Stella Maris College(Autonomous), Chennai-600086

Department of Mathematics

End Semester Examination - November 2022

RESEARCH METHODS AND TOOLS

Code: 19MT/PC/RT34 Duration: 3 hours

Class: II M.Sc. Max. Marks: 100

THEORY:

Answer any TWO questions $(2 \times 10 = 20)$

1. What is research and brief about data collection for research.
2. Write in detail about data processing and data formatting.
3. List the characteristics of a good report.

PRACTICAL:

SECTION - A

Answer any TWO questions $(2 \times 20 = 40)$

1. (a) Type the following in Latex:

A Research on Ordinary Differential Equations and Operators: Analytical Approach

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Abstract

Ordinary differential equations assume an imperative part in the displaying of some true procedures. To ensure dependable outcomes, display plan and examination must record for uncertainty as well as variability in the model information.

Introduction

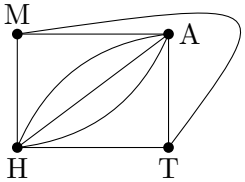
An ordinary differential equation can be composed in the form $L(y) = f(x)$, where $y(x)$ is an unidentified function. The *operator* L is linear if $L(y_1 + y_2) = L(y_1) + L(y_2)$. The general form of L is

$$L = P_N(x)\frac{d^N}{dx^N} + P_{N-1}\frac{d^{N-1}}{dx^{N-1}} + \ldots + P_1(x)\frac{d}{dx} + P_0(x)$$

Definition 1. The functions $y_1(x), y_2(x), \ldots, y_N(x)$ are said to be linearly independent when $C_1y_1(x) + C_2y_2(x) + \ldots + C_Ny_N(x) = 0$ only when $C_1 = C_2 = \ldots = C_N = 0$.

Lemma 1. Let F be locally Lipschitz continuous, then there exists $L \geq 0$ such that $|F(x) - F(y)| \leq L.|x - y|, \forall x, y \in B_k(x)$, where $B_k(x)$ signifies an open neighbourhood around x.

1. (b) Draw the following graph using tikz package:



1. (c) Using the \foreach command, draw the complete bipartite graph $K_{3,4}$ with the set of vertices $V = \{a_1, a_2, a_3\} \cup \{b_1, b_2, b_3, b_4\}$.

(10 + 5 + 5)

2. (a) Type the following document in Latex:
The linear system of algebraic equations

$$\begin{pmatrix} y_1 & y_2 & y_3 \\ y_1' & y_2' & y_3' \\ y_1'' & y_2'' & y_3'' \end{pmatrix} \begin{vmatrix} C_1 \\ C_2 \\ C_3 \end{vmatrix} = \begin{bmatrix} \phi(x) \\ \phi'(x) \\ \phi''(x) \end{bmatrix}$$

demonstrates linear autonomy of functions and the opposite in every case is genuine [**?**].
The probability density function of the probability distribution is

$$P[X_t \leq x] = \int_{-\infty}^{x} u_t(s)ds. \tag{1}$$

The objective is to solve the difficulty $\lim_{t\to-\infty} u(t) = x$, $\lim_{t\to+\infty} u(t) = y$. Given X_A a chance to be the way of operators satisfying the Cauchy's condition,

$$\begin{cases} X_A'(t) = A(t)X_A(t) \\ X_A(0) = I \end{cases}$$

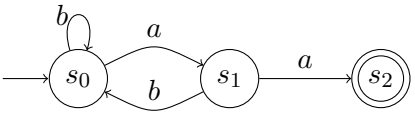
The trial particular solution for some functions are tabulated as follows:

$g(x)$	Form of y_p
$5x + 7$	$Ax + B$
$3x^2 - 2$	$Ax^2 + Bx + C$

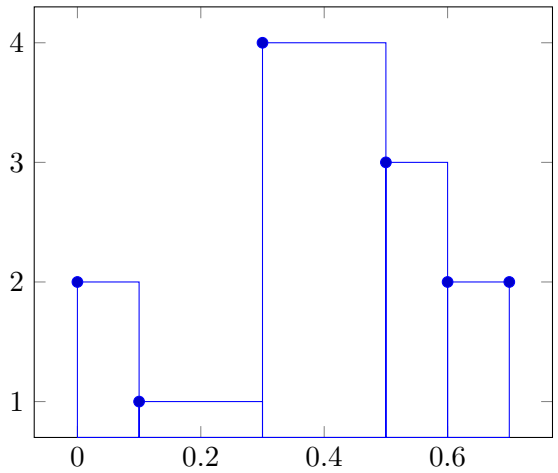
References

[1] Entisar and M. Darus, Some properties of differential operator associated with generalized hyper geometric functions, Volume 46, Issue 1, 2015, 75-83.

2. (b) Draw the following using tikz package in Latex:



2. (c) Create the following bar plot using pgfplots package:



(10 + 5 + 5)

3. (a) Create a presentation using beamer involving the below mentioned parts for the following document:
   - Title Page
   - Table of contents
   - Sections
   - Overlays

- Transition Effects
- Blocks
- columns
- Different themes

EVOLUTIONARY GRAPH THEORY
Paulo Shaikaro

Abstract

Evolutionary graph theory (EGT), studies the ability of a mutant gene to overtake a finite structured population. In this review, we describe the original framework for EGT and the major work that has followed it.

1 Introduction

Evolutionary graph theory (EGT), introduced by [**?**], studies the ability of a mutant gene to overtake a finite structured population. The reproduction of the individuals in the population is modeled and its structure is represented as a stochastic process.

2 Preliminaries

Definition 2. A *one-rooted* graph is a graph with a unique global source without incoming edges.

Definition 3. The single parameter that can be used to quantify the ability of a population structure is called cluster of strategies.

3 Main Results

Theorem 1. If $A_1, A_2, \ldots, A_r$ are a set of Latin squares of order m and $B_1, B_2, \ldots, B_r$ are a set of Latin squares of order m, then at least one ordered pair of the superimposed matrix occurs twice.

Theorem 2. Every partial assignment of a subgraph can be extended to a 3-colouring of the entire subgraph.

4 Conclusion

We have made a study on the evolutionary dynamics of a population with the help of Evolutionary Graph Theory.

References

[1] Van Leer B, Towards the ultimate conservative difference scheme, Journal of Computational Physics, Volume 14, 1974, 361-373.

3. (b) Create a stacked plot for the following categorical data representing the sale of different commodites (in thousands):

Store	Clothing	Equipment	Accessories	Food
Mall	1	1	3	2
Supermarket	1	1	3	2
Provisional Store	1	1	3	2

(15 + 5)

SECTION - B

Answer any TWO questions $(2 \times 20 = 40)$

4. (a) Write a MATLAB program to obtain the input from a specific state in terms of its agricultural production of wheat year wise on a scale of 0 - 100 over a period of 5 years and then calculate the following:
   (i) the year in which the wheat was the highest
   (ii) average production of wheat over the 5 years
   (iii) year(s) in which the production was below average

4. (b) Plot the functions $y = 12 - x^2$ and $y = 4x$ in the same figure using different colors in MATLAB and label the information of the curves. Further, if there is an intersection, plot the intersecting points with a different color.

4. (c) Write a MATLAB program to receive an integer and test whether it is divisible by 3. The program has to return YES if it is a number divisible by 3 and NO if it is a number not divisible by 3.

(10 + 6 + 4)

5. (a) After receiving a 3×3 matrix as a input from the user, write a MATLAB program to compute the following:
   (i) Row sum of the second row
   (ii) Sum of all elements of the matrix
   (iii) Trace of the matrix
   (iv) Eigenvalues of the matrix
   (v) Determinant of the matrix

5. (b) Draw a bar graph for the number of students who dropped out of school in different states of Tamil Nadu in the year 2016 using MATLAB:

Villupuram	Coimbatore	Krishnagiri	Chennai	Vellore	Kancheepuram
2472	2203	2073	1821	1801	1782

5. (c) Plot the surface curve $< 2cos\theta, 2sin\theta, 1 >, 0 \leq \theta \leq \frac{\pi}{2}$ in MATLAB.

(10 + 6 + 4)

6. (a) Write a MATLAB program to obtain a fifth degree polynomial as an input from the user and calculate its second derivative and integral value at 5.

6. (b) Solve the following system of linear equations in MATLAB with the help of matrices:

$$x + 2y - z + w = 6$$
$$-x + y + 2z - w = 3$$
$$2x - y + 2z + 2w = 14$$
$$x + y - z + 2w = 8$$

6. (c) Draw a pie chart with centre at $\{0, 0\}$, radius 5 cm to represent the gender distribution of the students in a class containing 22 boys and 18 girls. Also, label the areas and colour the area representing boys as blue and the area representing girls as green.

(7 + 7 + 6)

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