.
.
for i_m := 1 to n_m
    k := k + 1
```

3. Suppose we want to build a Klein bottle. The tasks involved in this project and the time required for each are recorded in the following table. [4+5+3=12]

Code	*Tasks*	*Time (in months)*
G	blow glass	7
Po	polish	5
Sh	shape	9
A	add hole	4
H	affix handles	5
Tw	twist	2
R	remove hole	4
Pa	paint	6

The glass must be blown before anything else. Polishing precedes all but G and *Sh;* shaping precedes all but G and *Po.* The hole must be added before it is removed and before the bottle is twisted. The handles go on before *Tw* and *Pa.* Once *Tw, R,* and *Pa* are completed, the project is finished.

(i) What type of scheduling problem is this (type I or II)? Draw the appropriate directed network. [4]

(ii) Find a critical path for this project. [5]

(iii) Find the slack of tasks for the critical path found in (ii). [3]

OR George has to do four things before his mathematics exam tomorrow morning: study, sleep, eat pizza, and check his e-mail. He intends to spend two different periods of time studying, three hours on each occasion. While the sessions could be back to back, at least one session must occur before he sleeps. Eating pizza requires one hour, but it also takes an hour for the order to arrive (and something else could be done during this interval). Eating pizza must precede sleeping and also at least one of the study sessions. George will get six hours of sleep if he sleeps after all

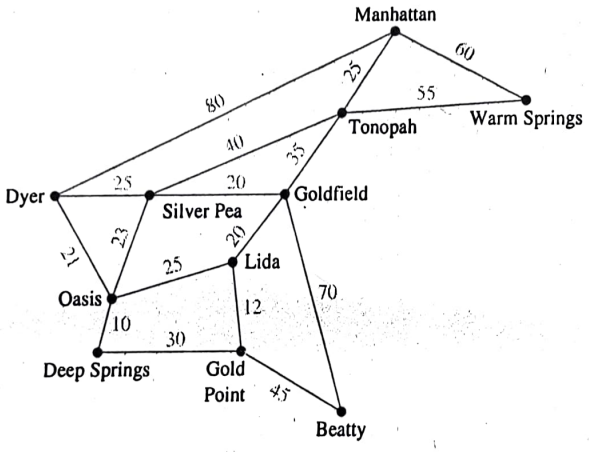
study has been completed, but he's willing to settle for five hours otherwise. If George checks his e-mail between study sessions, he will do so quickly and take only one hour; otherwise, he will spend two hours at this activity. [4+5+3=12]

(i) What type of scheduling problem is this (type I or II)? Draw the appropriate directed network. [4]

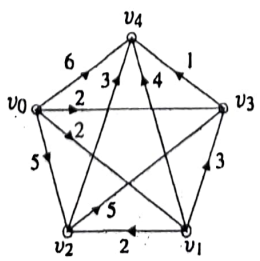
(ii) Find the shortest possible time in which George can complete his activities, and a way in which he can order them and complete them in this time. [5]

(iii) Assume that George decides to read his e-mail before eating his pizza. Does this change the answer to (i)? If so, how? [3]

4. Once upon a time, there was a city that has no roads. Getting around the city was particularly difficult after rainstorms because the ground becomes very muddy cars, got stuck in the mud and people got their boots dirty. The mayor wants to revamp the city, but he didn't want to spend more money than necessary. Mayer, therefore, specified two conditions: Enough streets must be paved so that everyone can travel from their house to anyone else home only along paved roads, and the paving should cost as little as possible. The roads represented by this graph are all unpaved. The weight on the edges is the cost (in $) to paved that road. Which roads should be paved so that there is a path of paved roads between each pair of towns with minimum cost? [10]



OR The following digraphs are acyclic, and canonical labelings are shown. Apply Bellman's algorithm to each digraph in order to find the lengths of shortest paths from v_0 to each other vertex. [10]



5. There are ten students who, in the coming semester, will be taking the courses shown in the following table. How many time periods must be allowed in order for these students to take the courses they want without conflicts? [10]

Arnold	Physics, Mathematics, English
Bill	Physics, Earth Science, Economics
Carol	Earth Science, Business
Calvin	Statistics, Economics
Eleanor	Mathematics, Business
Frederick	Physics, Earth Science
George	Business, Statistics
Huber	Mathematics, Earth Science
Ingrid	Physics, Water Skiing, Statistics
Jacquie	Physics, Economics, Water Skiing

OR The six teams entering the final round of the World Hockey Championships are Canada, Finland, Russia, Slovakia, Romania, and the United States. Albert, Bruce, Craig, Camelia, Oana and Yuri wish to bet with each other on who the winner will be and, ideally, they would like to all select different teams. The teams that each bettor is willing to support are shown in the following table.

Bettor	Teams
Albert	Canada, Finland, Slovakia, USA
Bruce	Slovakia, Romania
Craig	Russia, Slovakia
Camelia	Russia, Romania
Oana	Canada, Finland, Russia, Romania, USA
Yuri	Russia, Slovakia, Romania

USA - 2
Can - 2
Fin - 2
Rus - 4
Slov - 4
Rom - 4

Can these people indeed bet on different teams? Give such a selection or use Hall's Marriage Theorem to explain why such a selection is impossible. [10]

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Cluster Innovation Centre, University of Delhi, Delhi-110007

Examination	**: End Semester Examination – August 2022**
Name of the Course	**: B. Tech (Information Technology and Mathematical Innovations)**
Name of the Paper	**: Optimizing memory use through Data Structure and Design**
Paper Code	**: 32861203**
Semester	**: II**
Duration	**: 2 Hours**
Maximum Marks	**: 40**
Instructions	: This question paper contains six questions, out of which ***any four*** are to be attempted. Each question carries equal marks.

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1. Answer the following:
   (a) What are various searching algorithms? Explain in brief with suitable example.
   (b) Explain about linked list in brief including its complexities in various operations.
2. What is hashing and its types? What is its benefit to use? How collision is resolved in hashing? Explain the same with suitable example.
3. Answer the following about which sorting algorithm is best suitable when-
   (a) Array is sorted in reverse order
   (b) Array is already sorted
   (c) All elements of the array are equal
   (d) Array size is small
   (e) Array size is very big
4. What are different Asymptotic notations? Why they are so popular in Designing an algorithm? Sort the following in ascending order of time complexity- $\sqrt{\log n}$, $\log \log n$, $n \log n$, n^3, $n^{\log n}$, $n^{(\sqrt{\log n})}$, $n!$
5. What is sorting? Explain about comparison based sorting? Using best comparison based sorting, sort the following keys- 100, 30, 24, 68, 52, 11, 32, 54.
6. What is heap? How it is used in sorting. Using the given keys below construct a Max Heap and sort the keys in Reverse Descending order. Also tell the time complexity of the whole process. Keys- 45, 36, 76, 23, 89, 115, 98, 39, 41, 56, 48, 52, 32.

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Examination	**: End Semester Examination – August 2022**
Name of the Course	**: B. Tech (Information Technology and Mathematical Innovations)**
Name of the Paper	**: Reflecting thought processes via Object Oriented Programming**
Paper Code	**: 32861204**
Semester	**: II**
Duration	**: 2 Hours**
Maximum Marks	**: 40**

Instructions:

Attempt all questions. Parts of a question must be answered together.

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1. Answer the following questions: [5×2 Marks=10]

A. Why Java is called platform independent? What is the significance of bytecode?
B. Write the difference between "finally", "finalize ()" and "final" in Java.
C. What are the differences between "throw" and "throws" clause in exception handling?
D. Write the uses of "Super" Keyword in Java.
E. Why main method is defined as static in Java?

2. Answer the following questions: [5×4 Marks=20]

A. Write the output of following code segment:

```
class demo{
static void f(){
try{
int i=0;
int j=10/i;
}
finally{
System.out.println("Inside f() finally");
}
static void g(){
try{
int X[]={10};
X[10]=10;
return;
}
finally{
System.out.println("Inside g() finally");
}
static void h(){
try{ System.out.println("Hello");
}
finally{
System.out.println("Inside h() finally");
```

```
}
public static void main(String args[]){
try{
f();
g();
}
catch(Exception e) {
System.out.println("Caught");
}
h(); }
```

B. Write the output of following code segment:

```
class demo2{
public static void main(String args[]){
int i=-12;
int j=i>>2;
System.out.println(j);
i=j<<3;
System.out.println(i); }}
```

C. Consider the following code:

```
Package p1;
public class X{
int i;
public int j;
protected int k;
private int w;
}
Package p2;
public class Y{
....
..... }
```

Discuss the access rights of variables of class X in class Y.

D. What are command-line arguments in Java? Input a list of integers of n numbers and displays them in sorted order.

E. A class W implements two interfaces X & Y. What happens if

i) X & Y contains a method with the same name but different signature.

ii) X & Y contains the variables with same name.

3. Answer the following questions: [2×5 Marks=10]

A. Create a class TwoDim which contains x and y coordinates as int. Define the default constructor, parameterized constructor and void print () to print the coordinates. Now reuse this class in ThreeDim adding a new dimension as z of type int. Define the constructors for the subclass and override the method void print () in the subclass. Implement main () to show dynamic method dispatch.

B. Write a recursive method to compute the factorial of a given number.

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Examination	**: End Semester Examination – August 2022**
Name of the Course	**: B. Tech (Information Technology and Mathematical Innovations)**
Name of the Paper	**: Physics at work II:Deconstructing Devices**
Paper Code	**:32861205**
Semester	**: II**
Duration	**: 2 Hours**
Maximum Marks	**:40**

Instructions: Attempt <u>any four</u> questions out of six questions

1. (a) State and prove Gauss's law of electrostatics .Write it in differential form.
   (b) Determine the electric field intensity inside and outside an uniformly charged spherical shell. (5+5 =10)

2. (a) Derive Poisson's and Laplace's equations
   (b) What is an electric dipole ? Calculate potential and field due to an electric dipole at any point in space . (4+6=10)

3. (a) Define D,P and E and establish relationship between them.
   (b) Derive an expression for capacity of a parallel plate capacitor filled with dielectric. (5+5=10)

4. (a) Give the principle and working of a dc generator.
   (b) A coil of wire of certain radius has 600 turns and a self inductance of 108 mH. What will be the self inductance of second similar coil with 500 turns? (6+4=10)

5. Derive (a) Integral and Differential form of Faraday 's Law.
   (b) Mutual Inductance of Two Solenoids. (5+5=10)

6. (a) Write short notes on organic solar cells.
   (b) Mention five important achievements in the field of solar energy. (5+5=10)

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Examination	**: End Semester Examination –August 2022**
Name of the Course	**: B.Tech (IT&MI)**
Name of the Paper	**: Art of Communication and creative writing**
Paper Code	**: 32861206**
Semester	**: II**
Duration	**: 2 Hours**
Maximum Marks	**: 25**

Instructions:

This question paper contains six questions, out of which any five are to be attempted. Each question carries equal marks.

1. Describe two characteristics of composing a weblog and how to maintain a successful blog.
2. Briefly discuss on the structuring of a science report on IMRaD format.
3. Discuss the contribution of art of writing by the Sumerian civilization.
4. Describe the process, types and patterns of communication.
5. Describe the importance of literature review in scientific writing.
6. Describe different forms of communication through vlogging.

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Examination	**: End Semester Examination – August 2022**
Name of the Course	**: B. Tech (Information Technology and Mathematical Innovations)**
Name of the Paper	**: Business Processes and strategic IT alignment**
Paper Code	**: 32865201**
Semester	**: II**
Duration	**: 2 Hours**
Maximum Marks	**: 50**
Instructions	**: Answer any 4 questions of the following. All questions carry equal marks.**

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1. Discuss the business process of HR and marketing with examples.
2. Discuss the business process of stock market companies.
3. How will the Russia-Ukraine war affect the Indian currency with respect to other currencies? Discuss.
4. Suppose you are a businessman dealing in western wear clothes. How will demographic and cultural factors affect your business?
5. Discuss the concept of the 4 Ps. Explain the 4 Ps of Patanjali, in brief.
6. Discuss the evolution of the E-commerce market with the help of a relevant example.
